APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

BARBER LAW FIRM

ATTORNEYS AT LAW

Suite 3400
425 West Capitol Avenue
Little Rock, Arkansas 72201

P 501.372.6175
F 501.375.2802

www.barberlawfirm.com

LARRY E. CHISENHAL
DIRECT 501.687.1441
lchisenhall@barberlawfirm.

May 1, 2018

Ms. Mary Loos
Arkansas Public Service Commission
1000 Center Street
Little Rock, Arkansas 72201

Re: Docket No. 07-078-TF
Black Hills Energy Arkansas, Inc.

Dear Ms. Loos:

Enclosed for filing in the above-referenced docket is Black Hills Energy Arkansas, Inc.'s (f/k/a SourceGas Arkansas Inc.) Energy Efficiency Program Portfolio Annual Report for the program year 2017. The Report is comprised of both a narrative report and an electronic spreadsheet.

Please contact me at lchisenhall@barberlawfirm.com at (501) 372-6175 if you have any questions.

Yours Very Truly,

BARBER LAW FIRM

Lawrence E. Chisenhall, Jr.
Attorney

Encl.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

BEFORE THE

ARKANSAS PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE APPLICATION	**)**	
FOR APPROVAL OF ARKANSAS	**)**	**Docket No. 07-078-TF**
WESTERN GAS COMPANY'S INITIAL	**)**	
ENERGY EFFICIENCY PROGRAM PLAN	**)**	

Comprehensive Energy Efficiency Plan

Program Year 2017

Annual Report

Black Hills Energy

May 1, 2018

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table of Contents

1.0 EXECUTIVE SUMMARY 4
1.1 Historical Summary of the Comprehensive Energy Efficiency Plan 4
1.2 Program Year 2017 Results 5
1.2.1 Major Accomplishments 5
1.2.2 Goals and Objectives for EE Portfolio: 5
1.2.3 Progress Achieved vs. Goals and Objectives: 6
1.2.4 High Level Recap of Portfolio Savings, Participation Levels, and Prior Year Comparisons 6
1.2.5 Highlights of Well-Performing Programs: 8
1.2.6 What's Working and What's Not 9
1.2.7 Planned Changes to Programs or Budgets 9
1.2.8 Estimation of EE Resource Potential 9
1.2.9 Training 10
1.2.10 Conclusion 10
2.0 PORTFOLIO PROGRAMS 11
2.1 Equipment Rebate Program 11
2.1.1 Program Description 11
2.1.2 Program Highlights 11
2.1.3 Program Budget, Savings, and Participants 12
2.1.4 Description of Participants 12
2.1.5 Challenges & Opportunities 12
2.1.6 Planned or Proposed Changes to Program & Budget 12
2.1.7 BHEA's Response to Evaluators' Recommendations 13
2.2 Home Energy Savings Program 14
2.2.1 Program Description 14
2.2.2 Program Highlights 14
2.2.3 Program Budget, Savings, and Participants 16
2.2.4 Description of Participants 16
2.2.5 Challenges & Opportunities 16
2.2.6 Planned or Proposed Changes to Program & Budget 16

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.2.7 BHEA's Response to Evaluators' Recommendations 17
2.3 Commercial & Industrial Solutions Program 18
2.3.1 Program Description 18
2.3.2 Program Highlights 18
2.3.3 Program Budget, Savings, and Participants 19
2.3.4 Description of Participants 19
2.3.5 Challenges & Opportunities 20
2.3.6 Planned or Proposed Changes to Program & Budget 20
2.3.7 BHEA's Response to Evaluators' Recommendations 20
2.4 Energy Efficiency Arkansas 21
2.4.1 Program Description 21
2.4.2 Program Highlights 21
2.4.3 Program Budget, Savings, and Participants 21
2.4.4 Description of Participants 21
2.4.5 Challenges & Opportunities 22
2.4.6 Planned or Proposed Changes to Program & Budget 22
3.0 SUPPLEMENTAL REQUIREMENTS 23
3.1 Staffing 23
3.2 Stakeholder Activities 23
3.3 Information Provided to Consumers to Promote EE 24

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

1.0 Executive Summary

1.1 Historical Summary of the Comprehensive Energy Efficiency Plan

This annual report is provided to the Arkansas Public Service Commission ("APSC" or the "Commission") as a review of Black Hills Energy Arkansas, Inc.'s (f/k/a SourceGas Arkansas, Inc., f/k/a Arkansas Western Gas Company), ("BHEA" or the "Company") Comprehensive Energy Efficiency Plan ("CEEP") for Program Year 2017 and plan results pursuant to Section 9 of the "Rules for Conservation and Energy Efficiency Programs ("C&EE Rules"). These rules require that each operating utility within the jurisdiction of the Commission file an Annual Report by May 1st of each year. The report should address "the performance of each conservation and energy efficiency program operated by the utility."[1]

BHEA's CEEP came into being on June 30, 2011, when it was approved by the APSC in Order No. 25 in Docket No. 07-078-TF. At that time it had a planned end date of December 31, 2013. However, by Order No. 2 in Docket No. 13-002-U, BHEA's Program Year ("PY") 2013 goals and budget were extended through PY 2014. Order No. 15 of Docket 13-002-U extended PY 2014 budgets and incentive structure through December 31, 2015 while increasing BHEA's energy efficiency ("EE") savings target baseline to 0.50% of 2013 retail sales, as adjusted for the sales of Self-Direct customers. Order No. 62 of Docket 07-078-TF allowed the Company to reallocate incentive funds from the Arkansas Weatherization Program ("AWP") to its Home Energy Savings Program ("HESP") for 2015 as well. Order No. 25 of Docket 13-002-U extended PY 2015 targets and budgets for PY 2016. Order No. 64 of Docket 07-078-TF approved the modified plan for PY 2016 as filed by BHEA. Order No. 68 of the same docket approved BHEA's CEEP for Program Years 2017 – 2019.

To evaluate and measure the individual program results, BHEA uses APSC-approved deemed savings. The deemed savings are defined by the Arkansas Technical Reference Manual ("TRM") Version 6.1, approved by Order No. 25 in Docket No. 10-100-R. TRM Version 1.0 was originally approved by Order No. 9 in Docket No. 07-152-TF. In order to insure energy savings are being accurately reported, BHEA, CenterPoint Energy Resources Corp. d/b/a CenterPoint Energy Arkansas Gas ("CenterPoint"), and Arkansas Oklahoma Gas Corporation ("AOG") have engaged a third party Evaluation Measurement and Verification ("EM&V") contractor, ADM Associates, Inc. ("ADM"), to evaluate their CEEPs for PY 2011 through 2019. Beginning in PY 2016, Southwestern Electric Power Company (SWEPCO) has also engaged ADM.

[1] Section 9, Page 11 of the APSC Rules for Conservation and Energy Efficiency

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

1.2 Program Year 2017 Results

1.2.1 Major Accomplishments

For the sixth consecutive year, the Company achieved greater than 100% of its net savings goal as established by the APSC, realizing 1,261,851 net therms for PY 2017. The Company's 2017 filed savings goal was 1,180,976 net therms and was designed to provide savings great enough to meet or exceed the APSC-established net goal for the Company of 1,095,350. This net goal was derived by calculating 0.50% of BHEA's 2015 retail sales (249,382,063 therms), as adjusted for the 2015 sales of Self-Direct customers (30,312,160 therms). In the end, BHEA's total evaluated net energy savings for 2017 was 115% of the Company's net Commission-established goal. In addition, BHEA's portfolio was cost-effective, with a Total Resource Cost Benefit Ratio ("TRC") of 2.71.

2017 Portfolio Summary										
Net Energy Savings		Costs			Cost-Effectiveness			Goal Achievement		
Demand Therms	Energy Therms	Actual Expenditures	LCFC	Performance Incentives	TRC Net Benefits (NPV)	TRC Ratio	PAC Ratio	Commission Established Target % of Baseline	Actual Savings Achieved % of Baseline	% of Target Achieved (%)
n/a	1,261,851	$ 3,319,247	$ 344,664	$ 263,470	$ 5,634,023	2.71	2.33	0.50%	0.58%	115%

Figure 1 – 2017 EE Portfolio Summary

1.2.2 Goals and Objectives for EE Portfolio:

BHEA's primary goals and objectives are to provide energy savings opportunities to its customers of all rate classes and market segments. BHEA strives to meet and exceed its energy savings goal established by the APSC.

The Company has worked to achieve the following objectives in PY 2017:

<u>Commercial & Industrial Solution ("C&I Solutions") Program:</u>

- Continue evaluating, and, when possible, adding new measures for Commercial & Industrial ("C&I") customers
- Continue to offer Direct Installation ("DI") of measures as a gateway to further participation in BHEA's C&I Program
- Continue to strive to facilitate inter-fuel coordination of projects with SWEPCO and Entergy Arkansas, Inc. ("EAI"), Oklahoma Gas and Electric Company ("OG&E"), and Empire District Electric Company ("Empire") ("participating electric utilities")

<u>Residential Programs:</u>

- Facilitate meetings to keep trade allies updated on changes to residential programs

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Incorporate the United States Department of Energy's Home Performance with ENERY STAR Program ("HPwES") into BHEA's Home Energy Solutions Program ("HESP")
- Continue the successful inter-fuel promotion of HESP and programs offered by SWEPCO and EAI

The Company also worked to present all marketing materials on the website www.ExcessIsOut-Arkansas.com Examples are provided in Appendix B.

BHEA's portfolio of programs continues to seek adherence to the energy efficiency objectives listed in Section 2 of the Commission's C&EE Rules by:

- Reducing end-use natural gas consumption in a cost-effective manner to save money for consumers and conserve non-renewable resources;
- Protecting the environment by encouraging installation of energy efficiency measures that help reduce carbon dioxide emissions and air pollutants;
- Increasing residential and commercial customer awareness of available energy efficiency opportunities, including equipment upgrades and behavioral changes;
- Generating customer awareness of energy efficiency programs through the Excess is Out campaign to support energy efficiency objectives;
- Identifying cost-effective natural gas savings measures;
- Improving relationships with customers, trade allies, and stakeholders by providing value-added energy efficiency services, training and education, hardware, verification, and support; and
- Supporting a more robust local and statewide economy by using local labor (when possible), and helping Arkansas residents reduce their monthly energy expenses.

1.2.3 Progress Achieved vs. Goals and Objectives:

The APSC savings goal for a gas utility in 2017 was the realization of a 0.50% reduction from the utility's 2015 baseline throughput (249,382,063 CCF), excluding volumes used by Self Direct customers (30,312,160 CCF). This represented a savings goal for BHEA of 1,095,350 net therms. The Company achieved 115% of this goal, and therefore qualifies for an incentive of $263,470 according to APSC Docket 13-002-U, Order No. 7.

1.2.4 High Level Recap of Portfolio Savings, Participation Levels, and Prior Year Comparisons

The chart below details the upward trend of BHEA's budgets, expenses, and energy savings beginning with PY 2013 and continuing through PY 2017. BHEA did experience a spike in savings in 2013 due to the overwhelming success of BHEA's C&I program. When funds for certain, more popular programs ran low, the Company used the budget flexibility granted by the APSC to shift dollars between programs, allowing for the achievement of additional savings, rather than restricting customers from participating in popular programs. In PYs

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2014, 2015, and 2016 and 2017 customer participation was more in line with planned savings.

Company Statistics

Program Year	Revenue and Expenditures					Energy				
		Budget		Actual			Plan		Evaluated	
	Total Revenue (a) ($000's)	Portfolio Budget (b) ($000's)	% of Revenue (%=b/a)	Portfolio Spending (c) ($000's)	% of Revenue (%=c/a)	Total Annual Energy Sales (d) (Therms)	Net Annual Savings (e) (Therms)	% of Energy Sales (%=e/d)	Net Annual Savings (f) (Therms)	% of Energy Sales (%=f/d)
2013	$ 142,929	$ 2,204	1.5%	$ 1,780	1.2%	260,638,176	1,303,990	0.50%	1,544,913	0.59%
2014	$ 158,491	$ 3,171	2.0%	$ 2,718	1.7%	275,605,281	1,003,050	0.36%	1,138,776	0.41%
2015	$ 151,268	$ 3,886	2.6%	$ 3,515	2.3%	245,166,884	1,256,556	0.51%	1,417,271	0.58%
2016	$ 137,007	$ 4,123	3.0%	$ 3,862	2.8%	239,218,521	1,262,068	0.53%	1,540,466	0.64%
2017	$ 153,343	$ 3,513	2.3%	$ 3,319	2.2%	193,520,336	1,180,352	0.61%	1,261,851	0.65%

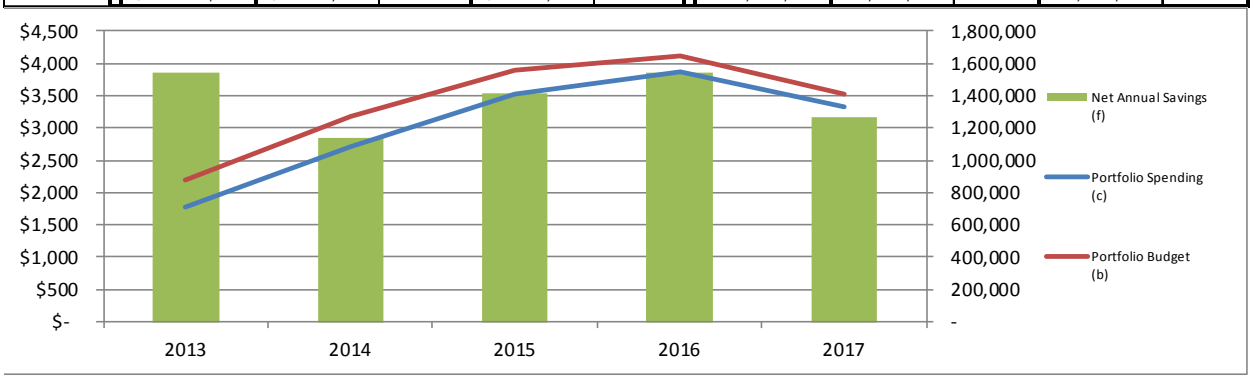


Figure 2 – Company Statistics for Program Years 2013 - 2017

BHEA spent 95% of its budget in 2017, as Figures 3 and 4 show below. The majority of dollars the Company spent went to Customer Incentives and Marketing and Delivery.

EE Portfolio Expenditures by Program

Program Name	Target Sector	Program Type	2017 Budget ($)	2017 Actual ($)	% of Budget
Commercial & Industrial Solutions Program	Residential	Custom	1,374,482	1,331,689	97%
Home Energy Savings Program	Residential	Whole Home	1,502,615	1,500,570	100%
Equipment Rebate Program	All Classes	Consumer Product Rebate	558,737	435,696	78%
Energy Efficiency Arkansas	All Classes	Behavior/Education	52,096	49,182	94%
Regulatory	-	-	25,000	2,109	8%
		Total	**3,512,930**	**3,319,247**	**94%**

Figure 3 – BHEA's 2017 EE Portfolio Costs by Program

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

EE Portfolio Expenditure Summary by Cost Type				
	2017 Total Expenditures			
Cost Type	% of Total	Budget ($)	Actual ($)	% of Total
Planning / Design	2%	58,481	61,857	2%
Marketing & Delivery	41%	1,450,462	1,452,975	44%
Incentives / Direct Install Costs	46%	1,629,568	1,526,793	46%
EM&V	4%	145,651	121,160	4%
Administration	6%	203,768	154,353	5%
Regulatory	1%	25,000	2,109	0%
	100%	**3,512,930**	**3,319,247**	100%

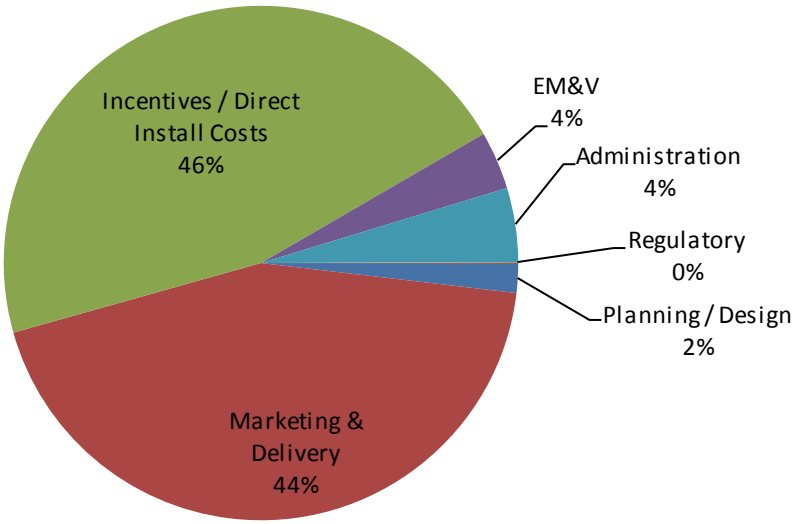


Figure 4 – BHEA's 2017 EE Portfolio Summary by Cost Type

1.2.5 Highlights of Well-Performing Programs:

While BHEA was encouraged by the performance of its CEEP as a whole, certain programs did perform at higher levels than others. Top performing programs are as follows:

Commercial & Industrial Solutions Program

BHEA had 22 C&I customers participate by installing Energy Conservation Measures ("ECM") in 2017 through C&I Solutions. This represented total net savings of 658,017 therms. New this year, BHEA piloted two new savings measures. Three hotel locations installed five pump controls on their hot water systems, netting 1,531 therms. Four hotels also installed nine Dry Smart systems in their laundry facilities, netting savings of 10,053 therms. Energy efficient aerators, pre-rinse spray valves, showerheads, and weather stripping were installed for commercial applications at no charge to customers. Net savings

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

for these direct install measures were 55,310 therms. Ultimately, this program provided savings of 713,327 net therms or 100% of the goal.

Equipment Rebate Program

The BHEA Equipment Rebate Program ("ERP") provided rebates to 693 participants during 2017. By September 30, 2017, rebate dollars for residential tankless water heaters had been exhausted. Smart thermostats were also included for the first time in 2017. BHEA experienced net savings from this program of 73,840 therms. While participation was strong, the program suffered from lower Net-To-Gross Ratios and fewer early replacements.

Home Energy Savings Program

BHEA engaged six contractors that performed 810 Assessments across its service territory. 2,056 coupons were paid to contractors for work done in customers' homes. A total net savings of 474,684 therms was achieved versus a net savings goal for HESP of 379,880 therms.

1.2.6 What's Working and What's Not

BHEA's ERP results were mixed this year. In 2017, BHEA restricted rebates to one furnace and one water heater per customer account. The Company was able to continue rebating furnaces thru the end of the year, but was unable to hit participation or savings goals. Tankless water heaters were once again fully subscribed by the end of September.

The HESP customer experience with this program has been very positive. Sixty-three percent of homes weatherized were done in conjunction with other participating utilities.

C&I Solutions continues to be a strong program, however, the Company is beginning to see a reduction in the number of large savings projects that typically come from manufacturing facilities. BHEA believes this reduction is due to participating customers completing the major projects that have been recommended as well as additional customers choosing to self-direct their EE efforts.

1.2.7 Planned Changes to Programs or Budgets

Planned changes to programs or budgets are detailed in program specific comments.

BHEA continues to appreciate the budget flexibility granted to the Company by the APSC.

1.2.8 Estimation of EE Resource Potential

In 2015, the Arkansas Parties Working Collaboratively ("PWC") completed and filed the results of the potential study that had been commissioned in 2015 and was performed by Navigant Consulting Group. The findings were approved by Order No. 31 in Docket 13-002-U.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

1.2.9 Training

In 2017, BHEA and its implementation staff provided training to customers, trade allies, and employees of the Company, as well as continued training for the program administrator. Details of training achievements for 2017 are reported in the training sections of the Standardized Annual Report Packet ("SARP") Workbook.

- Members of the implementation staff participated in training opportunities by attending training provided by the Association of Energy Services Professionals ("AESP"), Arkansas Chapter of The Association of Energy Engineers ("AAEE"), as well as Arkansas Manufacturing Solutions ("AMS").
- The BHEA program administrator attended trainings to increase knowledge in marketing energy efficiency, how to incorporate new technology, and in evaluation methods. These conferences included ones held by AESP, AAEE, and AMS.

1.2.10 Conclusion

BHEA's success in 2017 has been due to intensive focus on increasing customer awareness of available programs through the implementation efforts provided by CLEAResult and BHEA. The Company spent 95% of its allotted Budget Dollars and achieved 115% of its APSC established goal for the 2017 Program Year. BHEA's portfolio performance qualified the Company to receive an EE incentive for the 2017 Program Year.

BHEA CEEP saw a portfolio TRC of 2.17 for 2017.

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.0 Portfolio Programs

2.1 Equipment Rebate Program

2.1.1 Program Description

BHEA's ERP promotes high efficiency natural gas comfort heating equipment and tankless water heating equipment in new and existing homes and businesses. This program is available to all residential and non-residential customers. Both residential and commercial new construction installations are eligible. Customers must use natural gas as their primary heating fuel to receive a furnace rebate. Potential customers who have made a commitment to take natural gas service from BHEA as the primary heating fuel are also eligible for furnace rebates.

BHEA provides a financial incentive in the form of prescriptive rebates to customers who purchase and install qualifying comfort heating and water heating measures. After purchasing and installing new equipment, customers may fill out rebate forms with detailed information about the purchase and installation and mail them in, or the rebate forms may be completed online at www.ExcessIsOut-Arkansas.com. Customers may expect their rebate checks in four to eight weeks. Trade allies are given a $50 rebate for each installation to help them recover costs incurred when helping customers fill out the rebate forms.

2017 was the first year that the Company offered incentives on the purchase of smart thermostats. Through an email, selected customers were able to receive a code allowing them to purchase ecobee 4 thermostats at a reduced cost directly from ecobee. 130 thermostats were rebated.

2.1.2 Program Highlights

- Furnace rebates were available to customers thru December 31, 2017.
- Water heater rebates were only available thru September 31, 2017.
- A total of 693 rebates were paid through ERP in 2017.
    - 382 Residential furnaces with 95% AFUE or greater;
    - 87 Commercial furnace with 95% AFUE or greater.
    - 78 Residential water heaters were rebated
    - 16 Commercial water heaters were rebated
    - 130 Smart thermostats were rebated
- Net therm savings of 73,840 therms were achieved.
- The TRC for ERP was 1.19 for 2017.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.1.3 Program Budget, Savings, and Participants

Equipment Rebate Program

	Expenditures			Energy Savings (Therms)			Demand Savings (Therms)			Participants		
Program	**Budget**	**Actual**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Actual**	**%**
Program Year 2015	$ 833,179	$ 704,466	85%	83,677	118,003	141%	n/a	n/a	-	1,567	1,764	113%
Program Year 2016	$ 718,375	$ 704,518	98%	91,991	114,778	125%	n/a	n/a	-	1,461	870	60%
Program Year 2017	**$ 558,737**	**$ 435,696**	**78%**	**87,322**	**73,840**	**85%**	**n/a**	**n/a**	**-**	**1,461**	**693**	**47%**

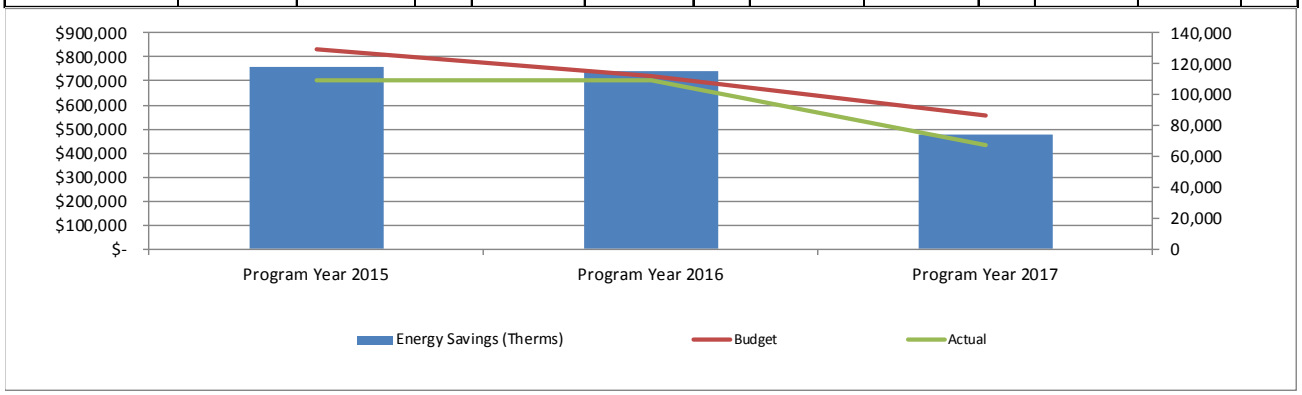


Figure 5 – 2017 Heating Equipment Rebate Program Trends

2.1.4 Description of Participants

- Each piece of equipment being rebated is defined as a participant.

2.1.5 Challenges & Opportunities

- The number of participating contractors who had not previously participated in the program has increased through efforts to directly contact trade allies and provide them with information about BHEA program offerings.
- BHEA will continue to have face-to-face meetings with builders to increase new construction participation.
- Net-to-gross ratios were reassessed by ADM during 2017. These values were reduced for all measures particularly for custom new construction installations.
- In PY 2017, BHEA began the process for offering conservation kits to its customers but due to delays in fulfillment by its vendor, the decision to defer the kits savings and costs into 2018 was made, thus reducing the participation and savings levels for 2017.

2.1.6 Planned or Proposed Changes to Program & Budget

- BHEA will continue to update and revise the program to incorporate new technology and equipment.
- A mail in rebate for smart thermostats will be implemented during 2018.
- No changes are planned for 2018 from the APSC approved budgets. However, the Company may, at its discretion, make budget shifts within the Commission's budget

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

flexibility guidelines to assist stronger performing programs. BHEA plans to only make any such shift in funds and savings from programs that are not expected to need the full amount of the approved budget.

2.1.7 BHEA's Response to Evaluators' Recommendations

- **Maintain year-round offering of smart thermostat rebates.** The program provided a rebate offer for ecobee smart thermostats in August, producing significant Therms savings in a short period of time. This should be maintained as a year-round program offering.
    - BHEA will be instituting a mail in rebate for at least ecobee and Nest thermostats in 2018. We limited the program to ecobee in 2017 to allow us to know when the thermostat had been connected to a home's wireless network. BHEA was notified by ecobee when the thermostats were activated, thus verifying that the unit was indeed installed.
- **Expand eligibility list.** Elsewhere in Arkansas, there is a larger eligibility list that includes the Nest Learning Thermostat and the Honeywell Lyric. Expanding the allowed brands should increase program participation and savings.
    - BHEA will be addressing adding more thermostats to include more brands.
- **Focus new construction outreach on production models rather than custom builds.** This segment has a higher NTGR and could produce more cost-effective savings due to larger participant volume.
    - In BHEA's service territory, having natural gas in a home tends to be seen more in non-starter homes, which are many times custom builds. BHEA continues to work with mass market builders to off natural gas packages in starter homes.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.2 Home Energy Savings Program

2.2.1 Program Description

BHEA's HESP began to offer comprehensive residential energy efficiency audits on a limited basis in November of 2013. This program was added to the Company's portfolio in order to offer qualifying BHEA residential customers an EE program that will provide them with lasting energy savings benefits and increased home comfort. Building on the solid base established in prior years, this program was fully subscribed in 2017 and was able to produce savings to overcome the deficit in the ERP.

HESP is designed to fulfill the requirements established by the APSC in Docket 13-002-U, Order Nos. 22 and 23. These orders instructed the Investor Owned Utilities ("IOUs") – BHEA, SWEPCO, EAI, CenterPoint, AOG, OG&E, and Empire – to design and implement a Consistent Weatherization Approach beginning in 2016. The goal of the Commission was to provide consistent weatherization programs to all residential customers in the state of Arkansas served by the IOUs.

Through this program, BHEA residential customers are connected with trained service providers (trade allies) that perform a comprehensive home energy assessment, install EE weatherization measures designed to save energy, improve indoor comfort, air quality, and safety in existing residences. The assessment and many building envelop measures are provided to customers at no charge. BHEA trade allies are currently providing duct sealing, air infiltration measures, insulation, combustion safety checks, and with customer approval, installation of energy efficient aerators and showerheads.

The Company continued its association with the Home Performance with Energy Star Program ("HPwES") in 2017. HPwES is a program backed by the Department of Energy and Environmental Protection Agency that promotes a "whole-house" approach to each home being assessed that begins with a comprehensive home energy assessment. As most of the joint homes being weatherized by BHEA are also SWEPCO customers, the move to become an HPwES partner has been under consideration for some time. ADM has also recommended the partnership in their evaluation reports in years past. SWEPCO has been an HPwES partner for some time and has, in fact, received the ENERGY STAR Partner of the Year for the fourth consecutive year in 2017. BHEA also applied for the award in 2017, but was not selected.

2.2.2 Program Highlights

- In PY 2017, the HESP achieved 125% of its revised plan savings goal with a net savings of 474,684 therms.
- As the demand for services continues to be great, BHEA elected to expand the incentive dollar pool within the existing HESP budget and weatherize more homes than anticipated during 2017. BHEA almost always has a waiting list for program

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

services, especially for gas only homes, so trade allies were given the authorization to perform more weatherizations toward the end of the year.

- Trade allies working within this program must meet minimum certification requirements (Business Performance Institute or Residential Energy Service Network) as well as undergo BHEA specific program training.
- In conjunction with SWEPCO, training opportunities for trade allies was provided.
- To reduce customer inconvenience, quality assurance and quality control visits were coordinated with other utilities.
- BHEA's contractors are providing weatherization services for the amount of the rebates.
- The Company continued the use of an allotment system to increase trade ally consistency and performance along with prolonging program availability.
- In homes where the electric provider is not an IOU, BHEA pays the full cost of the audit as well as the installation of energy saving measures.
- 2017 results were as follows:
    - 810 energy assessments were performed
        - 295 were BHEA only homes
        - 469 were joint homes with SWEPCO
        - 46 were joint homes with EAI
    - 831 heating systems had duct sealing done. (Some homes being weatherized had multiple heating systems)
    - 765 homes had air infiltration measures done
    - 258 homes received insulation
    - 120 showerheads were installed
    - 82 aerators were installed
- The assessment to action conversion rate for 2017 was 99%. This is an increase over 2015's value of 98.5% and 2016's 98.3%. The success in this metric is a product of the trade allies performing the weatherizations in conjunction with the assessments. Customers are not required to schedule a time for trade allies to return to perform the measures.
- Upon completion of the assessment and weatherization, customers are provided with a report of what has been done along with material on other EE programs offered by BHEA.
- The TRC ratio for HESP in 2017 was 3.55.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.2.3 Program Budget, Savings, and Participants

Home Energy Savings Program

	Expenditures			Energy Savings (Therms)			Demand Savings (Therms)			Participants		
Program	**Budget**	**Actual**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Actual**	**%**
Program Year 2015	$ 1,256,736	$ 1,165,130	93%	342,239	487,668	142%	n/a	n/a	-	1,027	5,583	544%
Program Year 2016	$ 1,529,639	$ 1,474,417	96%	371,622	574,107	154%	n/a	n/a	-	1,591	3,467	218%
Program Year 2017	**$ 1,502,615**	**$ 1,500,570**	**100%**	**379,880**	**474,684**	**125%**	**n/a**	**n/a**	**-**	**1,591**	**2,866**	**180%**

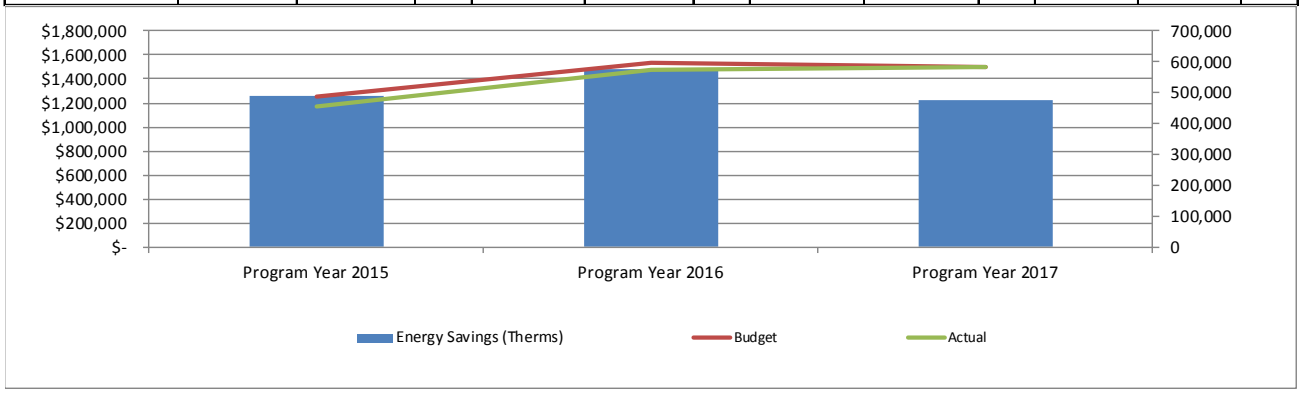


Figure 6 – 2017 Home Energy Savings Program Trends

2.2.4 Description of Participants

- A Participant of BHEA's HESP represents an incentivized measure, including assessments.

2.2.5 Challenges & Opportunities

- BHEA's primary challenge is to strike a balance between customers wanting to participate and the funds available to provide services, particularly on assessments performed on BHEA only homes.
- Since this is the only BHEA program that requires trade allies to be registered and trained to participate, recruiting and training trade allies is critical.
- Net-to-gross ratios were reassessed by ADM during 2017. These values were reduced for all measures.

2.2.6 Planned or Proposed Changes to Program & Budget

- BHEA will continue to update and revise the program to incorporate new technology and equipment.
- No changes are planned for 2018 from the APSC approved budgets. However, the Company may, at its discretion, make budget shifts within the Commission's budget flexibility guidelines to assist stronger performing programs. BHEA plans to only make any such shift in funds and savings from programs that are not expected to utilize the approved budget.

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.2.7 BHEA's Response to Evaluators' Recommendations

- **Consider outreach to public housing.** Public housing authorities continue to participate in other BHE programs but there was no participation from these groups in the HESP in 2017.
    - To this point in the program's history a short waiting list has always been in place. All of our trade allies market their services to customers, and BHEA has let the program continue to move forward with that parameter. BHEA will talk with some of the public housing authorities as opportunities arise.

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.3 Commercial & Industrial Solutions Program

2.3.1 Program Description

This program is available to all BHEA C&I customers, both existing facilities and new construction where natural gas is the primary heating/water heating/process fuel, or where the potential customer has made a commitment to take natural gas from BHEA as its primary heating/water heating/process fuel. BHEA provides financial incentives to encourage installation of energy efficient measures.

The C&I Solutions Program promotes cost effective natural gas energy savings through energy efficiency. It is a threefold program that gives C&I customers the opportunity to save on their natural gas usage. The program provides for the direct installation of water aerators, low flow showerheads, pre-rinse spray valves, and weather stripping at no cost to customers. Prescriptive rebates for comfort heating boiler equipment, boiler component installations and replacements, as well as qualifying Energy Star commercial cooking equipment are available. Custom incentives for customer specific measures are also available.

The calculation of savings for C&I Solutions may be determined through the use of TRM V6.1 or through custom Measurement and Verification. This process employs point of use metering of natural gas both prior to and subsequent to measure installation.

The custom part of C&I Solutions is highly dependent on frequent customer contact by BHEA's implementers, trade allies, and BHEA account managers. Budget cycles can be long and getting EE projects approved difficult. Facility audits are done by the Company's implementers and are presented to the customer. Follow up is necessary to keep the customer thinking about the potential for natural gas savings and reductions in process, maintenance, and facility costs. Continued contact with potential customers is facilitated through phone calls, invitations to energy efficiency learning opportunities, along with additional site visits.

2.3.2 Program Highlights

- BHEA's C&I Solutions Program was available to all C&I customers in 2017, except those electing to self-direct their energy savings.
- In PY 2017, C&I Solutions achieved 100% of its revised plan savings goal with a net savings of 713,327 therms.
- Savings were distributed as follows:
    - Custom
        - 12 customers and 28 projects
        - Savings of 642,801 therms
    - Dry Smart Laundry Controls
        - 4 customers
        - Savings of 10,053 therms

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Hot Water Pump Controls
  - 3 customers
  - Savings of 1,531 therms
- Comfort Heating Boilers
  - 2 customers and 3 boilers
  - Savings of 3,631 therms
- Commercial Cooking Equipment
  - 1 customers and 4 pieces of equipment
  - Savings of 1,382
- Direct Install
  - 47 customers
  - 150 aerators
  - 215 showerheads
  - 15 pre-rinse spray valves
  - 5355 feet of weather stripping
  - 2,964,007 gallons of water saved
  - Savings of 92,686 therms

- The TRC for C&I Solutions was 2.23 for 2017.

2.3.3 Program Budget, Savings, and Participants

Commercial & Industrial Solutions Program

	Expenditures			Energy Savings (Therms)			Demand Savings (Therms)			Participants		
Program	**Budget**	**Actual**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Actual**	**%**
Program Year 2015	$ 1,671,526	$ 1,582,469	95%	776,630	811,600	105%	n/a	n/a	-	800	386	48%
Program Year 2016	$ 1,780,824	$ 1,626,576	91%	798,455	851,581	107%	n/a	n/a	-	3,044	3,810	125%
Program Year 2017	**$ 1,374,482**	**$ 1,331,689**	**97%**	**713,150**	**713,327**	**100%**	**n/a**	**n/a**	**-**	**3,044**	**620**	**20%**

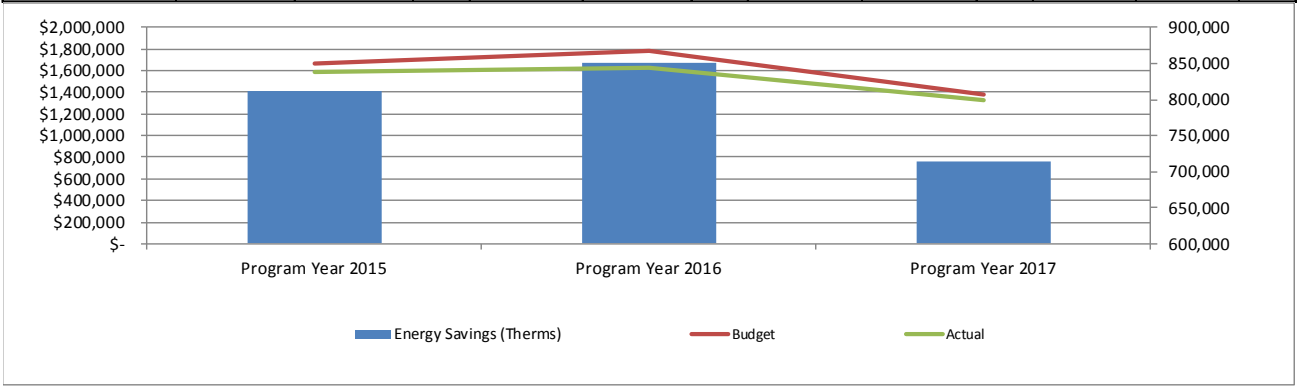


Figure 7 – 2017 Commercial & Industrial Solutions Program Trends

2.3.4 Description of Participants

- A Participant of BHEA's C&I Solutions is defined as any measure installed.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.3.5 Challenges & Opportunities

- BHEA's primary challenge in this program is assisting CLEAResult in finding opportunities for custom projects. A large capital investment by customers can be required to participate in this program.
- BHEA employs a Commercial and Industrial Account Manager to promote the Company's EE Portfolio at customer meetings and outside events. The account manager works with CLEAResult to provide contacts for follow up.

2.3.6 Planned or Proposed Changes to Program & Budget

- BHEA will continue to update and revise the program to incorporate new technology and equipment.
- In 2018, incentive levels for custom projects are being reduced to $0.75 per therm saved annually.
- No changes are planned for 2018 from the APSC-approved budgets. However, the Company may, at its discretion, make budget shifts within the Commission's budget flexibility guidelines to assist stronger performing programs. BHEA plans to only make any such shift in funds and savings from programs that are not expected to need the full amount of the approved budget.

2.3.7 BHEA's Response to Evaluators' Recommendations

- **Work to expand the steam trap initiative with laundry facilities into a "comprehensive maintenance/optimization" offering.** This would include steam trap replacement, steam line insulation, leak repair, and boiler tune-up.
    - BHEA will evaluate this for inclusion but probably not until the next 3 year filing.
- **Work with the Evaluators and the IEM to develop interim partially-deemed protocols for non-TRM measures in the maintenance package.** Some of the measures identified for the maintenance package do not have TRM values. However, they have consistently evaluated well, with no projects in the last three years of implementation having a realization rate below 90% for any of the three Arkansas gas utilities.
    - BHEA will work with the Evaluators and IEM.

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.4 Energy Efficiency Arkansas

2.4.1 Program Description

The Energy Efficiency Arkansas ("EEA") program is a joint-utility program coordinated by the Arkansas Energy Office ("AEO") to deliver cost-effective, relevant, consistent, and fuel neutral information and training that encourages people living in Arkansas to consume less energy through energy efficiency and conservation measures. This program includes the dissemination of educational material and messages through print, television and radio advertisements, as well as training and certification programs.

Through the work done by the PWC Commercial and Industrial Collaborative, the EEA website www.energyarkansas.com is now a springboard for national accounts and other C&I customers to gain EE information for all participating utilities.

2.4.2 Program Highlights

- EEA was available to all BHEA customers for all of 2017.
- For more detailed information, see the separate annual report being filed by the EEA Program in Docket No. 07-083-TF.

2.4.3 Program Budget, Savings, and Participants

Energy Efficiency Arkansas

	Expenditures			Energy Savings (Therms)			Demand Savings (Therms)			Participants		
Program	**Budget**	**Actual**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Evaluated**	**%**	**Plan**	**Actual**	**%**
Program Year 2015	$ 69,183	$ 48,456	70%	0	0	-	n/a	n/a	-	0	0	-
Program Year 2016	$ 69,183	$ 44,643	65%	0	0	-	n/a	n/a	-	0	0	-
Program Year 2017	**$ 52,096**	**$ 49,182**	**94%**	**0**	**0**	**-**	**n/a**	**n/a**	**-**	**0**	**0**	**-**

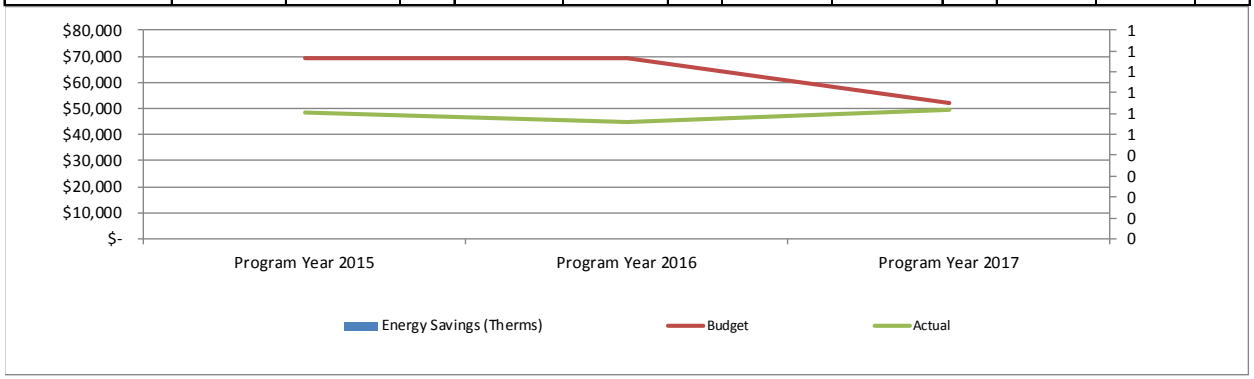


Figure 8 – Energy Efficiency Arkansas Program Trends

2.4.4 Description of Participants

- Participants in this program are difficult to quantify due to the nature of the program.

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

For more detailed information, see the separate annual report being filed by the EEA Program

2.4.5 Challenges & Opportunities

- For more detailed information, see the separate annual report being filed by the EEA Program in Docket No. 07-083-TF.

2.4.6 Planned or Proposed Changes to Program & Budget

- For more detailed information, see the separate annual report being filed by the EEA Program in Docket No. 07-083-TF.

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

3.0 Supplemental Requirements

3.1 Staffing

- Current staffing for BHEA's EE programs is one full-time individual.
- The Company has a Commercial and Industrial Account Manager who continues to leverage any contact with customers as an opportunity to promote EE programs.
- BHEA's implementer, CLEAResult, employs the equivalent of 4 full-time employees to work on BHEA's programs.

3.2 Stakeholder Activities

BHEA's EE team, including its program implementation and evaluation team members, was again very active with the Parties Working Collaboratively (PWC). The PWC held two face-to-face meetings and eight conference calls in PY 2016. The following is a high-level summary of the matters discussed during these PWC events:

- EM&V Planning and TRM V6.1 Scope of Work
- Use of the Real Economic Carrying Charge (RECC)
- Discussion of a Common Carbon Cost
- Measure Quantification for Benefit/Cost Ratio of 1.0
- Documentation of all Benefits Attributed to the Energy Efficiency Measures and Programs
- Discussion of Provision e: Transparency in Workbooks
- Additional Clarifications: Volume 1
  - Process Evaluation: Protocol C- Consistent Weatherization Approach
  - NTG clarifications
  - Behavioral Clarifications
- Additional Clarifications: Volume 2
  - Primary Research vs. TRM Values
  - TRM 7.0 Measure updates
- Timing and Application of the TRM
- Proposed SARP Workbook changes (Non Energy Benefit (NEB))
- NEBs and avoided/deferred replacement costs, interactive effects

As a result of these PWC meetings, the following is a listing of the Commission filings that were made and Commission orders that were issued:

- Docket No. 13-002-U, January 26, 2017, Joint Comments and Recommendations in response to Order Number 36 regarding Recommendations on Issue B: Inclusion of Carbon Costs in Future Analysis; Issue D: Measure Qualification on the Basis of a Threshold Benefit/Cost Ratio (BCR) of 1.0; Recommendations on Issue E: Documentation of all Benefits Attributed to Energy Efficiency Measures and Programs in Future Plans and Annual Reports; Timing and the Application of TRM.
- Docket No. 13-002-U, February 22, 2017, Order Number 37 Document 264. This order

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

directed Staff to reconvene the EE Reporting Needs Working Group to address these and other changes to the SARP and file any recommended changes to the SARP no later than August 31, 2017, in Docket No. 10-010-U. The Commission approves the transition to a prospective application of the TRM and, as requested, directs the PWC to review and update TRM Version 6.o and to reissue it as early as possible in PY 2017 as Version 6.1, for application in PY 2017.

- Docket No. 13-002-U, Document 274. Direct Testimony of Dr. Johnson, Independent Evaluation Monitor (IEM), summarizing the PY2016 Annual Summary Report on Evaluation, Measurement, and Verification Findings filed on behalf of the General Staff of the Arkansas Public Service Commission.
- Docket No. 13-002-U, November 2, 2017, Order No. 40. The Commission ordered the continued use of RECC (Issue A); Continued adherence to the Commission Checklist (Issue C); Determined that BCR may be less than 1.0; Common Carbon Cost (Issue B) PWC to consider the findings and recommendations of the NSPM as it resumes work on the next three-year cycle of planning and to address the carbon pricing issue in that context.
- Docket No. 10-100-R, May 10, 2017. Joint Motion to Approve Technical Reference Manual Version 6.1 and to Waive Hearing filed by the General Staff of the Arkansas Public Service Commission and Supplemental Testimony and Concordance TRM 6.1 Dr. Katherine Johnson, Johnson Consulting Group filed on behalf of the General Staff of the Arkansas Public Service Commission. In addition, Supporting Testimony for TRM 6.1 from Staff.
- Docket No. 10-100-R, May 25, 2017. Order No. 25 (Commission) Based upon the recommendation of the Moving Parties, and upon the testimony of Mr. Klucher and Dr. Johnson, TRM 6.1 is approved and adopted for use in computing and evaluating 2017 EE program results
- Docket No. 10-100-R, August 31, 2017. Supporting Testimony and Exhibits of Matthew S. Klucher, Director, Rates and Demand Resources, in Support of TRM 7.0 filed on behalf of the General Staff of the Arkansas Public Service Commission and Joint Motion by the PWC to Approve TRM 7.0.
- Docket No. 10-100-R, September 13, 2017. Order No.26 (Commission) By Order of the Commission. Based upon the recommendation of the parties, and upon the testimony of Mr. Klucher and Dr. Johnson, TRM 7.0 is approved and adopted for use in computing and evaluating PY 2018 EE program results.

