Public Service Company of Oklahoma 2023 Energy Efficiency & Demand Response Programs: Annual Report

Prepared for:

Oklahoma Corporation Commission

In accordance with annual reporting requirements:
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Chapter 35. Electric Utility Rules
Subchapter 41. Demand Programs
165:35-41-7. Reporting

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1 Executive Summary

This report presents an evaluation of the performance of the energy efficiency and demand response programs, also known as the Demand Portfolio, offered by the Public Service Company of Oklahoma (PSO) in 2023. PSO is submitting this report to fulfill the requirements outlined in Title 165: Oklahoma Corporation Commission Chapter 35. Electric Utility Rules Subchapter 41. Demand Programs 165:35-41-7.

PSO filed a comprehensive portfolio of energy efficiency and demand response programs (Portfolio Filing) to the Oklahoma Corporation Commission (OCC) for Program Years 2022 - 2024. This portfolio was approved by the OCC in Cause No. PUD 2021000041. The focus of this report is participation during the second program year, 2023, of the implementation cycle, spanning from January 1, 2023, to December 31, 2023.[1]

For the purposes of this report, projected, reported, and verified impacts are defined as follows:

- **Projected Impacts:** refer to the annual energy savings (kWh) and peak demand reduction (kW) estimates approved by the OCC as part of PSO's 2022 – 2024 portfolio.[2]
- **Reported Impacts:** refer to energy savings (kWh) and peak demand (kW) reduction estimates based on customer participation in 2023.
- **Verified Impacts:** refer to energy savings (kWh) and peak demand (kW) reduction estimates for 2023 developed through independent program evaluation, measurement, and verification (EM&V).
    - **Realization Rate:** The difference between verified impacts and reported impacts is often referred to as the Realization Rate (RR). This is calculated as the verified impact divided by the reported impact. Therefore, an RR greater than 100% represents verified impacts greater than reported impacts.

PSO's independent, third-party evaluator, ADM Associates, Inc. (ADM), performed the evaluation, measurement, and verification of PSO's energy efficiency and demand response programs.[3] Verified impacts reflect actual program participation (as opposed to projected participation) and adjust for any findings from ADM's independent evaluation,

[1] All the programs represent program participation from January 1, 2023 – December 31, 2023, except the Energy Saving Products Program. The reported savings for LED retail discounts span the period of December 1, 2022 – November 30, 2023. This offset allows for the reconciliation of retail sales data and manufacturer/retailer invoices.
[2] Approved by the OCC in Cause No. PUD 2021000041.
[3] A description of ADM and their commitment to safety is included in 5.4.3Appendix G:.

which includes a detailed review of program materials and calculations, interviews with program participants, and, in some cases, detailed on-site data collection.

All impacts presented in this report represent energy savings or peak demand reduction at-the-meter except for Section 1.2, Appendix B:, and 5.4.3Appendix C:, where impacts are presented at the generator. At-the-generator impacts are adjusted using an estimated line loss factor of 1.0586 for energy efficiency and 1.0781 for demand. Program impacts including projected, reported, and verified annual energy savings and peak demand reduction during 2023 are summarized in the following sections.

1.1 2023 Program Offerings

PSO offered customers a suite of residential energy efficiency subprograms under Residential Energy Services, a suite of commercial and industrial energy efficiency subprograms under Business Rebates, and a home weatherization program for low-income customers. The Residential Energy Services program consists of the following subprograms: Multifamily and Manufactured Homes, Energy Saving Products, Home Rebates, Behavioral Modification, and Education Kits. The Business Rebates program consists of the following subprograms: Custom and Prescriptive (including Oil & Gas, Agriculture, and Strategic Energy Management), Small Business Energy Solutions, and Commercial Midstream.

PSO also offered customers two demand response programs, one residential (Power Hours) and one commercial/industrial (Peak Performers). Additionally, PSO performed energy efficiency in electric distribution for a reduction in meter-level energy consumption through the application of conservation voltage reduction. Program names, program year start dates, and targeted customer sectors are shown in Table 1-1.

Table 1-1: Program Start Dates

Program	Sector	Start Date
Energy-Efficiency Programs		
Business Rebates	Commercial & Industrial, Small Business	January 1st, 2023
Residential Energy Services	Residential	January 1st, 2023
Home Weatherization	Low-Income Residential	January 1st, 2023
Conservation Voltage Reduction	Multiple Classes	January 1st, 2023
Demand Response Programs		
Power Hours	Residential	January 1st, 2023
Peak Performers	Commercial & Industrial	January 1st, 2023

1.2 Summary of Portfolio Benefit-Cost Ratios

ADM calculated the annual cost-effectiveness of PSO's programs based on reported total spending, verified net energy savings, and verified net demand reduction for each of the energy efficiency and demand response programs. Additional inputs to the cost effectiveness tests included estimates of natural gas savings, line-loss adjustments, emissions reductions, measure lives, discount rates, participant costs, and avoided costs. All program spending inputs were provided by PSO as shown in 5.4.3Appendix B:. The methods used to calculate cost-effectiveness were informed by the California Standard Practice Manual.[4]

The specific tests used to evaluate cost-effectiveness for the Oklahoma Corporation Commission are the Utility Cost Test and the Total Resource Cost Test. The benefit-cost ratios for those tests as well as the Rate Payer Impact Test, the Societal Cost Test, and the Participant Cost Test are presented in Table 1-2. Detailed cost-effectiveness assumptions and findings are presented in 5.4.3Appendix B:.