3.3 Information Provided to Consumers to Promote EE

BHEA's marketing plan relies on traditional marketing channels to promote the programs. Additionally, BHEA uses customer touch points such as service calls, customer newsletters, and speaking engagements at seminars, conferences, and community events to spread the

ARSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

word about its programs. Over the past year, marketing for BHEA's energy efficiency programs has included:

- Fourth quarter radio marketing campaign to promote energy efficient furnaces
- Fourth quarter marketing through Facebook advertisement to promote energy efficient furnaces
- Continued Internet presence through the www.ExcessIsOut-Arkansas.com website which features:
    - A website that is mobile and tablet compatible;
    - A list of energy savings tips;
    - Information on all BHEA's EE programs and instructions on how to participate in each program, with contact information for further questions;
    - Printable rebate forms;
    - Online rebate application;
    - Links to other useful resources, such as a free online energy audit tool and energy efficiency organizations;
    - Samples of marketing materials;
    - A direct email link for more information or questions regarding any BHEA EE program;
- Continued Internet presence through the www.blackhillsenergy.com website that contains information about all BHEA EE programs with links to www.ExcessIsOut-Arkansas.com for more specific program information; and
- Program materials are distributed at multiple events during the year, where BHEA customers are able to learn more about the programs.

Examples of these offerings can be seen in Appendix B of this report.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Comprehensive Energy Efficiency Plan

Program Year 2017

Annual Report

Appendix A – ADM Associates, Inc. – Black Hills Energy Arkansas EM&V Contractor Report

Black Hills Energy

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Evaluation of 2017 DSM Portfolio

Submitted to:

Black Hills Energy Arkansas

April 2018

Final

ADM Associates, Inc.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Prepared by:

Adam Thomas
Jeremy Offenstein, Ph.D.
Jennifer Shen
Chris Johnson
Lily Forest
Melissa Culbertson

Corporate Headquarters:
3239 Ramos Circle
Sacramento, CA 95827
Tel: (916) 363-8383

ADM Associates Inc.
Energy Research & Evaluation

19650 Liberty St.
Suite 425
Fremont, CA 94538
Tel: (510) 371-0763

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Acknowledgements

We would like to thank the staff at Black Hills Energy Arkansas (BHE) for their time and effort in contributing to the EM&V of the 2017 programs. This evaluation was conducted with regular coordination with staff at BHE, who provided quick feedback and turnaround to the requests of the evaluation team as well as open and forthright insights into the operations of their programs.

Further, we would like to acknowledge our gratitude towards BHE customers, implementation contractor staff, and trade allies. As with the staff at BHE, their active participation allowed for the evaluation team to collect all needed data for this effort.

In final, we would like to thank staff at the Independent Evaluation Monitor for their involvement in providing thorough answers and clarification to the evaluation team when higher-level questions arose over the course of the 2017 EM&V effort.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

TABLE OF CONTENTS

Section Title ..... Page

1. Executive Summary 1-1
2. General Methodology 2-1
3. Portfolio-Level Findings 3-1
4. Equipment Rebates 4-1
5. Commercial and Industrial (C&I) Solutions Program 5-1
6. Home Energy Savings Program 6-1
7. Recommendations for TRM Updates 7-1
8. Appendix A: Site Reports 8-1
9. Appendix B: Deferred Replacement Cost Calculations 9-1

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

LIST OF TABLES

Table 1-1 Gross Impact Summary 1-2

Table 1-2 Net Impact Summary 1-2

Table 1-3 BHE 2017 DSM Portfolio Performance against Goals 1-3

Table 1-4 BHE 2017 Verified Electric Savings 1-4

Table 1-5 BHE 2017 Verified Water Savings 1-4

Table 1-6 BHE 2017 Deferred Replacement Cost 1-5

Table 3-1 Summary of Data Collection Efforts 3-1

Table 3-2 Assessment of Customer Education by Program 3-3

Table 3-3 Assessment of Trade Ally Training by Program 3-3

Table 3-4 Assessment of Marketing & Outreach by Program 3-4

Table 3-5 Assessment of Budgetary, Management, and Program Delivery Resources by Program 3-5

Table 3-6 Summary of BHE Portfolio Acquisition Costs 3-5

Table 3-7 End-Uses Addressed by Program 3-5

Table 3-8 Assessment of Project Comprehensiveness by Program 3-6

Table 3-9 Assessment of Targeted Customer Sectors by Program 3-8

Table 3-10 Assessment of Cost-Effectiveness 3-9

Table 3-11 Assessment of Data & QA/QC Procedures by Program 3-10

Table 4-1 Equipment Rebates Historical Performance against Goals 4-1

Table 4-2 Determining Appropriate Timing to Conduct a Process Evaluation 4-4

Table 4-3 Determining Appropriate Conditions to Conduct a Process Evaluation 4-4

Table 4-4 BHE Equipment Rebate Data Collection Summary 4-5

Table 4-5 Equipment Rebates Non-Energy Benefits 4-14

Table 4-6 TRM V6.1 Annual Furnace Heating Load 4-19

Table 4-7 Residential Furnace RUL 4-20

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 4-8 Residential Water Heating Baseline Energy Factors 4-22

Table 4-9 TRM V6.1 Estimated Annual Hot Water Use 4-22

Table 4-10 Residential Water Heating Baseline Energy Factors 4-22

Table 4-11 EFLH Values 4-23

Table 4-12 Hot Water Requirements by Facility Size 4-24

Table 4-13 Hot Water Requirements by Unit or Person 4-25

Table 4-14 Equipment Rebates Verified Therms Savings 4-26

Table 4-15 Equipment Rebates Net Savings Summary 4-26

Table 4-16 Smart Thermostat kWh Savings Summary 4-28

Table 5-1 C&I Solutions Program Historical Performance against Goals 5-1

Table 5-2 Custom Project Participation Summary 5-4

Table 5-3 Determining Appropriate Timing to Conduct a Process Evaluation 5-5

Table 5-4 Determining Appropriate Conditions to Conduct a Process Evaluation 5-5

Table 5-5 BHE C&I Solutions Data Collection Summary 5-7

Table 5-6 C&I Solutions Direct Install Respondent Titles 5-13

Table 5-7 C&I Solutions Direct Install Satisfaction Levels 5-15

Table 5-8 C&I Solutions Prescriptive Steam Trap Satisfaction Levels 5-20

Table 5-9 Rebate Benchmarking 5-21

Table 5-10 C&I Solutions Non-Energy Benefits 5-23

Table 5-11 DI Aerator Savings Calculation Parameters 5-24

Table 5-12 1.0 GPM Commercial Aerator Savings 5-24

Table 5-13 0.5 GPM Commercial Aerator Savings 5-25

Table 5-14 Pre-Rinse Spray Valves Savings Calculation Parameters 5-25

Table 5-15 DI Showerhead Savings Calculation Parameters 5-27

Table 5-16 Daily Hot Water Reduction 5-27

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-17 DI Weather Stripping Savings Calculation Parameters 5-28

Table 5-18 $EFLH_H$ By Weather Zone 5-28

Table 5-19 Deemed Therm Savings per Linear Foot 5-29

Table 5-20 C&I Solutions Boiler Equipment Rebates Program Verified Therms Savings 5-29

Table 5-21 C&I Solutions Cooking Equipment Rebates Program Verified Therms Savings 5-30

Table 5-22 C&I Solutions Cooking Equipment Net Savings Summary 5-31

Table 5-23 C&I Solutions Prescriptive Steam Trap Net Savings Summary 5-31

Table 5-24 BHE C&I Solutions Custom Project Summary 5-33

Table 5-25 BHE C&I Solutions Custom Project Free-Ridership Results 5-37

Table 5-26 Pump Control Savings Inputs – Pipe Losses 5-40

Table 5-27 C&I Solutions Verified Therms Savings 5-41

Table 5-28 C&I Solutions Net Savings Summary 5-41

Table 5-29 Commercial & Industrial Solutions Verified Net Water Savings 5-41

Table 5-30 Commercial & Industrial Solutions Verified Net Electric Savings 5-41

Table 6-1 HESP Historical Performance against Goals 6-1

Table 6-2 Determining Appropriate Timing to Conduct a Process Evaluation 6-3

Table 6-3 Determining Appropriate Conditions to Conduct a Process Evaluation 6-4

Table 6-4 CWA Program Metrics Summary 6-4

Table 6-5 BHE HESP Data Collection Summary 6-5

Table 6-6 Home Energy Savings to 2016 Recommendations 6-5

Table 6-7 QA Violation Definitions by Measure 6-8

Table 6-8 Source of Awareness 6-11

Table 6-9 HESP Ex Ante Summary 6-19

Table 6-10 HESP Verified Savings Summary 6-25

Table 6-11 HESP Net Savings Summary 6-25

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 6-12 HESP Verified Net Water Savings 6-26

Table 6-13 HESP Verified Net Electric Savings 6-26

Table 7-1 Steam Trap lbs./hr. Discharge Rate 7-2

Table 7-2 Steam Traps Gallons/hr. Discharge Rate 7-2

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

LIST OF FIGURES

Figure 1-1 Savings Share by Measure - Residential 1-2

Figure 1-2 Savings Share by Measure – C&I 1-3

Figure 1-3 Summary of Goal Attainment & Budget Expenditure by Program 1-4

Figure 4-1 Heating Equipment Rebates Commercial Participation by Facility Type 4-2

Figure 4-2 Heating Equipment Rebates by Month 4-3

Figure 4-3 Equipment Rebate Sources of Program Awareness 4-6

Figure 4-4 Thermostat Types installed by Residential Retrofit Participants 4-7

Figure 4-5 Residential Equipment Rebates - Reasons for Purchas of High Efficiency Furnaces/Water Heaters 4-8

Figure 4-6 Participant Contractor Experience 4-9

Figure 4-7 Participant Satisfaction Scores 4-10

Figure 4-8 Number of Years Participating in the Program 4-11

Figure 4-9 Percentage utilized program marketing materials 4-12

Figure 4-10 Trade Ally Program Marketing 4-12

Figure 4-11 Trade Ally Program Training Participation 4-13

Figure 4-12 Residential Equipment Rebates FR Diagram 4-18

Figure 5-1 Total Net Therms by Program Channel 5-2

Figure 5-2 BHE Direct Install Participation Summary 5-3

Figure 5-3 C&I Solutions Direct Install Monthly Therms Savings 5-3

Figure 5-4 C&I Solutions Process Flow 5-11

Figure 5-5 Past Experience & Future Plans with Direct Install Measures 5-14

Figure 5-6 Likelihood of Installation without the Program 5-15

Figure 5-7 Sources of Program Awareness for Steam Trap Retrofits (n=9) 5-18

Figure 5-8 Time Elapsed since Last Steam Trap Inspection or Replacement 5-19

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Figure 5-9 C&I Solutions Custom Project Free-Ridership Diagram 5-37

Figure 6-1 Program Savings Share by Measure 6-2

Figure 6-2 HESP Premises and Savings by Month 6-3

Figure 6-3 Home Efficiency Meter Graphic 6-7

Figure 6-4 Per-Home Therms Savings: Assessment vs. Install-Only 6-9

Figure 6-5 % Houses with Each Measure 6-9

Figure 6-6 Reasons for Participation 6-11

Figure 6-7 Recipients of Assessment 6-12

Figure 6-8 Home Energy Assessment Scheduling 6-13

Figure 6-9 Actions taken by Assessor 6-14

Figure 6-10 Energy Efficiency Prior to CWA Program 6-15

Figure 6-11 Future Home Improvements 6-15

Figure 6-12: Satisfaction with Various Program Aspects 6-16

Figure 6-13 Home Ownership Status 6-17

Figure 6-14 Home Vintage 6-18

Figure 6-15 Educational Attainment 6-18

Figure 6-16 HESP Participant Income 6-19

Figure 6-17 Difference in Expected and Evaluated Ex-Post Duct Sealing CFM 6-21

Figure 6-18 Difference in Expected and Evaluated Ex-Post Air Sealing CFM 6-22

Figure 6-19 Major Measure Free-ridership 6-24

Figure 9-1 Residential Tankless WH Deferred Replacement Cost Calculation 9-1

Figure 9-2 C&I Tankless WH Deferred Replacement Cost Calculation 9-2

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

1. Executive Summary

This report is to provide a summary of the evaluation effort of the 2017 Demand Side Management (DSM) portfolio by BHE. This evaluation was led by ADM Associates (ADM, referred to herein as the Evaluators). This report provides verified gross and net savings estimates for evaluated programs.

1.1 Summary of BHE DSM Programs

In 2017, the BHE DSM portfolio contained the following programs:

- Equipment Rebates;
- Commercial & Industrial (C&I) Solutions; and
- Home Energy Savings.

1.2 Evaluation Objectives

The goals of the 2017 Evaluation, Measurement, & Verification (EM&V) effort are as follows:

- For prescriptive measures, verify that savings are being calculated according to appropriate Technical Resource Manual (TRM) V6.1 guidelines.
- For custom measures, this effort comprises the calculation of savings according to accepted protocols (such as International Performance Measurement and Verification Protocol). This is to ensure that custom measures are cost-effective and provide reliable savings.
- Conduct process evaluation of all BHE programs and of the portfolio overall. This is to provide a comprehensive review of program operations, marketing and outreach, quality control procedures, and program successes relative to goals. From this, the Evaluators are to provide program and portfolio-level recommendations for BHE. Process evaluation activities include interviews of key program actors, surveys of participants and non-participants, literature reviews and best-practices assessments, and documentation of program activities, successes, and shortcomings. Further, this includes a summary of utility and implementer response to recommendations made in the 2016 process evaluations.

1.3 Summary of Findings

1.3.1 Impact Findings

Table 1-1 and 1-2 present the gross and net impact by program.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 1-1 Gross Impact Summary

Program	Annual Energy Savings (Therms)		Lifetime Energy Savings (Therms)		Gross Realization Rate
	Ex Ante	Ex Post	Ex Ante	Ex Post	
Equipment Rebates	98,227	100,780	1,460,135	1,498,085	102.60%
Commercial & Industrial Solutions	717,900	717,948	4,878,414	4,878,754	100.00%
Home Energy Savings	493,983	520,601	8,209,397	8,651,756	105.40%
Total	1,310,110	1,339,329	14,547,946	15,028,595	102.20%

Table 1-2 Net Impact Summary

Program	Annual Energy Savings (Therms)		Lifetime Energy Savings (Therms)		NTGR	Net Realization Rate
	Ex Ante	Ex Post	Ex Ante	Ex Post		
Equipment Rebates	79,717	73,840	1,177,150	1,090,367	73.3%	92.60%
Commercial & Industrial Solutions	714,915	713,327	4,836,042	4,825,313	99.4%	99.80%
Home Energy Savings	469,284	474,684	7,798,930	7,888,671	91.2%	101.20%
Total	1,263,916	1,261,851	13,812,122	13,804,351	94.2%	99.80%

The contribution to portfolio savings by program is summarized in Figure 1-1.

Figure 1-2 and Figure 1-3 summarize the share of savings by measure category for residential and non-residential segments, respectively.

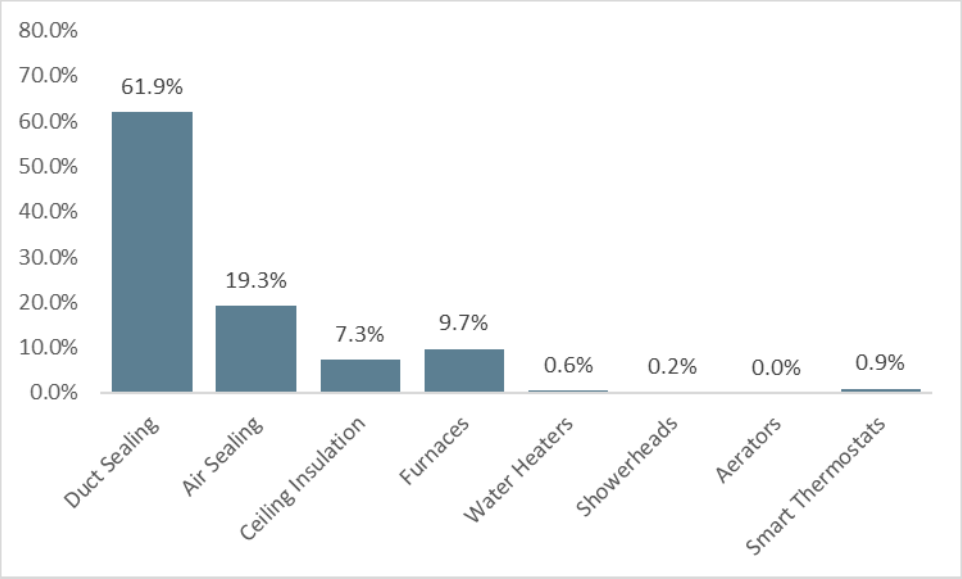


Figure 1-1 Savings Share by Measure - Residential

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

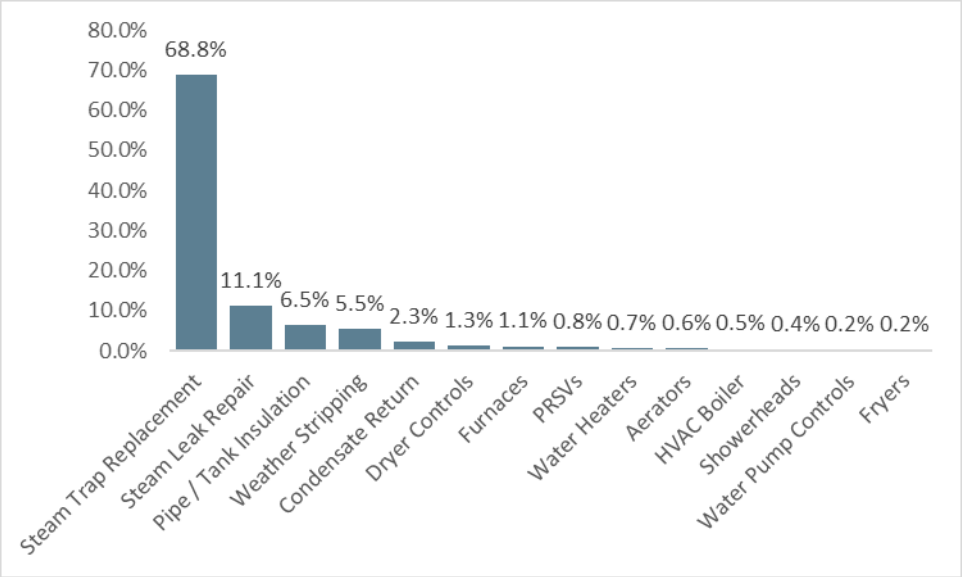


Figure 1-2 Savings Share by Measure – C&I

From this, the Evaluators have identified the following High Impact Measure (HIMs):

- Residential
  - Duct sealing
  - Air sealing
  - Ceiling Insulation
  - Furnaces
- Non-residential
  - Steam trap replacement
  - Steam leak repair
  - Pipe / tank insulation
  - Weather stripping

Further, the Evaluators put the net savings into the context of BHE's 2017 goal. Table 1-3 summarizes the performance against goals of programs evaluated in this report.

Table 1-3 BHE 2017 DSM Portfolio Performance against Goals

Program	*2017 Verified Net Therms*	*2017 Net Therms Goal*	*% Goal Reached*
Equipment Rebates	73,840	87,946	84.0%
C&I Solutions	713,327	713,150	100.0%
Home Energy Savings	474,684	379,880	125.0%
Total	1,261,851	1,180,976	106.8%

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The BHE portfolio overall exceeded filed savings goals by 106.8%. Percent of goal attained and budget spent by program is summarized in Figure 1-4.

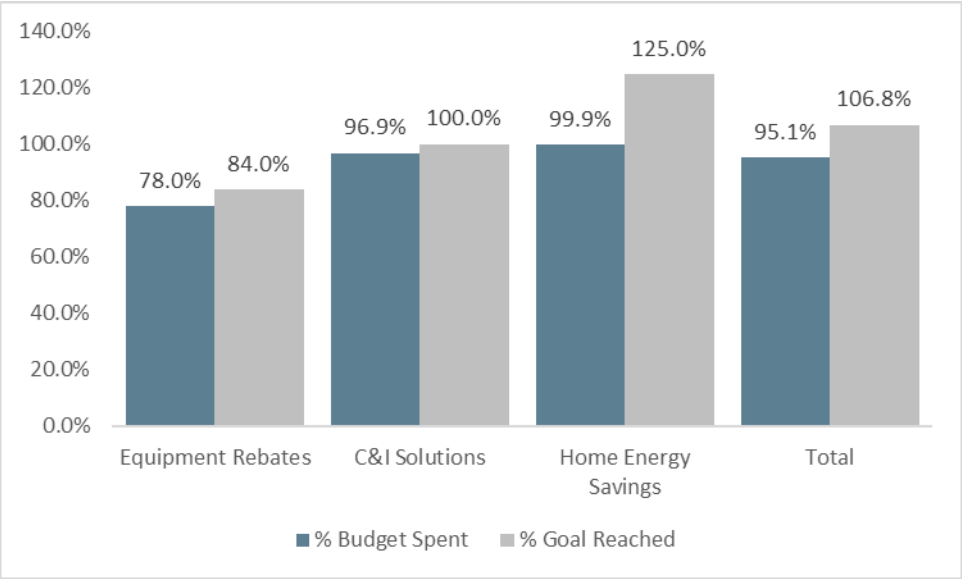


Figure 1-3 Summary of Goal Attainment & Budget Expenditure by Program

The non-energy benefits (NEBs) attained by the BHE portfolio in 2017 are detailed in the tables to follow.

Table 1-4 BHE 2017 Verified Electric Savings

Program	Measure	Net Annual kWh	Net Peak kW	Lifetime Net kWh
Equipment Rebates	Smart Thermostats	69,345	0	762,794
C&I Solutions	Door Sweeps	7,332	5.86	80,647
Home Energy Savings	Duct Sealing	368,069	245.44	6,625,246
	Air Sealing	61,988	36.62	681,867
	Ceiling Insulation	40,491	33.97	809,822
Total		547,225	321.89	8,960,376

Table 1-5 BHE 2017 Verified Water Savings

Program	Measure	Net Annual Water	Net Lifetime Water
C&I Solutions[1]	Direct Install	2,964,007	23,907,354
	Custom	7,010,951	42,614,757
	Prescriptive	71,745	358,723
Home Energy Savings	Aerators	59,057	590,573
	Showerheads	315,994	3,159,934
Total		10,421,754	70,631,341

[1] Direct Install comprised showerheads, PRSVs, and faucet aerators. Custom comprised of steam traps, steam leak repair, and condensate return improvement. Prescriptive projects included steam trap replacement.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 1-6 BHE 2017 Deferred Replacement Cost

Program	Measure	DRC per Unit	Total DRC
Equipment Rebates	Res Tankless WH	$294.88	$23,000.64
	C&I Tankless WH	$122.44	$1991.04
		Total	$24,991.68

1.3.2 Process Findings

Following a review of present program offerings and interviews with utility and third-party implementation staff, the Evaluators found that:

1.3.2.1 Portfolio Findings

- The portfolio had a reduced budget and savings goal in 2017. This was due to a new basis year for goal and budget setting for the 2017-2019 triennial cycle having lower sales than the prior basis year.
- BHE and third-party implementation staff have been very responsive to recommendations; most recommendations have been adopted and several others remain under consideration.

1.3.2.2 Equipment Rebates

- Residential measures displayed higher free-ridership than in the last program cycle (the last prior NTGR study was completed in 2014). This may be indicative of condensing furnaces and tankless water heaters advancing in overall market adoption. However, the NTGRs for these measures still show significant room for improvement via program intervention and the measures are cost-effective.
- No low flow mailer kits were distributed in . BHE distributed kits in early 2018.

1.3.2.3 C&I Solutions

- The program is consistently meeting savings and participation goals. With 713,327 net Therms in 2017, the program has met savings goals every year since program inception in 2011.
- In 2017 the program had increased reliance upon steam trap replacement and steam leak repair, and as a result the average EUL of measures installed in the 2017 program year is lower than observed in prior program years. Overall, the C&I Solutions Program has an EUL of 6.79 years.
- The Evaluators identified significant water savings from steam trap replacement, steam leak repair, and condensate return projects.
- BHE and the other Arkansas gas utilities saw increased participation in their small business channel due to successful outreach to laundry and hotel facilities for steam trap replacement, steam leak repair, dryer controls, and water pump controls.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

1.3.2.4 Home Energy Savings

- The program continues to be a resounding success. The HESP accounted for 37.6% of portfolio savings, its highest contribution rate to-date. As with other BHE programs, savings declined in absolute terms compared to 2016 due to an overall reduction in program budget.
- The Consistent Weatherization Approach has not affected program operations or effectiveness; the program offerings were already compliant with the Consistent Weatherization Approach.

1.3.2.5 Response to Program Recommendations

In 2016, two program or portfolio level recommendations were provided to BHE as part of the EM&V of their portfolio. The Evaluators reviewed BHE's response to recommendations from the 2016 EM&V report and categorized them as follows:

1) **Adopted.** This applied to recommendations that pertained to the correction of an issue (such as using an incorrect baseline methodology) or modifications in program outreach that do not require a filing (such as adding 'thank you' messaging to the Water Conservation Program).
2) **Under consideration.** This applies most typically to larger recommendations that would require APSC approval.
3) **Rejected.** This applies to recommendations which are reviewed by BHE and rejected. A recommendation by the Evaluators to consider a midstream approach for storage tank units was rejected, in lieu of adopting higher minimum qualifying standards for the program.
4) **Not applicable.** This would apply to recommendations which are no longer applicable to the BHE portfolio. An example of this included a recommendation pertaining to the residential furnace application form; the Evaluators recommended that BHE remove "Old Unit Age" as an application requirement, and BHE responded that an application rejection would not be triggered due to that missing field.
5) **Incomplete.** This applies to recommendations which were included in the 2016 EM&V report but have either not yet been adopted or have been explicitly rejected by BHE. No recommendations fell under this category.

Both recommendations were adopted. The recommendations pertained to:

1) Reviewing large outlier projects for duct sealing and air sealing; and
2) Adding smart thermostats to the Equipment Rebates Program.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

1.4 Report Organization

This report is organized with one chapter providing the full impact and process summary of a specified program. The report is organized as follows:

- Chapter 2 provides general methodologies;
- Chapter 3 provides a summary of portfolio-level issues;
- Chapter 4 provides results for the Equipment Rebates Program (ERP);
- Chapter 5 provides results for the C&I Solutions Program;
- Chapter 6 provides results for the Home Energy Savings Program;
- Chapter 7 provides a summary of TRM recommendations; and
- Appendix A provides the site-level custom reports for the C&I Solutions Program.
- Appendix B provides Deferred Replacement Cost Calculations

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2. General Methodology

This section details general impact evaluation methodologies by program-type as well as data collection methods applied. This section will present full descriptions of:

- Gross Savings Estimation;
- Sampling Methodologies;
- Free-Ridership determination;
- Process Evaluation Methodologies; and
- Data Collection Procedures.

2.1 Glossary of Terminology

As a first step to detailing the evaluation methodologies, the Evaluators provide a glossary of terms to follow[2]:

- *Ex Ante* – Forecasted savings used for program and portfolio planning purposes (from the Latin for "beforehand")
- *Ex Post* – Savings estimates reported by an evaluator after the energy impact evaluation has been completed (From the Latin for "From something done afterward")
- *Deemed Savings* – An estimate of an energy savings or demand savings outcome (gross savings) for a single unit of an installed energy efficiency measure. This estimate (a) has been developed from data sources and analytical methods that are widely accepted for the measure and purpose and (b) is applicable to the situation being evaluated (e.g., assuming 17.36 Therms savings for a low-flow showerhead)
- *Gross Savings* – The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated
- *Gross Realization Rate* – Ratio of Ex Post Savings / Ex Ante Savings (e.g., if ADM verifies 15 Therms per showerhead, Gross Realization Rate = 15/17.36 = 86%)
- *Free-Rider* – A program participant who *would have* implemented the program measure or practice in the absence of the program. Free-riders can be total, partial, or deferred

[2] Arkansas TRM V6.1, Volume 1, Pg. 89-95

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- *Spillover* – Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program that exceed the program-related gross savings of the participants. There can be participant and/or non-participant spillover rates depending on the rate at which participants (and non-participants) adopt energy efficiency measures or take other types of efficiency actions on their own (i.e., without an incentive being offered).
- *Net Savings* – The total change in load that is attributable to an energy efficiency program. This change in load may include, implicitly or explicitly, the effects of free drivers, free riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand (e.g., if Free-Ridership for low-flow showerheads = 50%, net savings = 15 Therms x 50% = 7.5 Therms).
- *Net-to-Gross-Ratio (NTGR)* = (1 – Free-Ridership % + Spillover %), also defined as Net Savings / Gross Savings
- *Ex Ante Net Savings* = Ex Ante Gross Savings x Ex Ante Free-Ridership Rate
- *Ex Post Net Savings* = Ex Post Gross Savings x Ex Post Free-Ridership Rate
- *Net Realization Rate* = Ex Post Net Savings / Ex Ante Net Savings
- *Effective Useful Life (EUL)* – An estimate of the median number of years that the efficiency measures installed under a program are still in place and operable
- *Gross Lifetime Therms* = Ex Post Gross Savings x EUL

2.2 Overview of Methodology

The proposed methodology for the evaluation of the 2017 BHE DSM Portfolio is intended to provide:

- Net impact results at the 90% confidence and +/-10% precision level; and
- Program feedback and recommendations via process evaluation

In doing so, this evaluation will provide the verified net savings results, provide the recommendations for program improvement, and ensure cost-effective use of ratepayer funds. By leveraging experience and lessons learned from prior program year evaluations, the 2017 evaluation is expanded and can provide greater guidance as to methods by which program and portfolio performance could be improved.

2.2.1 Sampling

Sampling is necessary to evaluate savings for the BHE DSM portfolio insomuch as verification of a census of program participants is typically cost-prohibitive. As per evaluation requirements set forth by the Independent Evaluation Monitor (IEM), samples

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

are drawn in order to ensure 90% confidence at the +/- 10% precision level. Programs are evaluated on one of three bases:

- Census of all participants
- Simple Random Sample
- Stratified Random Sample

2.2.1.1 Census of Participants

A census of participant data was used for select programs where such review is feasible. Programs that received analysis of a census of participants include:

- Commercial & Industrial Solutions – Custom Component

2.2.1.2 Simple Random Sampling

For programs with relatively homogenous measures (largely in the residential portfolio), ADM conducted a simple random sample of participants. The sample size for verification surveys is calculated to meet 90% confidence and 10% precision (90/10). The sample size to meet 90/10 requirements is calculated based on the coefficient of variation (CV) of savings for program participants. CV is defined as:

$$CV(x) = \frac{Standard\ Deviation\ (x)}{Mean(x)}$$

Where x is the average Therms savings per participant. Without data to use as a basis for a higher value, it is typical to apply a CV of 0.5 in residential program evaluations. The resulting sample size is estimated at:

$$n_0 = \left(\frac{1.645 * CV}{RP}\right)^2$$

Where,

1.645 = Z score for 90% confidence interval in a normal distribution

CV = Coefficient of Variation

RP = Required Precision, 10% in this evaluation

With 10% required precision (RP), this calls for a sample of 68 for programs with a sufficiently large population. However, in some instances, programs did not have sufficient participation to make a sample of this size cost-effective. In instances of low participation, ADM then applied a finite population correction factor, defined as:

$$n = \frac{n_0}{1 + {}^{n_0}/_{N}}$$

Where

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

n_0 = Sample Required for Large Population

N = Size of Population

n = Corrected Sample

For example, if a program were to have only 100 participants, the finite population correction would result in a final required sample size of 41. The Evaluators applied finite population correction factors in instances of low participation in determining samples required for surveying or onsite verification. Programs subject to Simple Random Sampling included residential channels of the Equipment Rebate Program.

2.2.1.3 Stratified Random Sampling

For the BHE Commercial & Industrial programs, Simple Random Sampling is not an effective sampling methodology as the CV values observed in business programs are typically very high because the distributions of savings are generally positively skewed. Often, a relatively small number of projects account for a high percentage of the estimated savings for the program.

To address this situation, we use a sample design for selecting projects for the Measurement & Verification (M&V) sample that takes such skewness into account. With this approach, we select a number of sites with large savings for the sample with certainty and take a random sample of the remaining sites. To further improve the precision, non-certainty sites are selected for the sample through systematic random sampling. That is, a random sample of sites remaining after the certainty sites have been selected is selected by ordering them according to the magnitude of their savings and using systematic random sampling. Sampling systematically from a list that is ordered according to the magnitude of savings ensures that any sample selected will have some units with high savings, some with moderate savings, and some with low savings. Samples cannot result that have concentrations of sites with atypically high savings or atypically low savings. Programs that were evaluated using stratified random sampling include:

- Equipment Rebates – Non-Residential;
- Non-Residential;
- Commercial & Industrial Solutions – Direct Install (DI) Component.

2.2.2 Free-Ridership

In determining ex post net savings for the BHE DSM portfolio, the Evaluators provide estimates of free-ridership for individual programs. Free-riders are program participants that would have implemented the same energy efficiency measures at nearly the same time absent the program. As per TRM guidelines, free-riders are defined as:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

> "…program participants who received an incentive but would have installed the same efficiency measure on their own had the program not been offered. This includes partial free riders, defined as customers who, at some point, would have installed the measure anyway, but the program persuaded them to install it *sooner* or customers who would have installed the measure anyway but the program persuaded them to install more efficient equipment and/or more equipment. For the purposes of EM&V activities, participants who would have installed the equipment within one year will be considered full free riders; whereas participants who would have installed the equipment later than one year will not be considered to be free riders (thus no partial free riders will be allowed)."[3]

Given this definition, participants are defined as free-riders through a binary scoring mechanism, in being either 0% or 100% free-riders. Models of free-ridership utilized in these EM&V efforts were aimed at providing a probability of free-ridership; this probability value was then rounded to a whole-number free-ridership value.

2.2.2.1 Residential Free-Ridership

The general methodology for evaluating free-ridership among residential participants involved examination of four factors:

(1) Demonstrated financial ability to purchase high-efficiency equipment absent the rebate

(2) Importance of the rebate in the decision-making process

(3) Prior planning to purchase high-efficiency equipment

(4) Demonstrated behavior in purchasing similar equipment absent a rebate

In this methodology, Part (1) is essentially a gateway value, in that if a participant does not have the financial ability to purchase energy efficient equipment absent a rebate, the other components of free-ridership become moot. As such, if they could not have afforded the high-efficiency equipment absent the rebate, free-ridership is scored at 0%. If they did have the financial capability, the Evaluators then examine the other three components. The respondent is determined to be a free-rider based upon a preponderance of evidence of these three factors; that is, if the respondent's answers indicate free-ridership in two or more of these three components, they are considered free-riders. Specific questions and modifications to this general methodology are presented in the appropriate program chapters.

For residential programs, free-ridership is calculated as the average score determined for the sample of participants surveyed. For programs that are contractor-driven, the free-rider score of a survey respondent incorporates the relative importance of advice from their contractor, provided that the contractor is a program trade ally that received

[3] Arkansas TRM V6.1, Pg. 50.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

training from the appropriate program. This value is then applied to the program-level savings to discount savings attributable to free-ridership.

2.2.2.2 Prescriptive Non-Residential Free-Ridership

The general methodology for evaluating free-ridership among prescriptive program participants involved examination of four factors:

(1) Demonstrated financial ability to purchase high-efficiency equipment absent the rebate

(2) Importance of the rebate in the decision-making process

(3) Prior planning to purchase high-efficiency equipment

(4) Importance of the contractor in influencing the decision-making process[4]

In this methodology, Part (1) is essentially a gateway value, in that if a participant does not have the financial ability to purchase energy efficient equipment absent a rebate, the other components of free-ridership become moot. As such, if they could not have afforded the high-efficiency equipment absent the rebate, free-ridership is scored at 0%. If they did have the financial capability, the Evaluators then examine the other three components. The respondent is determined to be a free-rider based upon a preponderance of evidence of these three factors; that is, if the respondent's answers indicate free-ridership in two or more of these three components, they are considered free-riders. Specific questions and modifications to this general methodology are presented in the appropriate program chapters.

For non-residential programs, free-ridership is calculated as the average score determined for the sample of participants surveyed. This value is then applied to the program-level savings to discount savings attributable to free-ridership.

2.2.2.3 Custom Free-Ridership

For custom projects from the C&I Solutions Program, free-ridership is assessed on a case-study basis, through which the Evaluators conduct an in-depth interview that includes a battery of questions addressing:

- The timing of learning of the program relative to the timing of the planning of the retrofit;
- The impact the program incentive has on measure payback relative to the stated payback requirements by the respondent;

[4] Contractor recommendations were considered to be program-inducement in instances where findings from vendor interviews showed that the program changed the mix of products sold by the vendor and that the vendor responsible for the customers' installation was a program trade ally.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Whether the respondent learned of the energy efficiency measure from a program-funded audit; and
- Whether any influence the program had in modifying the project affected savings by greater than 50%.

In the C&I Solutions chapter, the free-rider "case studies" are provided for every custom project.

2.2.3 Process Evaluation

The Evaluator's general approach to process evaluation begins with a review of the tests for timing and appropriateness of process evaluation as defined in Protocol C of the TRM V6.1. In this review, the Evaluators determine what aspects of the program warrant a process evaluation (due to issues identified in prior process evaluations).

The 2017 process overviews began with interviews of program staff. These interviews, along with guidance from IEM protocols, inform the establishment of goals for the process evaluation, provide background history of programs, and give an introduction to portfolio-level issues. From this, the Evaluators then develop a list of data collection activities. The data collection procedures for process evaluations typically included:

- *Participant Surveying*. The Evaluators surveyed statistically significant samples of participants in each program in order to provide feedback for the program and provide an assessment of participant satisfaction.
- *In-Depth Interviews*. The Evaluators conducted in-depth interviews with high-level program actors, including BHE program staff, third-party implementation staff, and program trade allies. These interviews are semi-structured, in having general topics to be covered, without fully prescribed question and answer frameworks.
- *Review of Marketing Materials*. The Evaluators reviewed marketing materials for each program, providing feedback as to the appropriateness of the message in reaching its target audience, the breadth of the audience that the effort is attempting to reach, and identifying possible cross-promotional opportunities.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

3. Portfolio-Level Findings

This chapter provides a summary of the portfolio-level findings and any cross-cutting evaluation activities that occurred over the course of the 2017 EM&V effort. Specifically, this chapter includes:

- A summary of program and portfolio performance in 2017;
- A summary of EM&V activities and expenditures in 2017;
- High-level findings that cut across programs.

3.1 Summary of EM&V Effort

All programs in the BHE DSM Portfolio received a formal process evaluation in 2012 and partial process evaluations in 2013 and 2014. However, due to the time elapsed since the last process evaluation there was increased process evaluation activity in 2017. Table 3-2 summarizes the data collection efforts for the 2017 EM&V effort. "Interviews" should be distinguished from "Surveys" in that "Interviews" reflect semi-structured, in-depth discussions with high-level program actors (such as utility staff and third-party implementation staff) whereas surveys are fully-structured and typically conducted with program participants.

Table 3-1 Summary of Data Collection Efforts

Program	# Site Visits	# Surveys	# Interviews
Equipment Rebates	0	48	21
C&I Solutions	18	27	2
Home Energy Savings	49	68	2
Total	67	103	25

.

3.2 Tests of Portfolio Comprehensiveness

The Arkansas Public Service Commission (APSC) has in place a set of criteria in order to determine whether a DSM portfolio qualifies as "Comprehensive". These criteria are:

- ***Factor 1:*** *Whether the programs and/or portfolio provide, either directly or through identification and coordination, the education,* ***training****, marketing, or outreach needed to address market barriers to the adoption of cost-effective energy efficiency measures;*
- ***Factor 2:*** *Whether the programs and/or portfolio, have adequate* ***budgetary****, management, and program delivery resources to plan, design, implement, oversee and evaluate energy efficiency programs;*

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- ***Factor 3:*** *Whether the programs and/or portfolio, reasonably address all major* ***end-uses*** *of electricity or natural gas, or electricity and natural gas, as appropriate;*
- ***Factor 4:*** *Whether the programs and/or portfolio, to the maximum extent reasonable, comprehensively address the needs of customers at one time, in order to avoid* ***cream-skimming*** *and lost opportunities;*
- ***Factor 5:*** *Whether such programs take advantage of opportunities to address the comprehensive needs of* ***targeted customer sectors*** *(for example, schools, large retail stores, agricultural users, or restaurants) or to leverage non-utility program resources (for example, state or federal tax incentive, rebate, or lending programs);*
- ***Factor 6:*** *Whether the programs and/or portfolio enables the delivery of all achievable,* ***cost-effective*** *energy efficiency within a reasonable period of time and maximizes net benefits to customers and to the utility system;*
- ***Factor 7:*** *Whether the programs and/or portfolio, have evaluation, measurement, and verification "EM&V") procedures* ***adequate*** *to support program management and improvement, calculation of energy, demand and revenue impacts, and resource planning decisions.*

The Evaluators reviewed the BHE programs and portfolio in order to assess whether it was in compliance with the APSC Comprehensiveness Goals. In assessing these metrics, the Evaluators score them on numerous subcomponents. The scoring methodology is as follows:

●: Meets all requirements and is in full compliance with this performance indicator

◒: Meets some requirements and is in partial compliance with this performance indicator

○: Is not in compliance with this performance indicator.

NA: Performance indicator is not applicable to this program.

3.2.1 Factor 1: Education, Training, Marketing, and Outreach

3.2.1.1 Assessment of Education

The Evaluators assessed the educational components of the BHE programs, in order to identify whether the programs were providing potential participants with the needed information to guide their decision-making, and whether the channels used to reach the target markets are appropriate. The Evaluators found that:

- BHE's programs used a range of channels to provide educational materials to their programs' target markets. The educational materials included brochures, case studies, and presentations to trade & industry groups.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- BHE program staff conducts outreach and education through a wide range of potential program partners, including contractors, retailers, home builders, and local governments.

The breadth of educational materials by program is summarized in Table 3-2.

Table 3-2 Assessment of Customer Education by Program

Program	Provides Educational Materials	Outreach Through Multiple Channels	Education Targeted to Specific Market Barriers	Coordination of Education by Multiple Entities
Equipment Rebates	●	●	●	●
C&I Solutions	●	●	●	●
Home Energy Savings Program	●	●	●	●

3.2.1.2 Assessment of Training

The Evaluators reviewed each BHE program to assess whether:

1) The program is trade ally-driven;
2) If not, could or should the program be trade ally-driven;
3) The program provides training classes to support their program offerings; and
4) The program needs trade ally certification.

A summary of the Evaluators' assessment of training for each BHE program is presented in Table 3-3.

Table 3-3 Assessment of Trade Ally Training by Program

Program	Trade Ally Training Offered	Training Requirements Adhere to Best Practices	Trade Allies Participate in Training
Equipment Rebates	●	●	●
C&I Solutions	●	●	●
Home Energy Savings Program	●	●	●

BHE does not require trade ally registration to participate for most programs. Their approach has been to allow all licensed dealers or contractors to apply for the appropriate equipment rebates. Trade ally training and registration is required for Home Energy Savings, however. Staff at BHE and CLEAResult came to this conclusion given the extent of service provided by the program, thus requiring trade ally training and registration as warranted.

3.2.1.3 Marketing & Outreach

The Evaluators reviewed the marketing and outreach strategies associated with each of the BHE programs. These strategies were reviewed to assess whether they adequately

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

addressed the relevant participant barriers, the extent to which trade allies were actively marketing the program (where appropriate), and whether the materials were correctly targeted in marketing a comprehensive approach to energy efficiency.

A summary of the Evaluators' assessment of BHE marketing and outreach is presented in Table 3-4.

Table 3-4 Assessment of Marketing & Outreach by Program

Program	Marketing Addresses Specific Barriers	Trade Allies Promote Program	Marketing Support Provided to Trade Allies	Marketing Performed Through Diverse Channels
Equipment Rebates	●	●	●	●
C&I Solutions	●	●	●	●
Home Energy Savings Program	●	●	●	●

After reviewing the marketing and outreach materials, the Evaluators concluded that:

- Most programs have marketing materials that address specific barriers associated with the targeted segments or technologies.
- C&I Solutions has observed much higher participation from program trade allies and completed multiple projects originated by trade ally referral. More than half of custom project savings in 2017 came from projects originated by program trade allies.
- The BHE programs are marketed through a diverse range of channels, including mass-media advertising, online advertising, meetings and training sessions with professional organizations and trade groups, and partnered marketing with municipal governments.
- The BHE programs for the non-residential sector all apply past participant case studies in their marketing.

3.3 Factor 2: Budgetary, Management, and Program Delivery Resources

Several performance indicators were assessed in reviewing the adequacy of budgetary, management, and program delivery resources presented in Table 3-6. This included:

- Self-reports from program management staff
- Cost per Therm saved
- Review of trade ally resources dedicated to program promotion

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 3-5 Assessment of Budgetary, Management, and Program Delivery Resources by Program

Program	Budget is Sufficient to Support Program Goals	Cost per-Therm Aligns with Program Plan	Program Has Sufficient Staffing	Program Has Sufficient Trade Ally Support
Equipment Rebates	●	●	●	●
C&I Solutions	●	●	●	●
Home Energy Savings Program	●	●	●	●

From this review, the Evaluators concluded that the BHE portfolio overall has the adequate budget and staff allocations. Across all programs, actual costs per-Therm are significantly lower than planned. Table 3-6 summarizes the acquisition costs of first-year savings by program and provides a comparison against the acquisition costs from the filed plan.

Table 3-6 Summary of BHE Portfolio Acquisition Costs

Program	Planned $/Therm	Actual $/Therm	% Reduction from Plan
Equipment Rebates	$6.35	$5.90	7.12%
C&I Solutions	$1.93	$1.87	3.14%
Home Energy Savings	$3.96	$3.16	20.08%
Overall	$2.91	$2.59	10.98%

Overall, the BHE portfolio had acquisition costs that were 11.0% lower than 2017 plan values.

3.4 Factor 3: Addressing Major End-Uses

The Evaluators identified the end-uses served by each of the BHE programs. Most BHE programs are designed around a specific technology or end-use. Table 3-7 summarizes the end-uses addressed by each program.

Table 3-7 End-Uses Addressed by Program

Program	HVAC	Hot Water	Appliances	Food Service	Building Envelope	Industrial Process	Behavioral
Equipment Rebates	●	●	○	○	○	○	○
C&I Solutions	●	●	○	●	●	●	○
Home Energy Savings Program	○	●	○	○	●	○	○

● Measure targeted ◒ Measure offered ○ Measure not offered

Presently, the BHE portfolio covers most end-uses. The Evaluators found that sectors where the program offerings were not providing sufficient outreach and market transformation included:

- **Behavioral savings.** BHE cancelled their Home Energy Reports program to allow for the development of the Home Energy Savings weatherization program. This has had the tradeoff of filling residential building envelope but leaving a gap

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

in behavioral savings. Given the program budget allotment, the Evaluators concluded that BHE was correct in prioritizing weatherization over behavioral savings.

- **Residential appliances.** The TRM V6.1 includes deemed savings for residential appliances, including dishwashers and clothes washers. These are not presently offered in any BHE programs. However, given the low unit energy savings of these measures, any offering for this end-use would need to be an upstream, multi-utility effort to be cost-effective.

3.5 Factor 4: Comprehensively Addressing Customer Needs

To assess Factor 4, the Evaluators reviewed BHE programs to discern the extent of:

- Program-provided technical assistance;
- Incentives of comprehensive projects/measure suites; and
- Tiered incentives for higher efficiency levels.

The BHE portfolio has no specific requirements for installation of multiple measures. Customers are able to participate to an extent of their choice. This is a program best-practice in enabling customers to engage in energy efficiency in a manner in accordance with their budget constraints. In addition, there is a bonus incentive offered for simultaneous installation of a 95% AFUE furnace and tankless water heater[5].

Table 3-8 summarizes the comprehensiveness of offerings for each program.

Table 3-8 Assessment of Project Comprehensiveness by Program

Program	*Technical Assistance and/or Audits*	*Information Provided for Comprehensive Efficiency*	*Bundled Incentives for Multiple Measures*	*Tiered Incentives for Premium Efficiency*	*Trade Ally Incentives for Premium Efficiency*
Equipment Rebates	◒	●	●	●	●
C&I Solutions	●	●	●	●	○
Home Energy Savings Program	●	●	NA	●	●

Findings from the assessment of this factor included:

- Most BHE prescriptive programs offer incentives to trade allies for installation of top-tier efficiency measures. This has included incentives for condensing furnaces, and tankless water heaters.

[5] Examples include Entergy Arkansas Inc.'s Commercial & Industrial Solutions Program, which escalates incentives based on multiple measure installations.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- The BHE portfolio formerly offered tiered incentives for premium efficiency across all of their rebate programs. In some cases, this tiering has been removed in lieu of only including premium efficiency. Examples include:
  - The incentives for the Heating Equipment Rebates Program used to increase from $450 for units with 90-04.99 AFUE to $650 for units with 95 AFUE or greater. The program now only offers incentives for 95 or greater AFUE ($500 per unit). This decision was made due to low participation in this group; most program participants historically elected for the 95% AFUE model. The overall incentive was reduced in order to allow for greater total participation.
- Other retained tiered incentives include:
  - High efficiency boiler incentives are $1,400/MMBtuh for units < 94% efficient and $2,000/MMBtuh for units with 94% efficiency or greater.
  - The C&I Solutions program pays an incentive per verified therm, and as a result projects with higher savings are by design paid a higher incentive.
- The BHE portfolio has programs that bundle on-site technical assistance with direct installation.
- The range of technical assistance varies by program. The Equipment Rebate Program offers technical assistance through trade allies. C&I Solutions provides on-site technical assistance that is directly funded by the program.
- The programs have procedures for following up with customers after their participation (including thank-you calls or emails) and verification inspection.
- Marketing materials typically make attempts at cross-promotion of programs.