[4] California Standard Practice Manual: Economic Analysis of Demand Side Management Programs, October 2001. Available at: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf.

Table 1-2: Benefit-Cost Ratios

Program	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost Test	Participant Cost Test
Energy-Efficiency Programs					
Business Rebates	1.96	1.62	0.48	1.91	3.77
Residential Energy Services	1.75	1.98	0.42	2.33	4.89
Home Weatherization	1.75	2.96	0.62	3.54	4.66
Conservation Voltage Reduction	1.80	1.96	0.57	2.45	NA
Total - EE Programs	**1.82**	**1.95**	**0.51**	**2.36**	**6.21**
Demand Response Programs					
Power Hours	2.02	3.57	2.00	3.57	NA
Peak Performers	2.85	11.40	2.77	11.40	4.13
Total - DR Programs	**2.56**	**7.14**	**2.51**	**7.14**	**5.07**
Research and Development Programs					
Research and Development	NA	NA	NA	NA	NA
Total - R&D Programs	**NA**	**NA**	**NA**	**NA**	**NA**
Portfolio Total	**1.87**	**2.11**	**0.56**	**2.51**	**6.20**

Portfolio performance can also be reviewed on a levelized dollar per energy savings (kWh) or dollar per peak demand reduction (kW) basis. Energy-efficiency programs are designed to reduce energy usage while providing the same or improved service to the end-user in an economically efficient way, regardless of whether energy usage occurs during peak or non-peak periods. Energy savings occur for the lifetime of the energy efficiency measures installed. As such, program performance was assessed on a levelized dollar per lifetime energy savings (kWh) basis for energy-efficiency programs. Levelized cost in $/kWh is calculated as shown in the formula below:

Equation 1-1: Levelized Cost ($/kWh)

$$Levelized\ Cost\ (in\ \$/kWh)\ =\ C\ x\ Capital\ Recovery\ Factor\ /\ D$$

$$Capital\ Recovery\ Factor = \ [A * (1 + A)\hat{}(B)]/[(1 + A)^{B} - 1]$$

Where:

A = Societal Discount rate (5%)

PSO WACC Discount Rate (7.35%)

B = Estimated measure life in years[5]

C = Total program costs

D = Annual kWh savings

Table 1-3 shows how PSO's portfolio of energy-efficiency programs performed on a levelized cost basis for the program year from a societal (5% discount rate) and a weighted average cost of capital (WACC) (7.32% discount rate) based calculations. The verified net lifetime energy savings in Table 1-3 are at the generator and include a line loss adjustment factor of 1.0586.

Table 1-3: Levelized $/kWh for Energy-Efficiency Programs[6]

Program Year	Total Costs	Verified Net Lifetime Energy Savings (kWh)	Levelized $/kWh	Verified Net Lifetime Energy Savings (kWh)	Levelized $/kWh
		Societal Discount (5%)		Weighted Average Cost of Capital Discount (7.32%)	
2023 Residential[7]	$14,819,810	351,628,051	$0.042	306,243,084	$0.048
2023 Commercial[8]	$10,596,028	356,805,515	$0.030	311,866,420	$0.034
2023 CVR	$2,008,740*	523,807,874	$0.043	420,906,405	$0.053
2023 EE Programs	**$27,424,578**	**1,232,241,441**	**$0.039**	**1,039,015,909**	**$0.046**

* To calculate levelized cost, a lifetime cost associated with CVR based on net present value was used, calculated at $22,392,535.

Demand response programs are designed to encourage customers to change their normal consumption patterns during periods when prices are high, or system reliability is potentially constrained. These programs encourage load reduction during a brief period of time, usually a limited number of days during the summer. As such, demand response program performance was assessed on a peak demand reduction (kW) per dollar basis. Table 1-4 shows how PSO's portfolio of demand response programs (Peak Performers and Power Hours) performed on a $/kW reduction basis for the program year. The verified net peak demand reduction in Table 1-4 includes a line loss adjustment factor of 1.0781.

Table 1-4: $/kW for Demand Response Programs

Program Year	Total Costs	Verified Net Peak Demand Reduction from DR (kW)	$/kW
2023	$4,932,783	87,623	$56.30

[5] Calculated as described in 5.4.3Appendix B:.
[6] Lifetime savings reduced by 5% societal discount or weighted average cost of capital discount factor.
[7] Residential Programs include Home Weatherization and Residential Energy Services.
[8] Commercial Programs include Business Rebates.

1.3 Summary of Energy Impacts

Energy Impacts are presented as annual energy savings, peak demand reduction, and lifetime energy savings. Energy impacts are presented, in general, for projected impacts (goals prepared during portfolio planning), reported impacts (estimated impacts developed during implementation), verified gross impacts (confirmed impacts through evaluation efforts), and verified net impacts (confirmed program influenced impacts through evaluation efforts). Net impacts are the result of applying a Net-to-Gross (NTG) ratio representing the percentage of gross savings directly attributable to program influences. Program year results of annual energy savings, represented at the meter, are shown in Table 1-5.

Table 1-5: Summary of Gross Energy Impacts – 2023[9]

Program	Gross Annual Energy Savings (Meter, MWh)				Net Impacts (Meter)	
	Projected	Reported	Verified	Gross Realization Rate	NTG Ratio	Net Annual Energy Savings (MWh)
Energy-Efficiency Programs						
Business Rebates	39,209	38,733	40,799	105%	89%	36,173
Residential Energy Services	41,268	55,963	58,979	105%	90%	53,353
Home Weatherization	2,527	4,535	4,535	100%	100%	4,535
Conservation Voltage Reduction	35,726	29,757	35,108	118%	100%	35,108
Total – EE Programs	**118,729**	**128,988**	**139,422**	**108%**	**93%**	**129,169**
Demand Response Programs						
Power Hours	0	0	214	-	100%	214
Peak Performers	63	0	1,092	-	100%	1,092
Total - DR Programs	**63**	**0**	**1,306**	**-**	**100%**	**1,306**
Research and Development Programs						
Research and Development	196	0	0	-	0%	0
Total – R&D Programs	196	0	0	-	0%	0
Portfolio Totals	**118,988**	**128,988**	**140,728**	**109%**	**93%**	**130,475**

1.4 Summary of Peak Demand Impacts

Peak demand impacts, or coincident peak demand reduction, represents the reduction in consumption during the PSO peak period. When energy impacts are not available at the

[9] Rounding may affect totals and net-to-gross ratio multiplication/division in table.

hourly level, an average reduction across the peak demand period is used. Peak demand is reported for both gross and net impacts. Table 1-6 summarizes the peak demand impacts at the meter of PSO's energy efficiency and demand response programs during the program year.

Table 1-6: Summary of Demand Impacts – 2023[10]

Program	Gross Peak Demand Reduction (Meter, MW)				Net Impacts (Meter)	
	Projected	Reported	Verified	Gross Realization Rate	NTG Ratio	Net Peak Demand Reduction (MW)
Energy-Efficiency Programs						
Business Rebates	7.96	7.12	7.25	102%	85%	6.17
Residential Energy Services	7.40	12.02	13.07	109%	87%	11.31
Home Weatherization	0.91	2.40	2.40	100%	100%	2.40
Conservation Voltage Reduction	9.25	9.25	10.82	117%	100%	10.82
Total – EE Programs	**25.52**	**30.79**	**33.54**	**109%**	**92%**	**30.70**
Demand Response Programs						
Power Hours	19.72	20.76	22.03	106%	100%	22.03
Peak Performers	63.00	91.09	58.75	64%	100%	58.75
Total - DR Programs	**82.72**	**111.85**	**80.78**	**72%**	**100%**	**80.78**
Research and Development Programs						
Research and Development	0.23	0.00	0.00	0%	0%	0.00
Total – R&D Programs	**0.23**	**0.00**	**0.00**	**0%**	**0%**	**0.00**
Portfolio Total	**108.48**	**142.64**	**114.32**	**80%**	**98%**	**111.48**

Table 1-7 compares the verified net energy impacts to projected net savings for PSO's programs during the program year.

[10] Rounding may affect totals and net-to-gross ratio multiplication/division in table.

Table 1-7: Summary of Net Energy Impacts – 2023

Program	Projected Net		Verified Net		Percent of Verified/Projections	
	MWh	MW	MWh	MW	MWh	MW
Energy-Efficiency Programs						
Business Rebates	36,534	7.39	36,173	6.17	99%	83%
Residential Energy Services	38,450	6.68	53,353	11.31	139%	169%
Home Weatherization	2,527	0.91	4,535	2.40	179%	264%
Conservation Voltage Reduction	35,726	9.25	35,108	10.82	98%	117%
Total – EE Programs	**113,236**	**24.24**	**129,169**	**30.70**	**114%**	**127%**
Demand Response Programs						
Power Hours	0	19.72	214	22.03	-	112%
Peak Performers	63	63	1,092	58.75	1733%	93%
Total - DR Programs	**63**	**82.72**	**1,306**	**80.78**	**2073%**	**98%**
Research and Development Programs						
Research and Development	188	0.23	0	0.00	-	-
Total – R&D Programs	**188**	**0.23**	**0**	**0.00**	**-**	**-**
Portfolio Total	**113,487**	**107.19**	**130,475**	**111.48**	**115%**	**104%**

1.5 Summary of Overall Program Satisfaction

Participants from each program were surveyed about their overall experience with the program. In general, participant satisfaction for the program year is estimated at 87%.[11] Participant satisfaction results by subprogram are summarized in Table 1-8. Process evaluation findings by program are presented in Chapters 3 and 4 of this report.