3.6 Factor 5: Targeting Market Sectors & Leveraging Opportunities

The Evaluators reviewed whether the BHE portfolio offered a comprehensive range of energy efficiency opportunities to all major customer sectors. Table 3-9 summarizes the market sectors and what programs target or allow each sector.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 3-9 Assessment of Targeted Customer Sectors by Program

Program	**Residential**	**Multifamily**	**Mobile Home**	**Small Commercial**	**Large Commercial**	**Industrial**	**Agricultural**	**Public Sector**
Equipment Rebates	●	◒	◒	●	◒	◒	◒	●
C&I Solutions	○	○	○	●	●	●	●	●
Home Energy Savings Program	●	●	◒	○	○	○	○	●

● Program targets this sector
◒ Sector is eligible for this program
○ Sector is ineligible for this program

Each sector has several programs for which they are eligible, and at least one program that targets them. Segment-specific findings include:

- Agriculture and Industrial sectors are not specifically targeted by the Equipment Rebate Program as the equipment used by these facilities generally requires custom calculations.
- Public Sector facilities are targeted with a wide range of programs. This has included residential programs that reach out to public housing authorities.
- Home Energy Savings is a residential program and did not target any of the commercial sectors.

In addition, the Evaluators reviewed the extent of collaboration and leveraging of available partnership opportunities by BHE.

Examples of cross-utility coordination included:

- BHE has brought on a third-party implementer (CLEAResult) for their C&I Solutions Program. This implementer uses the same program design and incentive levels for CenterPoint and AOG. This has allowed for reduced program costs for C&I Solutions, which is the largest program in each of the three gas utility portfolios. Further, dual-fuel projects are coordinated with SWEPCO and EAI.
- In late 2013, BHE established the Home Energy Savings Program. This weatherization program used a program model applied elsewhere in Arkansas by Entergy. Beginning in 2016, the program corresponded to the Consistent Weatherization Approach as designed by the Arkansas Parties Working Collaboratively (PWC). BHE has program partnering agreements with multiple electric utilities to leverage the effectiveness of program funds. In addition to multiple investor-owned utilities, BHE is developing partnerships with municipal

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

utilities and rural cooperatives that have an interest in providing weatherization services to their residential customers.

- Through a joint contract, the Evaluators provide EM&V to AOG, CenterPoint, and BHE. This allows for sharing of fixed EM&V costs (such as development of data collection instruments) and more seamless comparison of program offerings and lessons learned across the natural gas energy efficiency portfolio. This has reduced the overall cost of EM&V across all three natural gas utilities.

Examples of coordination with non-utility partners included:

- BHE's programs are marketed through industry partners who include professional organizations, trade groups, universities, and homeowners' associations.
- BHE works with a local technical college to help provide training opportunities to trade allies and students interested in careers related to energy efficiency.

3.7 Factor 6: Cost-Effectiveness of Energy Efficiency

To assess this factor, the Evaluators reviewed whether:

- Programs met net savings goals;
- The NTG ratios were in line with industry norms; and
- Programs passed cost-effectiveness (TRC) testing.

A summary of Factor 6 findings is provided in Table 3-10.

Table 3-10 Assessment of Cost-Effectiveness

Program	*NTGR*	*NTGR Within Industry Norms*	*Met Net Savings Goal*	*Program TRC*
Equipment Rebates	73.3%	Yes	No	1.19
C&I Solutions	99.4%	Yes	Yes	2.23
Home Energy Savings Program	91.2%	Yes	Yes	3.55

All programs passed TRC in 2017.

3.8 Factor 7: Adequacy of EM&V Procedures

The Evaluators conducted a review of EM&V procedures by program as implemented by several parties:

- QA/QC and EM&V procedures by BHE program staff;
- QA/QC and EM&V procedures by third-party implementation staff (where applicable)
- QA/QC and EM&V procedures by the Evaluators.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The EM&V of the BHE programs incorporated industry best practices and was conducted in an iterative process that incorporated feedback from BHE and implementation contractors as well as the Independent Evaluation Monitor (IEM).

Further, the Evaluators found that based on 2012 and 2013 program recommendations; BHE has significantly increased the stringency of QA/QC procedures, introducing randomized post-inspection to their programs.

Finally, the Evaluators reviewed the quality of program tracking data in order to assess whether the data allowed for complete evaluation. Further, the Evaluators reviewed the extent to which individual savings calculations were performed using facility-specific inputs into the TRM V6.1 algorithms versus the use of simplifying assumptions[6]. The results of the review are summarized in Table 3-11.

Table 3-11 Assessment of Data & QA/QC Procedures by Program

Program	***Tracking Contains Necessary Fields***	***Savings Calculations Performed and Reported***	***Savings Calculations Based on Facility Data***	***QA/QC Inspections by Program Staff***
Equipment Rebates	●	●	●	●
C&I Solutions	●	●	●	●
Home Energy Savings Program	●	●	●	●

Findings of this review included:

- Home Energy Savings has a very robust QA/QC process which is well-defined in the program manual and executed by CLEAResult staff.
- Commercial water heater calculations were improved significantly in response to evaluation recommendations, and were more transparent than in prior years.
- QA/QC inspections are in place for all programs.

[6] Examples of this could include assuming average facility square footage for commercial water heating and using that as an input to the savings calculation, as opposed to collecting facility-specific square footage.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

4. Equipment Rebates

The Equipment Rebates Program provides incentives to residential and business customers for high-efficiency space heating and water heating equipment. This program is an aggregated program combining the former Heating Equipment Rebates and Water Heating & Conservation Programs. Eligible measures for this program include:

- $500 for furnaces with 95% or higher AFUE;
- $300 for tankless water heaters with an EF of 0.90 or greater; and
- $75 for a smart thermostat.

Additionally, the program may provide self-install mailer kits with low flow devices, though this channel was inactive in 2017. Further, a $50 trade ally incentive is provided for all qualifying furnace and water heating equipment. The Equipment Rebate Program is targeted at Residential and Small Commercial market sectors. Retrofit and New Construction applications are both allowed, utilizing the same baseline AFUE. The marketing efforts for the Equipment Rebate Program were largely directed at HVAC contractors; their involvement is seen as crucial, as they are generally a primary source of information for end-use customers when deciding upon a replacement system.

Smart thermostats are provided via an online offering, linking BHE customers directly to the EcoBee website with a $75 discount promotion code.

4.1 Program Overview

The Heating Equipment Rebates and Water Heating & Conservation programs began in 2010. The combined Equipment Rebate Program is designed to incentivize the purchase of high efficiency space heating and water heating equipment. Presently, the program incentivizes high efficiency furnaces and high efficiency water heaters. The program was internally implemented by BHE until September 2012, at which point CLEAResult was brought on board to implement BHE's prescriptive programs.

The history of program performance and expenditures is presented in Table 4-1.

Table 4-1 Equipment Rebates Historical Performance against Goals

Program Year	# Participants		Budget		Net Therms	
	Actual	Goal	Spent	Allocated	Achieved	Goal
2016	1,077	1,580	$704,718	$677,375	114,778	91,911
2017	692	1,456	$435,696	$558,217	74,751	87,946

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

4.1.1 Participation Summary

4.1.1.1 Residential Participation - Furnaces

The 2017 residential heating component had a total of 382 processed rebates at 361 premises.

Ninety-two percent of residential rebates issued were for retrofit projects. Eight percent were for new construction projects.

4.1.1.2 Residential Participation – Water Heaters

The residential component had a total of 78 tankless residential rebates at 78 premises. Ninety-one percent of 2017 residential participants were in retrofit applications, with 9% being new construction applications.

4.1.1.3 Residential Participation – Smart Thermostats

The program rebated 130 smart thermostats in 2017. BHE tracked the baseline thermostat type on the program application; 53.8% had a programmable thermostat and 46.2% had a manual thermostat. BHE only claimed savings for thermostats that were verified by EcoBee has having been registered and activated in a premise served by BHE. Nineteen percent of the thermostats rebated were never activated and had no savings claimed.

4.1.1.4 Commercial Participation - Furnaces

Commercial participation comprised of 87 95+AFUE furnaces. Ninety-one percent of commercial rebates were for retrofit projects. Nine percent were for new construction projects. Figure 4-1 summarizes the participation levels by facility type.

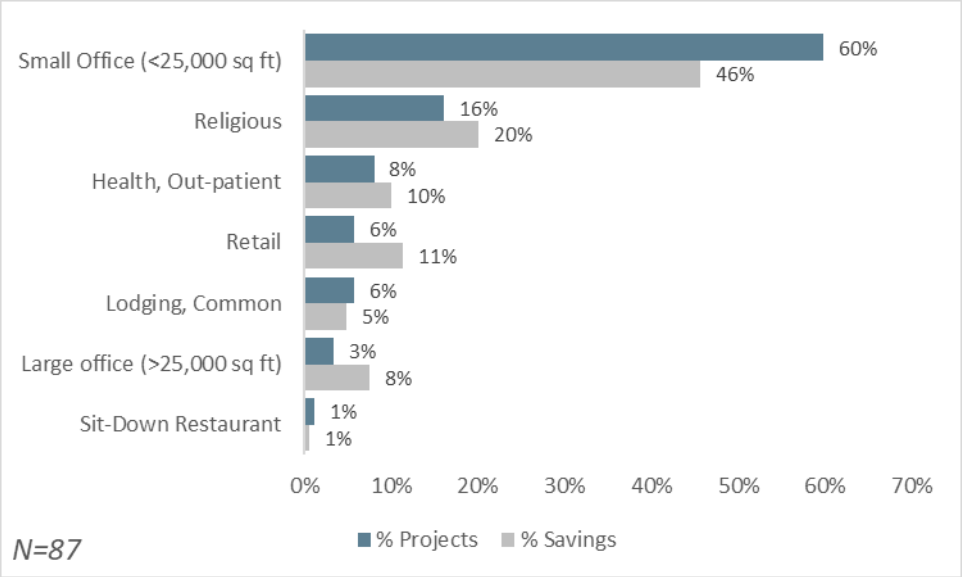


Figure 4-1 Heating Equipment Rebates Commercial Participation by Facility Type

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The most notable decline compared to 2016 is in participation from schools. In 2016, 69% of commercial furnace rebates were for K-12 education facilities. No educational facilities participated in 2017.There was a notable increase in participation from religious facilities, which increased from 3% to 16% of program participation from 2016 to 2017.

4.1.1.5 Commercial Participation – Water Heaters

The commercial component had a total of 16 rebates at 7 premises. All units were tankless units. 10 of the rebated units were in one new construction elementary school. The remaining systems were retrofit projects in fast food and lodging facilities. Figure 4-2 summarizes non-residential participation by facility type.

4.1.1.6 Participation Timing

Figure 4-2 summarizes the participation by month as determined by the date of rebate delivery. The two lines represent the total number of units installed in the specified month of 2017. There was a significant amount of spring-time installation of furnaces. This high level of spring installations is due to two factors:

1) As found in 2016, much of the participation is driven by customers needing replacement of their air conditioner. The program trade allies use this opportunity to upsell residential customers on a cooling-heating package deal.
2) The cooling season is the high season for residential new construction.

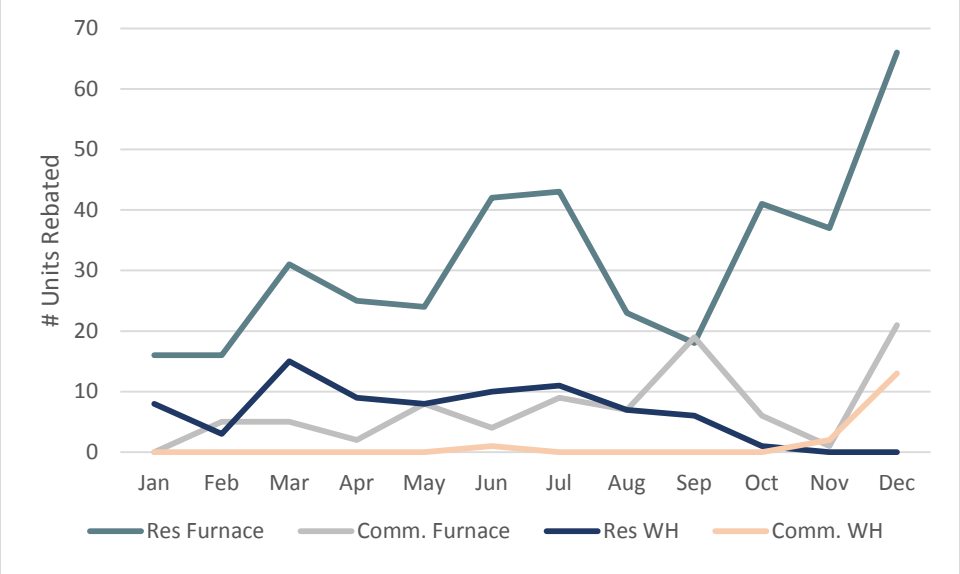


Figure 4-2 Heating Equipment Rebates by Month

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

4.2 Equipment Rebates Process Evaluation

The Evaluators conducted a formal process evaluation of the Heating Equipment Rebates Program and Water Heating & Conservation Programs in 2012 and a targeted process evaluation in 2013 and found that the program was successful in meeting participation, savings, and satisfaction goals. Table 4-2 and

Table 4-3 summarize the Evaluators' review of the Equipment Rebate Program in comparison to TRM V6.1 Protocol C for timing and conditions of conducting a process evaluation.

Table 4-2 Determining Appropriate Timing to Conduct a Process Evaluation

Component	Determination
New and Innovative Components	Mixed. Two programs were aggregated, but with no change in measure offerings.
No Previous Process Evaluation	No. The program received a comprehensive process evaluation in 2012.
New Vendor or Contractor	No. CLEAResult has implemented the program since 2012.

Table 4-3 Determining Appropriate Conditions to Conduct a Process Evaluation

Component	Determination
Are program impacts lower or slower than expected?	No. The program exceeded savings goals in all prior program years.
Are the educational or informational goals not meeting program goals?	No. The programs have had successful consumer and contractor outreach & education.
Are the participation rates lower or slower than expected?	No. The program met participant goals in all prior program years.
Are the program's operational or management structure slow to get up and running or not meeting program administrative needs?	No. The 2012 process evaluation found that operational and management structure to be up to speed and efficient in administering the program.
Is the program's cost-effectiveness less than expected?	No, the program's cost-effectiveness was within expected boundaries.
Do participants report problems with the programs or low rates of satisfaction?	No. 2012 participant surveys found high satisfaction levels.
Is the program producing the intended market effects?	Yes. Interviews with participating contractors in 2012 found significant market transformation occurring.

Due to the time elapsed since the last process evaluation, increased process evaluation activities were completed in 2017.

4.2.1 Data Collection Activities

The process evaluation of the Equipment Rebate Program included the following activities:

- *Program Actor In-Depth Interviews*. The Evaluators conducted in-depth interviews with a series of program actors. These interviews covered a range of

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

topics, including marketing efforts, feedback on program delivery, an assessment of barriers to program implementation and success, and recommendations for program improvement. Program Actors interviewed include:

- *BHE Program Staff*. The Evaluators interviewed staff at BHE involved in the administration of the Equipment Rebate Program. These interviews built upon interviews conducted in 2012, keeping apprised of BHE's involvement as the program develops.
- *Third Party Implementation Staff Interviews.* The Evaluators conducted interviews with CLEAResult personnel involved with the program. These interviews addressed development of the program in 2017.

- *Participant Surveying*. The Evaluators surveyed separate samples of residential and non-residential participants in the Equipment Rebate Program. In addition to their use in developing free-ridership and spillover estimates, these surveys informed the process evaluation of the Equipment Rebate Program. These surveys addressed issues including participant satisfaction with the program offerings, demographics, and other contextual issues regarding the participation process. Further, the data from these surveys served to quantify the extent of early replacement.

Table 4-4 summarizes the data collection for this process evaluation effort. This includes the titles, role, and sample sizes for data collection.

Table 4-4 BHE Equipment Rebate Data Collection Summary

Target	Component	Activity	N	Role
BHE Program Staff	Manager of Energy Efficiency	Interview	1	Overall administration of BHE DSM programs. This manager is involved in the larger strategic decisions associated with the DSM portfolio, and is involved with the Equipment Rebate Program and in the overall coordination of utility resources.
CLEAResult Staff	Program Coordinator	Interview	1	Handles day-to-day operations, including mass market outreach, application review, billing, and logistics
Program Participants	Residential Space Heating	Survey	36	Residential retrofit respondents included retrofit participants that received incentives for high efficiency furnaces rated at 95 AFUE or higher.
	Residential Water Heating	Survey	12	Residential retrofit respondents included retrofit participants that received incentives for tankless water heaters rated .90 EF or higher.
Trade Allies	HVAC Contractors	Interview	19	HVAC trade allies market the space heating program to their customers. The Evaluators conducted semi-structured interviews with 19 trade allies

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

4.2.2 Process Results & Findings

This section will present the results and key findings from the data collection activities. These findings are based upon interviews with utility staff, implementation staff and surveys with participants.

4.2.2.1 Response to Program Recommendations

In 2016, the Evaluators made one recommendation across the three program channels.

- **Heating Equipment:**

  Add a bonus incentive for installation of smart thermostats. Smart thermostats are included in the 2017-2019 triennial program. *Recommendation adopted.*

4.2.3 Residential Survey Response

The Evaluators completed 48 surveys with residential program participants in the Equipment Rebate Program.

4.2.3.1 Program Awareness

BHE's marketing of the Equipment Rebate Program is driven through multiple channels, including both customer-direct outreach and marketing through HVAC and plumbing contractors. Most respondents learn of the program through installing contractors (71% of respondents).

The sources of awareness for the Equipment Rebate Program are summarized in Figure 4-6.

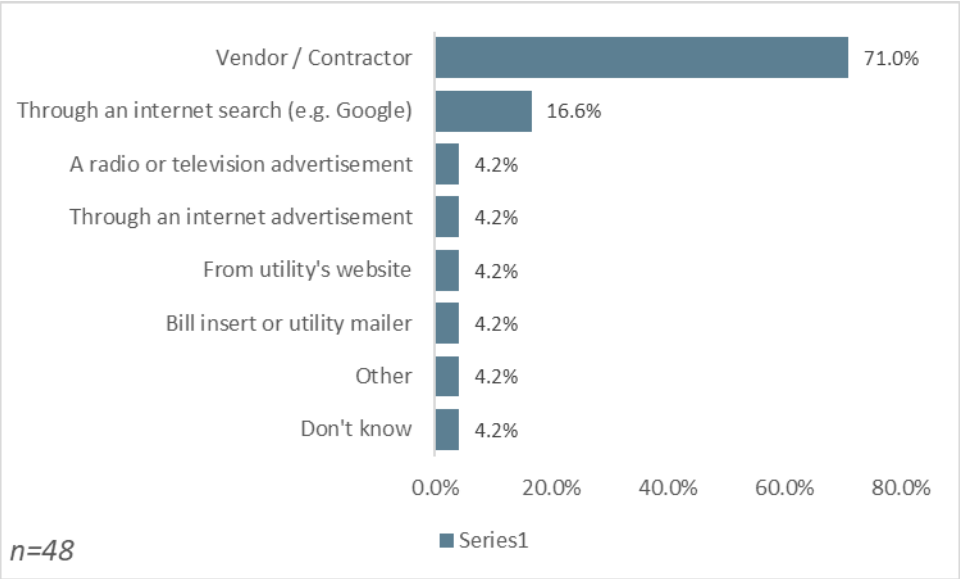


Figure 4-3 Equipment Rebate Sources of Program Awareness

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Furnace respondents were asked to identify if their preexisting equipment was functional. Sixty-seven percent of respondents said the equipment was still functioning at the time of the replacement, while 38% said it was not functional.

4.2.3.2 Efficiency and Features of the Furnace

Respondents were asked to identify what type of thermostat they use with their furnace. Their responses are summarized in Figure 4-11.

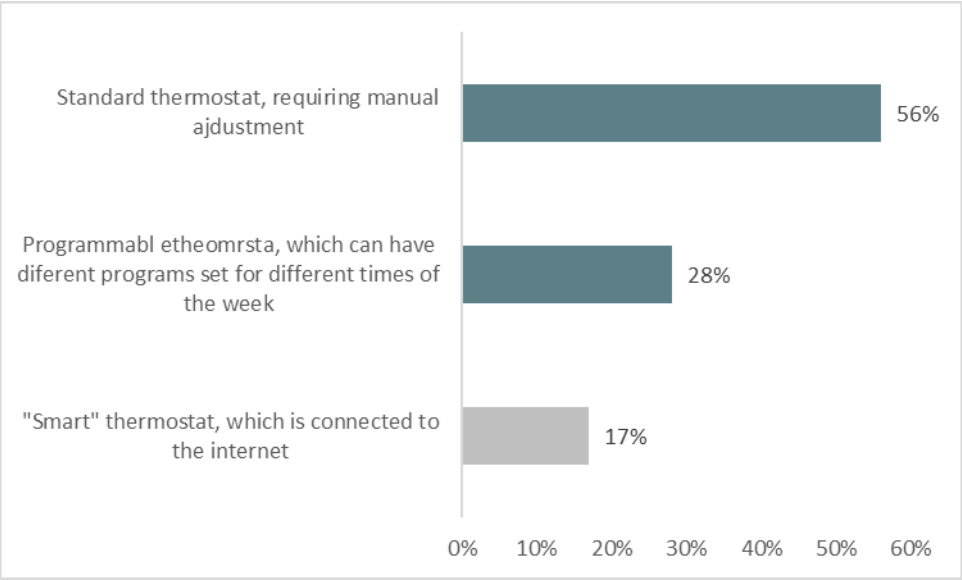


Figure 4-4 Thermostat Types installed by Residential Retrofit Participants

In Figure 4-11, we have highlighted responses for smart thermostats. In the past three years, the percent of respondents indicating that they had a smart thermostat installed with their furnace has gone from 12.9% to 17.0%.

Respondents were further asked to identify the extent to which they use their thermostat's functionality. Twenty-five percent of respondents with a programmable thermostat state that they made no use of its programs. Of the respondents that indicated having a smart thermostat, 67.0% stated that they use its Wi-Fi connectivity and related features. The Evaluators would recommend that any inclusion of smart thermostats in their program should be paired with education on the value of using its features.

4.2.3.3 Reasons for Participation

Participants were also asked about the importance of some of the motivating factors that helped in the decision-making process before purchasing the high efficiency space or water heating equipment, such as, saving money on their bills, improving home comfort, and getting the rebate. Figure 4-11 tabulates the results.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

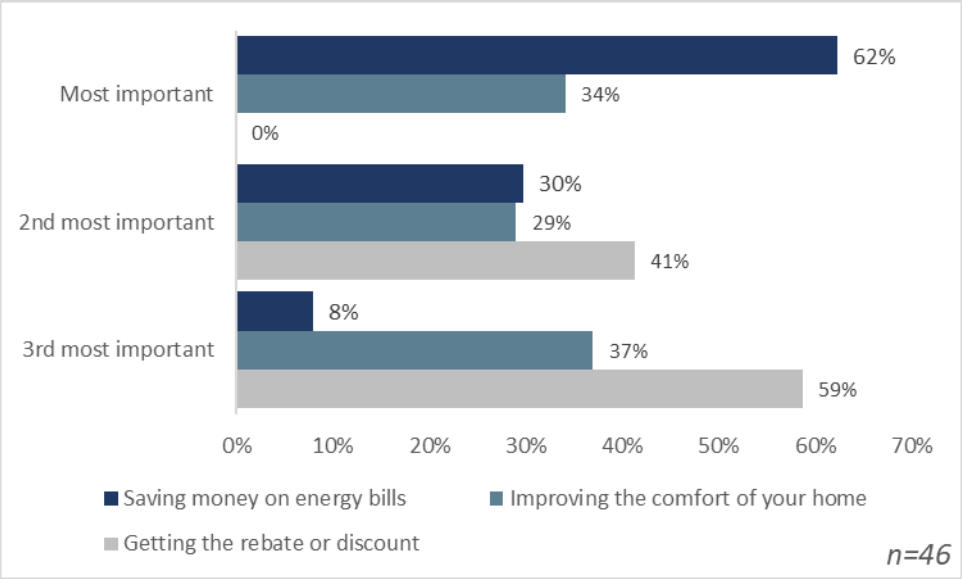


Figure 4-5 Residential Equipment Rebates - Reasons for Purchas of High Efficiency Furnaces/Water Heaters

Sixty-two percent of the respondents indicated that the most important factor that contributed to their decision to purchase the energy efficient furnace or water heater was saving money on energy bills, followed by, improving the comfort of their home (34%).

4.2.3.4 Contractor Interactions

Participants were asked to rate several statements regarding their experience with the contractor who installed the equipment on a scale of 1 to 5, with 1 meaning “Strongly Disagree” and 5 meaning “Strongly Agree”. Figure 4-7 tabulates those results.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

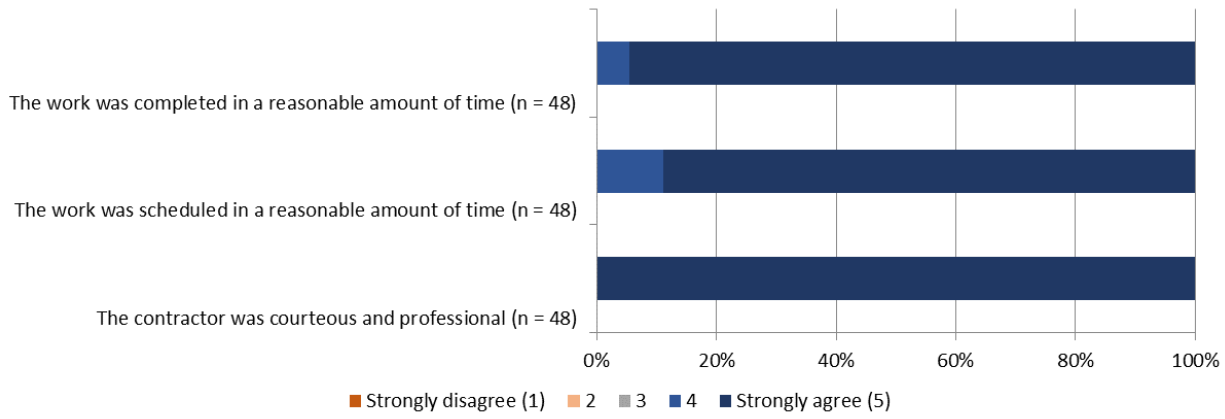


Figure 4-6 Participant Contractor Experience

Respondents were overwhelmingly positive in their assessments of their experiences with the installing contractors.

4.2.3.5 Program Satisfaction

Participants were asked to rate their satisfaction on a scale of 1 to 5, with 1 meaning "Very Dissatisfied" and 5 meaning "Very Satisfied" on a range of items related to their program experience. Figure 4-14 tabulates the satisfaction results of various program elements. The last two elements rated were only asked to those participants who contacted a program staff member.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

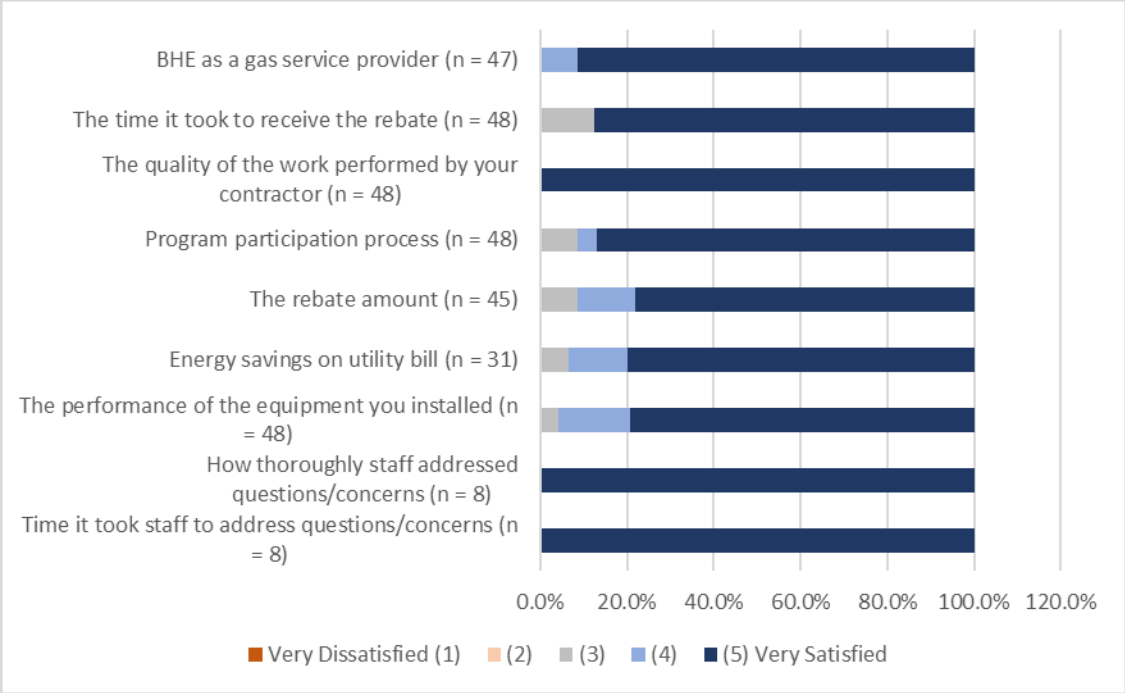


Figure 4-7 Participant Satisfaction Scores

Overall, satisfaction with the program is high. Respondents indicated particularly high satisfaction with the quality of the work performed by the contractor, the energy savings on their utility bill, and the performance of the equipment installed. Respondents also reported high satisfaction with BHE as their gas service provider.

On the operational side, customers indicated high satisfaction levels with incentive amounts and the application process, with mean scores of 4.85 and 4.85, respectively.

Respondents were asked at the end of the survey whether their participation in BHE's Equipment Rebate Program increased or decreased their satisfaction with the utility. Seventy-three percent of respondents said that their satisfaction had increased with BHE after participating in the program, while 27% of respondents said that their participation did not affect their satisfaction with BHE.

4.2.1 Trade Ally Survey Response

The evaluators surveyed 19 trade allies who participated in the Residential Space Heating programs through Black Hills Energy (BHE), Arkansas-Oklahoma Gas Corporation (AOG), and CenterPoint Arkansas (CNP). The purpose of these interviews was to assess program effects on trade ally decision making, as well as to gain insight into trade ally satisfaction and overall perceptions of the program. Figure 4-11 summarizes how long trade allies participated in utility-sponsored space heating rebate programs. Forty-seven percent have participated in the programs since inception.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

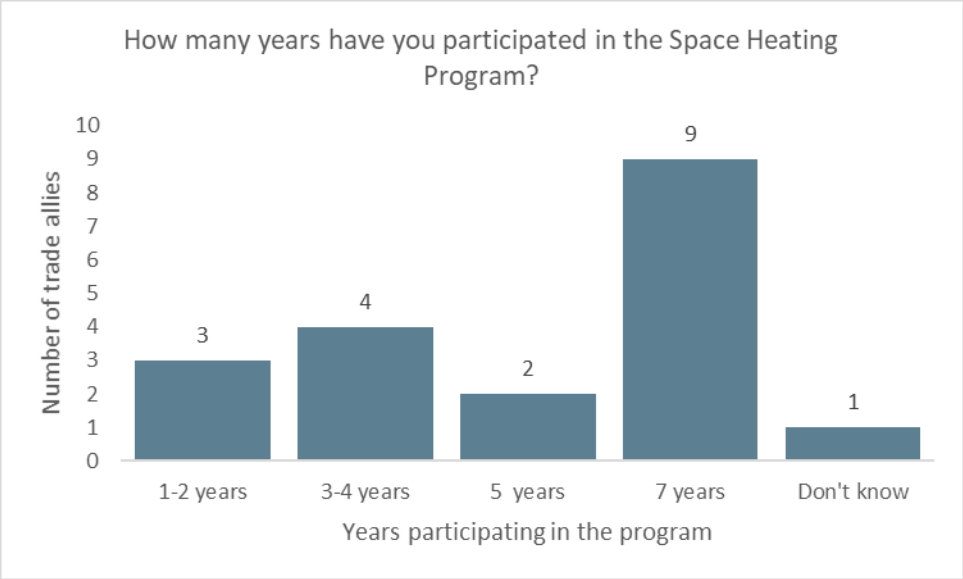


Figure 4-8 Number of Years Participating in the Program

4.2.1.1 Customer Awareness

When asked about customer awareness, 59% trade ally respondents indicated not knowing what percentage of their customers were aware of the program. 21% of respondents stated less than a quarter of their customers were aware of the program.

4.2.1.2 Trade Ally Marketing

Trade allies typically do not use marketing material developed by their corresponding utility company to promote the program. Fifty-nine percent of surveyed respondents stated they do not use program provided marketing materials, while 12% of respondents said they do so regularly. Seventeen percent indicated not knowing that such materials may exist. Figure 4-12 displays the percent of trade allies who have used marketing materials, have not used marketing materials, don't know if they have used program developed marketing materials, and didn't know it exists.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

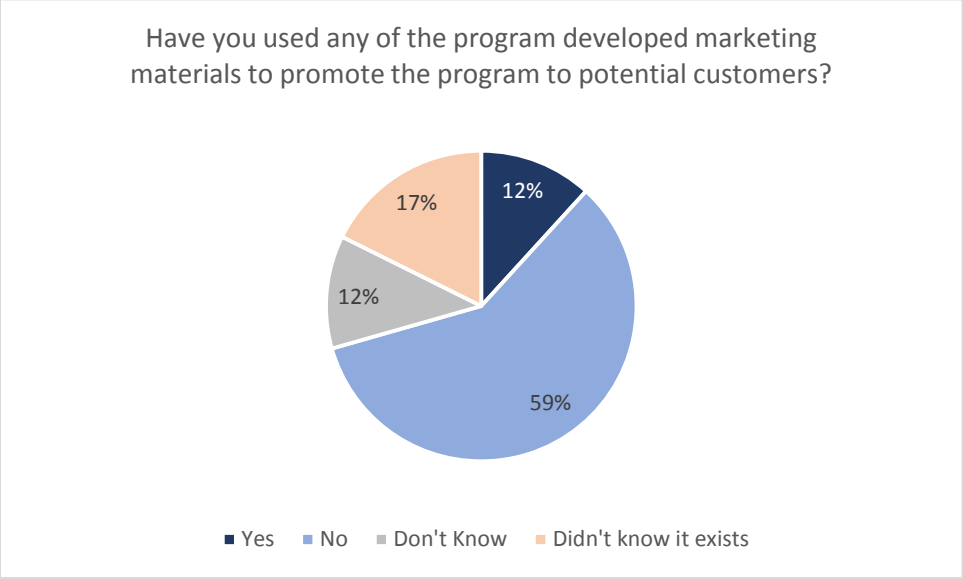


Figure 4-9 Percentage utilized program marketing materials

Figure 4-13 shows the most common ways trade allies market the space heating programs. The most popular way trade allies promote the program is through direct outreach or word of mouth (35%). Twenty-two percent of trade allies mentioned that they only talked about the rebate on-site with a customer. Characterizing the program as an added-value to their regular sales practices.

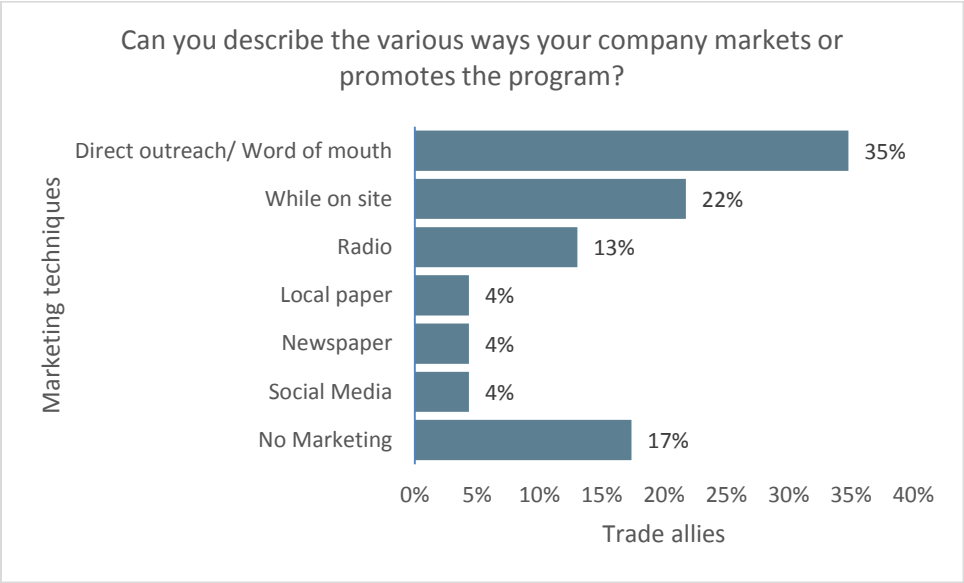


Figure 4-10 Trade Ally Program Marketing

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

4.2.1.3 Program Training Experience

Sixty nine percent of trade allies have not particpated in any program provided training. A quarter of the respondants have participated in program provided training. Of those that participated, all participants took in-person training.

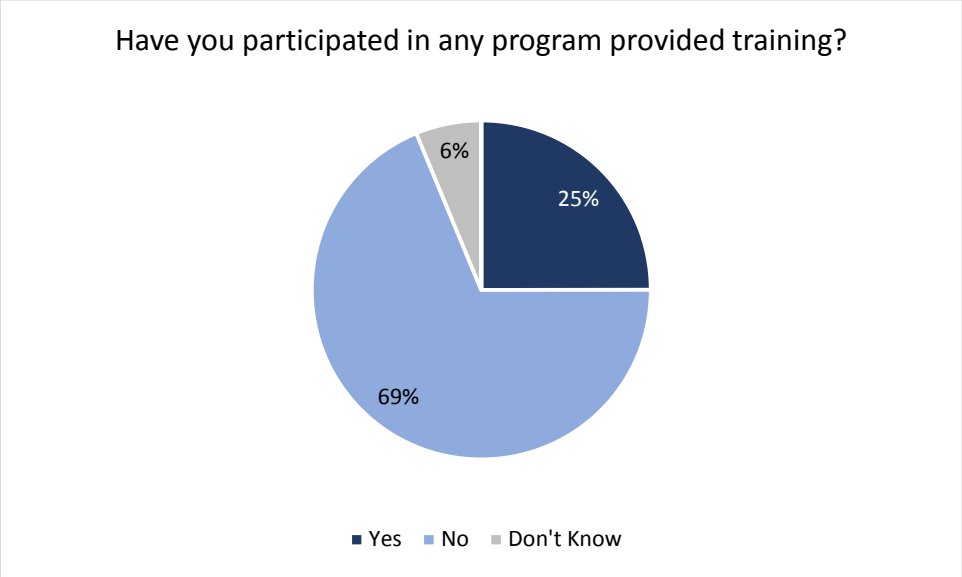


Figure 4-11 Trade Ally Program Training Participation

4.2.1.4 Interaction with Program Staff

When asked about the nature and frequency of communication with program staff, all responses were positive, regardless of frequency of contact. When asked about the timeliness of answering questions, only one respondent noted that it was difficult to find the correct person to contact.

4.2.1.5 Benefits of Participating in the Program

When trade allies were asked if their organization benefited from participating in the program 95% of them said yes and 5% said no. A general consensus among responses is that the rebates help upsell 90-95 AFUE or higher furnaces, but that it may not have increased the number of customers.

4.2.1.6 Trade Ally Satisfaction

Trade allies were asked to rate their level of satisfaction with various aspects of the program, including the available incentives and their communications with program staff. Responses were provided on a scale of 1 to 5 where 1 represented "very dissatisfied" and 5 represented "very satisfied." 78% responded that they were very satisfied, with 22% responding they were somewhat satisfied.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

4.2.1.7 Trade Ally Recommendations

Contractor feedback was very positive with 78% reporting they were very satisfied with the program; the remaining 22% reported that they were somewhat satisfied with the program.

Comments from the trade allies regarding program improvement included:

> *"Create a tiered rebate system based off equipment efficiency, Including variable speed furnaces."*
>
> *"Get the rebate to $1000; other states have rebates from $1500-1800."*

Some feedback involved better information provided to the customer or trade ally:

> *"Advertise it better. Send marketing materials to customers."*
>
> *"Provide an example of utility savings for 5-10 years after installing a high efficiency unit, so customer can see payback and savings. Increase rebate amount."*
>
> *"Contractors know all about the furnace rebates, but homeowners do not. This is because most marketing materials are with them. Suggestion: inform more new home owners directly or just send more information to customers directly."*

4.3 Equipment Rebate Program Impact Evaluation

The evaluation effort of the Equipment Rebate Program included the following:

- *Desk Review of Residential Calculations.* The Evaluators utilized TRM V6.1 values in assessing savings from residential furnaces and water heaters.
- *Calculation of Deferred Replacement Costs.* The Evaluators used the calculation tool developed by the IEM to assess deferred replacement cost for residential and commercial water heaters.
- *Commercial Verification*. The Evaluators applied TRM V6.1 deemed savings parameters in assessing savings of the commercial component.
- *Free-Ridership Rates.* Free-ridership rates were developed from current-year survey efforts.

4.3.1 Summary of Non-Energy Benefits

Table 4-5 summarizes the non-energy benefits by measure that will be credited to the Equipment Rebates Program.

Table 4-5 Equipment Rebates Non-Energy Benefits

Measure	Electric Savings	Water Savings	Propane Savings	Deferred Replacement

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

				Cost
Residential Tankless WH				✓
Commercial Tankless WH		✓		✓
Smart Thermostat	✓			

4.3.2 Residential Impact Evaluation

4.3.2.1 Residential Free-Ridership

Free-ridership was re-addressed in the 2017 evaluation. The last primary evaluation of free-ridership rates occurred in 2014. The approach was based on survey self-reports, using the following questions:

Q14. Prior to learning about the [PROGRAM], did you have plans to install a [MEASURE]?

1. Yes
2. No
98. DON'T KNOW
99. REFUSED

DISPLAY Q15 IF Q14=1**]**

Q15. Just to be clear, did you have plans to install a [MEASURE] as opposed to a standard efficiency [BASELINE]?

1. Yes
2. No
98. DON'T KNOW
99. REFUSED

Q16. Would you have been financially able to purchase the [MEASURE] if there was not a rebate available through the [UTILITY_SHORT] program?

1. Yes
2. No
98. DON'T KNOW
99. REFUSED

Q17. How likely is it that you would have purchased and installed the same [MEASURE] that you had rebated through the program if the rebate was not viable? Would you say.. [READ. MARK ONE.]

1. Very likely
2. Somewhat likely
3. Neither particularly likely or unlikely
4. Somewhat unlikely
5. Very unlikely
98. DON'T KNOW
99. REFUSED

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Q18. How influential was your contractor in helping you finalize the selection of your equipment? [READ. MARK ONE.]

1. Very influential
2. Somewhat influential
3. Neither particularly influential or uninfluential
4. Somewhat uninfluential
5. Very uninfluential
98. DON'T KNOW
99. REFUSED

Q19. Did you install the [MEASURE] sooner than you otherwise would have because of the rebate available through the [UTILTIY_SHORT] program?

1. Yes
2. No
98. DON'T KNOW
99. REFUSED

[DISPLAY Q20 IF Q19 = 1**]**

Q20. When would you have installed the [MEASURE] if rebates through the [UTILITY_SHORT] program were not available?

1. Within 6 months of when you installed it
2. Between 6 months and one year
3. 1-2 years
4. 2-3 years
5. More than 3 years
98. DON'T KNOW
99. REFUSED

The plans score was factored by the programs impact on timing. Specifically,

- If the respondent stated that they would have installed the measure more than one year after the measure was installed, the prior plan score reduced to zero.
- If the respondent stated that they would have installed the measure in 6 months to one year, then the prior plans score was reduced by one-half.
- If the respondent stated that they would have installed the measure at the same time or within 6 months of when it was installed, the prior plans score was not adjusted.

A likelihood of installing the measure in the absence of the program was developed based on respondents stated likelihood of installing a measure. Specifically, responses to this question were scored as follows:

- Very likely: 1

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Somewhat likely: .75
- Neither particularly likely nor unlikely: .5
- Somewhat unlikely: .25
- Very unlikely: 0

Contractor Influence: This score is first determined via respondent answers to Question 18. The scores are as follows:

- Very influential: .5
- Somewhat influential: .25
- All other answers: .00

This value is then scaled by .667 due to contractor estimates that the rebate assisted them in upselling to a high efficiency model two-thirds of the time.

The resulting NTGRs are as follows:

- Residential Furnace Retrofit: 72.22%
- Residential Water Heating Retrofit: 75.0%

For new construction applications, we apply the 2017 values developed as part of the new construction survey effort completed for CenterPoint Energy Arkansas. The values are:

- New Construction: Owner-built custom: 45%
- New Construction: Builder production homes: 91%

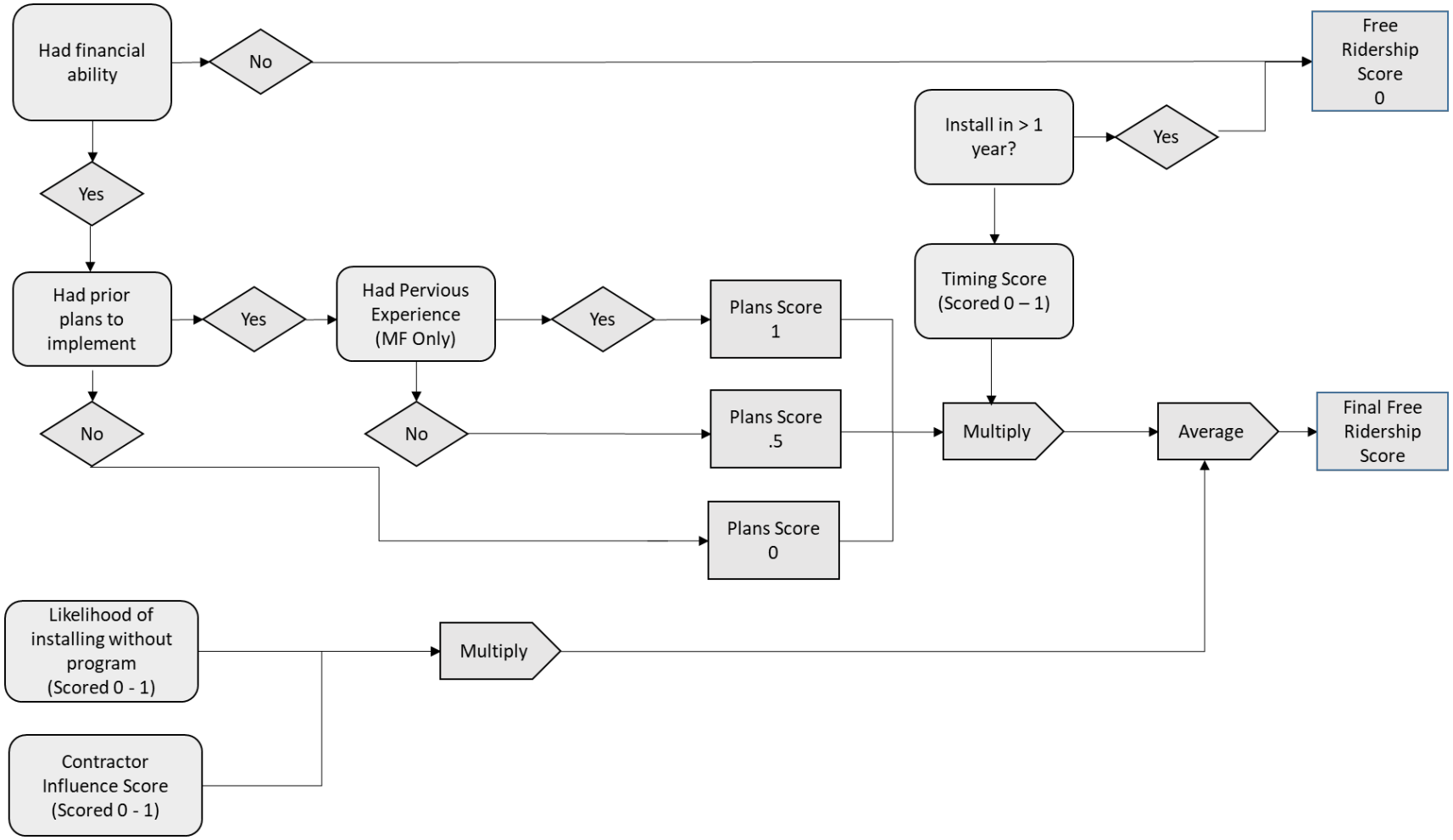


Figure 4-12 Residential Equipment Rebates FR Diagram

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TE-Doc. 321

4.3.2.2 Energy Savings Calculations - Furnaces

The TRM V6.1 update, which included updated heating equivalent full load hours ($EFLH_H$) values, updated heating load values for weather zones 6 and 9, and updated remaining useful life values, did not add new data requirements for residential furnaces.