[11] Program participants that report being either somewhat satisfied or very satisfied with the overall program they participated in.

Table 1-8: Overall Program Satisfaction Reported by Subprogram Participants

Program	Percent Satisfied
Business Rebates - Prescriptive and Custom	90%
Business Rebates - SBES	100%
Multi-Family	100%
Home Weatherization	90%
Energy Saving Products	84%
Homes Rebates - Single Upgrade	97%
Homes Rebates - Multiple Upgrades	96%
Homes Rebates - New Homes	67%
Education	94%
Behavioral	69%
Power Hours	77%
Business Demand Response	82%

2 Introduction

This report presents an evaluation of the performance of the energy efficiency and demand response programs offered by Public Service Company of Oklahoma (PSO) in 2023. PSO is submitting this report to fulfill the requirements outlined in Title 165: Oklahoma Corporation Commission Chapter 35. Electric Utility Rules Subchapter 41. Demand Programs 165:35-41-4.

PSO contracted with ADM to perform comprehensive program evaluation, measurement, and verification (EM&V) for 2023. ADM's evaluation findings for each energy-efficiency program are provided in Chapter 3 of this report, and evaluation findings for the demand response program are provided in Chapter 4. Table 2-1 summarizes program-level participation, program contribution to portfolio-level savings, and number of measures offered.

Table 2-1: Program Level Participation

Program	% Of Portfolio Savings (Reported)	Participants*	Number of Measure Types
Business Rebates	30.03%	890	18
Residential Energy Services	43.39%	273,197	57
Home Weatherization	3.52%	1,909	8
Conservation Voltage Reduction	23.07%	40,715	1
Cumulative EE Totals	**100.00%**	**316,711**	**84**
Power Hours	27.27%	12,953	1
Business Demand Response	72.73%	1,911	1
Cumulative DR Totals	**100.00%**	**14,864**	**2**
Cumulative R&D Totals	**0.00%**	**0**	**1**
Cumulative Portfolio Totals	**100%**	**331,575**	**87**

*Participants represent a residence or business who participated as opposed to the number of measures or projects. For Energy Saving Products subprogram of Residential Energy Services, the actual number of customers is unknown and instead this count is of unique customers that received rebates for qualifying downstream measures.

2.1 Reduced Emissions and Water Consumption

Reduced emissions occur as the result of energy savings achieved through PSO's Demand Portfolio displacing marginal fossil fuel based electric generation. The EPA's Emissions and Generation Resource Integrated Database (eGRID) is a comprehensive source of emissions data related to the electric power sector in the U.S. Included in the eGRID database are estimates of non-baseload emission rates for various greenhouse gasses in different sub regions of the country. The PSO service territory falls into eGRID sub region SPP South (SPSO). Table 2-2 below lists 2023 values from eGRID non-baseload output emission rates for SPSO.

Table 2-2: Generation Resource Integrated Database Greenhouse Gas Annual Output Emission Rates

eGRID Sub region	Annual Non-baseload Output Emission Rates		
	Carbon dioxide (CO_2) (lb/MWh)	Methane (CH_4) (lb/GWh)	Nitrous oxide (N_2O) (lb/GWh)
SPP South (SPSO)	1,528.17	105	15

Using the eGRID emission rates and lifetime energy savings for measures installed through the PSO Demand Portfolio in 2023 results in the estimated emissions reductions listed in Table 2-3.

Table 2-3: Emission Reduction Estimates

Lifetime Energy Savings (Net at Generator) (MWh)	Carbon dioxide Reduction (CO_2) (tonnes)	Methane Reduction (CH_4) (tonnes)	Nitrous oxide Reduction (N_2O) (tonnes)
1,818,681	1,260,645	87	12

Reductions in water consumption at participant homes/facilities resulting from PSO's 2023 portfolio of programs were only tracked for the programs and measures in which deemed water savings values are available. The result was an annual water savings of 349,276 gallons. Many of the energy efficiency measures commonly associated with water savings in the residential sector (faucet aerators, low flow shower heads, efficient clothes washers, etc.) were limited in the portfolio design because of the high prevalence of natural gas water heating in the PSO service territory. The Business Rebates Program does offer incentives for measures that have water saving potential for C&I customers (e.g., variable frequency drives on pump motors). The effects on water consumption for these measures were not quantified for 2023.

There are also water savings associated with reduced energy generation attributable to PSO's energy efficiency and demand response programs. PSO's generation fuel mix as of December 31, 2022, was made up of coal (~11%), natural gas (~20%), purchased power (~41%) and wind (~28%).[12]

A 2003 report by the National Renewable Energy Laboratory (NREL) provides estimates of water consumption per MWh of energy consumed for all U.S. states. The estimate in Oklahoma is 510 Gallons per MWh consumed. Using the NREL water consumption estimates and lifetime energy savings for measures installed through the PSO Demand Portfolio in 2023 results in the lifetime water savings estimates listed in Table 2-4.

Table 2-4: Water Savings Estimates, Thermoelectric Generation

Lifetime Energy Savings (Net at Generator) (MWh)	Overall Generation Percentage Thermoelectric	Water Consumption per MWh Consumed (Gallons/MWh)	Lifetime Water Savings (Gallons)
1,818,681	78%	510	723,471,206

2.2 Milestones Achieved in Market Transformation Programs

While PSO's energy-efficiency programs are designed primarily as energy efficiency resource acquisition programs, there are some market transformation characteristics, briefly summarized below.

Education Kits: Program goals often reach beyond energy savings with programs such as the Education Program (known as Energy Saving Kits) providing education content to 5th grade students through their teachers. The kits provide content supporting 5th grade curriculum while educating youth on the benefits of energy efficiency. PSO has developed a website to accompany the Energy Saver Kits with online activities focused on educating students and their families. Over the past three years, at least 81% of teachers reported high student engagement with the lessons. Also, over 80% of teachers in this period found the curriculum to be current, relevant, and a beneficial learning tool, attesting to its effectiveness. The student survey involves a pre- and post-lesson energy efficiency knowledge test. The average quiz score increased by more than 17% after teachers utilized the Energy Saver Kit curriculum. Participant satisfaction for the kits goes beyond those in the program with a strong positive impact on local communities.

Energy Saving Products (ESP) Program: The ESP program includes retail markdowns of certain energy efficiency measures, such as door sweeps, door seals, air filters, and spray foam. The goal of the markdowns is to increase sales to customers who would have otherwise purchased less efficient options in the absence of a price discount. These types of programs have market transformation effects in terms of retailer stocking decisions and manufacturer shipment decisions.

[12] https://www.psoklahoma.com/lib/docs/company/about/PSO_2023_Fact_Sheet.pdf

The ESP expanded their offerings through the years to include rebates for Level 2 electric vehicle chargers and limited time offerings of energy efficiency measures at discounts on PSO website. The addition of these measures and channel is an example of how PSO continues to transform the market by affecting customer purchasing decisions in preferred purchasing channels.

Home Rebates – New Homes: The program provides educational training for both builders and raters that influence energy efficiency offerings in building performance and new homes.

Commercial Midstream: PSO offers a commercial midstream program for both lighting and HVAC energy efficient products. Midstream programs provide opportunities for market transformation by increasing stocking of energy efficient equipment options by participating distributors. Stocking can be increased either directly through the provision of stocking incentives or indirectly through reducing the cost of more expensive efficient equipment, and in that way, reduce the amount of capital the distributor has tied up in stock. Midstream programs leverage distributors to educate end-users and purchasers.

Service Provider Recruitment and Training: PSO's Business Rebates and Home Rebates programs include service provider training opportunities that focus on increasing awareness and knowledge of building science approaches to energy efficiency. This aspect of the program has potential market transformation effects beyond the energy savings induced through the program. For a complete list of service provider training events refer to Appendix E:. Service provider participation continues to grow for the Business Rebates Program.

2.3 Limited waiver OAC 165:35-41-4(b)(5) for Heat Pumps

PSO received a rule waiver allowing fuel switching for a limited number of air source heat pumps, new construction heat pump water heaters, and mini-split air source heat pumps annually. The request was driven by customer interest to remove natural gas fired equipment in homes and buildings for situations such as those with solar who wish to make the best use of their solar generation. Heat pump technology has advanced, and marketing heat pumps had to be limited before the waiver due to customers not understanding the fuel switching rule and disappointed when not eligible for a rebate. The quantities of units approved and incentivized by baseline fuel type is shown in Table 2-5.

Table 2-5: Heat Pump Participation

Heat Pump	Residential (Existing Homes)	Multifamily	New Construction	Residential (Existing Homes)
Technology	ASHP	ASHP	ASHP	HPWH
Approved Qty of fuel switching conversions from natural gas	70	50	NA	10
Actual Qty Converted from natural gas	19	0	NA	9
Actual Qty converted from propane	2	0	NA	0
Actual Qty with natural gas backup replaced with same source	239	123	NA	0
Actual Qty with electric backup replaced with same source	8	0	NA	12
Actual Incentivized Total	**268**	**123**	**83**	**21**

2.4 Annual Utility Growth Metrics and Portfolio Ratios

The Oklahoma Title 165:35-41-7 reporting rules provide guidance for providing context on the utility load growth and the Demand Portfolio relative to load and revenue. Table 2-6 shows weather-normalized annual growth rates for PSO's total utility energy sales, distribution, and peak demand, for the program year as well as the previous two years.