According to Arkansas TRM V6.1, savings for residential furnaces are calculated as follows:[7]

$$Annual\ Therm\ Savings = Heat\ load \times \left({}^{1}/_{AFUE_{base}} - {}^{1}/_{AFUE_{eff}} \right)$$

$$Heat\ load = \frac{{}^{therms}/_{site\ area}}{year} \times site\ area$$

Where:

Site area = square footage of the project site. If site area is unknown, use installed capacity (btuh)/30 (btuh/ft^2).

$AFUE_{base}$ = baseline efficiency of the furnace, 80% AFUE.

$AFUE_{eff}$ = efficiency of the new furnace installed, in AFUE.

Table 4-6 summarizes the heating load multipliers per square foot from the TRM V6.1.

Table 4-6 TRM V6.1 Annual Furnace Heating Load

Vintage	Heating Load (Therms/Ft.^{2}/Year			
	Zone 9 – Rogers	Zone 8 – Fort Smith	Zone 7 – Little Rock	Zone 6 – El Dorado
1979 & Earlier	.404	.360	.336	.296
1980-1989	.303	.270	.252	.222
1990-1999	.202	.180	.168	.148
2000 & Later	.152	.135	.126	.111

Example savings calculations are as follows:

- Retrofit – 90,000 Input BTU furnace, 95% AFUE
- Output BTU = 90,000 x .95 = 85,500
- Site Area = 85,500 / 30 = 2,450
- Year built: 1986
- Location: Fort Smith, Zone 8.

$$Retrofit\ Therms\ Savings = 2{,}450 ft.^2 \times .270 \frac{Therms}{ft.^2} \times \left(\frac{1}{.80} - \frac{1}{.95} \right) = 130.56\ Therms$$

[7] Arkansas TRM V6.1 Volume 2, Page 54

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The same furnace in a new construction project would save:

$$NC\ Therms\ Savings = 2{,}850 ft.^2 \times .135 \frac{Therms}{ft.^2} \times \left(\frac{1}{.80} - \frac{1}{.95}\right) = 75.94\ Therms$$

4.3.2.3 Impact of Early Replacement

As per the TRM V6.1, and the procedures for calculating the impact of early replacement for residential furnaces, early retirement AFUE is calculated by a degradation factor of a 78 AFUE unit. This is calculated as:[8]

$$AFUE_{base_early} = (Base\ AFUE) \times (1 - M)^{age}$$

Where:

$Base\ AFUE$ = efficiency of the existing equipment when new, 78% AFUE.
M[9] = maintenance factor, 0.01.
age = the age of the existing equipment, in years.

Following this, lifetime savings are determined based on the Remaining Useful Life (RUL) of the old equipment. The TRM V6.1 updated the RUL table, which has been reflected in Table 4-7.[10]

Table 4-7 Residential Furnace RUL

Unit Age	RUL	Unit Age	RUL
5	14.7	**19**	3.6
6	13.7	**20**	3.2
7	12.7	**21**	2.9
8	11.8	**22**	2.6
9	10.9	**23**	2.4
10	10.0	**24**	2.1
11	9.1	**25+**	0.0
12	8.3		
13	7.5		
14	6.8		
15	6.2		
16	5.5		
17	4.5		
18	4.0		

This data was collected from 2017 participants as follows:

[8] Arkansas TRM V6.1 Volume 2, Pg. 54
[9] Maintenance factor of 0.01 is the average maintenance factor for gas furnaces taken from the October 2010 National Renewable Energy publication "Building America House Simulation Protocols", table 30.
[10] AR TRM V6.1, Volume 2, Pg. 56

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- A random sample of retrofit participants was surveyed to provide an estimate of what percent of furnace retrofits were of functional units.
- In these interviews, respondents were also asked to provide an estimate of unit age.
- The results of this survey are then extrapolated to the population of retrofits in the residential component.

For early retirements, the Evaluators applied the average unit age determined from participant surveying. Subsequent to this, the annual Therms for all retrofit units are calculated based on a weighted average of normal and early retirement parameters.

Overall, ADM found that 67% of furnaces replaced were functioning units. Respondents were asked to identify the age of their replaced unit. The mean age of replaced units:

- 17.39 for functioning units[11]
- 20.85 for failed units

Based on the degradation equation from TRM V6.1, this leads to an Early Retirement AFUE of:

$$AFUE_{base_early} = (.78) \times (1 - .01)^{17.39} = .6549$$

Further, based on the values in Table 4-7, the RUL of the early replacement units is 4 years. For years 16-20 of the unit EUL, the normal replacement baseline applies. The savings for each residential retrofit unit were calculated using both the normal and early replacement baselines, and final savings reflect a weighted average of these two values based on participant survey data findings.

4.3.2.4 Energy Savings Calculations – Water Heaters

Energy savings values for tankless water heaters were developed using installed Energy Factor ratings as determined by the Gas Appliance Manufacturers Association Directory of Certified Water Heating Products. Tank sizing must follow AHRI standards.

In TRM V6.1 Savings are calculated as:[12]

$$therm_{Savings} = \frac{\rho \times C_p \times V \times \left(T_{SetPoint} - T_{Supply}\right) \times \left(\frac{1}{EF_{pre}} - \frac{1}{EF_{post}}\right)}{Conversion\ Factor}$$

Where

[11] In determining the average age of functioning units, the Evaluators excluded six high outliers; these units were all over 30 years old and the Evaluators concluded that their inclusion in the Early Replacement population would be inappropriate.

[12] Arkansas TRM V6.1, Volume 2. Pg. 131-143

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ρ = Water density, 8.33 lbs./gal.

C_p = Specific heat of water, 1 BTU/lb·°F

V = Estimated annual hot water use (gal per year)

$T_{SetPoint}$ = Water heater set point, if unavailable, use 120°F

T_{Supply} = Average supply water temperature

EF_{pre} = Baseline value

EF_{post} = Energy Factor of new water heater

$Conversion\ Factor$ = 100,000 BTU = 1 therm

Baseline energy factors are summarized in Table 4-8.

Table 4-8 Residential Water Heating Baseline Energy Factors

Minimum Required Energy Factors by Size[13]				
30 Gallon	**40 Gallon**	**50 Gallon**	**75 Gallon**	**80 Gallon**
.61	.59	.58	.53	.52

Volume estimates are provided in Table 4-9.

Table 4-9 TRM V6.1 Estimated Annual Hot Water Use

Weather Zone	Tank Size (Gal) of Replaced Water Heater			
	40	**50**	**65**	**80**
9	18,401	20,911	25,093	30,111
8	18,331	20,831	24,997	29,996
7	18,267	20,758	24,910	29,892
6	17,815	20,245	24,293	29,152

Supply water temperatures are presented in Table 4-10

Table 4-10 Residential Water Heating Baseline Energy Factors

Weather Zone		Water Main Temperature
9	Fayetteville	65.6
8	Fort Smith	66.1
7	Little Rock	67.8
6	El Dorado	70.1

4.3.2.5 Energy Savings Calculations – Smart Thermostats

Smart thermostat savings were calculated using the Arkansas TRM V6.1 protocol. The savings multipliers are shown in Table 4-14[14].

[13] 10 CFR Part 430 Energy Conservation Program for Consumer Products: Energy Conservation Standards for Water Heaters; Final Rule
http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/htgp_finalrule_fedreg.pdf
[14] AR TRM V6.1 Vol 2.0 Pg. 83

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 4-11 Smart Thermostat Deemed Savings Factors

Baseline	Therms/Ft.^{2}	kWh/Ft.^{2}
Manual	.037	.450
Programmable	.009	.113
Default	.033	.399

4.3.3 Commercial Impact Evaluation

Due to a low participant population, the Evaluators applied a NTGR developed in the commercial survey effort for CenterPoint in 2017 to the BHE program. The NTGRs are:

- Space Heating: 70.37%
- Water Heating: 78.57%.

4.3.3.1 Space Heating

Savings were calculated as follows:[15]

$$Therms\ Savings = \frac{BTU\ Capacity * EFLH_H * \left(\frac{1}{Effic_{pre}} - \frac{1}{Effic_{post}}\right)}{100{,}000\ Therms/BTU}$$

The EFLH for a facility is a function of facility type and weather zone. The TRM V6.1 EFLH values are summarized in Table 4-10.

Table 4-12 EFLH Values[16]

Building Type	Zone 6	Zone 7	Zone 8	Zone 9
Assembly	575	798	855	824
College/University	630	874	936	902
Fast Food Restaurant	288	440	474	455
Full Menu Restaurant	181	328	370	336
Grocery Store	688	935	995	965
Health Clinic	646	885	922	895
Lodging	389	587	635	605
Large Office (>30k Ft^2)	811	1,014	1,054	1,036
Small Office (<30k Ft^2)	353	538	568	538
Religious Worship	537	745	798	769
Retail	780	1,041	1,131	1,099
School	774	1,026	1,089	1,064

For example, if a Small Office in Fayetteville (Zone 9) installed a 70,000 BTU 96% AFUE Furnace, the resulting Therms savings are calculated as:

[15] Arkansas TRM V6.1, Volume 2. Pg. 247
[16] Data pulled from Arkansas TRM V6.1 Volume 2, Table 459. Pg. 537.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

$$Therms\ Savings = \frac{70{,}000\ BTU * 538\ EFLH * \left(\frac{1}{.80} - \frac{1}{.96}\right)}{100{,}000\ BTU/Therm} = 78.45\ Therms$$

4.3.3.2 Water Heaters

Commercial water heater savings calculations incorporate more facility-specific information than the residential methodology. Therms savings for commercial water heaters are calculated as: [17]

$$Therms\ Savings = \frac{\rho * C_P * V * \left(T_{SetPoint} - T_{Supply}\right) * \left(\frac{1}{EF_{pre}} - \frac{1}{EF_{post}}\right) * Days/Year}{100{,}000\ BTU/Therm}$$

P = Water Density, 8.33 lbs./Gallon

C_P = Specific Heat of Water, 1 BTU/Lb. F

V = Average daily hot water use (gallons)

$T_{setpoint}$ = Water Heater setpoint, 140 deg F

T_{supply} = Supply water temperature, 58 deg F

EF_{pre} = Energy factor of existing water heater (.675 - .0015V)

EF_{post} = Energy factor of installed water heater

Days/Year = Days per year of operation

The required facility-specific inputs are volume and days/year. Volume can be calculated based on square footage of the facility or from units served. Table 4-12 presents the volume and days of usage values for a facility by square footage.[18] Table 4-13 presents the volume and days of usage values by unit produced or person served.

Table 4-13 Hot Water Requirements by Facility Size

Building Type	Daily Demand (Gallons / Unit / Day)	Unit	Units / 1,000 Sq. Feet	Applicable Days / Year	Gallons / 1,000 Sq. Feet / Day
Small Office	1	Person	2.3	250	2.3
Large Office	1	Person	2.3	250	2.3
Fast Food Rest.	.7	Meal/Day	784.6	365	549.2
Sit-down Rest.	2.4	Meal/Day	340	365	816
Retail	2	Employee	1	365	2.0
Grocery	2	Employee	1.1	365	2.2
Warehouse	2	Employee	.5	250	1.0
Elementary School	.6	Person	9.5	200	5.7
Jr. High/High School	1.8	Person	9.5	200	17.1
Health	90	Patient	3.8	365	342.
Motel	20	Unit (Room)	5	365	100.0

[17] Arkansas TRM V6.1, Volume 2. Pg. 365-367
[18] Ibid

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Hotel	14	Unit (Room)	2.2	365	30.8
Other	1	Employee	.7	250	.7

Table 4-14 Hot Water Requirements by Unit or Person

Building Type	***Size Factor***	***Average Daily Demand***
Dormitories	Men	13.1 Gal. per Man
	Women	12.3 Gal. per Woman
Hospitals	Per Bed	90.0 Gal. per Patient
Hotels	Single Room with Bath	50.0 Gal. per Unit
	Double Room with Bath	80.0 Gal. per Unit
Motels	# Units:	
	Up to 20	20.0 Gal. per Unit
	21 to 100	14.0 Gal. per Unit
	101 and Up	10.0 Gal. per Unit
Restaurants	Full Meal Type	2.4 Gal. per Meal
	Dive-in Snack Type	0.7 Gal. per Meal
Schools	Elementary	0.6 Gal. Per Student
	Secondary and High School	1.8 Gal. Per Student

The Evaluators performed the TRM energy savings calculations for all rebated water heaters. The result of these calculations was verified gross savings of 2,875 Therms (108.8% gross realization).

4.3.3.3 Commercial Desk Review Findings

The Evaluators conducted desk reviews for all commercial water heating projects. The adjustments to program savings were minor (a 9.2% increase) and the Evaluators could not discern a specific trend or cause of the deviation.

4.3.3.4 Equipment Rebates Commercial Free-Ridership

Due to the low participant levels, the Evaluators applied the NTGR finding from the 2017 CenterPoint evaluation of 78.57% and 70.37% for furnaces and water heaters (respectively).

4.4 Verified Savings

Table 4-14 presents the gross savings results of the evaluation of the 2017 Equipment Rebates Program. Total gross savings summarizes the savings calculations performed by TRM protocols for residential and commercial furnaces.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 4-15 Equipment Rebates Verified Therms Savings

Facility Category	Measure Category	Expected Therm Savings	Verified Therms Savings	EUL	Lifetime Therms Savings
Residential	Furnace - Retrofit	68,579	69,733	13.24	922,818
	Furnace - NC	2,682	2,839	20	56,787
	Water Heater - Retrofit	3,495	4,071	20	81,421
	Water Heater - NC	340	413	20	8,254
	Smart Thermostat	5,132	5,074	11	55,809
Non-Residential	Furnaces	11,750	11,824	20	236,474
	Water Heaters	6,249	6,826	20	136,522
Total Gross Savings		98,227	100,780	14.87	1,498,085

Net savings for the Equipment Rebate Program were calculated using residential free-ridership rates based on prior evaluation efforts. The resulting net savings are presented in Table 4-15.

Table 4-16 Equipment Rebates Net Savings Summary

Facility Category	Free-Ridership Rate		Net Annual Savings		Net Realization Rate	EUL	Net Lifetime Therms Savings
	Ex Ante	Ex Post	Ex Ante	Ex Post			
Res Retrofit Furnaces	22.08%	27.78%	53,437	50,362	94.2%	13.24	666,459
Res NC Furnaces	35.17%	47.41%	1,739	1,482	85.2%	20	29,647
Res Retrofit Water Heaters	15.57%	25.01%	2,951	3,053	103.5%	20	61,065
Res NC Water Heaters	48.32%	54.96%	176	186	105.9%	20	3,714
Smart Thermostat	0.00%	0.00%	5,132	5,074	98.9%	11	55,809
Non-residential Furnaces	10.35%	29.63%	10,534	8,320	79.0%	20	166,407
Non-residential Water Heaters	8.00%	21.43%	5,749	5,363	93.3%	20	107,266
Overall:	18.84%	26.73%	79,717	73,840	92.6%	14.77	1,090,367

4.4.1 Non-Energy Benefits Summary

4.4.1.1 Residential Tankless Water Heaters.

Residential tankless water heaters have an EUL of 20 years. The baseline system has an EUL of 11 years. This makes the systems eligible for the Deferred Replacement

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Cost Non-Energy Benefit. This NEB was calculated using the IEM calculation tool[19]. The input assumptions were as follows:

- Full installed cost of tankless system: $1,219
- Full installed cost of baseline storage tank system: $614
- Nominal Discount Rate: 7.0%
- Inflation Rate: 2.0%
- Real Discount Rate: 4.9%

The resulting deferred replacement cost is $294.88 per unit. The calculator for this is provided in Appendix B of this report.

There were 78 residential tankless systems rebated in 2017, and the resulting DRC value is $23,000.64.

4.4.1.2 Commercial Tankless Water Heaters.

Commercial tankless water heaters have an EUL of 20 years. The baseline system has an EUL of 15 years. This makes the systems eligible for the Deferred Replacement Cost Non-Energy Benefit. This NEB was calculated using the IEM calculation tool[20]. The input assumptions were as follows:

- Full installed cost of tankless system: $1,219
- Full installed cost of baseline storage tank system: $614
- Nominal Discount Rate: 7.0%
- Inflation Rate: 2.0%
- Real Discount Rate: 4.9%

The resulting deferred replacement cost is $124.44 per unit. The calculator for this is provided in Appendix B of this report. The Evaluators used the incremental costs associated with residential tankless systems as commercial costs are aligned with systems that are 200,000 BTU or greater in capacity (and therefore use the Combustion Efficiency baseline rather than the Energy Factor). All tankless systems rebated in commercial facilities in BHE's program were below 200,000 BTU and were units that are certified for residential applications.

There were 16 commercial tankless systems rebated in 2017, and the resulting DRC value is $1,991.04.

[19] Protocol L Avoided & Deferred Replacement Cost_08_31_16.xlsx

[20] Ibid.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

4.4.1.3 Smart Thermostats

BHE did not have a savings sharing agreement with any electric utilities for this component of their portfolio, and as a result all kWh savings from this measure are being credited to the Equipment Rebates Program. The Evaluators used the same approach for calculating kWh savings as was applied in calculating Therms savings. The results are in the table below.

Table 4-17 Smart Thermostat kWh Savings Summary

Savings Type	*Annual*	*Lifetime*
Gross	69,345	762,794
Net	69,345	762,794

4.5 Conclusions & Program Recommendations

4.5.1 Equipment Rebate Program Conclusions

The Evaluators have found that:

1. **Satisfaction with the program overall is high.** Satisfaction with the program operation includes customers' interactions with BHE, satisfaction with wait times, savings realized from program participation, and ease of the application process.
2. **Participation and savings declined in comparison to 2016.** Program budget, participation, and savings declined in comparison to 2016; BHE's program budgets were reduced across the board with the new triennial plan as the new basis year for savings goals had lower sales.
3. **Smart thermostats show early promise as a program addition.** In their first year of program inclusion, smart thermostats accounted for 6.4% of program savings. This savings was achieved over a three-week period in August when the rebate offer was delivered to BHE customers.
4. **No mailer kits were distributed.** Kit distribution has begun again in 2018.
5. **New construction custom homes continued to display low NTGR.** The Evaluators reassessed the NTGR of custom new construction housing and found a NTGR of 45%, lower than in the last study (2014). Production housing has a higher NTGR (91%).

4.6 Equipment Rebate Program Recommendations

The Evaluators' recommendations for the Equipment Rebate Program are as follows:

1. **Maintain year-round offering of smart thermostat rebates.** The program provided a rebate offer for EcoBee smart thermostats in August, producing

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

significant Therms savings in a short period of time. This should be maintained as a year-round program offering.

2. **Expand eligibility list.** Elsewhere in Arkansas, there is a larger eligibility list that includes the Nest Learning Thermostat and the Honeywell Lyric. Expanding the allowed brands should increase program participation and savings.
3. **Focus new construction outreach on production models rather than custom builds.** This segment has a higher NTGR and could produce more cost-effective savings due to larger participant volume.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

5. Commercial and Industrial (C&I) Solutions Program

The C&I Solutions Program is directed at developing and incenting energy efficiency measures for commercial and industrial customers. It is implemented by CLEAResult Consulting on behalf of BHE. CLEAResult handles program administration, marketing and outreach, direct install of energy savings measures, and technical review of custom efficiency projects. Program participants are provided:

(1) No-cost direct installation of low flow faucet aerators, showerheads, and pre-rinse spray valves (PRSVs), if they have gas water heating;

(2) No-cost direct installation of door air infiltration sealing if they have gas space heating;

(3) Prescriptive incentives for commercial boilers and controls (formerly rebated through the C&I Boiler Equipment Rebates Program);

(4) Prescriptive incentives for commercial kitchen equipment (formerly rebated through the Commercial Cooking Equipment Rebates Program);

(5) $.80 per therm for custom projects for large commercial and industrial customers (greater than 200,000 CCF annually); and

(6) $.90 per therm for custom projects for commercial and industrial customers (200,000 less CCF annually).

5.1 C&I Solutions Program Overview

The C&I Solutions Program had $1,374,482 in budget allocated for 2017. The C&I Solutions Program's historical performance is summarized in Table 5-1.

Table 5-1 C&I Solutions Program Historical Performance against Goals

Program Year	# Participants		Budget		Net Therms	
	Actual	Goal	Spent	Allocated	Achieved	Goal
2011	404	790	$486,284	$637,926	500,906	451,808
2012	518	773	$836,388	$1,012,822	560,574	536,810
2013	417	723	$1,382,015	$1,410,997	954,191	805,150
2014	215	762	$1,331,924	$1,525,075	789,523	694,577
2015	385	800	$1,520,715	$1,698,848	811,600	766,630
2016	185	2,817	$1,638,167	$1,832,824	851,581	798,455
2017	157	2,344	$1,331,689	$1,374,482	714,913	713,150

The C&I Solutions Program participants fall into one of five categories:

- Direct install;
- Prescriptive boiler rebates;

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Prescriptive food service rebates;
- Custom audit recipients;[21] and
- Closed custom projects.

Total net Therms and share of program savings by channel are summarized in Figure 5-1.

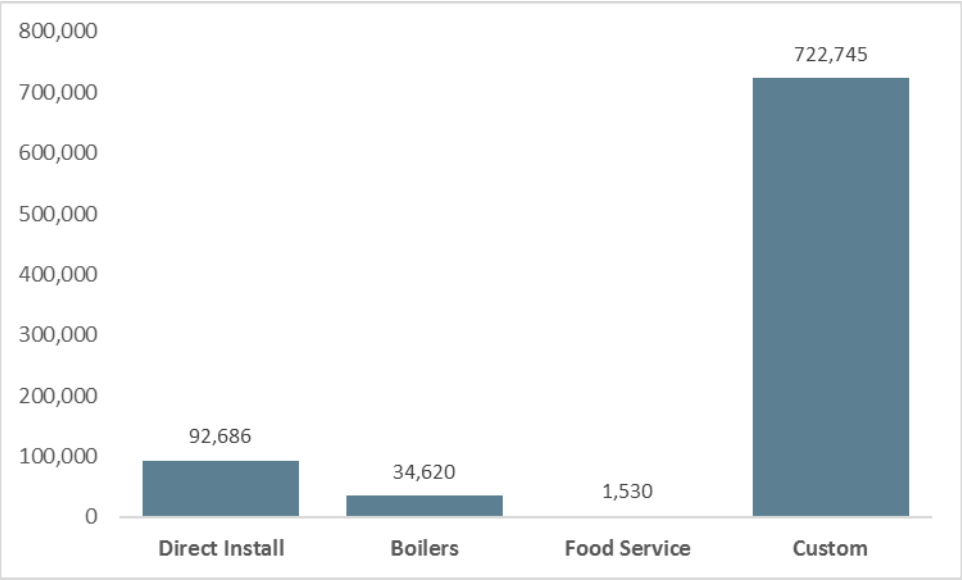


Figure 5-1 Total Net Therms by Program Channel

These participants are detailed in the subsections to follow.

5.1.1.1 Direct Install Participation Summary

In 2017, there were 137 direct install measures[22] installed at 51 unique premises. The summary of participation by facility type and the relative share of program Therms savings are summarized in Figure 5-2.

[21] The Evaluators tally audit recipients but do not count them towards Black Hills Energy' participation goal.
[22] "Measure" in this context means "measure category"; i.e., if a facility received showerheads and aerators it is counted as two measures.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

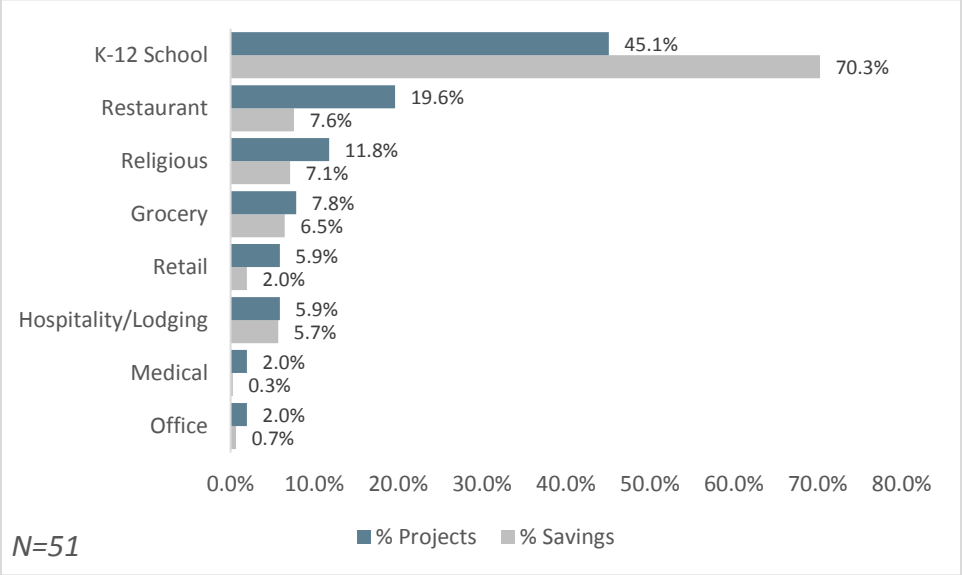


Figure 5-2 BHE Direct Install Participation Summary

Similarly to 2016, K-12 schools comprise the bulk of participation and savings from direct install. Figure 5-3 summarizes the timing of direct install savings, listing the volume of Therms savings by month. This chart is reflective of the amount of annual savings from projects installed in each month.

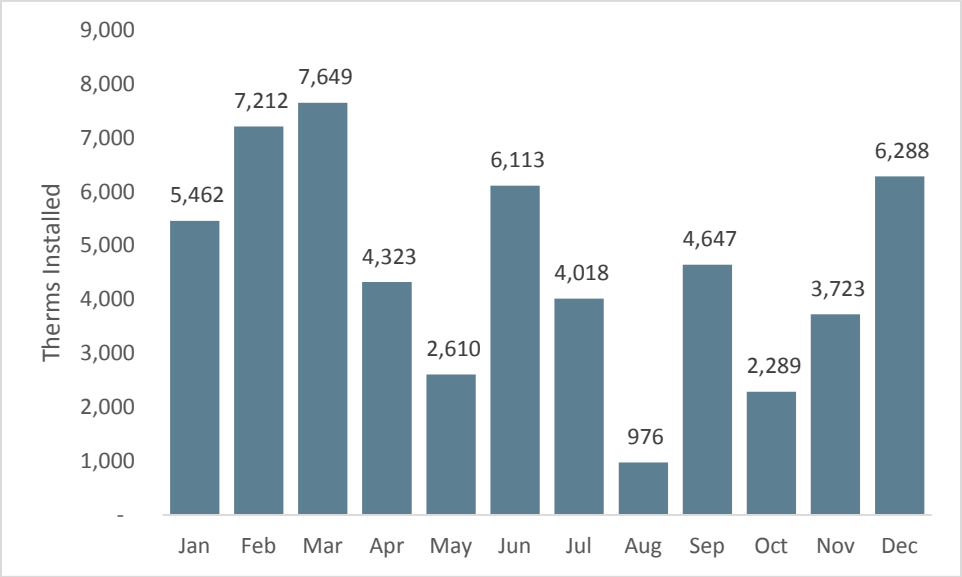


Figure 5-3 C&I Solutions Direct Install Monthly Therms Savings

5.1.1.2 Closed Custom Project Participation Summary

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-2 summarizes the completed custom projects for the program. Closed custom projects are projects that have been verified by the evaluator and an incentive has been issued by the implementer.

Table 5-2 Custom Project Participation Summary

Facility Type	Project ID	Measure	Verified Savings
Industrial	BHE-CIS2017-001	Condensate Return	17,305
		Insulation	8,136
		Steam Trap Replacement	30,835
Medical	BHE-CIS2017-002	Steam Trap Replacement	103,366
		Steam Leak Repair	32,604
Medical	BHE-CIS2017-004	Steam Trap Replacement	33,270
		Steam Leak Repair	17,359
		Insulation	348
Industrial	BHE-CIS2017-005	Steam Trap Replacement	72,228
Food Processing	BHE-CIS2017-006	Steam Trap Replacement	114,481
		Steam Leak Repair	33,830
		Insulation	26,748
Industrial	BHE-CIS2017-007	Steam Trap Replacement	36,995
Food Processing	BHE-CIS2017-008	Steam Trap Replacement	79,576
		Insulation	13,865
Industrial	BHE-CIS2017-009	Steam Trap Replacement	11,873

In addition, the program provided smaller-scale project rebates to laundry and hotel facilities.

Laundry facilities were targeted for steam trap replacement and steam leak repair projects. This was part of a larger effort by the program implementation team for the three Arkansas gas utilities. For BHE, this resulted in:

- (3) laundry facility steam trap/steam leak retrofits; and
- 10,035 annual gross Therms savings.

Hotel facilities were targeted with two program offerings:

1) **Dry Smart Controllers.** These controllers are an after-market moisture sensor for commercial clothes dryers that curtail dryer usage.
2) **Water Pump Controllers.** For these projects, controls were placed on water pumping systems in hotels that were in the baseline configuration providing constant water circulation. This results in excess heat loss in the piping. The controllers provide hot water when demanded in the guest rooms and common areas, reducing heat loss in the pipes.

The hotel outreach resulted in:

- (7) hotel facility retrofits; and
- 13,517 gross Therms savings.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

5.1.1.3 Prescriptive Boiler Rebate Summary

In 2017, the program rebated three HVAC boilers. Two boilers were in a university and one boiler was in a religious facility. The total savings from these projects was 6,267 Therms.

5.1.1.4 Prescriptive Cooking Equipment Rebate Summary

In 2017, there were four fryers rebated at once facility, totaling 1,728 gross Therms.

5.2 C&I Solutions Process Evaluation

The Evaluators conducted a formal process evaluation of the C&I Solutions Program in 2012 and targeted process evaluation activities in 2013 and 2014, and found that the program was successful in meeting participation, savings, and satisfaction goals. Table 5-3 and Table 5-4 summarize the Evaluators' review of the C&I Solutions Program in comparison to TRM V6.1 Protocol C for timing and conditions of conducting a process evaluation.

Table 5-3 Determining Appropriate Timing to Conduct a Process Evaluation

Component	Determination
New and Innovative Components	No. The program operates in the same manner as 2015.
No Previous Process Evaluation	No. The program received a comprehensive process evaluation in 2012 and partial process evaluations in 2013 and 2014.
New Vendor or Contractor	No. The program has been implemented by CLEAResult since 2011.

Table 5-4 Determining Appropriate Conditions to Conduct a Process Evaluation

Component	Determination
Are program impacts lower or slower than expected?	No. The program met savings goals in 2015 and 2016.
Are the educational or informational goals not meeting program goals?	No. The program has an established trade ally network.
Are the participation rates lower or slower than expected?	No. The program met participant goals in 2015 and 2016.
Are the program's operational or management structure slow to get up and running or not meeting program administrative needs?	No. The 2012 process evaluation found that operational and management structure to be up to speed and efficient in administering the program.
Is the program's cost-effectiveness less than expected?	No, the program's cost-effectiveness vastly exceeded expectations.
Do participants report problems with the programs or low rates of satisfaction?	No. Participant surveys found exceedingly high satisfaction levels.
Is the program producing the intended market effects?	Yes. Interviews with participants and trade allies have shown market transformation is occurring.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Due to the time elapsed since the last process evaluation, a process evaluation was conducted in 2017.

5.3 Data Collection Activities

The process evaluation of the C&I Solutions Program included the following data collection activities:

- *Program Actor In-Depth Interviews*. The Evaluators conducted in-depth interviews with a series of program actors. These interviews covered a range of topics, including marketing efforts, feedback on program delivery, an assessment of barriers to program implementation and success, and recommendations for program improvement. Program Actors interviewed include:
  - *BHE Program Staff*. The Evaluators interviewed staff at BHE involved in the administration of the C&I Solutions Program. These interviews built upon interviews conducted in 2016, keeping apprised of BHE's involvement as the C&I Solutions Program develops.
  - *Third Party Implementation Staff Interviews.* The Evaluators conducted interviews with CLEAResult involved with the C&I Solutions Program. These interviews addressed the development of the program over the 2017 program year as well as CLEAResult's perspective on a variety of implementation issues, including conversion of audits to completed projects and the process flow for direct install and custom projects.
- *Participant Surveying*. A census of custom participants was surveyed for this evaluation effort. These surveys included net-to-gross and process issues. The surveys provided valuable data for this process evaluation effort, providing participant feedback as to their program participation, recommendations for program improvement, and insight into the decision-making process.

Table 5-5 summarizes the data collection for this process evaluation effort. This includes the titles, roles, and sample sizes for data collection.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-5 BHE C&I Solutions Data Collection Summary

Target	Component	Activity	N	Role
BHE Program Staff	Manager, Energy Efficiency	Interview	1	Overall administration of BHE the larger strategic decisions associated with the DSM portfolio, and is involved with the C&I Solutions Program in the overall coordination of utility resources.
CLEAResult Staff	Program Manager	Interview	1	The Program Coordinator handles day-to-day operations, including tracking of outreach and implementation activities, payments for direct installation, and interfacing with Evaluation staff.
Program Participants	Custom Participants	Survey	7	Custom participants received a semi-structured interview at the beginning of a project and a structured survey at the close. The Evaluators interviewed a census of participants
	Direct Install Participants		11	Direct install participants received no-cost installation of faucet aerators, pre rinse spray valves, low flow showerheads, and weather stripping.
	Prescriptive Participants (Steam Traps)		9	This survey was completed with small business steam trap participants. It was a collection of (8) CenterPoint customers and (1) AOG customer, with the goal of developing NTGR estimates and providing feedback for three Arkansas gas utilities. This was aggregated among the three companies due to low participation levels.

5.3.1 Process Results & Findings

This section will present the results and key findings from the data collection activities. These findings are based upon interviews with utility staff, implementation staff, and surveys with participants.

5.3.1.1 Response to Program Recommendations

No process evaluation recommendations were made in 2016.

5.3.1.2 Program Theory & Design

The C&I Solutions Program was designed to provide outreach in hard-to-reach sectors of the C&I markets. The main bullets below list program activities and their expected outcomes as determined through the 2012 and 2013 process evaluations. The secondary bullets indicate new program enhancements.

- **Direct installation of high-return measures.** The C&I Solutions program provides no-cost direct installation of weather stripping, low flow faucet aerators, pre-rinse spray valves, and showerheads. These measures have a high return of savings relative to their cost and as such can be provided free-of-charge and remain cost-effective. The provided savings are unlikely to occur absent the

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

program; generally, if a respondent does not already have the equipment in place, the direct install activities induce an action that was not planned. It is also the intention that these activities will serve as an introductory teaser to energy efficiency for the recipients, and that they will then be further interested in participating in the custom component of the program.

- **Energy audits to medium and large customers.** These audits are conducted by CLEAResult staff, providing recommendations for energy efficiency improvements and an audit report. These audits are intended to generate the bulk of the program savings, yielding high-return custom projects.
- **Incentives for custom measures.** The C&I Solutions Program provides $0.80 per Therm for verified savings from custom projects. These projects may be driven by a program-funded audit, generated by a trade ally, or be customer-directed.
    - **Incentives for prescriptive measures in C&I Solutions.** This includes boiler and food service equipment at fixed incentive rates.
    - **Enhanced outreach to small business customers with sizable gas loads.** Customers with usage below 200,000 Therms annually qualify for $.90 per therm incentives.
- **Incentives for prescriptive measures.** C&I Boiler Equipment Rebates and Commercial Cooking Equipment Rebates were folded into C&I Solutions in the past two years. Prescriptive rebates for qualifying equipment are still advertised in the same manner and customer-facing material has not changed.
- **Referral to Equipment Rebate Program.** There are instances where the CLEAResult audit identifies energy savings opportunities that qualify for a prescriptive incentive from the above-mentioned program. In these instances, the project is referred to the program and savings are not credited to the C&I Solutions Program.

5.3.1.3 Program Administration

The C&I Solutions Program is overseen by the Manager of Energy Efficiency at BHE. This manager's responsibilities primarily include interfacing with CLEAResult, who directly implements the program. Other activities by this manager include providing updated customer lists to CLEAResult to better facilitate their implementation, review of custom applications, and at times assisting CLEAResult in customer interactions.

For CLEAResult, the program overall is led by the Senior Program Manager, who oversees the implementation of the C&I Solutions Program for all three Arkansas natural gas utilities. This manager handles high-level issues across the programs,

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

including regulatory compliance and reporting, as well as some level of intervention on the larger projects.

Much of the day-to-day activity is handled by the Program Coordinator. The Program Coordinator reviews direct install and audit activity, handles billing and administration with BHE, and coordinates with the Evaluators in facilitating EM&V activities.

Direct install and audit activities are run by Energy Engineers and Field Engineers. These engineers oversee crews that perform direct installation and conduct the energy audits. Additionally, their responsibilities include development of the audit report and recommendations, and following up with the customer to gauge interest in completing a project.

5.3.1.4 Program Implementation and Delivery

Throughout the program year, CLEAResult would provide the Evaluators with updates regarding their pipeline of custom projects. The Evaluators were provided with monthly updates, listing the full scope of facility audits, expected savings with associated recommended measures, and what stage the project was in. These stages are:

- *Pipeline*. Projects listed as Pipeline are in the first phase of involvement in the Commercial & Industrial Solutions Program. These participants are customers that have discussed the possibility of a facility audit and indicated interest to CLEAResult. These facilities will receive a Pre-Inspection at a later date and have not signed a project application.
- *Pre-Inspected*. Projects listed as Pre-Inspected are in the phase where CLEAResult has completed a facility audit. During these audits, CLEAResult conducts a comprehensive review of the facility's systems and operational practices. On this basis, CLEAResult then formulates initial recommendations for energy efficiency improvements. These are discussed with facility staff during the audit in order to address the feasibility of recommended measures.
- *Pre-Installation Calculation*. At this phase, CLEAResult is compiling high-level data needed to provide an initial estimate of energy savings. This step of the process compiles the information collected in the site audit, which are then used in the development of an Audit Report.
- *Audit Report Complete*. In this phase, feasible measures from the Pre-Inspection are compiled into a formal audit report, providing the participant with further detail as to the scope of the project, initial savings estimates, associated incentives, expected project costs, and the payback period of the measure. Additionally, should the measure provide operational benefits to the facility (such as improved comfort or product reliability), these are included as well to provide the customer

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

with a full scope of the benefits of the project. This report is provided at no cost to the participant.

- *Project Agreement*. At this point, the customer has informed CLEAResult and BHE that they intend to install a program-recommended measure. When this occurs, CLEAResult then involves the evaluators. CLEAResult provides the evaluators with an M&V plan for the facility, detailing the project scope and proposed data collection and analysis. The evaluators' engineering staff then reviews the M&V plan and makes recommendations for any changes needed. If this revises the savings amount, the reserved incentive amount in the application is revised. A project agreement is then signed, in which the reserved incentive amount is detailed and reflects edits made by the evaluators.
- *Post-Inspection*. This phase marks the completion of post-inspection for an installed measure. CLEAResult has, at this point, post-inspected a measure and revised savings accordingly if the installed project differs from the proposed project. At this point, 60% of the reserved incentive is paid to the customer.
- *M&V*. M&V marks the phase when post-installation data is collected for an installed project to allow for calculation of a final savings estimate, from which the remaining incentive to the customer is determined. There are some measures that do not require post-retrofit data; for such measures, the M&V phase is short and requires completion of calculations based upon inputs verified during the Post-Inspection. For facilities that require post-installation data, the data collection period can range from 30 days to 6 months.
- *Complete*. Facilities marked as Complete have received their full incentive. As stated prior, 40% of the reserved funds for the incentive are available to pay the remaining incentive amount owed to the customer. If the verified savings are below the Project Agreement savings, the customer's incentive is reduced accordingly, so as to keep incentive levels at $.80/Therm. If the verified savings are higher than the Project Agreement amount, CLEAResult and BHE determine if there are available incentive funds left for the program year. If the program has remaining funds, the customer receives a total incentive higher than the initial agreement. If no remaining funds are available, the customer's incentive is capped at the Project Agreement amount.

The process flow for the C&I Solutions Program is displayed in the figure below.

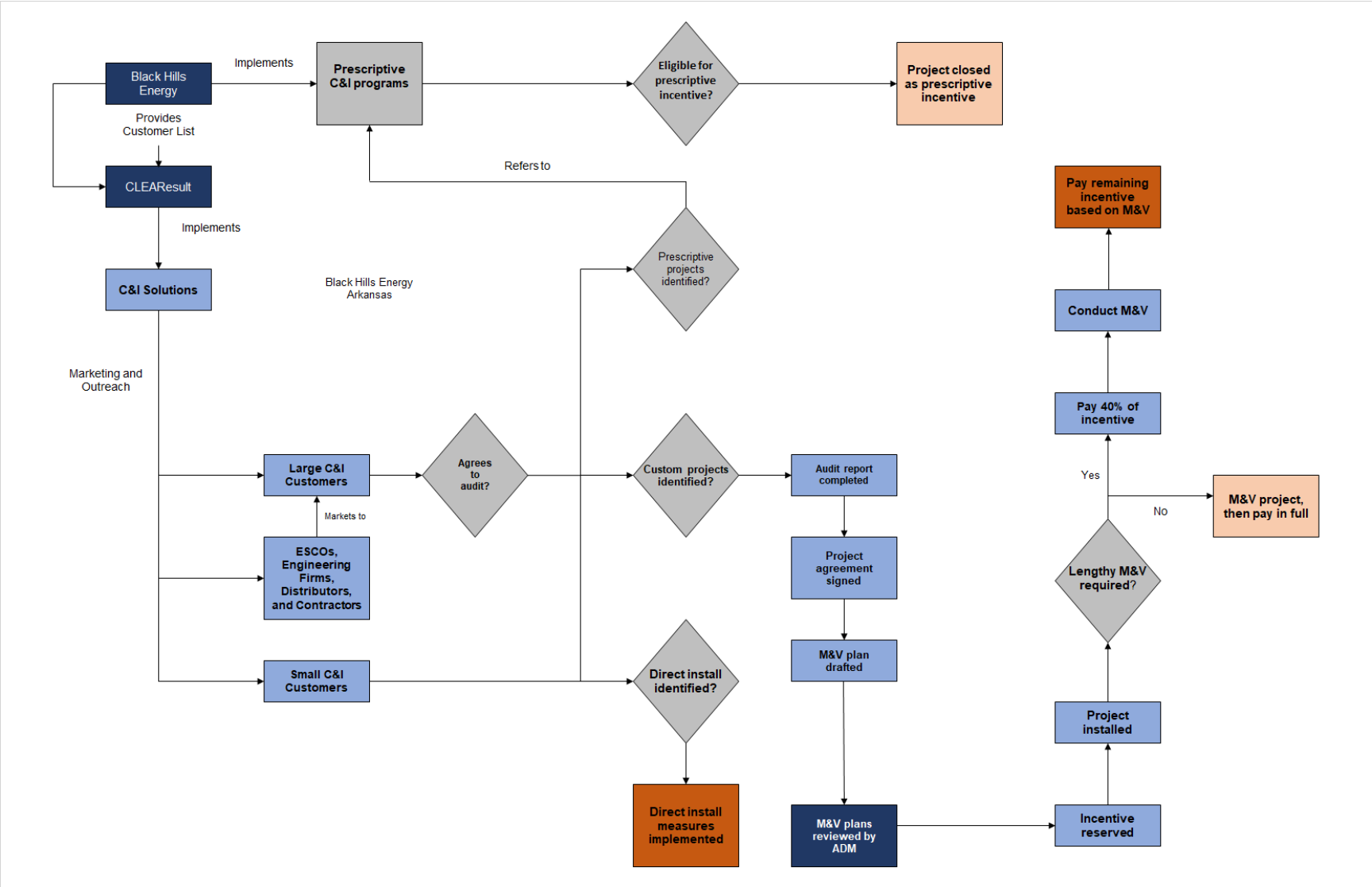


Figure 5-4 C&I Solutions Process Flow

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd. 5/1/2018 8:13:20 AM: Docket 07-078-TE-Doc. 321

5.3.2 Adherence to Protocol A

The CLEAResult tracking system contained full detail with project addresses, contact information, and measure inputs. Further, the tracking system provided the Therms savings for each line item.

During PY2017, the Evaluators received monthly tracking data updates as well as final tracking exports. The tracking system was updated to include necessary inputs as per AR TRM V6.1. Other than these updates, there were no major updates to the structure or content of program tracking data. The Evaluators previously reviewed program tracking data in PY2017 to assess its compliance with Protocol A of the AR TRM V6.1 which specifies that tracking data should be checked for:

- Participating Customer Information;
- Measure Specific Information;
- Vendor Specific Information;
- Program Tracking Information;
- Program Costs; and
- Marketing & Outreach Activities.

The Evaluators conducted a review of each of the above factors within PY2017 tracking data except for marketing and outreach activities as these are outside the scope of the tracking system's reporting.

Customer, Premise, Cost, and Vendor Information

Each of these factors was assessed individually based on the guidelines stated in AR TRM V6.1. Overall, the Evaluators conclude the following regarding tracking data completeness:

- Participating customer information was complete for nearly all participants.
- Custom and prescriptive projects contained complete information on the contractor that completed the installation. This was not needed for direct install as this is done in-house with CLEAResult staff.
- Tracking data included the measure and project costs for each project.
- Weather zones were provided in the tracking data.
- All inputs needed to re-calculate savings according to TRM V6.1 protocols were present in the direct install database.

Measure Specific Information

The content of tracking data was found to include sufficient information for all measures in PY2017.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

5.3.1 Direct Install Survey Response

The Evaluators surveyed 11 respondents from the direct install component of the C&I Solutions Program. These respondents received low flow devices including faucet aerators, showerheads, and pre-rinse spray valves and weather stripping. Table 5-6 summarizes the titles of the survey respondents.

Table 5-6 C&I Solutions Direct Install Respondent Titles

Title of Survey Respondent	
Facilities manager	9.1%
General Manager	45.5%
Owner	27.3%
Administrative	18.2%
n=11	

5.3.1.1 Program Awareness

Of the 11 respondents surveyed, 63.6% indicated having been directly contacted by a BHE representative about the program. Other sources of awareness indicated by respondents included friends and colleagues.

5.3.1.2 Program Participation

Respondents were asked several questions regarding their decision-making to participate in the program. Respondents were first asked for each of the types of direct install equipment they received if they (1) ever installed similar equipment in the past, (2) planned to install this equipment prior to participating in the program, and (3) would be financially able to install this equipment without the program. Respondents indicated that the cost barrier to this equipment is very low; the impact of the program on decision-making appears to be in advancing projects that would otherwise be forgotten about or deprioritized, rather than in inducing projects that are financially out of reach.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

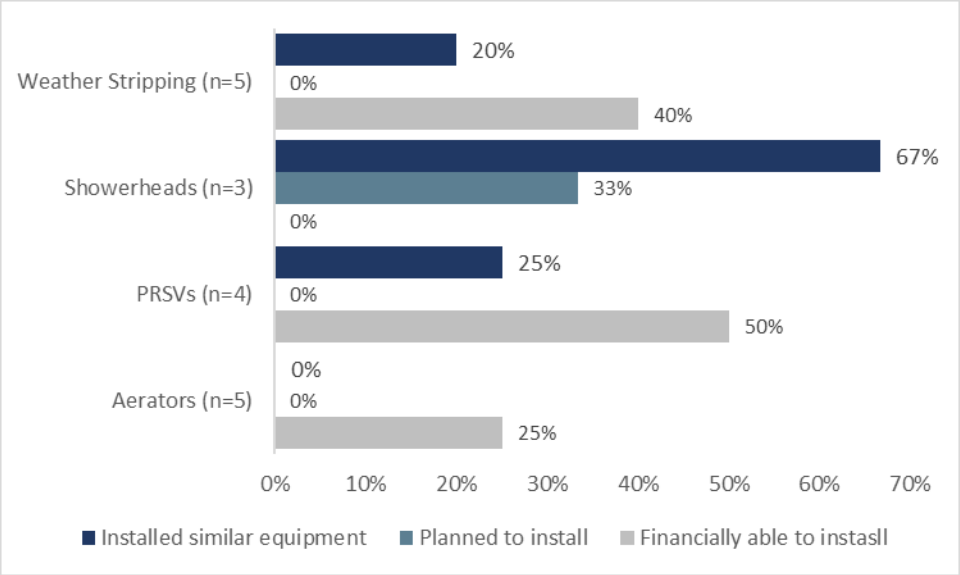


Figure 5-5 Past Experience & Future Plans with Direct Install Measures

Those that indicated that they had plans to install similar equipment were asked if they were likely to do so if it was not provided through the program. Respondents that were asked this both indicated that they would not have installed this equipment.

Eighteen percent of respondents had participated in BHE programs in prior years, and these respondents stated that their experience with BHE was “somewhat important” in their decision to participate in the C&I Solutions direct install program.