Table 2-6: Utility Growth Rates 2021 – 2023

Year	Net Sales (GWh)	Sales Growth	Energy at Generator (GWh)	Energy Growth	Peak Demand (MW)	Demand Growth
2021	18,310	1.81%	19,376	1.60%	4,220	1.75%
2022	18,617	1.67%	19,750	1.93%	4,196	-0.56%
2023	18,562	-0.29%	19,681	-0.35%	4,192	-0.11%
Compound Growth Rate	**0.69%**		**0.78%**		**-0.33%**	

Table 2-7 and Table 2-8 show weather-normalized annual growth rates and 2021 - 2023 compound growth rates (CPGR) for utility energy sales by customer class.

Table 2-7: 2021 – 2023 Weather Normalized Retail Meter Sales

	Residential		Commercial		Industrial		Other Retail		Total Retail		FERC	
Year	**GWh**	**%Chg**	**GWh**	**%Chg**	**GWh**	**%Chg**	**GWh**	**%Chg**	**GWh**	**%Chg**	**GWh**	**%Chg**
2021	6,325	0.18%	4,931	4.67%	5,834	2.16%	1,224	1.79%	18,314	1.97%	8	0.99%
2022	6,269	0.89%	5,035	2.10%	6,069	4.01%	1,269	3.69%	18,641	1.79%	9	2.08%
2023	6,216	0.84%	5,209	3.47%	5,939	2.13%	1,253	1.23%	18,619	0.12%	8	5.40%
CPGR	0.86%		2.78%		0.90%		1.20%		0.83%		1.73%	

Table 2-8: 2021 – 2023 Total System Weather Normalized Retail Meter Sales

	Total System	
Year	**GWh**	**%Change**
2021	18,314	1.97%
2022	18,641	1.79%
2023	18,619	-0.12
Compound Growth Rate	**0.83%**	

Table 2-9 shows 2023 Demand Portfolio funding as a percent of total annual electricity revenue.

Table 2-9: 2023 Demand Portfolio Funding

Funding	Value
2023 Demand Portfolio Program Cost ($M)	$33.27
2022 Operating Revenues ($M)	$1,892.1
Program Cost as % of Utility Operating Revenue	1.8%

Table 2-10 shows 2023 Demand Portfolio net energy savings as a percent of total annual energy sales.

Table 2-10: 2023 Demand Portfolio Energy Savings

Metric	Value
2023 Demand Portfolio Net Energy Savings (GWh)	130
2023 Metered Energy Sales (GWh)	18,619
Savings as % of Utility Sales	0.70%

2.5 High-Volume Electricity User Opt Out

The Oklahoma Title 165:35-41-4 rules allow for High-Volume Electricity Users "to opt out of some or all energy efficiency or demand response programs by submitting a notice of such decision to the director of the Public Utility Division and to the electric utility." A High-Volume Electricity User is defined as any single customer that consumes more than 15 million kWh of electricity per year, regardless of the number of meters or service locations. The number of customers eligible for High-Volume Electricity User opt out, their aggregate load as a percentage of total sales, the number of such customers that opted out of energy-efficiency programs for the program year, and the opt out percentage of total energy sales is shown in Table 2-11.

Table 2-11: High-Volume Electricity User Opt-Out – Energy Efficiency

Metric	2023	
	Opt-Out Eligible	Chose to Opt-Out -EE
Number of accounts	7,817	3,818
2023 Electric Sales (GWh)	7,031	6,834
Aggregate load as a percentage of total sales	38.4%	37.4%

Table 2-12 provides a summary of high-volume customers who opted out of demand response programs.

Table 2-12: High-Volume Electricity User Opt-Out – Demand Response

Metric	2023	
	Opt-Out Eligible	Chose to Opt-Out -DR
Number of accounts	7,817	3,736
2023 Electric Sales (GWh)	7,031	6,331
Aggregate load as a percentage of total sales	36.7%	33.1%

2.6 Program Implementation & Strategic Alliances

PSO has eight full-time employees dedicated to the implementation of energy efficiency and demand response programs. Additionally, PSO entered into contracts with several energy services companies (ESCOs) and contractors to aid in program implementation. A complete list of implementation contractors, including contact name, title, business address, phone number, email address, and program associations, is provided in Appendix D:.

ICF International (ICF) was contracted to implement the Business Rebates Program and most of the Residential Energy Services Program (Energy Saving Products Program, Multifamily and Manufactured Homes and Home Rebates Programs). The Home Weatherization Program was largely implemented by Titan ES, LLC, with some program participation also coming through Revitalize T-Town, working to preserve and revitalize low-income homes and communities. PSO contracted with AM Conservation to provide energy-efficiency kits distributed through the Education Program. Home Energy Reports were administered to select residential customers by Oracle. Conservation Voltage Reduction is implemented "in-house" with assistance of multiple contract vendors when necessary to deploy equipment.