Lastly, respondents were asked to state how likely they would be to install similar equipment in the absence of the program. Their responses are summarized in Figure 6-6 below.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

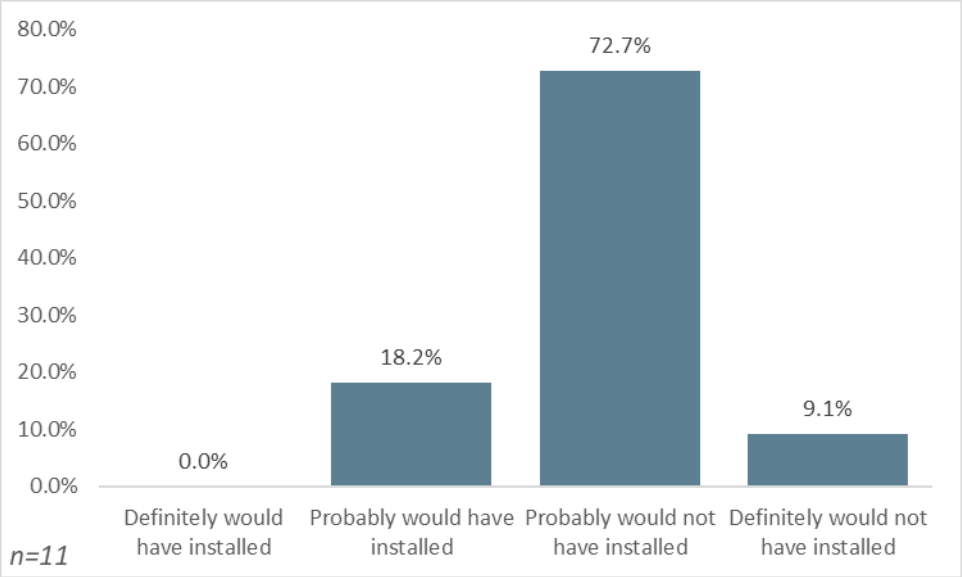


Figure 5-6 Likelihood of Installation without the Program

5.3.1.3 Program Satisfaction

Participants were asked to rate their satisfaction on a scale of 1-5, with 1 meaning "Very Dissatisfied" and 5 meaning "Very Satisfied" on a range of items related to their program experience. Table 5-7 tabulates the satisfaction results.

Table 5-7 C&I Solutions Direct Install Satisfaction Levels

Element of Program Experience	***Mean Score***	***Don't Know***
How long it took program staff to address your questions or concerns	4.90	9%
How thoroughly they addressed your questions or concerns	4.90	9%
The steps you had to take to participate in the program	4.90	9%
The range of equipment offered by the program	4.56	18%
The program overall	4.89	9%
n=11		

Overall satisfaction with the C&I Solutions Direct Install program is very high, with a score of 4.89. Respondents indicated markedly high satisfaction levels with all factors.

The respondents were asked for any comments or suggestions about energy efficiency programs or programs specific to commercial facilities. There were several positive comments including references to the improvement of the comfort of the facility with new weather stripping and how easy it was to participate.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

5.3.2 Custom Project Survey Response

The Evaluators conducted interviews with the seven decision-makers responsible for the completed custom projects in the C&I Solutions Program in 2017. Given the small number of interviews, reporting data in terms of percent response by question does not adequately present the participant response to the program. The Evaluators opted to present the results in terms of individual case studies, rather than aggregated survey responses.

BHE-CIS2017-001, 009: The participant is an industrial facility that received incentives for steam trap replacement, steam leak repair, and the installation of a condensate return system. They stated that they had in the past been able to complete steam trap replacement projects because they had an agreement with a vendor that the trap survey would be free if they agreed to purchase the vendor's product. They indicated that the vendor revoked this deal, and that the facility did not have the funds to pay for the survey to identify failed traps. They had attempted to secure this funding and it was rejected. They were then presented the program rebate offering from a steam trap trade ally, which allowed the replacement to go forward. The respondent noted that "*they just didn't give me the option. I was not expecting that, and we didn't have any room on the budget or plans for the costs".* The trap survey was sponsored by the C&I Solutions Program, during which other savings opportunities for steam leak repair and the improvement of the condensate return system were identified.

BHE-CIS2017-003: The participant is a medical facility which received incentives for steam trap replacement and steam leak repair. The respondent stated that while they do their own maintenance and steam trap replacement, they have not ever had a full steam system survey prior to this project. They respondent noted: *"I'm the plumber and the boiler operator of the facility. I've known there's major issues with our steam system, but I can't on my own get them all found. So when they did the survey they found a lot of problems I didn't know existed. We've never done a survey or anything like that. Just had the maintenance personnel taking care of what they could when they knew there was a problem".*

BHE-CIS2017-004: The participant is a medical facility which received incentives for steam trap replacement, steam leak repair, and insulation improvements. They have received numerous program-funded audits since 2013. The facility manager noted that the repeated efforts from CLEAResult to engage them in person primary drove them to act on the retrofit. The respondent noted: "*they would give me all the flyers, all the info. But it's little different when someone steps up to your face and says, 'hey! This is available!', and shows you just how much money you're leaving on the table. If the guy will come face-to-face, saying 'I'm here to save you money', well, I take it seriously. They did exactly that, and then we made the room for the project".*

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

BHE-CIS2017-005: The participant is an industrial facility that received incentives for steam trap replacement. The company that owns that facility had another location participate in a gas rebate program elsewhere in Arkansas in prior program years, and the staff from this location relayed their experience with the program to this location. This resulted in a pogrom-funded site audit and referral for a formal steam trap survey.

BHE-CIS2017-006: The participant is a food processing facility that received incentives for steam trap replacement, steam leak repair, and pipe insulation. This facility has participated in multiple projects in each of the past three program years as part of ongoing improvements to their steam system.

BHE-CIS2017-007: The participant is an industrial facility that received incentives for steam trap replacement. The facility staff have an energy consultancy developing projects in coordination with CLEAResult under the restriction of a maximum payback period of two years. The program incentives were necessary to bring the steam trap replacement within their allowed payback criterion.

BHE-CIS2017-008: The participant is a food processing facility that received incentives for steam trap replacement. They facility had never received a formal steam trap survey from an outside contractor prior to this project, and that long-failed traps were found through this formal survey. The management staff noted: *"we do replace steam traps when we see that they're failed. But if we learned anything from the audit, we learned we're not nearly as thorough as we think or would like to be".*

The Evaluators noted a common theme among many participants: The C&I Solutions Program is providing opportunities for facilities that are behind in maintaining their systems to bring them back to rated efficiency. Respondents to the Evaluators' survey efforts have often stated a lack of internal support for more than the most basic or cursory practices in system optimization and maintenance, and the program has filled this gap through financial incentives and through an ongoing relationship with program trade allies whom provide auditing services at a reduced cost or free-of-charge knowing there's a large pipeline of projects available through being active in the program.

5.3.3 Prescriptive Steam Trap Survey Response

The Evaluators conducted a separate survey for prescriptive steam trap participants. This survey aggregated participants from the CenterPoint and AOG programs (no Black Hills Energy customers were included as at the time of the survey they did not have qualifying projects for this survey). The survey responses included (8) CenterPoint Energy Arkansas participants and (1) AOG participant. These responses were aggregated for program feedback and NTGR assessment.

All nine respondents are retail dry cleaning and laundry facilities, serviced by a small hot water boiler. The decision-making for these projects came directly from facility owners

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

or proprietors. All projects in this survey qualified as small businesses (< 200,000 Therms). However, instead of a $.90/Therm incentive, they received a fixed rebate of $300 per trap.

5.3.3.1 Program Awareness

Respondents were first asked to identify how they became aware of the program. The key sources of program awareness were vendors and contractors (25%) and utility representatives (25%). The responses are summarized in Figure 5-7.

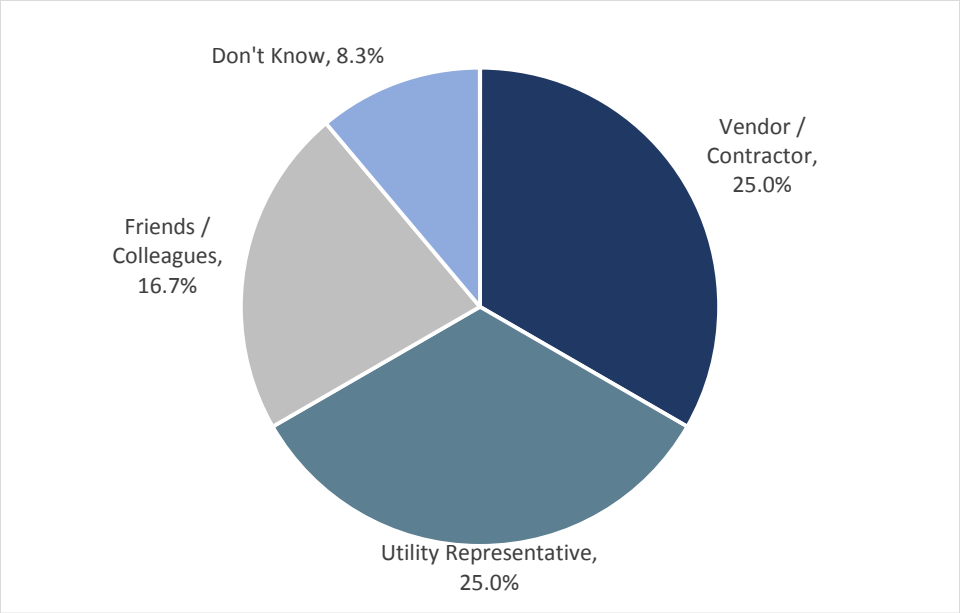


Figure 5-7 Sources of Program Awareness for Steam Trap Retrofits (n=9)

Respondents were asked to verify the quantity of steam traps replaced. Eight of the nine survey respondents confirmed that the tally shown in program tracking aligned with their recollection of the retrofit. One respondent stated that they could not remember how many steam traps were replaced.

Six of the nine respondents were able to identify how many steam traps their system has in total. On average, survey respondents had 19 steam traps in their steam system and replaced 7.5 steam traps through the program. Respondents were then asked to identify how long it has been since their steam system was inspected. The time elapsed is summarized in Figure 5-8. Eleven percent of respondents had a steam trap inspection completed within the last year. A large share of respondents (33.3%) could not recall at all when they last had their steam traps inspected.

Respondents were also asked to identify when the last time they had steam traps replaced. One third of respondents had replaced at least one steam trap in the past year. Respondents indicated that they would request replacement for a steam trap

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

when they noticed an obvious failure but that the formal inspection revealed greater need for replacement than they had anticipated.

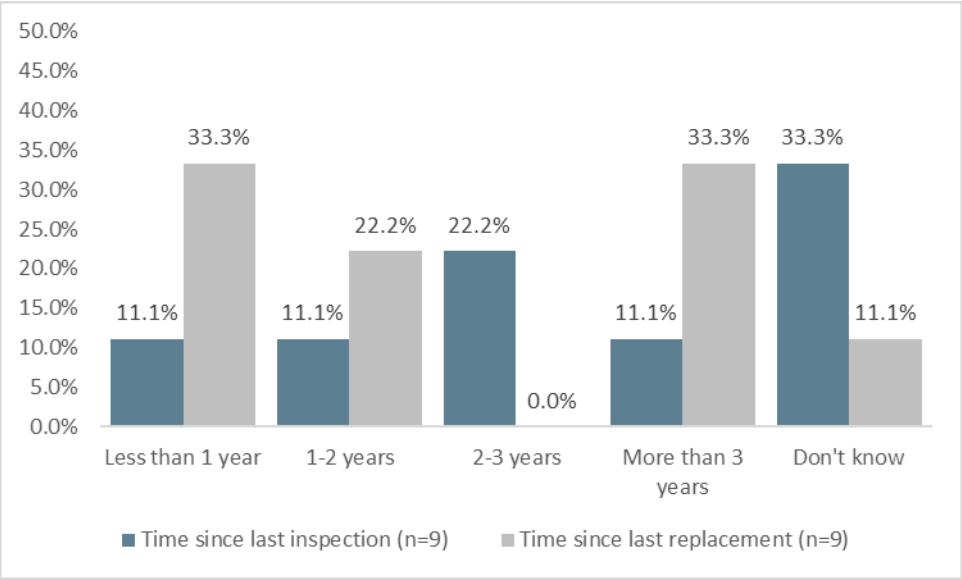


Figure 5-8 Time Elapsed since Last Steam Trap Inspection or Replacement

5.3.3.2 Contractor Experience

Two-thirds of respondents stated that their contractor contacted them with a cold-call, specifically selling the program offering. One third of respondents stated that they were referred to the program by a colleague that participated in the program. This demonstrates effective peer-to-peer marketing within the dry cleaning and laundry industry, as well as effective sales outreach by the program trade allies. All respondents indicated that they have never worked with the contractor prior to this project. This is an important performance metric, as for programs that offer what could be perceived as a "maintenance" project (steam traps, steam repair, or equipment tune-ups) there is a common concern that trade allies will bring the program to their current customers that they have on a maintenance contract. There were no instances of this being reported in the survey, and this is a key indicator that the program is bringing enhanced maintenance practices to this market segment.

In addition to this, two thirds of respondents stated that they were not thinking about steam trap replacement until contacted by a program contractor. These two thirds were the same two thirds that reported being contacted via cold-call; the other one third that learned of the program from a referral by a colleague stated that they learned of the program "while searching for options" about steam traps.

5.3.3.3 Impact of Financial Incentive

Respondents were mixed in assessing the impact of the program's financial incentive on their decision-making. Fifty-five percent of respondents reported that they had noted

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

a decrease in system efficiency leading up to the retrofit. Further, 44% stated that they "definitely would install" and 22% stated that they "probably would install" steam traps without a program incentive. However, 67% of respondents stated that the incentive moved up their timeline for installation by more than one year.

5.3.3.4 Participant Satisfaction

Respondents reported high satisfaction with the program in all components addressed by the survey. The survey included questions pertaining to interactions with program staff but no respondents reported speaking to BHE or CLEAResult staff over the course of their participation.

Table 5-8 C&I Solutions Prescriptive Steam Trap Satisfaction Levels

Element of Program Experience	***Mean Score***	***Don't Know***
The steps you had to take to participate in the program	4.89	0%
The amount of time you had to wait to receive your rebate	4.83	22%
The range of equipment offered by the program	4.63	11%
The program overall	4.89	0%
n=9		

When asked if they had any additional questions, most respondents did not report further comment. Those that did were all positive endorsements of the program:

"It's wonderful and I'm 100% satisfied"

"You guys did a good job"

"They're very professional on both ends"

5.4 Program Rebate Benchmarking

Table 5-9 summarizes a comparison of rebate offerings between BHE and utilities in other states.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-9 Rebate Benchmarking

Rebate Time	BHE	Nicor Gas	Consumers Energy	Vectren Indiana	Public Service of CO
Steam Trap Rebate	$300	$300	$100	$250	$250
Condensing (95%) Boiler	$2000	$2500	$900	$2500	$3500
Modulating Burner	$1000	NA	$800	NA	$750
Fryer	$500	$500	$500	$500	NA
Convection Oven	$400	$400	$500	$3.50	NA
Combi Oven	$1500	$900	$1800	$900	NA
Coveyor Oven	$1000	$1000	$400	NA	NA
Rack Oven	$1500	$1400	$1600	NA	NA
Custom Rebate	$.80	$.60-$.80	$.80	$1.00	$.50
Small Business Custom	$.90	$1.00	$.80	$1.00	$.50

BHE rebates for custom and small business custom incentives are in line with then benchmark utilities. Prescriptive rebates are in line as well. Some utilities offer higher incentives for HVAC boilers, but this is not uncommon in regions with a high space heating load.

5.4.1.1 Assessment of the Laundry Facilities Steam Trap Initiative

This initiative was a modest success in 2017, with three projects and 10,035 Therms savings. The Evaluators reviewed this offering to determine where it stands compared to benchmarks and to identify other areas for program improvement.

Based on the benchmark of incentives identified in Table 5-9, the Evaluators conclude that BHE's incentives are in line with benchmark utilities.

The program's greatest success has been in generating new leads for the contractors, who completed projects with laundry facilities with whom they had no prior relationship. This is an opportunity for expanded program offerings, with measure opportunities including:

- Boiler tune-up;
- Burner replacement/boiler controls;
- Steam & hot water line insulation; and
- Steam leak repair.

The trade allies that provide steam trap replacement services do not provide most of the other services specified; BHE should work with its trade allies to develop a referral initiative to contractors providing other services, as many of the services identified here could be provided as a "comprehensive maintenance package". At present time, steam leak repair and steam line insulation are not eligible for prescriptive incentives in the Arkansas TRM. However, the Evaluators conclude that an interim "partially-deemed"

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

mechanism is viable for these projects and would advise BHE to work collaboratively with the Evaluators and with the IEM in developing such a process

5.5 C&I Solutions Impact Evaluation

The impact evaluation of the C&I Solutions Program included the following:

- *Custom Project M&V.* The Evaluators conducted project-specific M&V on a census of custom projects completed through the C&I Solutions Program. Each project included an M&V plan and a project-specific report. The reports are provided in Appendix A.
- *Free-Ridership Estimation.* A free-ridership rate for DI participants was estimated through participant surveying. Respondents were asked a series of questions related to their past experience with the appropriate measures, whether they had ever installed similar equipment at the participating premise or at other premises within their organization, and whether they knew of the potential savings from the DI measures prior to participating. Given the types of measures covered by the DI component, the free-ridership rate is essentially focused on to what extent participating organizations had policies in place to install such equipment anyway. If such policies were not in place, then the installation of the equipment is generally considered to be program-induced.
- *Participant Spillover.* Spillover was addressed for two customer classes: Participants and Partial Participants. Participants were surveyed for free-ridership and process evaluation, and over the course of that survey are asked a series of questions addressing whether the C&I Solutions Program induced them to install other energy efficient equipment without program incentive. Additionally, the Evaluators asked these customers for an estimate of savings that they expect from these measures. This was supplemented with Partial Participant Surveying. Partial Participants are defined as those which received a facility audit and measure recommendations (with associated savings estimates). Samples of these participants were interviewed, and over the course of these interviews were asked if they installed any measures recommended through the program without having signed a Project Application or receiving an incentive.

Table 5-10 summarizes the NEBs credited to the C&I Solutions Program.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-10 C&I Solutions Non-Energy Benefits

Measure	Electric Savings	Water Savings	Propane Savings	Deferred Replacement Cost
Faucet Aerators		✓		
Low Flow Showerheads		✓		
Weather Stripping	✓			
Steam Trap Replacement		✓		
Steam Leak Repair		✓		
Condensate Return		✓		

5.5.1.1 Direct Install Energy Savings Calculations

The TRM V6.1 includes commercial faucet aerators, low flow showerheads and pre-rinse spray valves, weather stripping, and the evaluation of the C&I Solutions Program incorporated these deemed values. They are detailed in the subsections to follow.

Faucet Aerators

Deemed savings calculations for direct install faucet aerators were based upon:

- Rated flow of installed aerators;
- Usage by facility type; and
- Water temperature setting by facility type.

Savings are calculated as follows:[23]

$$Annual\ Therms\ = [(F_B * U_B) - (F_P * U_P) * Days * (T_H - T_C) * C_H * C_G / Eff_G]$$

$$Peak\ Therms\ = P * [(F_B * U_B) - (F_P * U_P) * (T_H - T_C) * C_H * C_G / Eff_G]$$

The inputs for this equation are defined in Table 5-11.

[23] Arkansas TRM V6.1, Volume 2. Pg. 368-371

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-11 DI Aerator Savings Calculation Parameters

Parameter	Description	Value
F_B	Baseline Flow Rate (GPM)	2.2
F_P	Post Flow Rate (GPM)	≤ 1.5
Days	Annual operating days for the facility[24]	
	Prison	365
	Hospital, Nursing Home	365
	Dormitory	274
	Multifamily	365
	Lodging	365
	Commercial	250
	School	200
T_C	Average supply (cold) water temperature (deg. F)	Zone 9: 65.6
		Zone 8: 66.1
		Zone 7: 67.8
		Zone 6: 70.1
T_H	Average mixed hot water temperature (deg. F)	105
U_B	Baseline water Usage Duration	
	Prison	30 min/day/unit
	Hospital, Nursing Home	3 min/day/unit
	Dormitory	30 min/day/unit
	Multifamily	3 min/day/unit
	Lodging	3 min/day/unit
	Commercial	30 min/day/unit
	School	30 min/day/unit
U_P	Post Water Usage Duration (assumed)	= U_B
C_H	Unit Conversion: 8.33 BTU/Gallons/deg. F	8.33
C_G	Unit Conversion: 1 Therm/100,000 BTU	1/100,00
Eff_G	Efficiency of Gas Water Heater	.8

These values translate into per-faucet savings values by facility type, detailed in Table 5-12 and Table 5-13 for 1.0 and 0.5 GPM aerators, respectively.[25]

Table 5-12 1.0 GPM Commercial Aerator Savings

Facility Type	Savings	Fayetteville (Zone 9)	Fort Smith (Zone 8)	Little Rock (Zone 7)	El Dorado (Zone 6)
Prison	Annual	53.91	53.22	50.90	47.75
Hospital / Nursing Home	Annual	5.35	5.32	5.09	4.78
Dormitory	Annual	40.47	39.95	38.21	35.85
Multifamily	Annual	5.35	5.32	5.09	4.78
Lodging	Annual	5.35	5.32	5.09	4.78
Commercial	Annual	36.92	3645	34.86	32.71
School	Annual	29.54	29.16	27.89	26.16

[24] For facilities that operate year round: conservatively assume operating days of 360/year;
For schools open weekdays except summer: 360 x (5/7) x (9/12) = 193
For dormitories with few occupants in the summer: 360 x (9/12) = 270
For normal commercial buildings: 360 x (5/7) = 257
[25] Table values interpolated based on data in Arkansas TRM V6.1, Volume 2. Pg. 368-371

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-13 0.5 GPM Commercial Aerator Savings

Facility Type	Savings	Fayetteville (Zone 9)	Fort Smith (Zone 8)	Little Rock (Zone 7)	El Dorado (Zone 6)
Prison	Annual	76.37	75.40	72.10	67.65
Hospital / Nursing Home	Annual	7.64	7.54	7.21	6.76
Dormitory	Annual	57.33	56.60	54.13	50.78
Multifamily	Annual	7.64	7.54	7.21	6.76
Lodging	Annual	7.64	7.54	7.21	6.76
Commercial	Annual	52.31	51.64	49.39	46.33
School	Annual	41.85	41.31	39.51	37.07

Direct Install Pre-Rinse Spray Valves

Low-flow pre-rinse spray valves PRSVs were also direct-installed at a wide range of facility types with food service applications. The savings per unit for these were calculated as follows:[26]

$$Annual\ Therms = [(F_B * U_B) - (F_P * U_P)] * Days * (T_H - T_C) * C_H * C_G / Eff_G$$

$$Peak\ Therms = P * [(F_B * U_B) - (F_P * U_P)] * (T_H - T_C) * C_H * C_G / Eff_G$$

Table 5-14 presents the definition of these parameters.[27]

Table 5-14 Pre-Rinse Spray Valves Savings Calculation Parameters

Parameter	Description	Value
F_B	Baseline Flow Rate (GPM)	2.25
F_P	Post Flow Rate (GPM)	1.28
Days	Annual operating days for the facility	
	Fast Food Restaurant	365
	Casual Dining Restaurant	365
	Institutional	365
	Higher Education	274
	School / K-12	200
T_C	Average supply (cold) water temperature (deg. F)	Zone 9: 65.6
		Zone 8: 66.1
		Zone 7: 67.8
		Zone 6: 70.1
T_H	Average mixed hot water temperature (deg. F)	120
U_B	Baseline water Usage Duration	
	Fast Food Restaurant	45 min/day/unit
	Casual Dining Restaurant	105 min/day/unit
	Institutional	210 min/day/unit
	Higher Education	210 min/day/unit
	School / K-12	105 min/day/unit
U_P	Post Water Usage Duration (assumed)	= U_B
C_H	Unit Conversion: 8.33 BTU/Gallons/deg. F	8.33
C_G	Unit Conversion: 1 Therm/100,000 BTU	1/100,000
Eff_G	Efficiency of Gas Water Heater	.8

[26] Arkansas TRM V6.1, Volume 2. Pg. 525-529
[27] Arkansas TRM V6.1, Volume 2. Pg. 525-529

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

In 2017, CLEAResult conducted pre- and post-installation flow testing of PRSVs, applying these values instead of the deemed GPM reduction. However, the rest of the algorithm inputs used TRM V6.1 values (hours per day, days per year, etc.).

Fifteen PRSVs were installed through the C&I Solutions Program in 2017. CLEAResult staff conducted on-site measurement for all units and included unique measurement values for each PRSV in the program tracking data.

Low Flow Showerheads

Low flow showerheads were added to the TRM V6.1. Deemed savings calculations for these showerheads were based upon:

- Rated flow of installed showerheads;
- Usage by facility type; and
- Water temperature setting by facility type.

Savings are calculated as follows:[28]

$$Annual\ therms\ = \frac{8.33 * C_p * \Delta V * \left(T_{HW} - T_{Suppy}\right) * \left(\frac{1}{E_t}\right)}{100{,}000\ BTU/therm} * \frac{days}{year}$$

$$Peak\ therms\ = \frac{8.33 * C_p * \Delta V * \left(T_{HW} - T_{Suppy}\right) * \left(\frac{1}{E_t}\right)}{100{,}000\ BTU/therm} * P$$

In this formula, ΔV is calculated as follows:

$$\Delta V = U * N * \left(Q_b - Q_p\right) * F_{HW}$$

Where

U = average shower duration (7.8 minutes)

N = Number of showers per showerhead per day

Q_b = Baseline flow rate (2.5 GPM);

Q_p = Installed flow rate (in GPM); and

F_{HW} = Hot Water Fraction (share of water which is from the water heater)

[28] Arkansas TRM V6.1, Volume 2. Pg. 380-387

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The inputs for this equation are defined in Table 5-15.

Table 5-15 DI Showerhead Savings Calculation Parameters

Parameter	Description	Value
F_B	Baseline Flow Rate (GPM)	2.2
F_P	Post Flow Rate (GPM)	≤ 1.5
Days	Annual operating days for the facility	
	Hospital, Nursing Home	365
	Lodging	365
	Commercial	250
	24 Hour Fitness Center	365
	School	200
T_C	Average supply (cold) water temperature (deg. F)	Zone 9: 65.6
		Zone 8: 66.1
		Zone 7: 67.8
		Zone 6: 70.1
T_H	Average mixed hot water temperature (deg. F)	120
U_P	Post Water Usage Duration (assumed)	= U_B
C_G	Unit Conversion: 1 Therm/100,000 BTU	1/100,00
E_T	Efficiency of Gas Water Heater	.8

Table 5-16 Daily Hot Water Reduction

Installed Flow Rate	Weather Zone	Hospital / Nursing	Lodging	Commercial Employee Shower	24 Fitness Center	Schools
2.0 GPM	9	2.5	3.5	1.9	56.3	2.0
	8	2.5	3.5	1.9	56.1	2.0
	7	2.5	3.5	1.8	55.4	2.0
	6	2.4	3.4	1.8	54.4	2.0
1.75 GPM	9	3.8	5.3	2.8	84.4	3.1
	8	3.8	5.3	2.8	84.1	3.1
	7	3.7	5.2	2.8	83.1	3.0
	6	3.6	5.1	2.7	81.5	3.0
1.5 GPM	9	5.0	7.1	3.8	112.6	4.1
	8	5.0	7.0	3.7	112.2	4.1
	7	4.9	6.9	3.7	110.8	4.0
	6	4.9	6.8	3.6	108.7	.9

Commercial Door Air Infiltration (weather stripping)

Weather stripping was added to the TRM V6.1. Deemed savings calculations for weather stripping were based upon:

- Air infiltration;
- Cooling and heating equivalent full-load hours; and
- Change in temperature between interior and exterior spaces.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Savings are calculated as follows:[29]

$$Annual\ therms = \frac{\left(CFM_{pre,day} * Hours_{day} + CFM_{pre,night} * Hours_{night}\right)\left(CFM_{reduction} * 1.08 * \Delta T * \frac{1.0kW}{ton}\right)}{80\%\ AFUE * \frac{100{,}000Btu}{therm}}$$

$$Peak\ therms = Annual\frac{therms}{ELFH_H}$$

The inputs for this equation are defined in *Table 5-17*.

Table 5-17 DI Weather Stripping Savings Calculation Parameters

Parameter	Description	Value
CFM_{pre}	Calculated pre-retrofit air infiltration rate (ft^3/min)	
CFMreduction	Average infiltration reduction	79%
ΔT	Change in temperature across gap barrier	
$Hours_{day}$	12 hour cycles per day, per month	4,380 hours
$Hours_{night}$	12 hour cycles per day, per month	4,380 hours
$EFLH_H$	Average heating equivalent full-load hours	Table 5-18

Table 5-18 $EFLH_H$ By Weather Zone

Building Type	Zone 6	Zone 7	Zone 8	Zone 9
Assembly	575	798	855	824
College/University	630	874	936	902
Fast Food Restaurant	288	440	474	455
Full Menu Restaurant	181	328	370	336
Grocery Store	688	935	995	965
Health Clinic	646	885	922	895
Lodging	389	587	635	605
Large Office (>30k SqFt)	811	1,014	1,054	1,036
Small Office (≤30k SqFt)	353	538	568	538
Religious Worship	537	745	798	769
Retail	780	1,041	1,131	1,099
School	774	1,026	1,089	1,064

These values translate into per linear foot savings values by weather zone, detailed in Table 5-19.[30]

[29] Arkansas TRM V6.1, Volume 2. Pg. 349-357
[30] Arkansas TRM V6.1, Volume 2. Pg. 357

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 5-19 Deemed Therm Savings per Linear Foot

Weather Zone	Gap Width (inches)			
	1/8	1/4	1/2	3/4
Zone 9	5.34	10.80	21.43	32.16
Zone 8	4.64	9.38	18.62	27.96
Zone 7	3.91	7.92	15.71	23.58
Zone 6	2.89	5.86	11.62	17.44

5.5.1.2 Direct Install Verification Rates

The Evaluators completed verification of direct install measures at 14 participating facilities. This sample included:

- 9 faucet aerators;
- 4 low flow showerheads;
- 2 PRSVs; and
- 1,595 liner feet of weather stripping

The verification rates were:

- Faucet aerators: 100%
- PRSVs: 100%
- Low flow showerheads: 100%
- Weather Stripping: 100%

5.5.2 Prescriptive Boiler Impact Evaluation

The program rebated three boilers at two facilities in 2017. Two of these boilers were installed in a university and one was installed in a religious facility. The Evaluators applied a stipulated 80% NTGR for these projects.

Table 5-20 C&I Solutions Boiler Equipment Rebates Program Verified Therms Savings

Savings	*Expected Therms Savings*	*Verified Therms Savings*	*Realization Rate*	*EUL*	*Lifetime Therms Savings*
Gross	4,475	4,539	101.4%	20	90,783
Net	3,580	3,631	101.4%	20	72,627

5.5.2.1 Direct Install Free-Ridership

The methodology for DI Free-Ridership was focused on the participants' past experiences with the appropriate equipment and whether they had organizational policies in place to install such equipment. Respondents were asked:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Q22. Before to participating in the C&I Solutions Program, did you have plans to install [LIST MEASURE]?

Q23 Would you have gone ahead with this planned project even if you had not participated in the program?

Q27 If the [PROGRAM] program representative had not recommended installing the [PROJECT_DESCRIPTION], how likely is it that you would have installed it anyway?

1. Definitely would have installed
2. Probably would have installed
3. Probably would not have installed
4. Definitely would not have installed
98. Don't know

These are combined into the following factors:

A. **Prior Plans:** If the respondent indicated plans to install prior to participation, they receive a "1" for this metric.

B. **Installation counterfactual:** If they respondent states that they would have gone ahead with this project without the program, they receive a "1" for this factor.

C. **Program Influence:** If a respondent states that they "Definitely would have" or "probably would have" installed this equipment without the program, they receive a "1" for this factor.

To be found a free-rider, a respondent must receive a "1" score for all three factors. The direct install channel was found to have 100% NTGR.

5.5.3 Prescriptive Commercial Cooking Impact Evaluation

Due to the limited participation, the impact evaluation was constrained to:

1. Documentation review to ensure savings were calculated according to TRM V6.1 protocols; and
2. Application of the stipulated 80% NTGR.

Table 5-21 presents the gross savings results for food service equipment rebated through the C&I Solutions Program. Total Gross Savings summarizes the savings calculations performed by TRM protocols for each measure category.

Table 5-21 C&I Solutions Cooking Equipment Rebates Program Verified Therms Savings

Food Service Savings	Expected Therms Savings	Verified Therms Savings	Gross Realization Rate	EUL	Lifetime Therms Savings
Gross	1,728	1,728	100%	12	20,736
Net	**1,382**	**1,382**	100%	12	**16,589**

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Net savings for the Commercial Cooking Equipment Rebates Program were calculated using deemed protocols and the stipulated 80% NTGR. The resulting net savings are presented in Table 5-22.

Table 5-22 C&I Solutions Cooking Equipment Net Savings Summary

Free-Ridership Rate		Net Annual Savings		Net Realization Rate	Net Lifetime Therms Savings	Net Peak Therms
Ex Ante	Ex Post	Ex Ante	Ex Post			
20%	20%	1,530	1,530	100%	18,365	4.18

5.5.4 Prescriptive Steam Trap Impact Evaluation

The steam trap replacement rebates are a simplified application developed to target small laundry facilities. These facilities are unlikely to receive a full audit from C&I Solutions due to limited opportunities for custom projects. The calculation of savings for these projects collects data on facility type as well as whether the trap services an industrial process, a dry cleaning system, or an HVAC system. Applicants are also required to submit operating pressure, orifice size, boiler efficiency, and annual hours of system pressurization.

The Evaluators did not find error in the steam trap calculations and the resulting realization was 100%. The gross and net savings are summarized in Table 5-23. The NTGR ratio for these projects was estimated at 85.7%.

Table 5-23 C&I Solutions Prescriptive Steam Trap Net Savings Summary

Steam Trap/Leak Savings – Laundry Facilities	Expected Therms Savings	Verified Therms Savings	Gross Realization Rate	EUL	Lifetime Therms Savings
Gross	8,906	8,906	100%	5	44,530
Net	8,906	7,632	100%	5	38,162

5.5.5 Prescriptive Program Free-Ridership

Due to low participation volume, the Evaluators applied 80% NTGR to boilers, burner replacement, and food service. For steam trap replacement, a survey was conducted with nine program participants (eight from CenterPoint and one from AOG), from which a NTGR estimate was developed. The NTGR methodology for prescriptive steam traps was as follows:

Q15 How did you choose the contractor to install the steam traps?

1. Contractor reached out to me
2. Prior work with contractor
3. Took competitive bids
4. Internet search
5. Personal or professional referral

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

6. Other (Specify) ____

Q19 How important was this input from your contractor in deciding to replace your steam traps? Would you say…

1. Very important
2. Somewhat important
3. Slightly important
4. Not at all important
88. Don't know

Q20. When did you first learn about the [PROGRAM] program and the rebates for steam traps? Was it….

1. Before thinking about replacing your steam traps
2. While collecting information about replacing your steam traps
3. After having selected the equipment to purchase
4. After your steam traps were installed
88. Don't know

Q23 If the financial incentives from the [PROGRAM] program had not recommended been available, how likely is it that you would have replaced the steam traps anyway? [READ. MARK ONE]

1. Definitely would have replaced
2. Probably would have replaced
3. Probably would not have replaced
4. Definitely would not have replaced
98. Don't know

Q24 Did the financial incentives from the program cause you to replace your steam traps sooner than you otherwise would have?

1. Yes
2. No
88. Don't know

Q25 How much later would you have replaced your steam traps if the program incentive were not available? [READ. MARK ONE]

1. Within 6 months
2. 6 months to 1 year
3. 1 to 2 years
4. 3-4 years
5. More than for years from now
98. Don't know

These are combined into the following factors:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

A. **Program timing.** If the respondent states that they learned of the program after having selected equipment or after having installed the equipment, they receive a "1" for this factor.

B. **Trade ally influence:** If the respondent indicated that they have worked with the trade ally before on similar projects outside of the program, or that the trade ally did not influence the project, hey receive a "1" for this factor.

C. **Program Influence #1:** If a respondent states that they "Definitely would have" or "probably would have" installed this equipment without the program, they receive a "1" for this factor.

D. **Program Influence #2:** If a respondent states that the project would have installed within one year, they receive a "1" for this factor.

If a respondent has "1" on program timing, they are automatically a free-rider.

If a respondent shows a "1" on the trade ally influence factor and on both program influence factors, they are a free-rider.

The NTGR for prescriptive steam traps was 85.7%.

5.5.6 C&I Solutions Large Custom Project Impact Evaluation

The Evaluators opted for a census of custom projects in order to capture the full variability associated with these projects; the measures are often unique with idiosyncratic issues, and as such extrapolation from the M&V of other projects would be inappropriate. Table 5-24 summarizes the custom projects completed and evaluated in 2017.

Table 5-24 BHE C&I Solutions Custom Project Summary

Facility Type	Project ID	Measure	Expected Savings	Verified Savings	M&V Protocol
Industrial	BHE-CIS2017-001	Condensate Return	17,305	17,305	Option A
		Insulation	8,136	8,136	Option A
		Steam Trap Replacement	30,835	30,835	Deemed
Medical	BHE-CIS2017-002	Steam Trap Replacement	103,366	103,366	Deemed
		Steam Leak Repair	32,604	32,604	Option A
Medical	BHE-CIS2017-004	Steam Trap Replacement	33,270	33,270	Deemed
		Steam Leak Repair	17,359	17,359	Option A
		Insulation	348	348	Option A
Industrial	BHE-CIS2017-005	Steam Trap Replacement	72,228	72,228	Deemed
Food Processing	BHE-CIS2017-006	Steam Trap Replacement	114,481	114,481	Deemed
		Steam Leak Repair	33,830	33,830	Option A
		Insulation	26,748	26,748	Option A
Industrial	BHE-CIS2017-007	Steam Trap Replacement	36,995	36,995	Deemed
Food Processing	BHE-CIS2017-008	Steam Trap Replacement	79,576	79,576	Deemed
		Insulation	13,865	13,865	Option A
Industrial	BHE-CIS2017-009	Steam Trap Replacement	11,873	11,873	Deemed
Medical	BHE-CIS2017-004	Steam Trap Replacement	33,270	33,270	Deemed

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Individual site reports detailing these analyses are provided in Appendix A. All custom projects were post-inspected with M&V approaches as described in the site-level analyses.

5.5.6.1 Custom Project Free-Ridership Methodology

The custom project free-ridership methodology is more complicated than that of the DI participants, due to the more complex nature of the projects and the effects of the facility audit and project incentive. The methodology used by the Evaluators in determining the free-ridership rates for custom projects examined the following factors:

- *Knowledge gained from program outreach*. If the project originated from program outreach (which may include program-sponsored training courses or facility audits), the respondent is asked if they had prior knowledge of the energy-saving opportunity recommended and eventually installed. If the respondent learned of the measure through the program audit or program–sponsored training, then they are considered to not have been free-riders, in that in the absence of the program, the likelihood of the facility receiving a similarly detailed audit are low. Questions used in evaluating this criterion include:

FI-1 Prior to participating in the C&I Solutions Program, did your organization install any equipment similar to [EQUIPMENT/MEASURE] at your facility without financial incentives or rebates?

- ❑ Yes
- ❑ No

FI-1a Did you learn of this measure through your participation in the Commercial & Industrial Solutions Program?

- ❑ Yes [IF YES, ASK FI-1b] Do you recall how you learned of the measure?
- ❑ No

- *Prior plans for a similar measure*. This component is examined in instances where the respondent knew of the measure prior to receiving and technical assistance through the C&I Solutions Program. Respondents are asked a series of questions related to whether they had plans for installing this equipment prior to having learned of the available financial incentives from the C&I Solutions Program. Questions used in this component include:

FI-1 Prior to participating in the C&I Solutions Program, did your organization install any equipment similar to [EQUIPMENT/MEASURE] at your facility without financial incentives or rebates?

- ❑ Yes
- ❑ No

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

FI-2 Did you have plans to install the [EQUIPMENT/MEASURE] that was upgrades through C&I Solutions before participating in the program?

- ❑ Yes
- ❑ No

If Yes: FI-2a Would you have gone ahead with this planned installation without the program rebates?

- ❑ Yes
- ❑ No

FI-2b Would this installation have included the same equipment without the program rebates?

- ❑ Yes
- ❑ No

- *Analysis of measure payback*. Respondents are asked to indicate what their required payback period is for energy efficiency improvements. This value is compared against the measure payback with and without the program incentive. If the financial incentive brings the project from over the threshold to under the threshold, then the project is considered to have been sufficiently influenced by the program incentive. This includes the following questions:

DM-5 Does your organization require a specific payback period in order to implement energy efficiency improvements?

- ❑ Yes [ASK DM-5A]
- ❑ No [SKIP TO DM-6]
- ❑ Don't know [DON'T READ]

DM-5a What **payback** *length of time* do you normally require in order to consider an energy investment cost effective?

___ Years

- ❑ Don't know

The stated payback requirement by the respondent is then compared against the payback of the recommended project with and without the program incentive.

- *Modification of the project*. Respondents are asked a series of questions addressing whether they modified the project as a result of their program participation. This includes changes in equipment quantity and/or efficiency level (where appropriate for the measure) and a change in project timing. Questions used to analyze this component include:

FI-5 If the C&I Solutions Program were not available, would you have installed the…

- ❑ Same quantity of energy efficient equipment,
- ❑ A lower quantity, or
- ❑ No energy efficient equipment at all?

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

[IF FI-5 = “Lower Quantity”]: FI-5a: By percentage, how much lower?

FI-6 If the C&I Solutions Program were not available, would you have installed …

- ❑ The same equipment with the same efficiency level,
- ❑ The same equipment with a lower energy efficiency level, but still above minimum code, or
- ❑ Standard efficiency equipment?

[IF FI-6 = “Lower efficiency level, but still above minimum code”]: FI-6a: By percentage, how much lower?

FI-7 Did the C&I Solutions rebate allow you to install [EQUIPMENT/MESURE] sooner than you otherwise would have?

- ❑ Yes

🡻

IF YES: FI-7a When would you otherwise have installed the equipment? (READ IF NEEDED)

- ❑ In less than 6 months later
- ❑ In 6-12 months later
- ❑ In 1-2 years later
- ❑ In 3-5 years later
- ❑ In more than 5 years later
- ❑ No, did not affect timing of purchase and installation

These results are then applied in the manner displayed in Figure 5-9.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

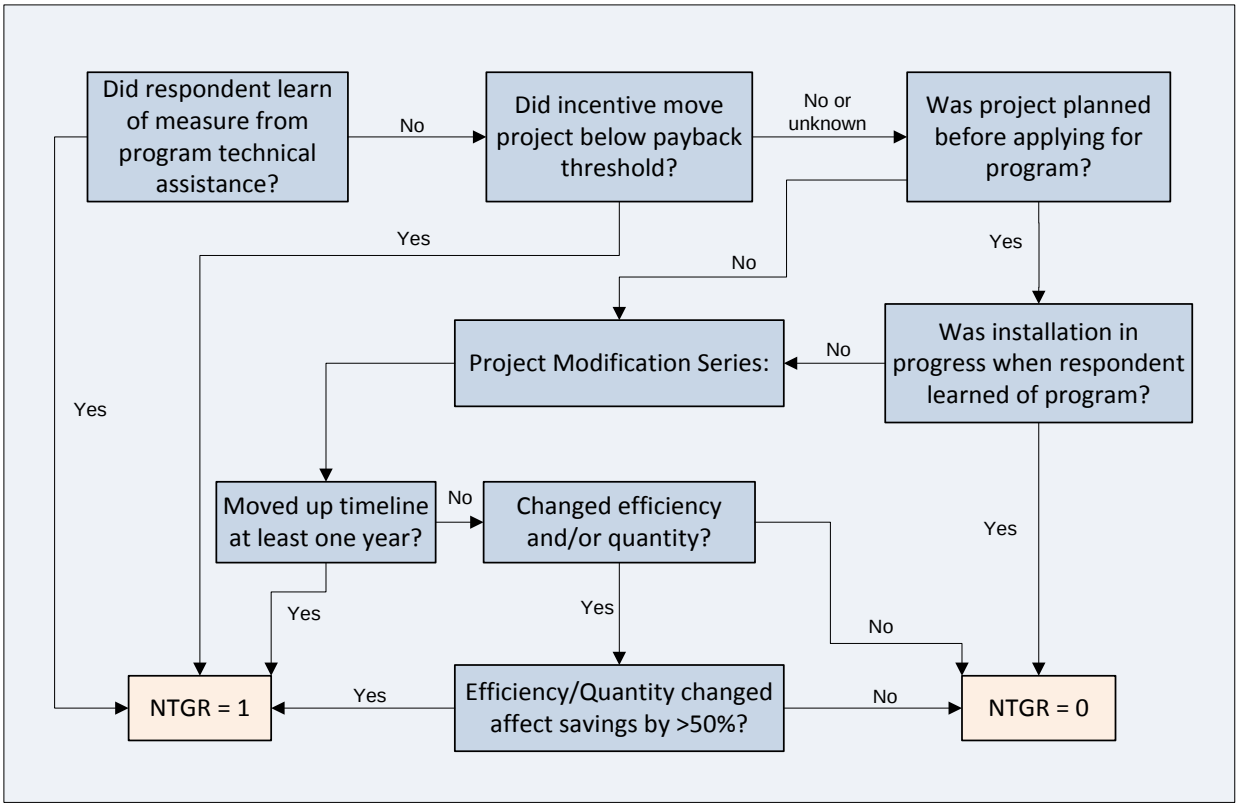


Figure 5-9 C&I Solutions Custom Project Free-Ridership Diagram

The resulting NTGRs by project are presented in Table 5-25.

Table 5-25 BHE C&I Solutions Custom Project Free-Ridership Results

Facility Type	***Project ID***	***Measure***	***Gross Savings***	***Net-to-Gross Ratio***
Industrial	BHE-CIS2017-001	Condensate Return	17,305	100%
		Insulation	8,136	100%
		Steam Trap Replacement	30,835	100%
Medical	BHE-CIS2017-002	Steam Trap Replacement	103,366	100%
		Steam Leak Repair	32,604	100%
Medical	BHE-CIS2017-004	Steam Trap Replacement	33,270	100%
		Steam Leak Repair	17,359	100%
		Insulation	348	100%
Industrial	BHE-CIS2017-005	Steam Trap Replacement	72,228	100%
Food Processing	BHE-CIS2017-006	Steam Trap Replacement	114,481	100%
		Steam Leak Repair	33,830	100%
		Insulation	26,748	100%
Industrial	BHE-CIS2017-007	Steam Trap Replacement	36,995	100%
Food Processing	BHE-CIS2017-008	Steam Trap Replacement	79,576	100%
		Insulation	13,865	100%
Industrial	BHE-CIS2017-009	Steam Trap Replacement	11,873	100%
		Overall Gross Savings:	632,819	100%
		Overall Net Savings:	632,819	100%

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Given the small number of participants, the free-rider assessments were a series of case studies as opposed to an extrapolated survey. The individual free-rider assessments are contained within the survey narrative responses detailed in Section 5.3.2.

5.5.6.2 Participant Spillover

Participant spillover is defined as savings from program participants that was not incentivized by the BHE programs. During participant surveying, both DI and Custom participants are asked questions addressing whether their participation had led to the installation of equipment that was not rebated by BHE. The estimated savings from these projects are tallied and added to the program savings as Participant Spillover.

OS-3 Has your organization's participation in the C&I Solutions Program led you to buy any energy efficient equipment for which you did not apply for a financial incentive?

- ❑ Yes

  ➔

  If Yes: OS-3a What type of equipment? _____

- ❑ No
- ❑ Don't know [DON'T READ]

The Evaluators did not identify any participant spillover.

5.5.6.3 Partial-Participant Spillover

Partial-participant spillover are savings resulting from projects that were recommended to recipients of audits through the C&I Solutions Program that were completed without filing for program incentives. Respondents are asked:

> Have you since implemented any of the recommendations from your facility audit?
>
> a. If Yes: Why didn't you install these measures through the available incentive program?

It is then clarified as to whether the respondent installed the project as specified in the audit or made modifications to the project. This is combined in providing an estimate of non-incentivized savings, which constitutes the Partial Participant Spillover.

There were no identified cases of partial participant spillover.

5.5.7 C&I Solutions Small Custom Impact Evaluation

This channel of the program includes the small custom project offerings provided to laundry and hotel facilities. The measures in this channel had savings calculated based on project M&V at a sample of facilities by CLEAResult, rather than site-specific M&V for all projects. The projects included:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- (1) steam leak repair at a laundry facility;
- (9) DrySmart controls at four hotels; and
- (5) water pump controls at three hotels.

Total expected savings from this channel was 14,646 Therms.

5.5.7.1 Savings from DrySmart Controls

A stipulated savings per input BTUH of the dryers was developed based on the metering of 10 units at five hotels in 2016. Clothes dryer cycles metered during this period were separated into the following categories:

1. Completed: when the clothes in the dryer dry at the same time the dryer stops
2. Shortstopped: when the door to the dryer is opened and kept open for 45 seconds or less after which the dryer finishes with a Completed cycle.
3. Truncated: when the dryer stops running due to cycle time or human intervention and the clothes are not dry. If the door is opened for 45 seconds or more, essentially a new cycle starts.

The OEM timers were set to 60 minutes in the baseline configuration to ensure the dryer does not stop before the clothes are dry. Cycle times of under five minutes were excluded to make sure the analysis does not include cycles where the burner has not operated yet.

The key parameters include the number of Completed cycles, number of Truncated cycles, number of Shortstopped cycles, length of each cycle, burner run time per cycle, and burner duty cycle over drying portion of the cycle.

The savings were calculated using the following formulas:

$$Burner\ minutes\ saved\ per\ day_{Completed} = \left(Avg\ Pre\ Time_{Completed} - Avg\ Post\ Time_{Completed}\right) \times Cycles\ per\ day \times \%\ Cycles\ Completed \times Duty\ cycle\ during\ savings\ period$$

$$Burner\ minutes\ saved\ per\ day_{Truncated} = (\%\ Truncated\ Pre - \%\ Truncated\ Post) \times Cycles\ per\ day \times Avg\ Dryer\ Truncated\ Cycle\ Length + \%\ Cycles\ Truncated_{post} \times Cycles\ per\ day \times (Avg\ Pre\ Time_{Truncated} - Avg\ Post\ Time_{truncated}) \times Truncated\ turn\ duty\ cycle$$

$$Therms\ saved = \left(Burner\ minutes\ saved\ per\ day_{Completed} + Burner\ minutes\ saved\ per\ day_{Truncated}\right) \times \frac{365}{60} \times \frac{BurnerInput}{100{,}000}$$

Where:

- 365 is the assumed operating days per year
- 60 minutes per hour

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- 100,000 BTUs per Therm

The mean savings for this measure from the metered sites was 6.28 CCF per input MMBTUH of the dryer system. This value was applied to 2017 units based on dryer capacity.

5.5.7.2 Savings from Water Pump Controls

The pump controllers reduce pipe losses and recovery energy by curtailing water circulation when there is no demand for DHW from the guest rooms or common areas in the lodging facility. Savings are calculated as follows:

$$Pipe\ Loss = \frac{GPM \times Specific\ Heat\ \times Specific\ weight \times 60\frac{Min}{Hr} \times 8760\frac{Hrs}{Yt} \times (T_{Outlet} - T_{Inlet})}{WH\ Efficienxy\ \times 100000\frac{BTU}{Therm}}$$

The mean savings for this measure from the metered sites was 6.28 CCF per input MMBTUH of the dryer system. This value was applied to 2017 units based on dryer capacity.

Table 5-26 Pump Control Savings Inputs – Pipe Losses

Parameter	Pre	Post	Notes
Specific Heat (BTU/lb.)	1	1	
Pump Rating (GPM)	17	17	Nameplate
Specific Weight (lbs/gallon)	8.2877	8.2877	Weight at 100 deg. F
Minutes/hr.	60	60	
Hrs./yr.	8760	1,024	Baseline is constant flow. Post is metered
T(outlet)	123.22	123.58	Metered
T(inlet)	120.47	108.58	Metered
WH Efficiency	80%	80%	Assumed baseline for large storage tank

There are secondary gas savings from avoided recovery energy. These savings are calculated as:

$$Recovery\ Energy = \frac{Pump\ Starts \times Pump\ Runtime \times GPM \times Specific\ weight \times 60\frac{Min}{Hr} \times (T_{Inlet} - T_{Return})}{WH\ Efficienxy\ \times 100000\frac{BTU}{Therm}}$$

addition to the parameters detailed in Table 5-26, inputs for this measure include:

- Starts/Year: 38,693 (metered)
- Runtime per start: 1.6 minutes (metered)

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Return temp at pump start: 103.4 deg. F (metered)

This results in 358 Therms saved per pump.

5.6 Verified Savings

Table 5-27 presents the gross savings results of the evaluation of the 2017 C&I Solutions Program. Total gross savings summarizes the savings calculations performed by TRM protocols for direct install measures as well as the project-specific M&V of custom measures.

Table 5-27 C&I Solutions Verified Therms Savings

Measure Category	Expected Therms Savings	Verified Therms Savings	EUL	Lifetime Therms Savings
Direct Install	55,324	55,310	10.17	562,415
Prescriptive	15,109	15,173	10.33	156,049
Large Custom	632,820	632,819	6.30	3,987,075
Small Custom	14,647	14,646	11.83	173,215
Total	717,900	717,948	6.78	4,878,754

Net savings for the C&I Solutions Program were calculated using survey data of direct install and custom participants. The resulting net savings are presented in Table 5-28.

Table 5-28 C&I Solutions Net Savings Summary

Measure Category	Free-Ridership Rate		Net Annual Savings		Net Realization Rate	Net Lifetime Therms Savings
	Ex Ante	Ex Post	Ex Ante	Ex Post		
Direct Install	0.0%	0.0%	55,310	55,310	100.00%	562,415
Prescriptive	20.0%	16.7%	12,138	12,646	104.19%	127,378
Large Custom	0.0%	0.0%	632,820	632,819	100.00%	3,987,075
Small Custom	0.0%	14.3%	14,647	12,552	85.70%	148,445
Overall:	2.0%	0.6%	714,915	713,327	99.78%	4,825,313

Table 5-29 Commercial & Industrial Solutions Verified Net Water Savings

Measure Category	Net Annual Water Saving (Gallons)	Lifetime Net Water Savings (Gallons)
Direct Install	2,964,007	23,907,354
Custom	7,010,951	42,614,757
Prescriptive	71,745	358,723
Total	10,046,703	66,880,834

Table 5-30 Commercial & Industrial Solutions Verified Net Electric Savings

Measure Category	Net Annual kWh	Net Peak kW	Lifetime Net kWh
Direct Install	7,332	5.86	80,647
Custom	0	0	0
Prescriptive	0	0	0
Total	7,332	5.86	80,647

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

5.7 Conclusions & Recommendations

5.7.1 Conclusions

The Evaluators have found that:

1. **The outreach to laundry and hotel facilities for small custom projects has been successful.** Laundry and hotel projects (comprised of steam trap replacement, leak repair, pump control, and DrySmart control) totaled 28,092 Therms savings. Targeted outreach such as this will be important in the future development of the program as opportunities for direct install decline.
2. **Direct install savings have declined significantly.** At 55,130 verified Therms, the program has continued its trend of declining direct install savings. This is planned however, as the program has sought to increase savings from higher-cost retrofits, in addition to facing saturation barriers due to the high levels of implementation of direct install measures in the early years of program operation.
3. **The measure life of the program is lower than typical for commercial gas programs due to large reliance on steam trap replacement and steam leak repair projects.** These projects accounted for 80% of program net savings. With these projects having a five-year EUL, the measure life for the BHE C&I Solutions Program is lower than typically observed for commercial gas efficiency programs
4. **Door air infiltration (weather stripping) has been a successful program addition.** The C&I Solutions Program had 41,481 net Therms from door air infiltration.
5. **The program is beginning to see increased small business participation in the custom channel.** Four small business projects were processed in the custom channel in 2017; prior to this year, small business participation in the custom channel was minimal.

5.7.2 Recommendations

1. **Work to expand the steam trap initiative with laundry facilities into a "comprehensive maintenance/optimization" offering.** This would include steam trap replacement, steam line insulation, leak repair, and boiler tune-up.
2. **Work with the Evaluators and the IEM to develop interim partially-deemed protocols for non-TRM measures in the maintenance package.** Some of the measures identified for the maintenance package do not have TRM values. However, they have consistently evaluated well, with no projects in the last three years of implementation having a realization rate below 90% for any of the three Arkansas gas utilities.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

6. Home Energy Savings Program

The Home Energy Savings Program is a weatherization program launched by BHE in late 2013. The program is designed to train contractors and home energy consultants to analyze the energy use for single and multifamily homes and identify specific energy efficiency improvements which may be undertaken by the customer.

The program provides energy assessments, along with direct installation of low-cost measures and pre-qualification for building envelope improvements.

Direct install measures include:

- Faucet aerators; and
- Low flow showerheads.

Eligible coupon measures include:

- Air sealing;
- Duct sealing; and
- Ceiling insulation.

The program is implemented by CLEAResult. In 2016, the program was certified as meeting the requirements of Home Performance with Energy Star®. This is mentioned in program marketing but is not used as the program's name.

6.1 Program Overview

The Home Energy Savings Program (HESP) is intended to be primarily vendor-driven program, with the marketing targeted at contractors in the BHE service territory. In 2017, the program had $1,502,615 in budget allocated. Table 6-1 summarizes the historical performance of the Home Energy Savings Program.

Table 6-1 HESP Historical Performance against Goals

Program Year	# Participants		Budget		Net Therms	
	Actual	Goal	Spent	Allocated	Achieved	Goal
2014	1,049	590	$709,875	$737,910	244,677	205,580
2015	1,476	1,027	$1,125,605	$1,256,736	487,668	342,239
2016	992	1,612	$1,474,417	$1,518,639	574,107	371,622
2017	821	3,031	$1,500,570	$1,502,615	474,684	379,880

6.1.1 Participation Summary

The HESP had 810 participants in 2017. Of these, 803 installed energy efficiency improvements.

Figure 6-1 summarizes the share of program savings contributed by each measure. Most savings came from duct sealing, air sealing, and ceiling insulation.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The Evaluators found that 515 of the 821 participating residences were jointly-rebated by an electric IOU.

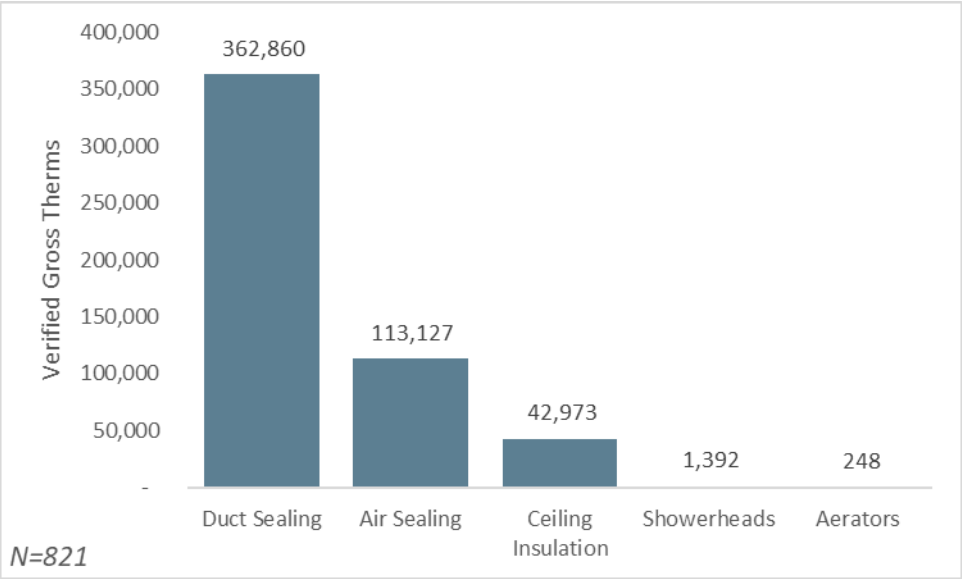


Figure 6-1 Program Savings Share by Measure

In addition, incentives were provided for 810 Assessments.

6.1.2 Contractor Participation

In 2017, the HESP had six registered trade allies. All registered allies were active in the program in 2017. The top three performing trade allies were responsible for 83% of projects completed and 88% of program net savings.

6.1.3 Participation Timing

Figure 6-2 summarizes the premises by month as determined by the date of rebate delivery as well as the cumulative savings from the program.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

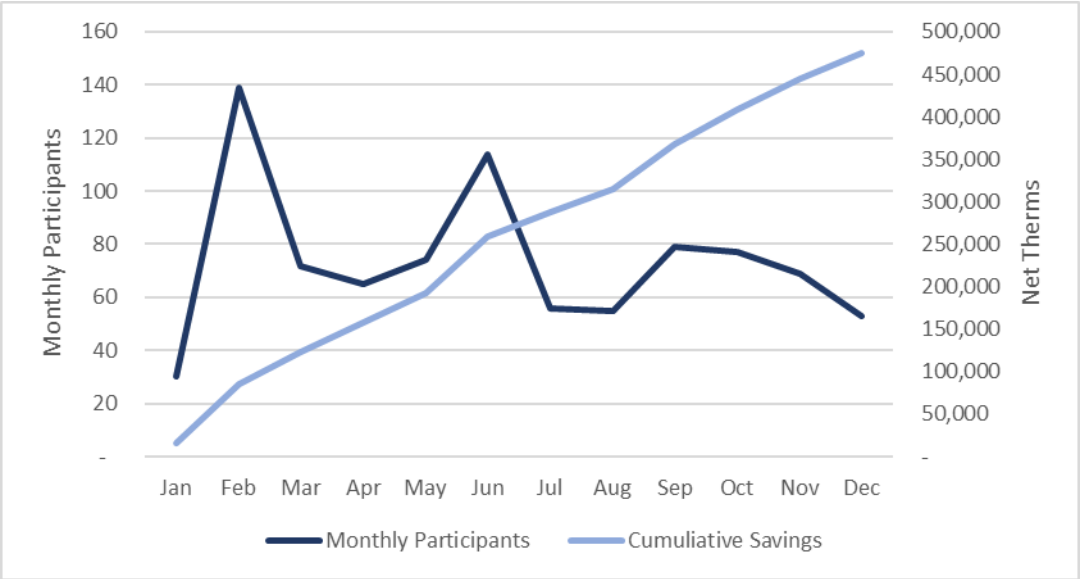


Figure 6-2 HESP Premises and Savings by Month

6.2 HESP Process Evaluation

The Evaluators conducted a formal process evaluation of the Home Energy Savings Program in 2014 and found that the program was successful in meeting participation, savings, and satisfaction goals. Table 6-2 and Table 6-3 summarize the Evaluators' review of the Home Energy Savings Program in comparison to TRM V6.1 Protocol C for timing and conditions of conducting a process evaluation.

Table 6-2 Determining Appropriate Timing to Conduct a Process Evaluation

Component	***Determination***
New and Innovative Components	No. The program is designed in a manner consistent with similar programs elsewhere and applies deemed savings values from the TRM.
No Previous Process Evaluation	No. The program received a comprehensive process evaluation in 2014.
New Vendor or Contractor	No. CLEAResult has implemented the program since program inception.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 6-3 Determining Appropriate Conditions to Conduct a Process Evaluation

Component	Determination
Are program impacts lower or slower than expected?	No. The program exceeded savings goals in prior program years.
Are the educational or informational goals not meeting program goals?	No. The programs have had successful consumer and contractor outreach & education.
Are the participation rates lower or slower than expected?	No. The program met participant goals in prior program years.
Are the program's operational or management structure slow to get up and running or not meeting program administrative needs?	No. The 2014 process evaluation found that operational and management structure to be up to speed and efficient in administering the program.
Is the program's cost-effectiveness less than expected?	No, the program's cost-effectiveness was within expected boundaries.
Do participants report problems with the programs or low rates of satisfaction?	No. 2014 participant surveys found high satisfaction levels.
Is the program producing the intended market effects?	Yes. Interviews with participating contractors in 2014 found significant market transformation occurring.

Due to the modifications needed to comply with the CWA, the Evaluators conducted a process evaluation in 2017.

6.2.1 CWA Metrics Summary

They key CWA metrics are presented in Table 6-4

Table 6-4 CWA Program Metrics Summary

Metric	Value
Program Name	Home Energy Savings Program
CWA Implementation	The CWA is implemented using a third-party contractor (CLEAResult) with a network of pre-approved trade allies that market the program. The program coordinates with SWEPCO and Entergy
Total Audits Completed	810
Total Submitted Projects	817
Conversion Rate	99% (802 of 810 assessments yielded projects)
Measures installed per-project	2.50
Cost per participant	No customer co-pay. BHE paid $894/home
Percent of contractors promoting program	100%

6.2.2 Data Collection Activities

The process evaluation of Home Energy Savings Program included the following activities:

- *Program Actor In-Depth Interviews*. The Evaluators conducted in-depth interviews with a series of program actors. These interviews covered a range of topics, including marketing efforts, feedback on program delivery, an assessment

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

of barriers to program implementation and success, and recommendations for program improvement. Program Actors interviewed include:

- *BHE Program Staff*. The Evaluators interviewed staff at BHE involved in the administration of the Home Energy Savings Program.
- *Third Party Implementation Staff Interviews.* The Evaluators conducted interviews with CLEAResult involved with the Home Energy Savings Program.
- *Participant Surveying.* The Evaluators surveyed 80 owner-occupants participants in the HESP, collecting feedback on their experiences with the program.

Table 6-4 summarizes the data collection for this process evaluation effort. This includes the titles, role, and sample sizes for data collection.

Table 6-5 BHE HESP Data Collection Summary

Target	Component	Activity	n	Role
BHE Program Staff	Manager of Energy Efficiency	Interview	1	Overall administration of BHE DSM programs. This manager is involved in the larger strategic decisions associated with the DSM portfolio, and is involved with the HESP Program and in the overall coordination of utility resources.
CLEAResult Staff	Program Coordinator	Interview	1	Handles day-to-day operations, including mass market outreach, application review, billing, and logistics
Program Participants	Single Family Owner-Occupants	Survey	68	This survey was conducted on a sample of single family owner-occupants which participated in the program.
		On-site inspection	49	On-site testing for duct leakage, air infiltration, and inspection of ceiling insulation was completed at 49 residences, comprising 124 measures.

6.2.3 Response to 2016 Recommendations

Responses by program staff to 2016 evaluation recommendations are summarized in the table below.

Table 6-6 Home Energy Savings to 2016 Recommendations

Recommendation	BHE/CLEAResult Response	Status of Issue
Flag duct and air sealing homes with leakage values at the extreme high and low end of the distribution for QC review	This has been incorporated into program QC	Recommendation adopted

6.2.4 Program Theory & Design

The HESP was designed in order to fill a gap in BHE portfolio offerings. Prior to this program, building envelope improvements were only available through the Arkansas

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Weatherization Program. This was not providing adequate participation for BHE, with no BHE homes weatherized through the AWP in 2015.

6.2.5 Program Administration

The HESP is overseen by the Manager of Energy Efficiency at BHE. This manager's responsibilities primarily include interfacing with CLEAResult, who directly implements the program. Other activities by this manager include providing updated customer lists to CLEAResult to better facilitate their implementation, participation in outreach events, and at times assisting CLEAResult in customer interactions.

For CLEAResult, the roles and responsibilities of program staff are as follows:

- **Program Manager.** The Program Manager oversees day-to-day activities, supervises program staff, and handles complaints from customers or contractors.
- **Senior Program Consultant.** The Senior Program Consultant manages the contractor network, including recruiting, training, and quality assurance from participating trade allies.
- **Program Consultant.** The Program Consultant assists the Senior Program Consultant with outreach and relationship management with contractors.
- **Program Coordinator/Specialist.** This staff member coordinates tracking data, develops samples for quality assurance inspection, and supports reporting and invoicing requirements.
- **Program Coordinator – Scheduling.** This staff member is responsible for scheduling QA appointments and assists with program outreach.
- **QA Verification Specialist.** The QA Verification Specialist conducts post inspections and communicates inspection results to contractors.

6.2.6 Program Implementation & Delivery

There are two program channels for the HESP: Assessment and Install-only. Formerly, there was a Tier 1 Energy Survey but that has been removed from the program due to it being an unpopular offering that yielded no savings in prior program years.

The two channels are:

- **Assessment.** The Assessment is a comprehensive audit which includes conducting duct blast and blower door testing. This testing is needed to pre-qualify a home for duct sealing and air sealing improvements. Before a home may receive an Assessment, program trade allies are required to calculate the gas intensity of the residence. In this, the contractor must take the customer's highest winter natural gas bill and divide it by the heated square feet of the home. Figure 6-3 summarizes the calculation process.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

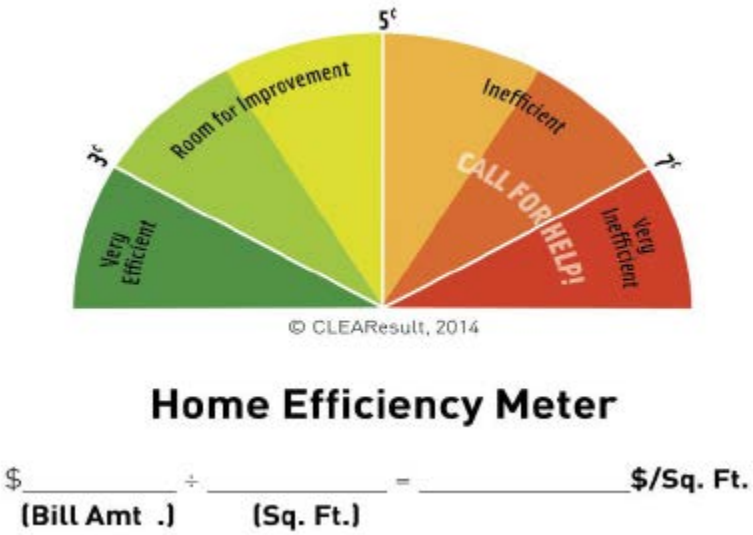


Figure 6-3 Home Efficiency Meter Graphic

A home must be at least 10 years old or have use above $0.05 per square foot during a winter season month to qualify for an Assessment.

- **Install-only.** Further, residential customers may opt to go directly through a contractor to install eligible measures without receiving an Assessment. This is allowed if the contractor is a registered trade ally with the program.

The criteria of $0.05/square foot of use on a customer's highest bill is used to ensure that program funds go towards project which will produce enough savings to be cost-effective. Further, all participating residences are required to have central natural gas space heating to receive an assessment and rebates for building envelope measures and natural gas water heating to be eligible for direct install measures.

Residential customers may enter into the program either by contacting the Energy Efficiency Solutions Center (EESC) to request an assessment or by working through a participating contractor who initiates the assessment and coupon process.

6.2.7 Marketing

The HESP is marketed to trade allies and to end-use customers. BHE partnered with Entergy and SWEPCO in marketing due to significant overlap in their service territories and the operation of a similar program by the electric utilities using CLEAResult as the implementer. The three utilities partnered in marketing collateral.

6.2.8 Quality Assurance

Staff at CLEAResult conducts post inspections at a minimum of 10% of the projects completed by each trade ally. Post inspections are conducted by a Quality Assurance

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Specialist. The post-inspection procedure includes designations of Major Violations and Minor Violations for each measure.

- Major Violations require immediate resolution which may include charging the contractor back for the coupon amount.
- Minor Violations may be resolved without coupon chargeback.

The definition of Major and Minor violations by measure are summarized in Table 6-7.

Table 6-7 QA Violation Definitions by Measure

Measure	***Definitions***
Direct Install	Major violation examples: ▪ Verified devices installed does not match claimed devices installed. ▪ Device installed on an appliance of non-eligible fuel type ▪ Installation of direct install equipment results in damage or inoperability of existing equipment Minor violation examples: ▪ None
Insulation	Major violation examples: ▪ Stated existing R-value: error > 1 step difference in R-value range chart on the coupon. ▪ Stated finished R-value: error of > 10% in R-value ▪ Stated square footage: error of >10% in square feet Minor violation examples: ▪ Improper installation of new insulation (such as varying depths) ▪ Bag count card not properly displayed ▪ Depth markers not properly displayed
Duct Sealing/Air Sealing	Major violation examples: ▪ Starting vs. finished air leakage rate: verification reveals discrepancy > 20% ▪ Minimum Ventilation Requirement (MVR): failure to identify correct MVR or take proper action in the event of the MVR not being met ▪ Duct sealing or air sealing materials: use of improper materials ▪ Combustion Safety Test (CST): not performing the CST or failing to take proper action on the results. Minor violation examples: ▪ None

6.2.9 Impact of Home Assessments

The Evaluators reviewed the measure installations energy savings for participants in the HESP. The Evaluators key findings from this review were:

- Conversion rates for Assessments are now at 99%. In 2015 the conversion rate was 98.5% and in 2016 it was 98.3%

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Similar to 2016, Assessment homes had significantly higher savings than homes that install-only. It should be noted that in 2017 there were only seven install-only homes, however.

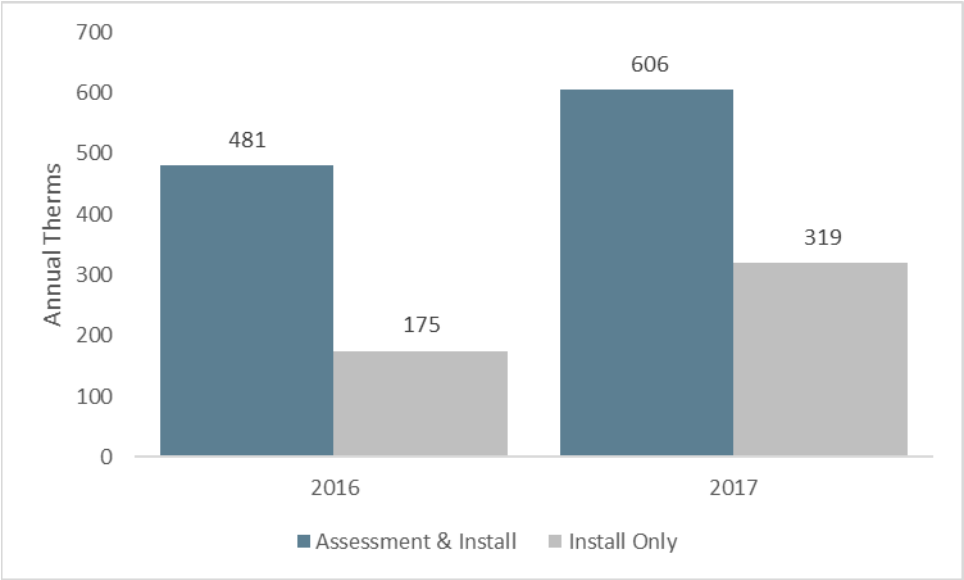


Figure 6-4 Per-Home Therms Savings: Assessment vs. Install-Only

As shown in Figure 6-7, the measure mixes changed significantly from 2016 to 2017.

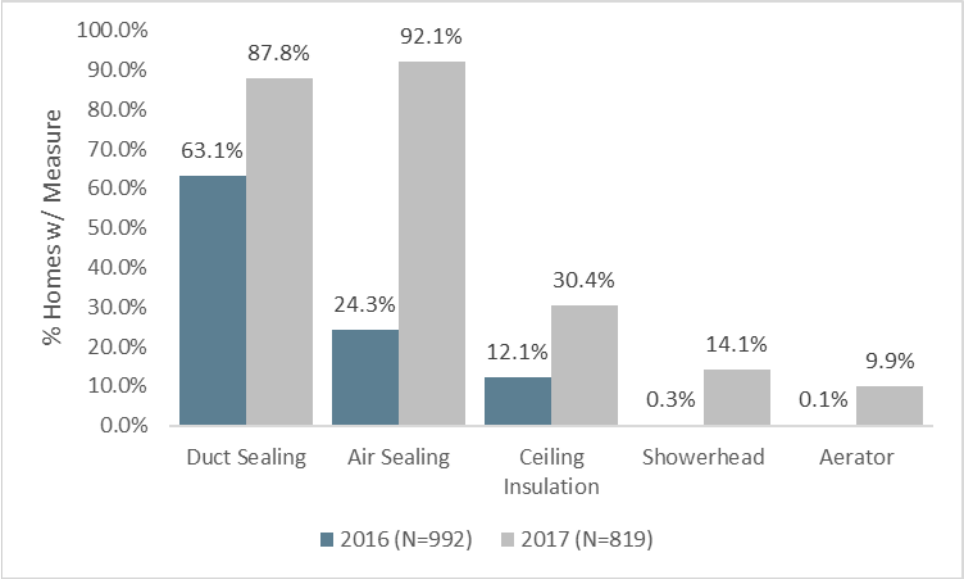


Figure 6-5 % Houses with Each Measure

As shown in Figure 6-7, the measure mixes changed significantly from 2016 to 2017. All measures showed increased prevalence compared to 2016, as 90.1% of participant homes were multi-measure.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

6.2.10 Trade Ally Outreach

In 2017, the HESP had six registered trade allies participate in 2017. This was reduced to four trade allies mid-year. One trade ally ceased operations in Arkansas entirely and another trade ally ceased working in northwest Arkansas. The roles and requirements of a Home Energy Consultant is as follows:

- **Home Energy Consultants (HECs).** HECs are allowed to provide Tie Assessments through the program, which receive rebates of $300[31] from BHE. When the home overlaps with a participating electric utility and has equipment that qualifies for both programs, the incentive cost is split equally. HECs must attend program training sessions held by CLEAResult in a classroom setting as well as in the field before being certified and allowed to perform Surveys and Assessments. Other requirements for HECs include:
  - Must have at least one employee with certification as either a Building Performance Institute Building Analyst (BPI-BA) or a RESNET Home Energy Rater (this rater is required to be present on all jobs in progress);
  - If the staff member with the appropriate certification leaves the company, the trade ally must hire a replacement or obtain a certification for another employee within 30 days (though this is extended if the needed courses are not available in that time frame).
  - Must own and maintain a Blower Door, Duct Blaster, combustion safety testing tools, energy modeling software (provided by the program), and all appropriate hand tools.

6.2.11 Participant Survey Response

The Evaluators surveyed 68 single-family participants in the HESP. These surveys were to collect data on participant experience with the program including sources of program awareness, motivations for participating, and satisfaction with the program. Further, the Evaluators collected demographic information on the respondents during the survey, as well as information to determine the free ridership score and spillover effect.

6.2.11.1 Program Awareness

BHE's marketing of their CWA program is driven through direct outreach methods such as social media, direct mail and email, as well as radio, TV, and print advertising. Thirty-five percent of participants found out about the rebate program through a friend, family member, or colleague. The second most commonly reported source of program awareness was from the BHE website (24%), followed by a social media posting (15%).

[31] The incentive is reduced to $150 if the home is 700 ft.^{2} or less.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Of those that cited a social media post, 80% specified that it as a posting on Facebook. Table 6-8 summarizes the sources of awareness by respondents.

Table 6-8 Source of Awareness

Source of Awareness	***% of Respondents***
Word of mouth from friends, relatives, or others	35%
BHE website	24%
Social media post	15%
Contractor contacted me	12%
Landlord singed up	6%
Email from BHE	3%
Utility Bill message	3%
Other website	3%
n=68	

6.2.11.2 Reasons for Participation

Participants were asked about their primary motivations for becoming involved with this program. Forty-one percent of those interviewed stated that their primary motivation for participation was to save money on their monthly utility bill. Saving energy (15%) and improving home comfort (12%) were the other top motivations for program involvement. Some participants noted that there were multiple reasons for their involvement in the program, hence there are more responses than the number of participants surveyed. All responses are summarized in Figure 6-6 below.

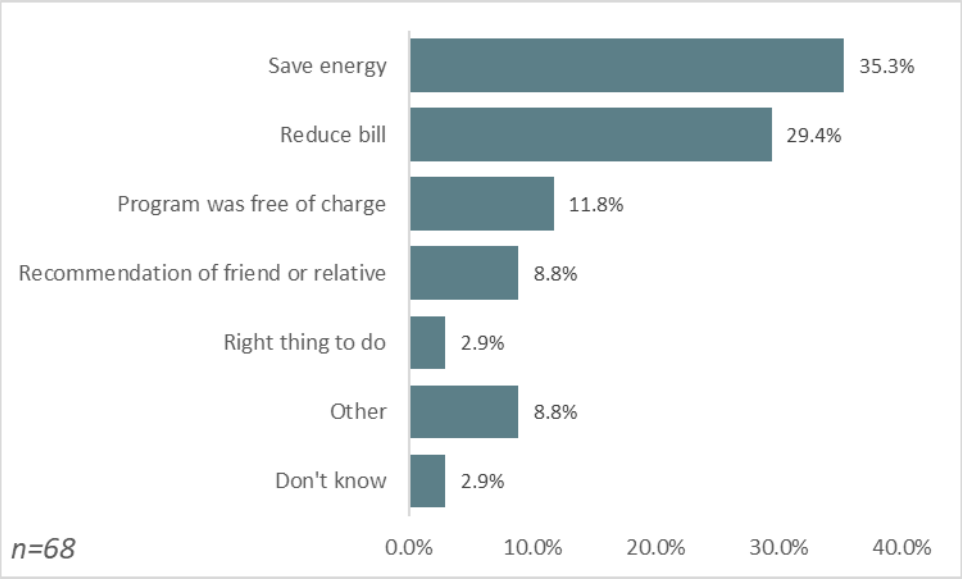


Figure 6-6 Reasons for Participation

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

6.2.11.3 Home Energy Assessment

Part of the HESP program involves the option to receive a home energy assessment from a program assessor. A series of questions was asked of participants to determine their experience and satisfaction with the energy assessment received. Figure 6-7 shows the percentage of participants who recalled having received a home energy assessment through the program; 84.8%% recalled having received an assessment.

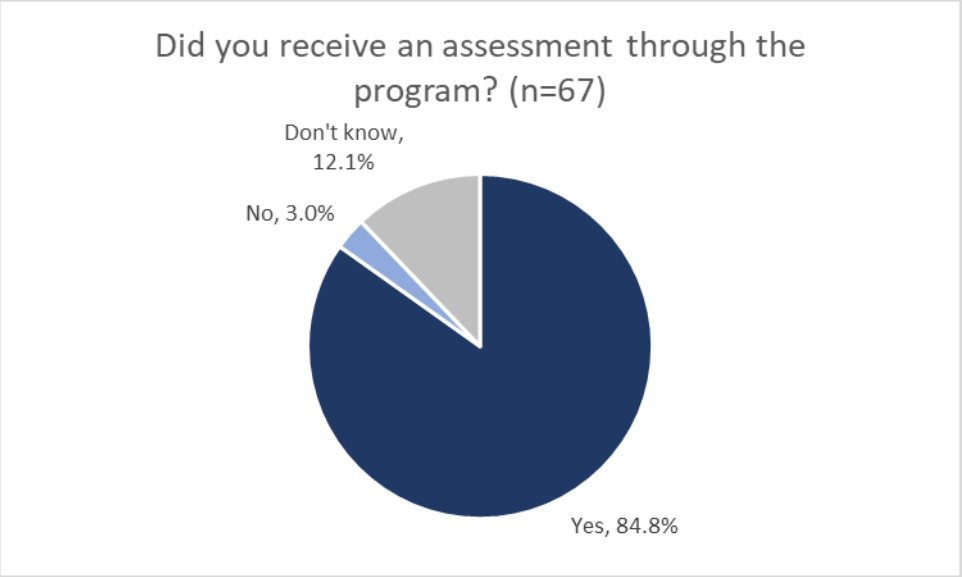


Figure 6-7 Recipients of Assessment

Eighty-five percent of respondents who received a home energy assessment were not planning on having an assessment of their home before learning about the program. Participants were then asked about the scheduling process, interaction with the assessor, and what occurred during the assessment. Sixty-nine percent of participants who received an assessment found that the scheduling process was very easy and 26% percent found the process somewhat easy or neutral, as shown in Figure 6-8.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

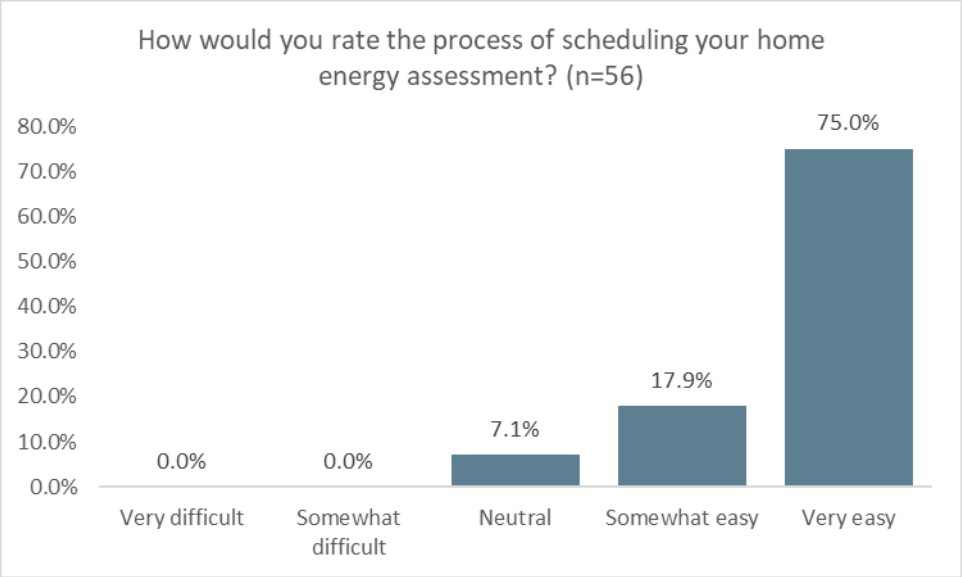


Figure 6-8 Home Energy Assessment Scheduling

Fifty-seven percent of those who received an assessment found the information to be helpful, while 28.6% found the assessment somewhat helpful or neutral. No respondents rated the assessment below “neutral” in level of helpfulness.

While the assessor was on site, participants had the option to have the assessor install energy efficient measures or leave them to be installed by the homeowner at a later time. Forty-eight percent asked the assessor to install items (major measures or direct install items) the day of the assessment. Respondents were also asked to identify whether specific actions were taken by the assessor, detailed in Figure 6-9 Actions taken by Assessor.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

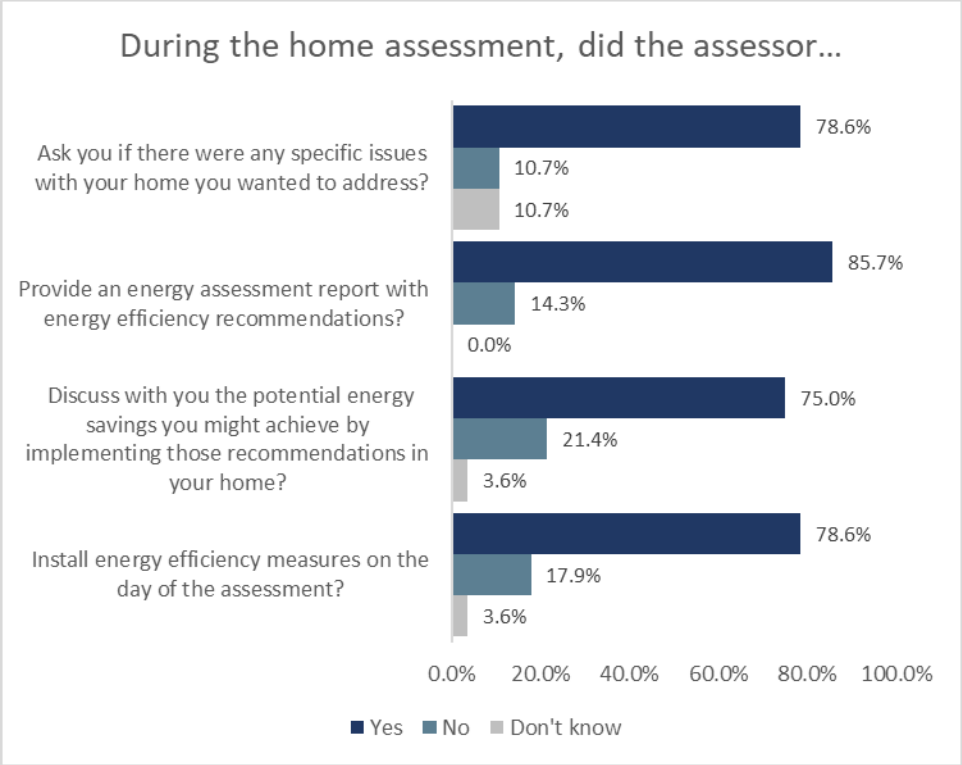


Figure 6-9 Actions taken by Assessor

6.2.11.4 Participant Interest in Energy Efficiency

Surveyed participants were asked a series of questions about their efforts to have a more energy efficient home. Ninety-one percent of participants described themselves as 5 or above on a scale of “1 to 10” where “1” means not at all knowledgeable and “10” means “Very Knowledgeable,” regarding ways to save energy in the home. A follow up question was asked to determine how much effort is put into having an energy saving home. Figure 4 captures the responses to efforts put into saving energy in the home prior to the HESP.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

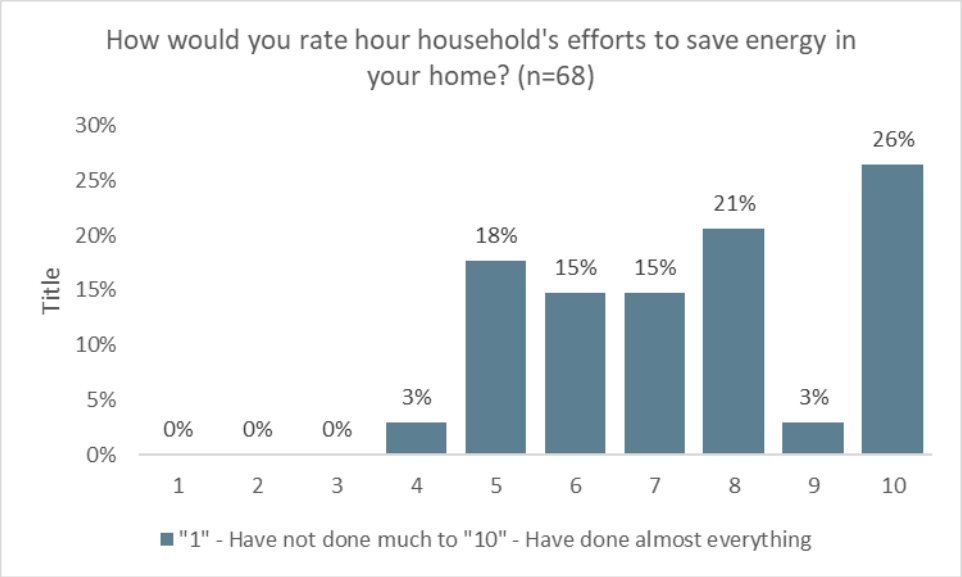


Figure 6-10 Energy Efficiency Prior to CWA Program

A series of questions were asked regarding the homeowner's intentions and interests in further home improvements. As recorded in Figure 7-12, generally homeowners are very interested in making more home improvements that would improve health and safety, improve home comfort, as well as increase the home's overall energy efficiency.

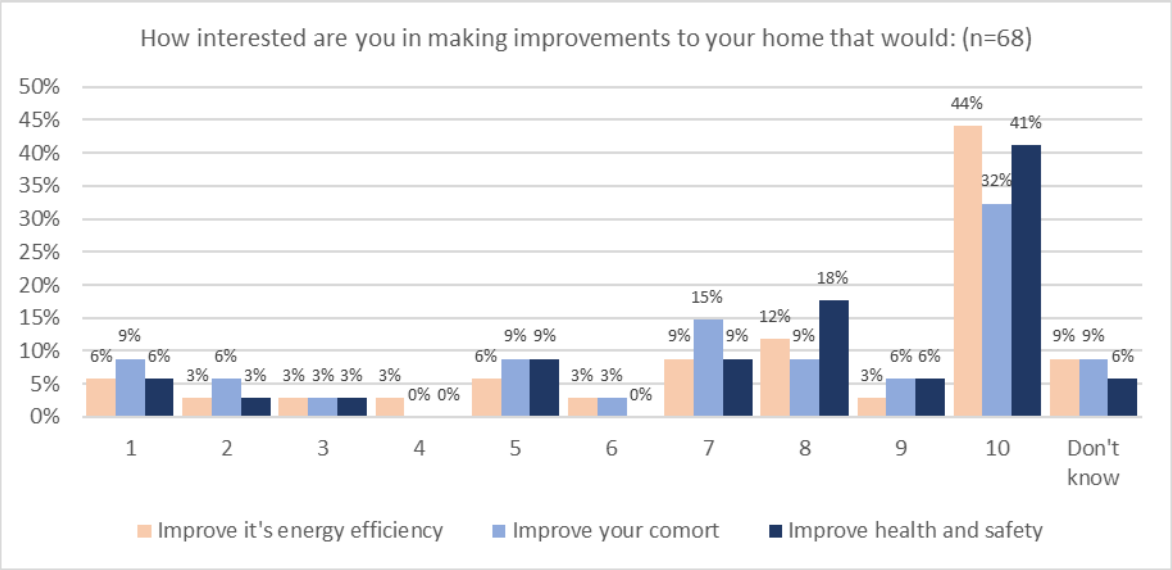


Figure 6-11 Future Home Improvements

6.2.11.5 Satisfaction

Customer feedback was generally positive about a variety of aspects of the program. For various aspects of the program, participants were asked to use a scale of 1 to 5,

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

where 1 is "very dissatisfied" and 5 is "very satisfied. Eighty-five percent reported that they were somewhat or very satisfied with the overall program experience.

The highest reported satisfaction, 91% were somewhat or very satisfied, was based on positive interactions with the contractor installing the equipment. The highest reported dissatisfaction, 16%, were very or somewhat dissatisfied with the savings on monthly utility bills. Figure 4 summarizes these responses.

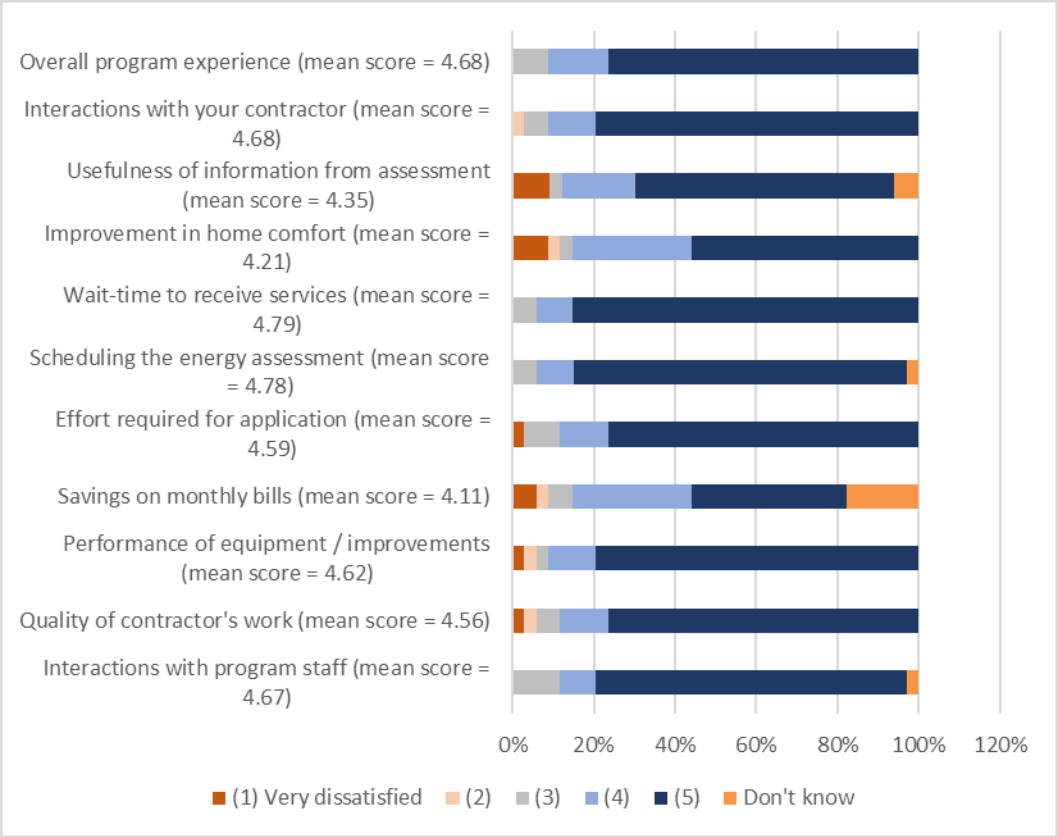


Figure 6-12: Satisfaction with Various Program Aspects

Participants that scored any competent at three or less were asked to provide details as to what caused their dissatisfaction. Examples given by respondents included:

> *"HES/BHE said they would send me a written home energy assessment but they never sent it and that was several months ago."*
>
> *"They did the minimum, they just were in too big of a hurry"*
>
> *"There was no improvement to my home or my bill, and they put some weather stripping around the door, but it doesn't do its job."*
>
> *"They did not really do anything or didn't tell me anything."*

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

There was no consistent pattern to the comments regarding installing contractor; the respondents that made these remarks comprised projects from the top four trade allies in the program.

6.2.11.6 Demographics

Participants were additionally asked a series of questions related to demographic information. Eighty-two percent of respondents own the property where this project took place, as seen in Figure 6-13.