Through EnergyHub's Mercury platform, PSO directs and initiates residential load management events. Finally, the Peak Performers program was implemented "in-house" by PSO, with database support provided by AEG. Additional customer engagement materials and services for the entire portfolio of programs were provided by Medium Giant. Examples of customer outreach materials used during the program year to promote PSO's energy efficiency and demand response programs are provided in Appendix F:.

For most programs in the program year portfolio, service providers were recruited to participate by submitting rebate applications on behalf of customers implementing qualifying energy efficiency measures. PSO's website contains lists of registered service providers and the associated products/services they provide.

2.7 Training and Customer Outreach

PSO regularly conducts various service provider training and customer outreach events, which are summarized in Appendix E:. During the program year, PSO's energy efficiency and demand response programs sponsored 45 training and outreach events:

- 26 PowerForward Overview Events
- 9 Business Rebates Service Provider Trainings
- 8 Residential Energy Services Trainings
- 1 New Homes Builder Recruitment Event
- 1 Business Rebates Lunch'n'Learn Event

2.8 Summary of Process Evaluation Findings

ADM completed surveying and interview efforts throughout the program year to inform the impact and process evaluations. Program participants, service providers, and program staff were satisfied with the program year portfolio offerings. Key process evaluation-related findings are summarized below. Additional findings are presented in Chapters 3 and 4.

2.8.1 Business Rebates

The business rebates program includes Prescriptive and Custom, Small Business Energy Solutions, and Commercial Midstream.

- Custom and Prescriptive participants and trade allies rated their overall satisfaction with the program at over 90%. Participants are most interested in future offerings related to their HVAC systems.
- Additional support and/or updates to program tools could improve or ease the participation process for Prescriptive and Custom trade allies. Suggestions included adjusting or improving the file upload process, providing trade allies with a phone or iPad app, reducing required fields for the application, making it easier to track projects' review process/progress, and enabling trade allies to delete old applications that have not been submitted.
- SBES participant satisfaction was 100%, higher than it has been in years past. Most participants are likely to recommend the program to others.
- SBES could ease or improve trade allies' participation process with additional support and/or updates to program tools. Two SBES trade allies noted opportunities to improve the participation process.
- SBES customer survey findings suggest there is interest in additional measure offerings. Over half of respondents indicated interest in incentives for HVAC equipment, tune-ups, smart thermostats, and lighting.
- Both lighting and HVAC distributors were satisfied with the Midstream offering overall.
- Midstream lighting customers were satisfied with the participation process, their lighting distributor, the equipment, and program offering overall.
- Midstream HVAC distributor and service provider interview findings suggest distributors and rebate processing companies take differing rebate processing fees. PSO's Midstream HVAC offering motivated a consultant to start a business that primarily generates revenue through recouping a percentage of rebate fees. The HVAC service provider observed that participating distributors individually determine processing fees and how much of the PSO incentive will be held back.

For example, he indicated one distributor may pay half of the incentive to the service provider or end use customer compared to another which pays 75% of the incentive.

- A single consulting company drove Midstream HVAC sales in 2022 and 2023. Program tracking data indicates a single HVAC consulting company acting as a distributor was responsible for most HVAC incentive dollars paid in 2022 and 2023, as well as nearly half of the incentive dollars paid in 2021. Though all distributor contacts communicated challenges in obtaining high-efficiency equipment, this consulting company was able to obtain high-efficiency equipment to complete a large multi-year project through the program.

2.8.2 Residential Energy Services

The Residential Energy Services program includes Multifamily and Manufactured Homes, Home Rebates, Energy Savings Products, Education, and Behavioral Modifications.

2.8.2.1 Multifamily & Manufactured Homes

- Participating decision makers were satisfied with the program overall. All four of the decisionmakers were satisfied with the program overall and their interactions with PSO staff.
- Properties that agree to inspections typically participate in the program. Both service providers observed a high success rate in implementing energy efficiency improvements at properties that had completed inspections.
- Program staff perceive the manufactured home portion of the program to have significant growth potential, though the manufactured home service provider communicated concern about the long-term viability of the program.
- Findings from ADM’s interview with the manufactured home service provider suggest two main barriers to program success: the electric eligibility requirement and land/home ownership arrangements. The manufactured home service provider stated that about 70% of manufactured homes in PSO territory have gas-fired space heating and are therefore ineligible to participate in the program. Additionally, he estimated a recruitment success rate of about 10% with individual homeowners, observing that these customers may feel suspicious of the program offerings and that it may be “too good to be true” or a scam.

2.8.2.2 Energy Saving Products

- A sizable portion of customers purchasing discounted products (88%) were unaware of any discounts on purchased items. Twelve percent of respondents were aware of a discount, with just two respondents that purchased air filters remembering that PSO was the one that provided the discount.