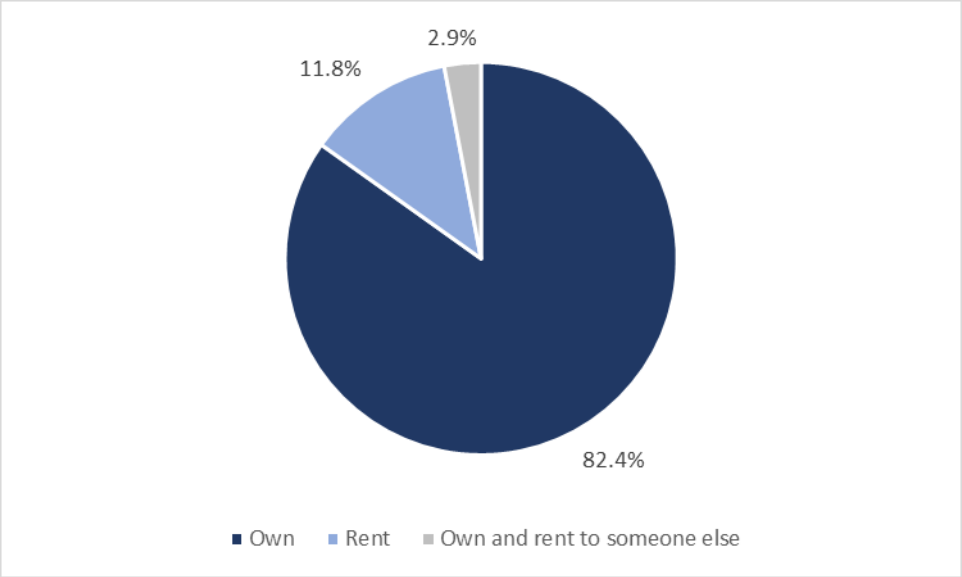


Figure 6-13 Home Ownership Status

Survey respondents' homes averaged 1,910 square feet. Figure 6-14 presents average home vintage. Most respondents' homes were built between 1970 and 1999.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

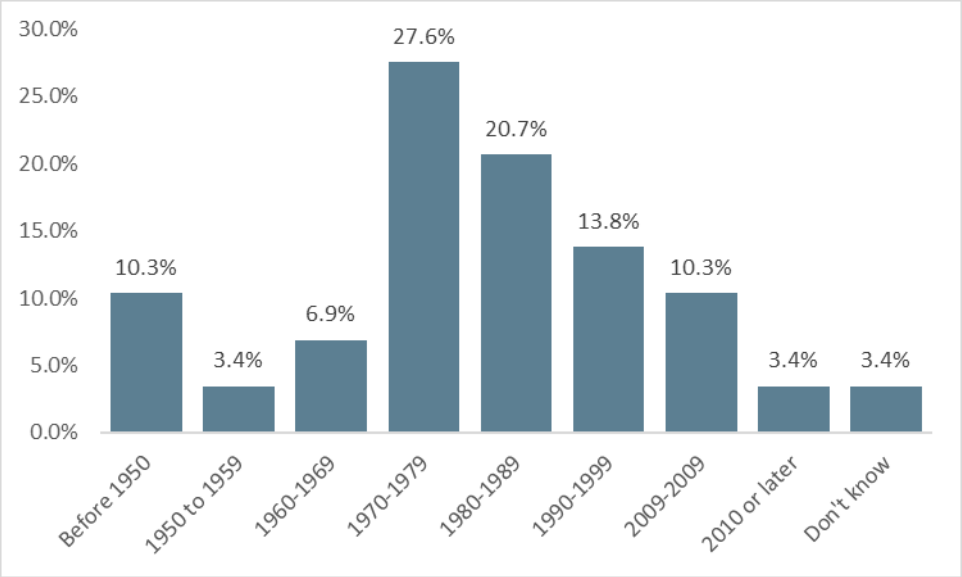


Figure 6-14 Home Vintage

Ninety percent of participants received a high school degree or higher education. The responses to education questions are compiled in Figure 7-17.

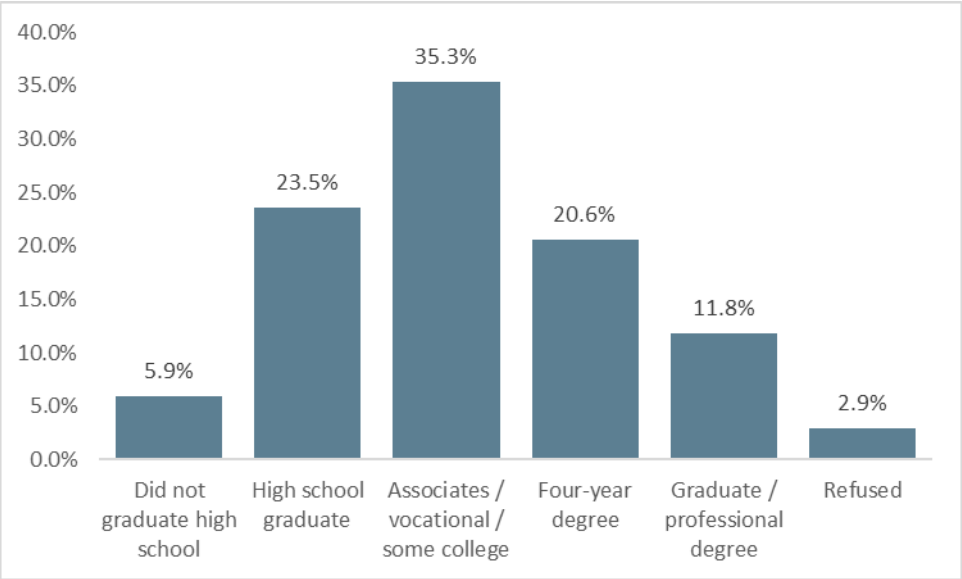


Figure 6-15 Educational Attainment

Thirty-three percent of survey participants refused to respond to income questions. The remaining 59% who disclosed an income have their salaries summarized in the Figure 6-17 below.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

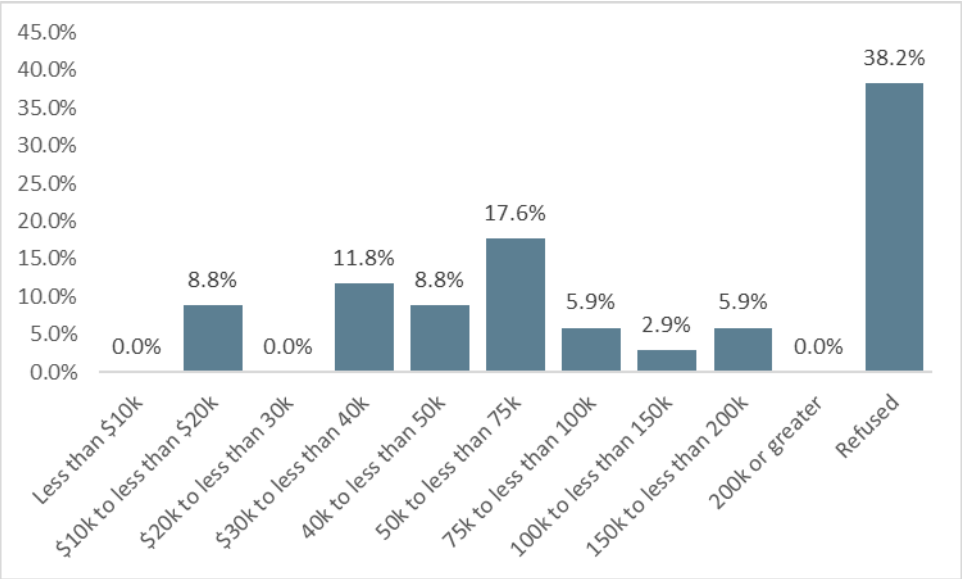


Figure 6-16 HESP Participant Income

6.3 HESP Impact Evaluation

The evaluation effort of the HESP included the following:

- *Desk Review of Residential Calculations.* The Evaluators utilized TRM V6.1 values in assessing savings from measures included in the program.
- *Field Verification.* Field inspections were completed at a sample of 42 residences. Field inspections included duct blast and blower door testing when participants received duct sealing or air sealing (respectively).

6.3.1 Tracking Review

The impact evaluation began with a review of program tracking data. The tracking data included a separate row for each measure installed. Every premise in the program had a unique rebate identifier, and thus one premise would have multiple rows to reflect the different measures completed. Table 6-9 summarizes ex ante savings by measure for the HESP.

Table 6-9 HESP Ex Ante Summary

Measure	*Ex Ante Therms*
Duct Sealing	346,008
Air Sealing	105,010
Ceiling Insulation	41,336
Showerhead	1,383
Aerator	246
Grand Total	**493,983**

The tracking data provided measured values for duct pressurization testing and blower door tests, allowing for the recreation of ex ante calculations based on leakage

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

reduction. Ceiling insulation included an indicator for baseline R-value. Program specifications are to bring the home's insulation level up to R-38 or R-49. The maximum allowed baseline insulation is R-22.

6.3.2 Field Verification Procedures

The Evaluators conducted field verifications at 42 premises. The field verification sample included the following measures:

- 16 ceiling insulation retrofits;
- 47 duct sealings;
- 51 air sealings.

For all measure types requiring on-site measurements, the square footage and heating and cooling types were verified. To verify ceiling insulation, the insulation type and measured depth were recorded.

To measure duct leakage, the Evaluators' field staff performed duct pressurization testing (using Duct Blasters®) on the ducting for central heating systems. System static pressure (SSP) on the duct system was first measured, where SSP is a measurement of static pressure at the supply side plenum of the duct system when the supply fan is on and operating with registers in their normal position. This pressure is unique for each system. The ducts were then pressurized by means of a Duct Blaster® connected to the return side of the system. Total duct leakage was measured with the registers sealed and the Duct Blaster® pressurizing the duct system. Total Duct leakage was then recorded.

Finally, total home infiltration, measured in CFM, was calculated. One-time measurements of pressure differential between the conditioned and unconditioned space were taken to calculate a snap shot of total home infiltration, in CFM.

6.3.2.1 Duct Sealing Field Results

The Evaluators found that 11 of 47 tested sites had post-retrofit leakage which differed from values listed in program tracking data by more than 20%. Figure 6-12 summarizes the differences in field test values. The line in this figure presents the Evaluators' tested post-retrofit CFM leakage minus the trade allies' post-retrofit CFM leakage. The data is presented in ascending order, based on lowest ex ante post-retrofit CFM to highest ex ante post-retrofit CFM.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

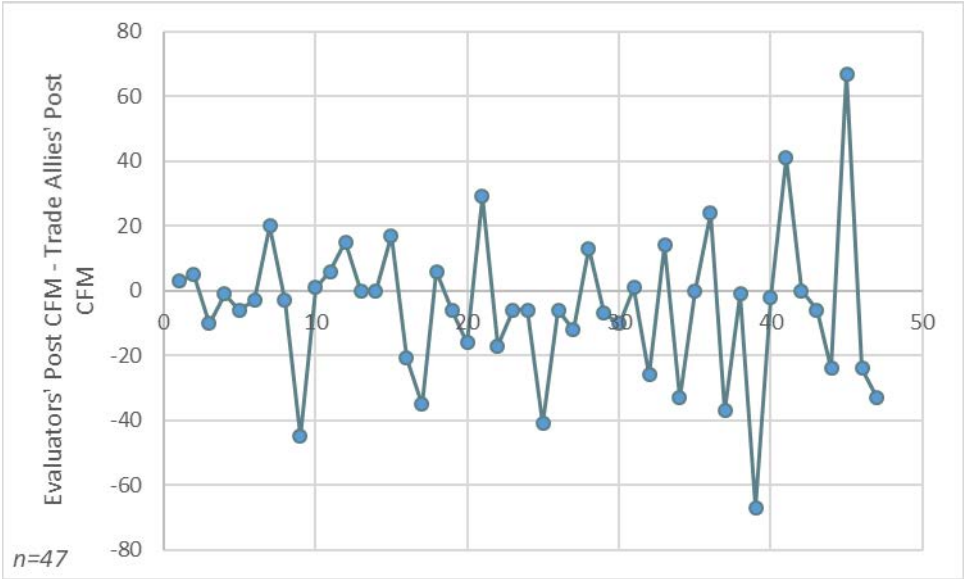
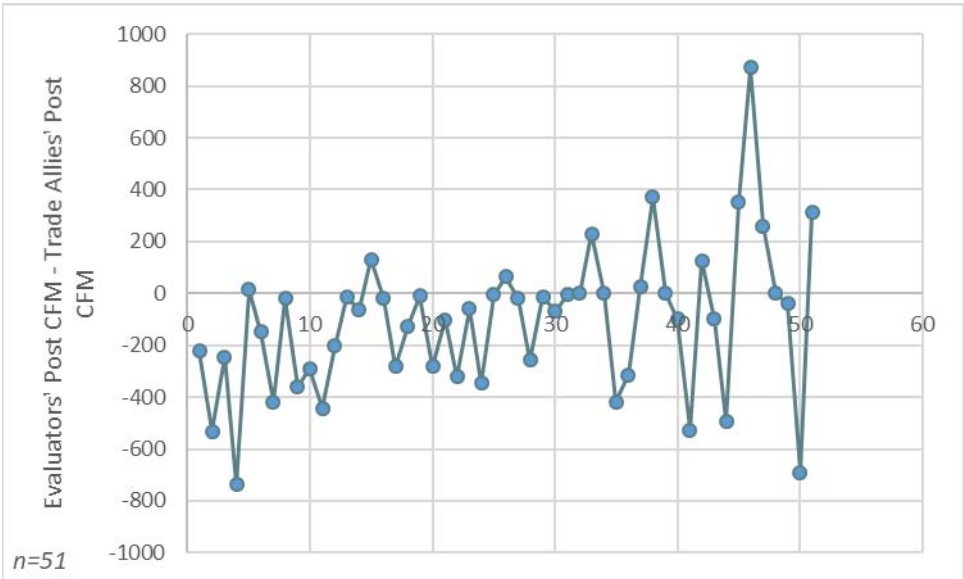


Figure 6-17 Difference in Expected and Evaluated Ex-Post Duct Sealing CFM

In aggregate, the Evaluators found that ex ante test values underestimated program savings. Based on the field results, the Evaluators found 104.72% gross realization.

6.3.2.2 Air Sealing Field Results

The Evaluators found that five of the 47 tested homes had post-retrofit air leakage values that differed from program tracking data more than 20%. Four of five of these values over state savings and one of five understate savings. The field test differences are summarized in Figure 6-13.



APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Figure 6-18 Difference in Expected and Evaluated Ex-Post Air Sealing CFM

In aggregate, the Evaluators found that ex ante test values underestimated program savings. Based on the field results, the Evaluators found 107.52% realization.

6.3.3 Net Savings Estimates

To assess the program's influence on major measures (i.e., duct sealing, air sealing, and insulation), program participants were asked questions regarding:

- If they could afford to install the equipment if it had not been provided for free through the program;
- If they had plans to complete the project;
- The likelihood of installing the equipment if it had not been provided for free; AND
- The timing of the project in the absence of the program.

The procedures for developing a free-ridership score based on the survey responses are summarized below.

In this methodology, financial ability is essentially a gateway value, in that if a participant does not have the financial ability to purchase energy efficient equipment absent a rebate, the other components of free-ridership become moot. Respondents that reported they could have afforded to implement the improvements were assigned an overall free-ridership score based on a prior plans score, a likelihood of installing the measure in the absence of the program, and a timing score.

<u>Prior Plans and Deferred Free-ridership</u>

The prior plans score was based on a response to a question regarding the presence of plans. Specifically, respondents were considered to have had prior plans if they answered "Yes" to the following question:

- Prior to learning about the program, did you have plans to implement the [Measure]?

The program influence on the timing of the project was incorporated in to the estimation of free-ridership in one of two ways. First, consistent with the Arkansas TRM definition of free-ridership, respondents who indicated that the project would have been completed in more than one year if the program was not available were assigned a free-ridership score of 0. For all other respondents, the plans score was factored by the program impact on timing. Specifically,

- If the respondent stated that they would have installed the measure in 6 months to one year, then the prior plans score was reduced by one-half.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- If the respondent stated that they would have installed the measure at the same time or within 6 months of when it was installed, the prior plans score was not adjusted.

Likelihood of Implementing Measure without Program

A likelihood of installing the measure in the absence of the program was developed based on respondents stated likelihood of installing a measure if the financial support was not provided or if the measure had not been recommended through the energy assessment. Specifically, responses to this question were scored as follows:

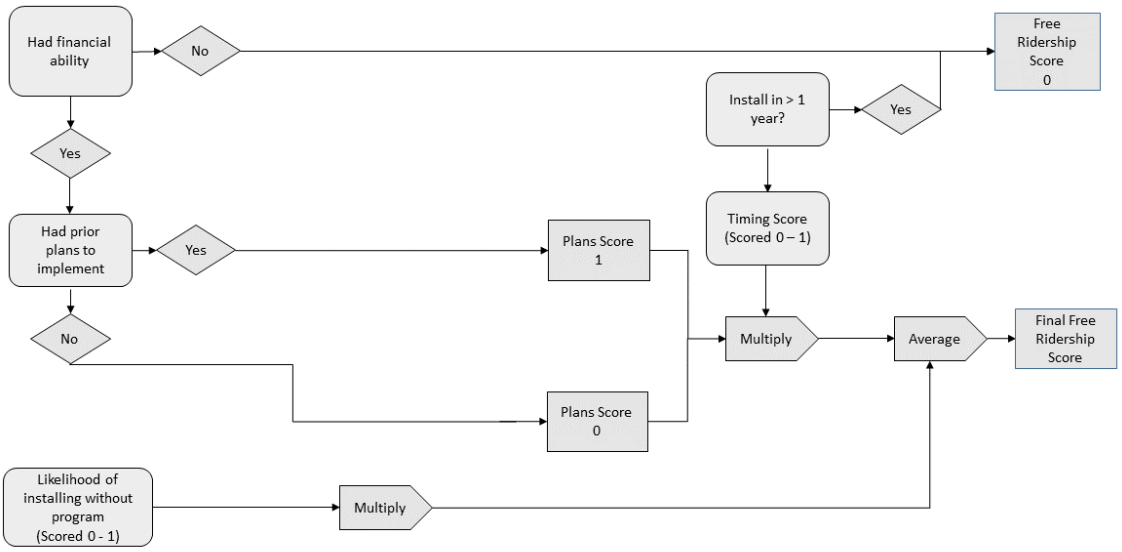
- Very likely: 1
- Somewhat likely: .75
- Neither particularly likely nor unlikely: .5
- Somewhat unlikely: .25
- Very unlikely: 0

The likelihood score was based on the lower value of the likelihood of installing the measure if the program financial support was not available or if the measure was not recommended through the energy assessment.

The overall free-ridership score for participants with the financial ability to install the measures was based on the average of the prior plans and the likelihood scores. The free-ridership scoring is summarized in Figure 6-19.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Figure 6-19 Major Measure Free-ridership



The responses to key NTGR questions was as follows:

- Would you have been financially able to complete these weatherization improvements without the financial assistance provided through the program?
  - 35% reported “yes”, 47% reported “no”, 18% reported “don’t know”
- Prior to learning about the Program, did you have plans to weatherize your home?
  - 35% reported “yes”, 65% reported “no”
- How likely is it that you would have completed similar weatherization improvements within one year of when you received it if the financial assistance was not available? Would you say...
  - Very likely: 20.6%
  - Somewhat likely: 26.5%
  - Neither likely nor unlikely: 8.8%
  - Somewhat unlikely: 14.7%
  - Very unlikely: 26.5%
  - Don’t know; 2.9%

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- How likely is it that you would have completed similar weatherization improvements within one year of when you received it if the financial assistance was not available? Would you say...
  - Very likely: 21.2%
  - Somewhat likely: 0.0%
  - Neither likely nor unlikely: 3.0%
  - Somewhat unlikely: 33.3%
  - Very unlikely: 39.4%
  - Don't know: 3.0%

In total, 6 of the 68 survey respondents provided answers that fully-aligned with the free-rider indicators on all questions. The resulting free-ridership rate is (6/68) = 8.82%, with a NTGR of 100% - 8.82% = 91.18%.

6.3.3.1 Direct Install Measures Free-ridership Methodology

Due to the low volume of direct install measures (which accounted for .31% of verified savings) the Evaluators did not develop a separate NTGR. DI measures received the 91.18% NTGR developed for the weatherization measures.

6.4 Verified Savings

Table 6-10 presents the gross savings results of the evaluation of the 2017 Home Energy Savings Program. Total Gross Savings summarizes the savings calculations performed by TRM protocols for program measures.

Table 6-10 HESP Verified Savings Summary

Measure	Ex Ante Therms	Ex Post Therms	EUL	Lifetime Therms
Duct Sealing	346,008	362,860	18	6,531,481
Air Sealing	105,010	113,128	11	1,244,402
Ceiling Insulation	41,336	42,973	20	859,468
Showerhead	1,383	1,392	10	13,920
Aerator	246	248	10	2,485
Total	**493,983**	**520,601**	**17.0**	**8,651,756**

Table 6-11 HESP Net Savings Summary

Free-Ridership Rate		Net Annual Savings		Net Realization Rate	EUL	Net Lifetime Therms Savings
Ex Ante	Ex Post	Ex Ante	Ex Post			
5.00%	8.82%	469,284	474,684	101.15%	16.62	7,888,671

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

6.4.1 Water & Electric NEBs

Table 6-12 HESP Verified Net Water Savings

Measure Category	Net Annual Water Saving (Gallons)	Lifetime Net Water Savings (Gallons)
Aerators	59,057	590,573
Showerheads	315,994	3,159,934
Total	**375,051**	**3,750,507**

Table 6-13 HESP Verified Net Electric Savings

Measure Category	Net Annual kWh	Net Peak kW	Lifetime Net kWh
Duct Sealing	368,069	245.44	6,625,246
Air Sealing	61,988	36.62	681,867
Ceiling Insulation	40,491	33.97	809,822
Total	**470,548**	**316.03**	**8,116,934**

6.5 Conclusions & Recommendations

The Evaluators' conclusions and recommendations are as follows.

6.5.1 Conclusions

- **Project comprehensiveness increased in 2017.** The HESP has significantly increased the rate of multi-measure projects in 2017. The notable causes of this include the following increases:
  - Percent of homes with air sealing increasing from 24.3% to 92.1%;
  - Percent of homes with ceiling insulation increasing from 12.1% to 30.4%
- **Direct install is occurring at an increased rate.** Fourteen percent of participant premises received showerheads and 9.9% received faucet aerators. This is up from .3% and .1% from 2016, respectively.
- **Conversion rate for Assessments is high.** In 2017, the conversion rate was over 99%%.

6.5.2 Recommendations

- **Consider outreach to public housing.** Public housing authorities continue to participate in other BHE programs but there was no participation from these groups in the HESP in 2017.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

7. Recommendations for TRM Updates

The Evaluators have the following recommendations for updates to the TRM.

7.1 DHW Temperature Setpoint

From 2016-2017, the Evaluators collected domestic hot water setpoint during field visits for residential programs (largely visits conducted for EM&V of Consistent Weatherization Approach Programs). Overall, temperature setpoints were collected at 194 residences. Temperature was recorded via measurement of hot water at the sink most proximal to the water heater, after allowing the water to stabilize at full temperature.

Our sample was comprised of 139 single family and 55 multifamily properties. The summary values are follows (confidence intervals are degrees Fahrenheit at 90%):

- Average setpoint: 123.13 (±0.76)
- Single family setpoint: 123.67 (±1.00)
- Multifamily setpoint: 121.76 (±0.86)

This setpoint revision applies to the following measures specified in TRM V7.0:

- 2.3.1 Water Heater Replacement
- 2.3.4 Faucet Aerators
- 2.3.5 Low Flow Showerheads
- 2.3.6 Showerhead Thermostatic Restrictor Valve
- 2.3.7 Tub Spout and Showerhead Thermostatic Restrictor Valve

7.2 Water Savings for Steam Trap Replacement

For 2017 projects, the Evaluators calculated water savings from steam trap replacement. This is a simple matter of converting the lbs. of steam into gallons of water by the conversion of 8.33 lbs. per gallon. The discharge rate in lbs. per hour and the conversion to gallons per hour are presented in the tables to follow.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Table 7-1 Steam Trap lbs./hr. Discharge Rate

Steam Trap Orifice	Steam Pressure												
	2	5	10	15	25	50	75	100	125	150	200	250	300
1/32	0	0	1	1	1	2	2	3	4	5	6	7	9
1/16	1	1	2	2	3	4	6	8	9	11	14	18	21
3/32	1	2	3	4	6	10	14	17	21	25	32	40	48
1/8	2	4	6	8	11	17	24	31	37	44	58	71	85
5/32	4	6	9	12	16	27	37	48	58	69	90	111	132
3/16	5	9	14	18	24	39	54	69	84	99	130	160	190
7/32	7	12	19	24	32	53	73	94	115	135	177	218	259
1/4	10	16	24	31	42	69	96	123	150	177	230	284	338
9/32	12	20	31	40	53	87	121	155	189	224	292	360	428
5/16	15	25	38	49	66	108	150	192	234	276	360	444	528
11/32	18	30	46	59	80	131	181	232	283	334	436	538	640
7/16	30	49	74	96	129	211	294	376	459	541	706	871	1036
15/32	35	57	86	111	149	244	339	434	529	624	814	1004	1195
1/2	39	64	97	125	168	276	384	491	599	707	922	1137	1353

Table 7-2 Steam Traps Gallons/hr. Discharge Rate

Steam Trap Orifice	Steam Pressure												
	2	5	10	15	25	50	75	100	125	150	200	250	300
1/32	-	-	0.12	0.12	0.12	0.24	0.24	0.36	0.48	0.60	0.72	0.84	1.08
1/16	0.12	0.12	0.24	0.24	0.36	0.48	0.72	0.96	1.08	1.32	1.68	2.16	2.52
3/32	0.12	0.24	0.36	0.48	0.72	1.20	1.68	2.04	2.52	3.00	3.84	4.80	5.76
1/8	0.24	0.48	0.72	0.96	1.32	2.04	2.88	3.72	4.44	5.28	6.96	8.52	10.20
5/32	0.48	0.72	1.08	1.44	1.92	3.24	4.44	5.76	6.96	8.28	10.80	13.33	15.85
3/16	0.60	1.08	1.68	2.16	2.88	4.68	6.48	8.28	10.08	11.88	15.61	19.21	22.81
7/32	0.84	1.44	2.28	2.88	3.84	6.36	8.76	11.28	13.81	16.21	21.25	26.17	31.09
1/4	1.20	1.92	2.88	3.72	5.04	8.28	11.52	14.77	18.01	21.25	27.61	34.09	40.58
9/32	1.44	2.40	3.72	4.80	6.36	10.44	14.53	18.61	22.69	26.89	35.05	43.22	51.38
5/16	1.80	3.00	4.56	5.88	7.92	12.97	18.01	23.05	28.09	33.13	43.22	53.30	63.39
11/32	2.16	3.60	5.52	7.08	9.60	15.73	21.73	27.85	33.97	40.10	52.34	64.59	76.83
7/16	3.60	5.88	8.88	11.52	15.49	25.33	35.29	45.14	55.10	64.95	84.75	104.56	124.37
15/32	4.20	6.84	10.32	13.33	17.89	29.29	40.70	52.10	63.51	74.91	97.72	120.53	143.46
1/2	4.68	7.68	11.64	15.01	20.17	33.13	46.10	58.94	71.91	84.87	110.68	136.49	162.42

7.3 Addition of Steam Leak Repair

The C&I Solutions Program has done a significant amount of steam leak repair projects in the past four program years. These projects have not had a realization rate below 90% as savings are readily predictable when the plume length, system pressure, and boiler efficiency are known. The Evaluators recommend that CLEAResult's workpaper for steam leak repair be included in a TRM update so as to remove the EM&V burden on a measure that does not warrant this level of review.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8. Appendix A: Site Reports

This appendix contains the individual site reports for C&I Solutions.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.1 BHE-2017-001

Program	BHE-2017-001
Project ID	C&I Solutions
Facility SIC Code	2341 – Women's Misses', Children's and Infants' Underwear and Nightwear
Measures	▪ Insulation ▪ Steam Trap Replacement ▪ Condensate Pumping Station Replacement
Annual Consumption	1,284,800 CCF

Project Background

The participant is a textile manufacturing facility. The facility operates 24 hours per day, 6 days per week. There are (7) valves insulated and (1) bare tank insulated. The site has also replaced (9) steam traps and has repaired (2) condensate pumping stations. They received incentives from Black Hills Energy for:

- ECM#1: Insulation
- ECM#2: Steam trap replacement
- ECM#3: Condensate leak repair

ECM#1: Insulation

Bare valve insulation parameters

Valve Line Size (inches)	Quantity	Equivalent Length	Total Equivalent Length
6	6	3.58	21.5
4	1	3.47	3.5
3	1	3.35	3.4
8	3	3.95	11.9
2	1	3	3.0
4	1	3.47	3.5
6	6	3.58	21.5

Bare tank insulation parameters

Diameter (Ft)	Height (ft)	Quantity	Surface Area (ft^2)
1.5	2	3.00	33.58

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM#2: Steam Trap Replacement

Steam trap replacement parameters

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate*
1/2	7/64	100	5	37
1/2	7/64"	100	5	24
1/2	7/64	100	5	37
1/2	7/64	100	5	37
1/2	7/64	100	5	37
3/4	7/64	100	5	37
3/4	#38	100	5	31
3/4	1/8	100	5	48
3/4	1/8	100	5	48

ECM#3: Condensate Improvement

Condensate leak repair parameters

Leak Flow (gal/min)	Avg. Condensate Return Temp. (F)	MU Water Temp. (F)	Leak Hours
2	180	66.1	8,400
1	180	66.1	8,400

M&V Methodology

ECM #1: Insulation

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement. Through this method, energy savings are calculated using key data and through the North American Insulation Manufacturers Association's 3E Plus software (http://www.pipeinsulation.org/).

The following parameters were used in energy savings calculations:

- The steam boiler is operated 8,400 hours annually
- Post insulation is 2" thick
- Boiler efficiency= 83%

The 3E Plus software was used to calculate heat loss (btu/hr/ft) for bare piping (pre-retrofit) and piping with 2-in insulation (post-retrofit). The calculator required these inputs: process temperature, ambient temperature, pipe size, base metal, insulation,

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

and jacket material. Annual Therms savings were calculated using the following equation:

$$Annual\ Therms\ Savings = (Bare\ Heat\ Loss - Insulated\ Heat\ Loss)\frac{BTU}{hr * ft} \times AOH\ (hrs) \times Pipe\ Length(ft) \times \frac{1\ therm}{100{,}000\ BTU} \div boiler\ efficiency$$

Where:

Bare heat loss = heat loss of pipe with no insulation (BTU/hr/ft)
Insulated heat loss = heat loss of pipe with 2" insulation (BTU/hr/ft)
AOH = annual operating hours
Pipe length = length of the pipe in (ft)
Therms conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$
Boiler efficiency = 83%

Measure Life

The EUL of this measure is 20 years.

ECM #2: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Steam trap orifice sizes are 1/2" and 3/4"
- Annual operating hours = 4,240 and 8,400
- Inlet pressure = 100(psig)
- Outlet pressure = 5 (psig)

Discharge rate (lb/hr) was calculated using Armstrong's steam loss through failed trap calculator (https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V6.1 Section 3.1.17. The formula is as follows:

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times OpHrs\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

Where:

Steam Trap Discharge Rate = Steam loss in lb/hr.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

OpHrs = annual hours the steam system is pressurized
H_{fg} = Latent heat of evaporation in Btu/lb from steam tables.
$E_{C\ Base}$ = 83%
Therms conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$

Measure Life
The EUL of this measure is 5 years.

ECM#3: Condensate Improvement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification are based on the following assumption:

- Annual hours system is pressurized = 8,400
- Boiler efficiency = 83%
- Make up water temperature = 66.1°F

System heat loss from a condensate leak was calculated as:

$$Heat\ Loss\ \left(\frac{Btu}{hr}\right) = Leak\ Rate\ \left(\frac{gal}{min}\right) * 8.34\ \left(\frac{lb}{gal}\right) * [Condensate\ Temp\ (F) - MU\ Water\ Temp\ (F)] * 60\ \left(\frac{min}{hr}\right)$$

Where:

Leak Rate = amount in gal/min of condensate that is leaking

Condensate Temp = average temperature of the condensate return in degrees Fahrenheit

MU Water Temp = Average Temperature of MU water in degrees Fahrenheit

The annual natural gas energy savings from repairing a condensate leak was calculated as follows.

$$Annual\ Energy\ Savings\ (Ccf) = Heat\ Loss\ \left(\frac{Btu}{hr}\right) x\ 8{,}400\left(\frac{hrs}{yr}\right)\ /\ (Eff\%\ x\ 100{,}000\frac{Btu}{Ccf})$$

Where:

Heat loss= amount of heat lost from system

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Eff %= Efficiency of boiler

Savings Results

ECM #1: Insulation installation

Therms savings were calculated using the insulation parameters listed in the table above.

Bare valve insulation savings

Valve Total Equivalent Length (feet)	Valve Line Size	Q_{pre}	Q_{post}	Therms Savings
21.5	6	1299	165.2	2,465
3.5	4	898.5	111.5	276
3.4	3	708.5	93.21	209
11.9	8	1673	197.60	1,769
3.0	2	493.1	68.44	129
3.5	4	898.5	111.50	276
21.5	6	1299	165.20	2,465
			Total:	**7,589**

Insulated Tank Savings

Diameter (Ft)	Height (ft)	Quantity	Surface Area (ft2)	Therms Savings
1.5	2	3.00	33.58	547
			Total:	**547**

ECM #2: Steam Trap Replacement

Using the above parameters, calculated savings of each replaced steam trap are presented in the table below.

Steam trap replacement savings

Line Size (inches)	Orifice Size (inches)	Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	Applied Discharge Rate	Therms Savings
1/2	7/64	100	5	37	1,867
1/2	7/64"	100	5	24	1,211
1/2	7/64	100	5	37	3,734
1/2	7/64	100	5	37	3,734
1/2	7/64	100	5	37	3,734
3/4	7/64	100	5	37	3,734
3/4	#38	100	5	31	3,129
3/4	1/8	100	5	48	4,845

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

3/4	1/8	100	5	48	4,845
				Total:	**30,835**

ECM#3: Condensate Leak Repair

The resulting annual gallons lost from the equation above and Therms savings are presented in the table below.

Condensate leak repair savings

Leak Flow (gal/min(	*Avg. Condensate Return Temp. (F)*	*MU Water Temp. (F)*	*Leak Hours*	*Annual Gallons Lost*	*Therms Savings*
2	180	66.1	8,400	1,008,00	11,536
1	180	66.1	8,400	504,000	5,768
				Total:	**17,304**

The calculated savings for ECM #1,2 and 3 are as follows:

- Annual Therms Savings: 56,276
- Lifetime Therms: 489,948
- Water savings: 1,820,067 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.2 BHE-2017-002

Program C&I Solutions
Project ID BHE-2017-002
Facility SIC Code 8062 – General Medical and Surgical Hospitals
Measures
- Steam leak repair
- Steam trap replacement

Project Background

The site is a not-for-profit hospital serving the rural communities of North Arkansas. The facility's steam system is pressurized 8,760 hours per year. The facility repaired (17) steam leaks and replaced (36) steam traps. The participant is a hospital that received incentives from Black Hills Energy for:

- ECM#1: Steam leak repair; and
- ECM#2: Steam traps replacement.

ECM #1: Steam leak repair

Steam leak repair parameters

Description	*Qty of Leaks*	*Plume Length (ft)*	*Leak (lbs/hr)*
Trap 1 Packing Leak	1	1	10
Trap 5 Packing Leak	1	1	10
Trap 19 Packing Leak	1	1	10
Trap 22 Gate Valve Packing Leak	1	1	10
Trap 36 Coil Split	1	4	54
Trap 45 Packing Leak	1	2	17
Trap 53 flange leak	1	2	17
Trap 126 Union Leak	1	1	10
Trap 128 Coupling Leak	1	1	10
Trap 129 Seal Leak	1	1	10
Trap 20 Valve nipple leak	1	1	9.934
Trap 31 AERCO / Split HTG coil leak (top coil)	1	3	30.590
AERCO Water Heater / Large Leak (Coil #2)	1	4	53.679
AERCO Water Heater / Coil #3 & #4 (Bottom)	2	2	17.432
Steam Riser Near AERCO Water Heater	1	1	9.934
Trap 25 Valve nipple leak	1	2	17.432
Trap 127 Autoclave - bad relief valve	1	1	9.934

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #2: Steam trap replacement

Steam trap replacement parameters

Trap Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*
1 1/2	5/16	60	5	125
2	5/8	15	5	136.8
1 1/2	1/2	15	5	109
3/4	1/8	60	5	31
2	5/8	15	5	51.3
1 1/4	11/32	15	5	39
1/2	3/16	60	5	35
3/4	1/8	60	5	20
3/4	1/8	60	5	31
2	0.421	60	5	226.84
2	0.421	60	5	226.84
3/4	1/8	60	5	31
3/4	1/8	60	5	31
3/4	7/32	60	5	61
3/4	1/8	60	5	24.8
3/4	1/8	15	5	9.6
3/4	5/32	60	5	21.6
1/2	1/8	60	5	31
3/4	7/64	60	5	24
3/4	7/64	60	5	12
3/4	7/64	60	5	12
3/4	1/8	60	5	18.6
3/4	7/64	60	5	16.8
3/4	1/8	60	5	15.5
3/4	7/64	60	5	14.4
3/4	1/8	60	5	10.85
3/4	1/8	60	5	12.4
1/2	1/4	15	0	12.4
3/4	7/32	15	5	9.9
3/4	5/32	60	5	12
3/4	1/8	60	5	7.75
1/2	1/8	60	5	12.4
3/4	7/32	15	5	16.5
1/2	1/8	60	5	3.1
1/2	1/8	15	5	2.4
3/4	1/8	60	5	2.4

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

M&V Methodology

ECM #1: Steam leak repair

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- System is pressurized = 8,760 hours
- Boiler efficiency: 83%

The equation used to calculate flow rate was derived by G.G. Rajan's "Energy savings in steam systems."

$$Leak\ Rate\ \left(\frac{lbs}{hr}\right) = 5.661 \times \exp[0.562 \times plume\ length(ft)]$$

Annual natural gas saving savings (Therms) was calculated using the following equation:

$$Annual\ Savings\ (therms) = Steam\ Flow\ Rate\ \left(\frac{lb}{hr}\right) \times hfg@65\ psig\ \left(\frac{btu}{lb}\right) \times AOH \times \frac{1\ therm}{100{,}000\ BTU} \div boiler\ efficiency(\%)$$

Where:

Steam flow rate = leak rate (lb/hr)
hfg@65 psig = latent heat (btu/lb) at 65 gage pressure PSIG
AOH = Annual operating hours

Therm conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$
Boiler efficiency = 83%

Measure Life

The EUL of this measure is 5 years.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #2: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Annual operating hours: 8,760 hrs (drip); 4,380 hrs (heat exchanger); 8,760 hrs (TK/Coil); and 8,760 hrs (AutoClave).
- Efficiency: 83%

Discharge rate (lb/hr) was calculated using Armstrong's steam loss through failed trap calculator(https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V3.0 Section 3.1.17. The formula is as follows:

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times EFLH_H\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

Where:

$Steam\ Trap\ Discharge\ Rate$ = Steam loss in lb/hr.
$EFLH_H$ = Equivalent full-load hours
h_{fg}= Latent heat of evaporation in Btu/lb from steam tables.
$Ec_{Base} =$ 83%
$Therm\ Conversion\ Factor$ = 100,000BTU/Therm

Measure Life

The EUL of this measure is 5 years.

Calculated Savings:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #1: Steam leak repair

Steam leak repair savings

Description	*Qty of Leaks*	*Plume Length (ft)*	*Leak (lbs/hr)*	*Annual Btu's Lost*	*Therms Savings*
Trap 1 Packing Leak	1	1	10	98,394,450	1,185
Trap 5 Packing Leak	1	1	10	98,394,450	1,185
Trap 19 Packing Leak	1	1	10	98,394,450	1,185
Trap 22 Gate Valve Packing Leak	1	1	10	98,394,450	1,185
Trap 36 Coil Split	1	4	54	97,718,479	-
Trap 45 Packing Leak	1	2	17	175,411,451	2,113
Trap 53 flange leak	1	2	17	175,411,451	2,113
Trap 126 Union Leak	1	1	10	98,394,450	1,185
Trap 128 Coupling Leak	1	1	10	98,394,450	1,185
Trap 129 Seal Leak	1	1	10	99,960,825	1,204
Trap 20 Valve nipple leak	1	1	9.934	99,960,825	1,204
Trap 31 AERCO / Split HTG coil leak (top coil)	1	3	30.590	302,988,970	3,650
AERCO Water Heater / Large Leak (Coil #2)	1	4	53.679	540,149,720	6,508
AERCO Water Heater / Coil #3 & #4 (Bottom)	2	2	17.432	175,411,451	4,227
Steam Riser Near AERCO Water Heater	1	1	9.934	99,960,825	1,204
Trap 25 Valve nipple leak	1	2	17.432	172,662,773	2,080
Trap 127 Autoclave - bad relief valve	1	1	9.934	98,394,450	1,185
				Total:	**32,604**

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #2: Steam trap replacement

Steam trap savings

Trap Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*	*Therms savings*
1 1/2	5/16	60	5	125	6,691
2	5/8	15	5	136.8	7,192
1 1/2	1/2	15	5	109	5,731
3/4	1/8	60	5	31	3,318
2	5/8	15	5	51.3	2,697
1 1/4	11/32	15	5	39	2,050
1/2	3/16	60	5	35	3,747
3/4	1/8	60	5	20	1,070
3/4	1/8	60	5	31	3,318
2	0.421	60	5	226.84	12,141
2	0.421	60	5	226.84	12,141
3/4	1/8	60	5	31	3,318
3/4	1/8	60	5	31	3,318
3/4	7/32	60	5	61	3,265
3/4	1/8	60	5	24.8	2,655
3/4	1/8	15	5	9.6	1,009
3/4	5/32	60	5	21.6	2,312
1/2	1/8	60	5	31	3,318
3/4	7/64	60	5	24	2,569
3/4	7/64	60	5	12	1,285
3/4	7/64	60	5	12	642
3/4	1/8	60	5	18.6	1,991
3/4	7/64	60	5	16.8	1,798
3/4	1/8	60	5	15.5	1,659
3/4	7/64	60	5	14.4	1,541
3/4	1/8	60	5	10.85	1,161
3/4	1/8	60	5	12.4	1,327
1/2	1/4	15	0	12.4	1,304
3/4	7/32	15	5	9.9	1,041
3/4	5/32	60	5	12	1,285
3/4	1/8	60	5	7.75	830
1/2	1/8	60	5	12.4	1,327
3/4	7/32	15	5	16.5	1,735
1/2	1/8	60	5	3.1	332
1/2	1/8	15	5	2.4	252
3/4	1/8	60	5	2.4	1,991
				Total:	**103,366**

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The calculated savings for ECM #1, and 2 are:

- Annual Therms Savings: 135,970
- Lifetime Therms: 842,867
- Water Savings: 1,396,209 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.3 BHE-2017-004

Program BHE-2017-004
Project ID C&I Solutions
Facility SIC Code 8062 – General Medical and Surgical Hospitals
Measures
- Steam trap replacement
- Steam leak repair
- insulation

Annual Consumption 753,110 CCF

Project Background

The site is a general hospital north-central Arkasnas. The facility is operational 24/7. The annual operating hours for this site is 8,760. There was (1) bare pipe that was insulated on site. The facility repaired (10) steam leaks and replaced (14) steam traps. The participant is a hospital that received incentives from Black Hills Energy for:

- ECM#1: Insulation;
- ECM#2: Steam leak repair;
- ECM#3: Steam traps replacement.

ECM #1: Pipe Insulation

TBare Pipes Insulated Parameters

Length (feet)	*Pipe Diameter (inches)*
3.58	*None given*

ECM #2: Steam leak repair

Steam leak repair parameters

Description	*Qty of Leaks*	*Plume Length (ft)*	*Leak (lbs/hr)*
1/8" orifice leak	1	1	9.93
1/8" orifice leak	1	1	9.93
1/8" orifice leak	1	1	9.93
1/8" orifice leak	1	1	9.93
1/8" orifice leak	1	1	9.93
1/8" orifice leak	1	1	9.93
1/8" orifice leak	1	1	9.93
1/8" orifice leak	1	3	30.59
1/8" orifice leak	1	3	30.59
1/8" orifice leak	1	2	17.43

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #3: Steam trap replacement

Steam trap replacement parameters

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate*
3/4	1/8	60	7	18.6
3/4	1/8	60	7	6
3/4	1/8	60	7	12.4
3/4	1/8	60	7	31
3/4	1/8	60	7	16
1	7/32	60	7	95
1	5/32	60	7	14.4
3/4	1/8	60	7	20
3/4	1/8	60	7	20
1/2	1/4	60	0	56
3/4	5/16	60	0	75
3/4	5/32	60	7	12
3/4	1/8	60	7	9.3
3/4	1/8	60	7	21.7

M&V Methodology

ECM #1: Pipe Insulation

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement. Through this method, energy savings are calculated using key data and through the North American Insulation Manufacturers Association's 3E Plus software (http://www.pipeinsulation.org/).

Measurement and verification activities are based on the following assumptions:

- The steam boiler operates 8,760 hours annually
- Insulation thickness: 1 in
- Insulation material type: 850F MF Blanket, Type IV, C553-11
- Boiler Efficiency: 83%

The 3E Plus software was used to calculate heat loss (btu/hr/ft) for bare piping (pre-retrofit) and piping with 1-in insulation (post-retrofit). The software required these inputs: process temperature, ambient temperature, pipe size, base metal, insulation, and jacket material. Annual therms savings was calculated using the following equation:

$$\begin{aligned} &Annual\ Therms\ Savings \\ &\quad = Heat\ Loss(Btu/hr) \\ &\quad \times AOH\ (hrs)/\ (boiler\ efficiency\ x\ 100{,}000\ Btu/Ccf) \end{aligned}$$

Where:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Bare heat loss = Leak rate (lbs/hr) x [Steam Enthalpy (Btu/lb) – MW Enthalpy (Btu/lb)

AOH = annual operating hours (8,760 hours)

Boiler efficiency = 83% efficiency

Therm conversion factor = $\frac{1\ therm}{100{,}000\ BTU/CcF}$

Measure Life

The EUL of this measure is 20 years.

ECM #2: Steam leak repair

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Annual operating hours leaking: 8,760
- Boiler efficiency: 83%
- Leak hole diameter: 1/8”

The equation used to calculate flow rate was derived by G.G. Rajan’s “Energy savings in steam systems.”

$$Leak\ Rate\ \left(\frac{lbs}{hr}\right) = 5.661 \times \exp[0.562 \times plume\ length(ft)]$$

Annual natural gas saving savings (Therms) was calculated using the following equation:

$$Annual\ Savings\ (therms) = Steam\ Flow\ Rate\ \left(\frac{lb}{hr}\right) \times hfg@65\ psig\ \left(\frac{btu}{lb}\right) \times AOH \times \frac{1\ therm}{100{,}000\ BTU} \div boiler\ efficiency(\%)$$

Where:

Steam flow rate = leak rate (lb/hr)
hfg@65 psig = latent heat (btu/lb) at 65 gage pressure PSIG
AOH = Annual operating hours

Therm conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$
Boiler efficiency = 80% efficiency (assumed)

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Measure Life

The EUL of this measure is 5 years.

ECM #3: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Steam trap orifice sizes 3/4" and 1"
- Annual operating hours: 8,760 hrs (drip) and 4,380 hrs (process)
- Inlet pressure: 60 (psig)
- Outlet pressures: 7 psig for non-thermostatic trap types or 0 psig for thermostatic trap types
- Efficiency: 83%

Discharge rate (lb/hr) was calculated using Armstrong's steam loss through failed trap calculator (https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V3.0 Section 3.1.17. The formula is as follows:

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times EFLH_H\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

Where:

$Steam\ Trap\ Discharge\ Rate$ = Steam loss in lb/hr.
$EFLH_H$ = Equivalent full-load hours
h_{fg}= Latent heat of evaporation in Btu/lb from steam tables.
$Ec_{Base} =$ 80% (assumed)
$Therm\ Conversion\ Factor$ = 100,000BTU/Therm

Measure Life

The EUL of this measure is 5 years.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Calculated Savings:

ECM #1: Insulation

Using the above parameters, calculated savings of each insulation installation are presented in the table below

Insulated pipe savings

Equivalent Pipe Length (feet)	*Pipe Diameter (inches)*	Q_{pre}	Q_{post}	*Therms Savings*
3.58	None given	1,056	136	348
			Total:	**348**

ECM #2: Steam leak repair

Therms savings for steam leak repairs are presented below. The calculation includes the steam leak parameters above.

Steam leak repair savings

Description	*Qty of Leaks*	*Plume Length (ft)*	*Leak (lbs/hr)*	*Annual Btu's Lost*	*Therms Savings*
1/8" orifice leak	1	1	9.93	99,960,825	1,204
1/8" orifice leak	1	1	9.93	99,960,825	1,204
1/8" orifice leak	1	1	9.93	99,960,825	1,204
1/8" orifice leak	1	1	9.93	99,960,825	1,204
1/8" orifice leak	1	1	9.93	99,960,825	1,204
1/8" orifice leak	1	1	9.93	99,960,825	1,204
1/8" orifice leak	1	1	9.93	49,980,413	602
1/8" orifice leak	1	3	30.59	307,815,301	3,709
1/8" orifice leak	1	3	30.59	307,815,301	3,709
1/8" orifice leak	1	2	17.43	175,391,327	2,113
				Total:	**17,359**

ECM #3: Steam trap replacement

The table below lists the therms savings for steam trap replacements.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Steam trap savings

Line Size (inches)	Orifice Size (inches)	Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	Applied Discharge Rate (lb/hr)	Therms Savings
3/4"	1/8"	60	7	18.6	1,971
3/4"	1/8"	60	7	6	636
3/4"	1/8"	60	7	12.4	1,314
3/4"	1/8"	60	7	31	3,286
3/4"	1/8"	60	7	16	848
1"	7/32"	60	7	95	10,069
1"	5/32"	60	7	14.4	1,526
3/4"	1/8"	60	7	20	1,060
3/4"	1/8"	60	7	20	1,060
1/2"	1/4"	60	0	56	2,968
3/4"	5/16"	60	0	75	3,975
3/4"	5/32"	60	7	12	1,272
3/4"	1/8"	60	7	9.3	986
3/4"	1/8"	60	7	21.7	2,300
				Total:	**33,270**

The calculated savings for ECM #1, 2, and 3 are as follows:

- Annual Therms Savings: 50,977
- Lifetime Therms: 346,889
- Water Savings: 480,675 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.4 BHE-2017-005

Program	BHE-2017-005
Project ID	C&I Solutions
Facility SIC Code	3496 – Miscellaneous fabricated metal wire products
Measures	▪ Steam trap replacement

Project Background

The site primarily deals with steel wire transformation and coating technologies. The system is operational 3,504 hours (process) and 8,760 hours (drip) annually. For this project there were (40) steam traps that were replaced. The participant is a steel wire and coating technology manufacturer that received incentives from Black Hills Energy for:

- ECM#1: Steam trap replacements

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #1: Steam trap replacement

Steam trap replacement parameters

Line Size (inches)	Orifice Size (inches)	Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	Applied Discharge Rate
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1	1/8	105	5	50
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	50
1	1/8	105	5	50
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	50
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32
1/2	1/8	105	5	32

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

M&V Methodology

ECM #1: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Steam trap orifice sizes 1/2" and 1”
- Annual operating hours: 8,760 hrs (drip) and 4,380 hrs (process)
- Inlet pressure: 105 (psig)
- Outlet pressures: 5 (psig)
- Efficiency: 82%

Discharge rate (lb/hr) was calculated using Armstrong’s steam loss through failed trap calculator (https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V3.0 Section 3.1.17. The formula is as follows:

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times EFLH_H\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

Where:

$Steam\ Trap\ Discharge\ Rate$ = Steam loss in lb/hr.
$EFLH_H$ = Equivalent full-load hours
h_{fg}= Latent heat of evaporation in Btu/lb from steam tables.
$Ec_{Base} =$ 82%
$Therm\ Conversion\ Factor$ = 100,000BTU/Therm

Measure Life

The EUL of this measure is 5 years.

Calculated Savings:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #1: Steam trap replacement

Steam trap savings

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*	*Therms Savings*
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1	1/8	105	5	50	5,465
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	50	5,465
1	1/8	105	5	50	5,465
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	50	5,465
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
1/2	1/8	105	5	32	1,399
				Total:	**72,228**

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The calculated savings for ECM #1 is as follows:

- Annual Therms Savings: 72,228
- Lifetime Therms: 361,142
- Water savings: 694,911 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.5 BHE-2017-006

Program C&I Solutions
Project ID BHE-2017-006
Facility SIC Code 2038 - Frozen Specialties
Measures
- Insulation;
- Steak leak repair; and
- Steam Trap replacement

Project Background

The facility produces frozen foods on behalf of national brands. The participant received incentives from Black Hills Energy for:

- ECM#1: Insulation;
- ECM#2: Steam leak repair; and
- ECM#3: Stream trap replacement.

ECM #1: Pipe Insulation

Bare pipes insulated parameters

Pipe Length (feet)	*Pipe Diameter (inches)*
2.5	3
40	1
1	3
2	8
0.5	1
2	8
0.5	2
0.5	3
3	1
6	4
3	1
7	1
4.5	4
0.5	1
1.33	1
4.5	4
1.33	3
4	1
17	2
1	1
1	1
1	1
32	4
2	2
2	3
4	2
11	2
5	2

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

0.67	2
7	4
2	2
2.5	2
1	1
0.5	1
14	6
2.5	4
3	3
1	1
6	2
2	6
15	1
6	1
7	1
9	6
5	4
15	1
17	2

Valve insulation parameters

Valve size (inches)	***Quantity***	***Equivalent length***	***Total equivalent length***
4	2	3.47	6.9
4	1	3.47	3.5
2	1	3	3.0
1	2	2.25	4.5
2	1	3	3.0
2	1	3	3.0
3	1	3.35	3.4
0.75	1	2	2.0
2	1	3	3.0
3	1	3.35	3.4
3	1	3.35	3.4
0.75	1	2	2.0
2	1	3	3.0
1	2	2.25	4.5
8	1	3.95	4.0
0.75	2	2	4.0
8	1	3.95	4.0
4	1	3.47	3.5
2	2	3	6.0
2	2	3	6.0
2	2	3	6.0
2.5	1	3.17	3.2
2.5	1	3.17	3.2
2.5	1	3.17	3.2
2	1	3	3.0
2	1	3	3.0

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2	1	3	3.0
2	1	3	3.0
2	1	3	3.0
2	1	3	3.0
2	1	3	3.0
2	1	3	3.0
0.75	1	2	2.0
1.25	1	2.5	2.5
4	1	3.47	3.5
4	1	3.47	3.5
2	1	3	3.0
2	1	3	3.0
2.5	1	3.17	3.2
3	1	3.35	3.4
4	1	3.47	3.5
6	1	3.58	3.6
12	1	4.05	4.1
4	1	3.47	3.5
6	1	3.58	3.6
4	6	3.47	20.8
4	4	3.47	13.9
3	2	3.35	6.7
3	1	3.35	3.4
3	1	3.35	3.4

Rectangular tank insulated parameters

Length (ft)	*Width (ft)*	*Height (ft)*	*Surface area (ft^2)*
12.0	7.0	8.0	192

ECM #2: Steam leak repair

Steam leak repair parameters

Description	*Qty of Leaks*	*Plume Length (ft)*	*Leak (lbs/hr)*
Trap 506 Packing Leak Above Trap	1	1	10
Trap 508 Packing Leak Above Trap	1	1	10
Trap 528 Valve Not Holding	1	1	10
Trap 529 Valve Not Holding	1	1	10
Trap 530 Trap Cap Leak	1	2	17
Trap 534 Relief Valve Leak	1	1	10
Trap 540 Nipple Leak	1	1	10
Trap 543 Steam Inlet & Relief Valve Leaks	1	3	31
Trap 545 Steam Inlet & Relief Valve Leaks	1	3	31
Trap 551 Steam Valve Gasket Leak	1	3	31
Trap 552 Relief Valve Leak	1	2	17
Trap 564 Leak at Union	1	4	54
Trap 570 Relief & Union Leak	1	2	17
Trap 572 Multiple Leaks	1	2	17

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Trap 575 Trap Has Multiple Leaks	1	2	17
Trap 577 Trap Has Multiple Leaks	1	3	31
Trap 579 Relief & Union Leak	1	1	9.934
Trap 580 Bad Regulator	1	1	9.934
Trap 544 Leak near trap	1	1	9.934

ECM #3: Steam trap replacement

Steam leak replacement parameters

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*
3/4	1/8	90	5	28
1/2	1/8	90	5	44
1	1/8	90	5	44
3/4	1/8	90	5	28
3/4	1/8	90	5	28
3/4	7/64	90	5	33
3/4	1/8	90	5	28
3/4	1/8	90	5	28
3/4	1/8	90	5	28
1/2	1/8	90	5	44
3/4	7/64	90	5	21
3/4	7/64	90	5	21
3/4	7/64	90	5	21
1/2	1/8	90	5	28
3/4	7/64	90	5	33
3/4	7/64	90	5	33
3/4	7/64	90	5	33
3/4	7/64	90	5	33
1	1/8	90	5	44
1-1/2	7/32	90	5	171
1	1/8	90	5	44
1-1/2	7/32	90	5	171
1	1/4	90	5	174
3/4	1/8	90	5	44

M&V Methodology

ECM #1: Pipe Insulation

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement. Through this method, energy savings are calculated using key data and through the North American Insulation Manufacturers Association's 3E Plus software (http://www.pipeinsulation.org/).

Measurement and verification activities are based on the following assumptions:

- **Full operating hours = 8,760 hours annually**

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- **The average annual ambient air temperature is 75°F**
- **The facility's boilers are approximately 83% efficient**

The 3E Plus software was used to calculate heat loss (btu/hr/ft) for bare piping (pre-retrofit). The software calculated heat loss based on these inputs: process temperature, ambient temperature, pipe size, base metal, insulation, and jacket material. Annual Therms was then calculated using the following equation:

$$Annual\ Therms\ Savings = (Bare\ Heat\ Loss - Insulated\ Heat\ Loss)\frac{BTU}{hr * ft} \times AOH\ (hrs) \times Pipe\ Length(ft) \times \frac{1\ therm}{100{,}000\ BTU} \div boiler\ efficiency$$

Where:

Bare heat loss = heat loss of pipe with no insulation (BTU/hr/ft)
Insulated heat loss = heat loss of pipe with 2" insulation (BTU/hr/ft)
AOH = annual operating hours
Pipe length = length of the pipe in (ft)
Therms conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$
Boiler efficiency = 83%

Measure Life

The EUL of this measure is 20 years.

ECM #2: Steam leak repair

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Annual operating hours leaking: 8,760
- Boiler efficiency: 83%

The equation used to calculate flow rate was derived by G.G. Rajan's "Energy savings in steam systems."

$$Leak\ Rate\ \left(\frac{lbs}{hr}\right) = 5.661 \times \exp[0.562 \times plume\ length(ft)]$$

Annual natural gas saving savings (Therms) was calculated using the following equation:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

$$Annual\ Savings\ (therms) = Steam\ Flow\ Rate\ \left(\frac{lb}{hr}\right) \times hfg@65\ psig\ \left(\frac{btu}{lb}\right) \times AOH \times \frac{1\ therm}{100{,}000\ BTU} \div boiler\ efficiency(\%)$$

Where:

Steam flow rate = leak rate (lb/hr)
hfg@65 psig = latent heat (btu/lb) at 65 gage pressure PSIG
AOH = Annual operating hours

Therm conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$
Boiler efficiency = 83% efficiency

Measure Life

The EUL of this measure is 5 years.

ECM #3: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Estimated system hours = 4,005 hours (Coil), 8,760 hours (Drip), 4,380 (Process 1), and 5,840 (Process 2)
- Inlet and outlet pressures = 90 psig and 5 psig respectively
- Boiler efficiency = 83%

Discharge rate (lb/hr) was calculated using Armstrong's steam loss through failed trap calculator (https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V6.1 Section 3.1.17. The formula is as follows:

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times OpHrs\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

Where:

Steam Trap Discharge Rate = Steam loss in lb/hr.
OpHrs = annual hours the steam system is pressurized
H_{fg} = Latent heat of evaporation in Btu/lb from steam tables.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

$E_{C\ Base}$ = 83%

Therms conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$

Measure Life

The EUL of this measure is 5 years.

Calculated Savings:

ECM #1: Insulation

Calculated savings for insulation are presented in the table below.

Pipe Insulation savings

Equivalent Pipe Length (feet)	Pipe Diameter (inches)	Q_{pre}	Q_{post}	Therms Savings
3.35	3	523.8	68	120
2.25	1	479.5	40	1,855
3.35	3	1054	85.58	102
3.95	8	2028	178.8	390
2.25	1	479.5	40	23
3.95	8	2137	188.8	411
3	2	354.6	25.74	17
3.35	3	550.2	42.6	27
2.25	1	293.4	20.48	39
3.47	4	1323	107.7	770
2.25	1	524.8	38.9	154
2.25	1	445.4	32.37	305
3.47	4	1357	110.6	592
2.25	1	593	44.66	29
2.25	1	514.9	43.39	66
3.47	4	1390	113.6	606
3.35	3	1164	95.3	150
2.25	1	157.2	29.22	54
3	2	232	34.48	53
2.25	1	146.4	27.37	2
2.25	1	203	37.06	3
2.25	1	157.2	29.22	14
3.47	4	730.9	88.66	2,169
3	2	414.2	56.67	75
3.35	3	594.8	76.43	109
3	2	288.9	46.45	102

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

3	2	377	51.96	377
3	2	364.9	50.43	166
3	2	427	58.27	26
3.47	4	777.3	93.81	505
3	2	222.1	31.96	40
3	2	326.9	47.28	74
2.25	1	203	37.06	18
2.25	1	136	25.56	6
3.58	6	1123	137.1	1,457
3.47	4	730.9	88.66	169
3.35	3	450.2	59.53	124
2.25	1	173.8	32.08	15
3	2	288.9	46.45	154
3.58	6	1157	140.9	214
2.25	1	233.8	36.62	37
2.25	1	107.2	17.88	57
2.25	1	153.7	24.88	95
3.58	6	581.3	74.87	481
3.47	4	663.7	81.15	307
2.25	1	212.6	33.54	283
3	2	197.5	29.74	301
			Total:	**13,146**

Valve insulation savings

Valve size (inches)	*Quantity*	*Equivalent length*	*Total equivalent length*	Q_{pre}	Q_{post}	*Therms savings*
4	2	3.47	6.9	421.3	53.49	269
4	1	3.47	3.5	854.5	67.51	288
2	1	3	3.0	810.4	62.9	237
1	2	2.25	4.5	551.9	41.17	243
2	1	3	3.0	769.8	59.44	225
2	1	3	3.0	749.7	57.74	219
3	1	3.35	3.4	1054	85.58	342
0.75	1	2	2.0	479.5	40	93
2	1	3	3.0	462.6	34.18	136
3	1	3.35	3.4	1054	85.58	342
3	1	3.35	3.4	1109	90.39	360
0.75	1	2	2.0	479.5	40	93
2	1	3	3.0	336.9	24.38	99
1	2	2.25	4.5	293.4	20.48	59
8	1	3.95	4.0	2192	193.9	833
0.75	2	2	4.0	514.9	43.39	199
8	1	3.95	4.0	2248	199.1	854
4	1	3.47	3.5	1390	113.6	467
2	2	3	6.0	401.7	55.08	219
2	2	3	6.0	353	48.91	193
2	2	3	6.0	401.7	55.08	219
2.5	1	3.17	3.2	393.6	52.61	17
2.5	1	3.17	3.2	510	66.77	22

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2.5	1	3.17	3.2	451.8	59.69	19
2	1	3	3.0	295.8	41.57	80
2	1	3	3.0	401.7	55.08	110
2	1	3	3.0	129.5	19.52	35
2	1	3	3.0	329.7	45.93	90
2	1	3	3.0	263.3	37.36	72
2	1	3	3.0	284.8	40.15	77
2	1	3	3.0	129.5	19.52	35
2	1	3	3.0	401.7	55.08	110
0.75	1	2	2.0	157.2	29.22	27
1.25	1	2.5	2.5	288.9	46.45	64
4	1	3.47	3.5	800.9	96.42	258
4	1	3.47	3.5	800.9	96.42	258
2	1	3	3.0	439.8	59.89	120
2	1	3	3.0	427	58.27	117
2.5	1	3.17	3.2	479.7	63.11	139
3	1	3.35	3.4	262.5	36.08	80
4	1	3.47	3.5	663.7	81.15	213
6	1	3.58	3.6	1157	140.9	384
12	1	4.05	4.1	1983	211.2	757
4	1	3.47	3.5	730.9	88.66	235
6	1	3.58	3.6	1023	125.8	339
4	6	3.47	20.8	402.9	51.35	772
4	4	3.47	13.9	367	47.15	469
3	2	3.35	6.7	262.5	36.08	160
3	1	3.35	3.4	289.9	39.52	89
3	1	3.35	3.4	362.3	48.48	111
					Total:	**11,250**

Rectangular tank insulation savings

Surface area (ft^2)	*Q_{pre}*	*Q_{post}*	*Therms savings*
192	274.9	30.45	2,352
		Total:	**2,352**

ECM #2: Steam leak repair

Steam leak repair savings

Description	*Qty of Leaks*	*Plume Length (ft)*	*Leak (lbs/hr)*	*Annual Btu's lost*	*Therms Savings*
Trap 506	1	1	10	100,543,864.71	1,211
Trap 508	1	1	10	100,543,864.71	1,211
Trap 528	1	1	10	50,271,932.35	606
Trap 529	1	1	10	50,271,932.35	606
Trap 530	1	2	17	88,217,284.79	1,063
Trap 534	1	1	10	100,543,864.71	1,211
Trap 540	1	1	10	67,029,243.14	808
Trap 543	1	3	31	309,607,726.26	3,730
Trap 545	1	3	31	206,405,150.84	2,487
Trap 551	1	3	31	309,607,726.26	3,730

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Trap 552	1	2	17	176,434,569.58	2,126
Trap 564	1	4	54	362,200,160.63	4,364
Trap 570	1	2	17	117,623,046.39	1,417
Trap 572	1	2	17	176,434,569.58	2,126
Trap 575	1	2	17	117,623,046.39	1,417
Trap 577	1	3	31	206,405,150.84	2,487
Trap 579	1	1	9.934	67,029,243.14	808
Trap 580	1	1	9.934	100,543,864.71	1,211
Trap 544	1	1	9.934	100,543,864.71	1,211
				Total:	**33,830**

ECM #3: Steam trap replacement

Steam trap replacement savings

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*	*Therms savings*
3/4	1/8	90	5	28	1,962
1/2	1/8	90	5	44	4,624
1	1/8	90	5	44	4,624
3/4	1/8	90	5	28	1,471
3/4	1/8	90	5	28	1,962
3/4	7/64	90	5	33	3,468
3/4	1/8	90	5	28	1,471
3/4	1/8	90	5	28	1,962
3/4	1/8	90	5	28	1,962
1/2	1/8	90	5	44	4,624
3/4	7/64	90	5	21	1,009
3/4	7/64	90	5	21	1,009
3/4	7/64	90	5	21	1,009
1/2	1/8	90	5	28	1,345
3/4	7/64	90	5	33	3,468
3/4	7/64	90	5	33	3,468
3/4	7/64	90	5	33	3,468
3/4	7/64	90	5	33	3,468
1	1/8	90	5	44	4,624
1-1/2	7/32	90	5	171	17,972
1	1/8	90	5	44	4,624
1-1/2	7/32	90	5	171	17,972
1	1/4	90	5	174	18,287
3/4	1/8	90	5	44	4,624
				Total:	**114,481**

Overall, project savings are as follows:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

- Annual Therms: 175,059
- Lifetime Therms: 1,445,671
- Water Savings: 1,426,457 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.6 BHE-2017-007

Program BHE-2017-007
Project ID C&I Solutions
Facility SIC Code 5085 – Industrial Supplies
Measures
- Steam trap replacement

Project Background

The site is an industrial supplies facility that produces and sells a variety of products such as power transmission and fluid power products. The estimated system hours for this site is 8,760. For this project, there were (3) steam traps fixed on site. The participant is an industrial manufacturer that received incentives from Black Hills Energy for:

- ECM#1: Steam trap replacement.

ECM #1: Steam trap replacement

Steam trap replacement parameters

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate*
3/4	9/64"	200	6	113
3/4	9/64"	200	6	113
3/4	9/64"	200	6	113

M&V Methodology

ECM #1: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Steam trap orifice sizes are 3/4”
- Annual operating hours = 8,760
- Inlet pressure = 200 (psig)
- Outlet pressure = 6 (psig)

Discharge rate (lb/hr) was calculated using Armstrong’s steam loss through failed trap calculator(https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V6.1 Section 3.1.17. The formula is as follows:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times OpHrs\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

Where:

Steam Trap Discharge Rate = Steam loss in lb/hr.
OpHrs = annual hours the steam system is pressurized
H_{fg} = Latent heat of evaporation in Btu/lb from steam tables.
$E_{C\ Base}$ = 82%
Therms conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$

Measure Life

The EUL of this measure is 5 years.

Calculated Savings:

ECM #1: Steam trap replacement

Steam trap replacement savings

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*	*Therms Savings*
3/4	9/64"	200	6	113	12,332
3/4	9/64"	200	6	113	12,332
3/4	9/64"	200	6	113	12,332
				Total:	**36,995**

Overall, project savings are as follows:

- Annual Therms: 36,995
- Lifetime Therms: 184,975
- Water Savings: 356,499 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.7 BHE-2017-008

Program C&I Solutions
Project ID BHE-2017-008
Facility SIC Code 2501 – Bread and Other Bakery Products
Measures
- Insulation
- Steam Trap replacement

Project Background

The site is a large bakery facility. The annual operating hours for this facility's boiler is 8,760 hours. There are (14) bare pipes that were insulated on site. The site has replaced (20) failed open steam traps. The participant is a retail bakery that received incentives from Black Hills Energy for:

- ECM#1: Insulation;
- ECM#2: Steam trap replacement.

ECM #1: Pipe Insulation

Bare pipes insulated parameters

Length (feet)	*Pipe Diameter (inches)*
6	6
30	4
9	3
13	2
80	2
15	1
18	1
9	1
16	1
20	6
220	2
39	2
15	1
36	4

Cylindrical tank insulated parameters

Length (feet)	*Pipe Diameter (inches)*
6	0.83
5	0.83
5	0.67

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #2: Steam trap replacement

Steam leak replacement parameters

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*
1	3/16	90	10	63
1 1/2	1/8	90	10	28
3/4	1/8	90	10	44
1	1/8	90	10	28
3/4	1/8	90	10	28
3/4	1/8	90	10	28
3/4	1/8	90	10	44
1/2	1/8	90	10	44
1/2	1/8	90	10	44
1/2	1/8	90	10	44
3/4	1/8	90	10	44
1/2	1/8	90	10	44
3/4	1/8	90	10	44
1/2	1/8	90	10	44
3/4	1/8	90	10	44
3/4	1/8	90	10	44
1	1/8	90	10	44
1/2	1/8	90	10	44
1/2	1/8	90	10	44
1/2	1/8	90	10	44

M&V Methodology

ECM #1: Pipe Insulation

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement. Through this method, energy savings are calculated using key data and through the North American Insulation Manufacturers Association's 3E Plus software (http://www.pipeinsulation.org/).

Measurement and verification activities are based on the following assumptions:

- The steam system 8,760 hours annually
- The average annual ambient air temperature is 75°F
- The facility's boilers are approximately 84% efficient
- Make up water is 65.6°F based on TRM guidelines in Weather zone 9 of Arkansas (V6.0, Table 138)

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The 3E Plus software was used to calculate heat loss (btu/hr/ft) for bare piping (pre-retrofit). The software calculated heat loss based on these inputs: process temperature, ambient temperature, pipe size, base metal, insulation, and jacket material. Annual Therms was then calculated using the following equation:

$$Annual\ Therms\ Savings = (Bare\ Heat\ Loss - Insulated\ Heat\ Loss)\frac{BTU}{hr * ft} \times AOH\ (hrs) \times Pipe\ Length(ft) \times \frac{1\ therm}{100{,}000\ BTU} \div boiler\ efficiency$$

Where:

Bare heat loss = heat loss of pipe with no insulation (BTU/hr/ft)
Insulated heat loss = heat loss of pipe with 2" insulation (BTU/hr/ft)
AOH = annual operating hours
Pipe length = length of the pipe in (ft)
Therms conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$
Boiler efficiency = 84%

Measure Life

The EUL of this measure is 20 years.

ECM #2: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Estimated system hours = 3,692 hours (Coil/ process) and 8,760 hours (Drip)
- Inlet and outlet pressures = 90 psig and 10 psig respectively
- Boiler efficiency = 84%

Discharge rate (lb/hr) was calculated using Armstrong's steam loss through failed trap calculator (https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V6.1 Section 3.1.17. The formula is as follows:

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times OpHrs\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Where:

Steam Trap Discharge Rate = Steam loss in lb/hr.
OpHrs = annual hours the steam system is pressurized
H_{fg} = Latent heat of evaporation in Btu/lb from steam tables.
$E_{C\ Base}$ = 84%
Therms conversion factor = $\frac{1\ therm}{100{,}000\ BTU}$

Measure Life

The EUL of this measure is 5 years.

Calculated Savings:

ECM #1: Insulation

Calculated savings for insulation are presented in the table below.

Pipe Insulation savings

Equivalent Pipe Length (feet)	Line size	Q_{pre}	Q_{post}	Therms Savings (CCF)
3.58	6.0	835.1	76.28	475
3.47	30.5	849.1	77.19	2,455
3.35	9.0	210.1	22.27	59
2.75	13.0	119.7	14.98	47
2.5	80.0	106	13.35	773
1.5	15.0	181.6	27.5	241
2	18.0	136	20.15	217
2.25	9.0	263.4	33.48	216
2	16.0	136	20.15	193
3.58	20.0	1227	108.6	2,333
3	220.0	124.4	14.65	2,152
3	39.0	146.8	17.04	528
2.25	15.0	85.97	11.98	116
3.47	36.0	849.1	77.19	2,898
			Total:	**12,703**

Cylindrical tank insulation savings

Diameter (ft)	Length (ft)	Quantity	Surface area (ft^2)	Therms savings
0.83	6	1	17	538
0.83	5	1	14	267
0.67	5	1	11	357
			Total:	**1,162**

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #2: Steam leak replacement

Steam leak replacement savings

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate*	*Therms Savings*
1	3/16	90	10	63	3,037
1 1/2	1/8	90	10	28	1,350
3/4	1/8	90	10	44	4,639
1	1/8	90	10	28	1,476
3/4	1/8	90	10	28	1,476
3/4	1/8	90	10	28	2,657
3/4	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
3/4	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
3/4	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
3/4	1/8	90	10	44	4,639
3/4	1/8	90	10	44	4,639
1	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
1/2	1/8	90	10	44	4,639
				Total:	**79,576**

Overall, project savings are as follows:

- Annual Therms: 93,441
- Lifetime Therms: 675,189
- Water Savings: 793,767 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

8.8 BHE-2017-009

Program	BHE-2017-009
Project ID	C&I Solutions
Facility SIC Code	2341 – Women's Misses', Children's and Infants' Underwear and Nightwear
Measures	▪ Steam trap replacement
Annual Consumption	1,284,800 CCF

Project Background

The participant is a textile manufacturing facility. Annul system offers are 3,672 for process steam traps and 7,488 for drip steam traps. There were (6) steam trap replacements on-site. The participant is a manufacturer that received incentives from Black Hills for:

- ECM#1: Steam trap replacement.

ECM #1: Steam trap replacement

Steam trap replacement parameters

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate*
1/2	1/8	85	5	27
3/4	7/64	85	5	20
3/4	3/32	85	5	23
3/4	7/64	85	5	32
1/2	1/8	85	5	41
1	1/8	85	5	27

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

M&V Methodology

ECM #1: Steam trap replacement

The M&V effort for this project follows the guidelines of the 2012 International Performance Measurement and Verification Protocol (IPMVP) Option A- Retrofit Isolation: Key Parameter Measurement.

Measurement and verification activities are based on the following assumptions:

- Annual operating hours = 3,672 (process) and 7,488 (drip)
- Inlet pressure = 85 (psig)
- Outlet pressure = 5 (psig)
- Boiler efficiency = 83%

Discharge rate (lb/hr) was calculated using Armstrong's steam loss through failed trap calculator(https://www.armstronginternational.com/knowledge/resources-library/calculators/steam-loss). Calculations for annual Therms savings were adopted from the Arkansas TRM V6.1 Section 3.1.17. The formula is as follows:

$$Therm_{savings} = \frac{Steam\ Trap\ Discharge\ Rate\ \times OpHrs\ \times\ h_{fg}}{Ec_{Base} \times Therm\ Conversion\ Factor}$$

Where:

Steam Trap Discharge Rate = Steam loss in lb/hr.
OpHrs = annual hours the steam system is pressurized
H_{fg} = Latent heat of evaporation in Btu/lb from steam tables.
$E_{C\ Base}$ = 83%
Therms conversion factor = $100{,}000\ BTU$

Measure Life

The EUL of this measure is 5 years.

Calculated Savings:

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

ECM #1: Steam trap replacement

Steam trap replacement savings

Line Size (inches)	*Orifice Size (inches)*	*Inlet Pressure (PSIG)*	*Outlet Pressure (PSIG)*	*Applied Discharge Rate (lb/hr)*	*Therms Savings*
1/2	1/8	85	5	27	1,188
3/4	7/64	85	5	20	880
3/4	3/32	85	5	23	2,064
3/4	7/64	85	5	32	2,872
1/2	1/8	85	5	41	3,680
1	1/8	85	5	27	1,188
				Total:	**11,873**

Overall, project savings are as follows:

- Annual Therms: 11,873
- Lifetime Therms: 59,365
- Water Savings: 118,917 gallons/year

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

9. Appendix B: Deferred Replacement Cost Calculations

This appendix presents the calculations of deferred replacement costs for residential and commercial tankless water heaters.

The two calculations are based off of a full-install cost of $614 for a baseline storage tank unit and an incremental cost of $605 for a tankless unit. These values cite the Illinois TRM.

	Inputs	
Measure Type=	Replacement On Burnout	
Nominal Discount Rate=	7.0%	
Inflation Rate=	2.0%	
Real Discount Rate=	4.9%	
	Program	**Baseline**
Equipment Type=	Tankless WH	Storage WH
Effective UsefulLife=	20	11
Remaining Useful Life=		
PW(EUL)=	12.57	8.35
PW(RUL)=		
Installed Cost=	$1,219	$614
Deferred Replacement Cost=		$ 310.12
PWF Formula=		$ 310.12
Incremental Cost=	$ 294.88	

Figure 9-1 Residential Tankless WH Deferred Replacement Cost Calculation

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

	Inputs	
Measure Type=	Replacement On Burnout	
Nominal Discount Rate=	7.0%	
Inflation Rate=	2.0%	
Real Discount Rate=	4.9%	
	Program	**Baseline**
Equipment Type=	Tankless WH	Storage WH
Effective UsefulLife=	20	15
Remaining Useful Life=		
PW(EUL)=	12.57	10.45
PW(RUL)=		
Installed Cost=	$1,219	$614
Deferred Replacement Cost=		$ 124.44
PWF Formula=		$ 124.44
Incremental Cost=	$ 480.56	

Figure 9-2 C&I Tankless WH Deferred Replacement Cost Calculation

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Comprehensive Energy Efficiency Plan

Program Year 2017

Annual Report

Appendix B – Supplemental Documentation

Black Hills Energy

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

2017 Residential Equipment Rebate Program

Applying for rebates just got easier! Now you can fill out your energy-efficiency rebate forms online.

To learn more about rebates for your home or to download rebate applications, please visit ExcessIsOut.com or contact:

Caroline Medlock
855-350-1563
caroline.medlock@clearesult.com

Bob Schlemmer
479-935-8884
bschlemmer@clearesult.com

We all want to use less where we can. Let us help you use significantly less natural gas and lower your monthly bill!

Black Hills Energy makes it easy to keep your home cozy and efficient. The Residential Rebate Program will help you replace old, outdated residential equipment with new energy and natural gas-saving equipment that will significantly reduce your home's monthly utility bill. Rebates are available to help offset the cost of new water heaters and furnaces for your home.

Last year, our customers received over $500,000 in rebates — this year, we want you to receive a portion of that. Funding is limited for 2017; schedule an equipment installation appointment with a participating contractor today!

Saving energy is a good deal. Saving money while you do it? That's excellent.

ELIGIBLE MEASURES	EFFICIENCY	CUSTOMER INCENTIVE
Water Heating Rebates		
Tankless Water Heater	0.90 EF or higher	$300
Heating Equipment Rebates		
Natural Gas Forced-Air Furnace	95% AFUE or higher	$500
Premium Efficiency Package		
Qualifying Furnace and Water Heater	As qualified above	$100 bonus[1]

[1]Qualifying units must be installed during 2017.

Black Hills Energy
Improving life with energy

Blower door used to detect air leakage.

Who qualifies?

To qualify for the BHE Home Energy Savings Program, the home must:

- Have a valid BHE residential account (new homes under a year old are not eligible)
- Be at least 10 years old OR have a monthly usage (as shown on the bill) of 5 cents per square foot or higher (see Home Efficiency Meter to calculate)
- Have been occupied for the previous 12 months
- Not have participated in a weatherization program offered either through a utility or the government in the past 5 years

"I found the program really helped me lower my natural gas bill. My home is more comfortable. Also I learned a few things I could do to lower my natural gas bill, for example to lower my thermostat and wash clothes in cold water vs hot!"

-Joy P. Rogers, AR

How do I start?

For more information or to participate in the program, call the Energy Efficiency Solutions Center toll free at **855-350-1563** to speak with an energy efficiency representative. You can also visit us online at **ExcessIsOut.com** to learn more.

Saving energy is a good deal. Saving money while you do it? That's even better.

Making energy-efficient choices is important to the environment, as well as your wallet. The BHE Home Energy Savings Program provides benefits for you, your community and the environment. We are partnering with participating electric utilities to bring you combined incentives for even more savings.

Once you see what difference energy efficiency improvements can make in your home, you may want to participate in other available residential programs, which include:

- Water Heating Rebate Program[3]
- Space Heating Equipment Rebate Program[3]

3. Check ExcessIsOut.com for incentive funding availability.

HOME PERFORMANCE WITH ENERGY STAR

Black Hills Energy
Improving life with energy

For more information, call **855-350-1563** or visit **ExcessIsOut.com**.

Black Hills Energy (BHE)[1] Home Energy Savings Program

in partnership with Home Performance with ENERGY STAR®

1. A member of the Arkansas Weatherization Network.

Let us help you use significantly less natural gas in your home and lower your monthly bill! Get a NO-COST professional home energy evaluation and start saving energy and money today.[2]

- Lower your energy bill.
- Increase the value of your home.
- Increase safety and energy efficiency.
- Improve comfort while reducing energy use.

HOME PERFORMANCE WITH ENERGY STAR

2. Home must be at least a year old to participate. Other restrictions may apply.

Black Hills Energy

Simple improvements. Lasting benefits.

If you notice any of these things in your home, you could benefit from participating in the no-cost Home Energy Savings Program.

- High energy bills
- Rooms that are too hot or too cold
- Drafty windows or doors

You have the power to lower your energy bill. By participating in the BHE Home Energy Savings Program, your home's energy use may be significantly improved. A more energy-efficient home means more savings on monthly utility bills.

Additional benefits include:

- Improved indoor air quality
- Increased comfort of your home
- Reduced carbon footprint

What to expect from participating in the BHE Home Energy Savings Program.

If needed, a Home Energy Savings participating contractor will install some or all of the energy-saving measures in your home at no cost:

AIR SEALING – Air sealing is done by some or all of the following methods:

- Weather stripping and door sweeps
- Caulking and sealing gaps and cracks
- Sealing around pipe and wire penetrations
- Isolating attic and garage spaces from the interior of the home with the above methods

DUCT SEALING – Typical houses have 20 percent or more of their conditioned air lost through leaks, holes and poorly connected air ducts. Sealing leaks can lead to improvements in:

- Comfort and indoor air quality
- Utility bill savings
- Life of equipment

INSULATION – Insulation helps keep your home cool in the summer and warm in the winter. When coupled with air sealing, you can potentially save up to 20 percent on heating and cooling costs.

- Homes with an R-14 or lower in the attic qualify for attic insulation.

DIRECT INSTALL MEASURES – These are installed by the contractor in your home where needed:

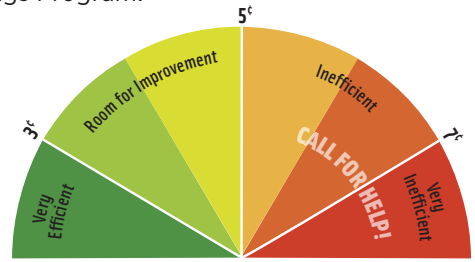
- Energy-saving showerheads
- Energy-saving faucet aerators

To see if your home qualifies, you can either give us a call or choose a participating contractor directly.

You can find the list of participating contractors at **ExcessIsOut.com**.

We make it easier for you to lower your natural gas bill; here's how:

Take your highest winter energy bill and divide it by the actual conditioned square footage of your home. This number determines your cost per square foot. Then, find where this number is on the home efficiency meter. If your energy costs are 5 cents or more per square foot, your home qualifies to participate in the BHE Home Energy Savings Program.



Home Efficiency Meter

© CLEAResult, 2016

$_____ ÷ _____ = _____$/Sq. Ft.
(Bill Amt.) (Sq. Ft.)

Now that you've calculated the energy cost per square foot of your home:

1. Call us toll free at **855-350-1563**.
2. We'll help determine if your home qualifies and answer any questions you may have about the program.
3. You can then contact a participating home energy consultant to set up an appointment at your convenience to begin the evaluation.
4. The consultant will show you the no-cost energy efficiency measures that may be available for your home.
5. Finally, if you have a natural gas water heater, your home energy consultant may install energy-saving sink faucet aerators and an energy-efficient showerhead.

Call **855-350-1563** today!

A no-cost home energy inspection leads to more comfort in Fayetteville, Arkansas

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd. 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Project at a glance

$717
incentives paid to the contractor

769
Total CCF savings

$0
Out-of-pocket cost to the homeowner

The opportunity

When Andrew bought his home in Fayettville, Arkansas, two home inspections unfortunately overlooked that the ducts were improperly sealed. As a result, it took a long time to heat up and cool down the 33-year-old, 3,100 sq. ft. home. Luckily, a no-cost home energy assessment through Black Hills Energy Arkansas' Home Energy Savings Program spotted the air- and duct-sealing problems the home inspectors missed. Black Hills Energy was even able to provide weatherization upgrades to the house at no out-of-pocket cost.

The project

To keep Andrew's house at desired temperatures, contractors completed air- and duct-sealing upgrades. They re-weatherstripped all the exterior doors, and foam sealed everything from bathroom exhaust fans and plumbing to the kitchen and vent pipes. They also weatherstripped two attic accesses. All the duct connection points of the house's two HVAC systems were sealed and five disconnected ducts were repaired. Now the air from the heating and cooling system can circulate throughout the house and, thanks to the improved weatherization, it stays inside.

The results

For Andrew, the results of this no-cost service were great on paper and in practice. The air sealing reduced air infiltration by 30 percent, while the duct sealing reduced duct losses by 44 percent in one of HVAC system and by 36 percent in the other one. Andrew is saving 769 therms per year and living in a more comfortable house.

To see how much Black Hills Energy could save you, call 855-350-1563, or visit ExcessIsOut-Arkansas.com today.

Black Hills Energy
Improving life with energy

Weatherization yard sign

This Home is Saving Energy & Money

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Brought to you by Black Hills Energy Home Energy Savings Program.
Learn more at EXCESSISOUT.com

855-350-1563

LEARN MORE AT energystar.gov

Black Hills Energy
Improving life with energy

Spanish language weatherization yard sign

Este hogar ahorra energía y dinero

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Presentado por el programa de ahorro de energía en el hogar de Black Hills Energy. Más información en EXCESSISOUT.COM

855-350-1563

LEARN MORE AT energystar.gov

Black Hills Energy

Improving life with energy

Commercial & Industrial Solutions Program

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The Commercial & Industrial Solutions Program helps our commercial customers implement energy efficiency improvements in their businesses.

To learn more about the program, please visit ExcessIsOut.com or contact:

Bill Dollar
479-595-1364
bill.dollar@clearesult.com

The Commercial & Industrial Solutions Program can help you:

- Determine opportunities to save energy in your facility.
- Contact a Trade Ally to complete energy-efficient improvements.
- Save money on your upgrades with incentives and rebates.

Black Hills Energy commercial customers are qualified during a no-cost energy efficiency assessment of the facility.

What are the Incentives?

For businesses using less than 200,000 cubic feet (CCF) per year:

- $0.90 per CCF saved in the first year of operation

For businesses using 200,000 CCF or more per year:

- $0.80 per CCF saved in the first year of operation

Incentives are available for a number of measures, including but not limited to:

- Steam trap replacements
- Water heating improvements
- Waste heat recovery
- Building thermal improvements
- Demand control ventilation optimization

Available Rebates

Rebates are available on energy-saving upgrades to:

- Furnaces
- Commercial cooking equipment
- Comfort heating boilers
- Tankless water heaters
- Convection and conveyer ovens

Our customers received over $600,000 in rebates last year.

How to Participate

Participation is simple:

1. Call 479-595-1364 for a no-cost energy efficiency assessment.
2. Receive your recommendations report.
3. Choose which recommended projects you want to complete.
4. Reserve your incentives.
5. Contact a Trade Ally to complete the work.
6. Inform us when projects are completed.
7. We will conduct a post-inspection of work.
8. You receive your incentive check in 4–8 weeks.

This Program is funded by Black Hills Energy ratepayers and not by federal or state funding.

Black Hills Energy
Improving life with energy

LUNCH & LEARN SEMINAR

Please join us to learn how Black Hills Energy incentives can help you make energy efficiency changes to your building that will save you energy and money.

During this beneficial seminar, hear energy efficiency ideas from energy efficiency experts:

- Dr. Darin Nutter PhD, PE, FASHRE in Session 1
- Andrew Chase Harding, PE, CEM in Session 2

Professional credits are available for qualified attendees.

WHEN: June 7, 2017

TIME: Session 1 (11 a.m.–12:15 p.m.)
Session 2 (12:45–2:00 p.m.)

WHERE: Black Hills Energy Training Room
655 E. Milsap Road # 104
Fayetteville, AR 72703

Lunch will be served and prizes will be given away at each session. Please be sure to RSVP by June 1, 2017 to Bill.Dollar@clearesult.com or call 479-316-4525.

Black Hills Energy
Improving life with energy

Pinnacle Foods finds big savings with a custom rebate

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Project at a glance

$323,068
Incentives paid

604,418
Total therm savings

The opportunity

Beginning in 2013, and continuing through today, CLEAResult has worked with Pinnacle Foods to examine energy efficiency opportunities at their plant. The engineers discovered many feet of uninsulated hot piping, several failed steam traps and various steam leaks throughout the facility. The steam system was running very inefficiently, but with the help of the Black Hills Custom Incentive Program help was on the way.

The projects

After visiting with Pinnacle Foods Facilities Management, it was clear that the incentives from Black Hills Energy could help Pinnacle Foods alleviate the huge loss of steam from these problems. Action was taken to address these issues and Black Hills Energy began an ongoing partnership with Pinnacle Foods that continues through today.

The results

Since 2013, the Black Hills Program has provided incentives to Pinnacle Foods for steam projects of all kinds—from repairing steam leaks to replacing a condensing economizer. According to the Environmental Protection Agency, so far the therm savings from this project are the equivalent of eliminating the carbon dioxide emissions from 360,597 gallons of gasoline or the electricity use of over 346 homes for one year.

To see what incentives and upgrades you could bring to your facility, visit www.ExcessIsOut-Arkansas.com.

Black Hills Energy
Improving life with energy

Baxter Regional Medical Center finds renewed comfort and savings

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

The opportunity

The world of medical care is notorious for running on tight margins. When issues arise at a facility, oftentimes the short-term solution is to place a bandage over what may be a much larger problem. Baxter Regional Medical Center (BRMC) in Mountain Home, Arkansas, found itself in a similar predicament.

The 500,000-square-foot building, which opened in 1963, utilizes four gas boilers to move steam throughout the facility. Steam traps then convert that steam into energy and heating for the whole medical center. In 2015, a contractor conducted a survey of the facility and discovered that 22 steam traps were failing, resulting in a significant waste of natural gas.

Project at a glance

$127,697
Incentives paid

169,551
Total therm savings

The project

By partnering with Black Hills Energy, BRMC received a no-cost energy assessment and was presented with a list of recommended improvements. BRMC chose to replace the failing steam traps, repair leaks in several traps performing at subpar levels, and install piping insulation. These upgrades were completed during two rounds in 2016 and 2017, improving steam heat retention throughout the facility.

The results

Since completing this work, BRMC has saved over 169,000 total therms. Between the $127,697 in incentives they were awarded and the continued efficiency savings they are now experiencing, BRMC can allocate more funds to staffing, equipment and additional efficiency upgrades. Increased savings means increased comfort for every employee and patient who comes through BRMC's doors.

To see what incentives and upgrades you could bring to your facility, visit www.ExcessIsOut-Arkansas.com.

Black Hills Energy
Improving life with energy

Old Town Dry Cleaners Case Study

Project at a glance

7,209
CCF saved

$3,800
Estimated annual savings

$1,107
Incentives paid

The opportunity

Old Town Dry Cleaners had a problem that turned into a great opportunity.

APSC FILED Time: 5/1/2018 8:14:34 AM Recvd: 5/1/2018 8:12:29 AM Docket: 07-078-TF Doc: 321

This Northwest Arkansas dry cleaners had faulty steam traps and leaky steam valves at two of their locations. To fix the problem, Old Town reached out to Black Hills Energy, who offered energy-saving replacements through the Commercial & Industrial Solutions Program. Intrigued by the prospect of both saving energy and increasing safety, Old Town gladly joined the program.

The project

Black Hills Energy performed an energy assessment and tested all steam traps at both locations. During the process, eight faulty steam traps and four leaking steam valves were identified. Old Town quickly decided to replace all of the defective equipment. New equipment was installed, making a big difference in energy efficiency and employee safety.

The results

Old Town accomplished their safety goals, with the help of Black Hills Energy, solved their problems and then some.

Old Town received $1,107 in incentives and is estimated to save 7,209 CCF and $3,800 a year. The project also eliminated a possible safety hazard, reducing the chance of steam escaping into the work space or an employee being harmed by leaking hot steam. The incentives even covered the entire project cost, resulting in no out-of-pocket expenses for the company.

In other words, it's now a safer, more efficient place for everyone.

To learn more about how your business can save, visit ExcessIsOut.com.

Black Hills Energy
Improving life with energy

Landing Page for www.excessisout-Arkansas.com

excess is out™ by Black Hills Energy

CONTACT US BECOME A TRADE ALLY/CONTRACTOR

WAYS TO SAVE - REBATES, PROGRAMS & SERVICES - FIND A CONTRACTOR MISSION Search

Get $500 off a new furnace.

Take comfort in the reliable performance and savings of a high-efficiency gas furnace.

Learn More »

How we've helped people and businesses like you save money

Homeowners

"With Black Hills Energy Rebates and new equipment we were able to save on our energy bills last year!"

Peggy and Fred,
Homeowners in Fayetteville

Small Business

"I found a great trade ally on the Excess Is Out website that helped me update the heating system and now I'm saving money."

Sue,
Small Business Owner in Springdale

Commercial & Industrial

"With the Black Hills Energy incentive program, we were able to net a large savings in our energy costs along with a nice rebate check."

Rudy Harper, Manager at Bell Corporation
Springdale, Arkansas

Government

"Black Hills Energy rebates allowed us to add over $51,000 to our general revenue fund. We can use that money to further the students' educational process."

Vic England, Energy Education Manager
Bentonville ISD

Highlighted rebates and programs | View All Programs »

Save money immediately by taking advantage of rebates on installed energy efficient equipment and save even more over time through reduced energy costs.

Water Heating

Heating Equipment

Commercial cooking

Commercial / industrial

Online rebate submission at www.excessisout-Arkansas.com

Black Hills Energy
Improving life with energy

APPLY FOR A REBATE | FIND MY REBATE STATUS

Welcome to the Black Hills Energy Efficiency Rebate Application

Black Hills Energy is proud to offer rebates on qualified water heating and comfort heating equipment. Start your rebate application process by clicking on "Apply for Rebate" above.

Need help? For assistance, call 1-855-350-1563 to speak with a Black Hills Energy specialist.

Black Hills Energy
Improving life with energy

APPLY FOR A REBATE | FIND MY REBATE STATUS

Welcome to the Black Hills Energy online rebate application. Please have your Black Hills Energy account number and equipment invoice ready for a quick application process.

Water & Comfort Heating Equipment

The rebates below are available for equipment typically found in homes.

Eligible Equipment	Efficiency Requirements	Rebate
Water Heating Equipment		
Tankless Water Heater	0.90 EF or higher	$300
Space Heating Equipment		
Natural Gas Forced-Air Furnace	95% AFUE or higher	$500

Please enter your Black Hills Energy account number and last name to get started:

Last Name *

Account Number *

Next

Need help? For assistance, call 1-855-350-1563 to speak with a Black Hills Energy specialist.

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Facebook advertisement – Fall 2017

Black Hills Energy
Published by Sprout Social [?] · 1 min ·

The leaf colors are changing. If your home is ready for a change, upgrade your natural gas furnace with a $500 rebate.

With a new high-efficiency heating system, you'll experience supreme comfort and everyday savings.

Click below to upgrade your furnace today.

Upgrade your natural gas furnace with a $500 rebate

At Black Hills Energy we believe that excess is out. Our mission is to help you improve the energy efficiency of your home or business by providing energy saving services through incentives and rebates that reduce your costs and...

EXCESSISOUT-ARKANSAS.COM

APSC FILED Time: 5/1/2018 8:14:34 AM: Recvd 5/1/2018 8:13:20 AM: Docket 07-078-TF-Doc. 321

Furnace rebate email – Fall 2017

Save $500 on a new natural gas furnace

Upgrade Now »

Fall—relaxing, calm and cozy. As the weather continues to cool down, the time is perfect to upgrade your home's heating. Right now, Black Hills Energy is offering a rebate of $500 when you install a new high-efficiency, natural gas furnace.

Your home will save energy and money, and you'll stay warm and comfortable throughout the chilly season.

This offer is only available while funds last—so click to learn more and get started.

Upgrade Now »