- Residential customers indicated a willingness to pay more for energy-saving versions of air filters, door seals, and door sweeps. Respondents were less likely to purchase ENERGY STAR® room air conditioners, ENERGY STAR® room air purifiers, and advanced power strips if they had cost more. This indicates that without the discounts, respondents would have still bought air filters, door seals, and door sweeps, but may not have bought room air conditioners, room air purifiers, and advanced power strips.
- Residential customers reported non-energy benefits of energy saving products, with the highest ratings for indoor air quality (55%) and increased home comfort (47%). Comparatively, carbon emissions and an increase in overall market value of the home had the least impact.
- EV Charger participants were satisfied with the rebate and the program had a remarkably high net promoter score. Most were satisfied with the charger they purchased, the rebate amount, the rebate turnaround time, and the application process. The net promoter score of the EV charger among survey respondents was exceptional at 90%. Most survey respondents were considered promoters of the EV charger rebate program.
- Based on the survey, most EV customers tend to charge their EVs a few times per day or just once per day. Survey participants stated that they either used the level 2 charger once a day (38%), a few times a week (43%), once a week (14%), or the charger was not installed (5%). Most customers are using an app to set charging times for their EV and the frequency of use tended to correlate with the frequency of charging. Charging duration varied, with over half (58%) indicating they typically charge their EV between 3 and 8 hours. Sixty-seven percent of respondents reported charging their vehicles between 12 and 7 am.
- EV charger rebates led to various non-energy benefits for participants, including significant reductions in long-term ownership costs and carbon emissions. Additionally, increased comfort in the home and improvements in the overall market value of homes were also notable, though to a slightly lesser extent. These findings highlight the multifaceted benefits that Level 2 EV chargers can offer, ranging from financial savings to environmental impact and enhanced living conditions.
- Half of the downstream survey respondents were aware of a rebate before purchasing the equipment. Most survey respondents learned of the program through the PSO PowerForward website, the retailer’s website, signage at the retailer, an internet search, or an email from PSO.

    - Most survey respondents purchased the equipment to save money on energy bills and replace existing appliances.
- Downstream participants were satisfied with the equipment and the program overall. Overall, the program participants were satisfied with the ENERGY STAR® appliances they installed, the application process, the rebate wait time, the rebate amount, and the variety of measures incentivized. The overall net promoter score of the downstream channel was particularly good at 63%. When analyzed by measure, the NPS was highest among people who purchased ENERGY STAR® heat pump water heaters (67%) and lowest among those who purchased a clothes washer or Wi-Fi thermostat (63%).

2.8.2.3 Home Rebates

The Home Rebates Program consists of energy efficient New Homes, Single Upgrades, and Multiple Upgrades.

New Homes

- There was an increase in the overall number of homes that were rebated in 2023. There was an approximately 15% increase in the number of homes rebated in 2023 compared to 2022.
- Energy efficiency ranks among the most crucial elements for home buyers. These include price, appearance, location, energy efficiency, interior features, and house size.
- Most home buyers were not aware of the program before taking the survey and reported the home builder did not describe any advantages to program-eligible homes. This contradicts builders stating that they explain energy efficiency and the program to buyers. Home builders reported convincing their customers to build to program standards.
- While many non-energy benefits are important to home buyers, the most important non-energy benefits are home value and comfort.

Single and Multiple Upgrades

- Single Upgrades survey results indicate an elevated level of participant satisfaction with the program. Most respondents expressed satisfaction with program staff interactions, the application process, and the overall program experience. Furthermore, participants reported tangible benefits from the energy-saving upgrades, including improved home comfort, increased reliability of heating and cooling appliances, and lower utility bills.
- There is less trade ally participation for the Single Upgrade Program than desired. PSO is looking to improve program marketing to increase regional diversity.

Additional marketing material is needed (specifically for the rural areas outside of Tulsa) to expand the awareness of the program to potential trade allies, which helps increase customers participation.

- Multiple Upgrades test-out completion rates improved in 2023. In previous program years, test out completion rates caused by customer hesitancy affected the overall number of participants in the Multiple Upgrades Program. Customer hesitancy towards the test-out process was caused by a delay from when the energy-efficient equipment was installed to when they were contacted by the TPVs. If a test-out is not completed, the project is automatically disqualified from the program and the customer does not receive a rebate for the energy-efficient equipment.
- Most multiple upgrades respondents reported positive experiences with program staff, contractors, and the overall program. Participants reported significant benefits from the energy-saving upgrades, including improved home comfort, enhanced reliability of heating and cooling appliances, and reduced noise from appliances.

2.8.2.4 Education Program

- The program's strength lies in its significant impact on teachers and students, providing valuable resources that are integral to lesson plans. Students demonstrated a 17% increase in knowledge of the energy efficiency content and 88% of teachers found the content to be useful training material towards their required curriculum.
- Teachers praised the Energy Saver Kit program curriculum for its relevance, suitability, and effectiveness as a teaching tool. Educators emphasized the program's essential role in providing depth, engagement, and hands-on experiences, enhancing their energy courses compared to traditional methods.

2.8.2.5 Behavioral Modification

- Significantly more treatment group participants reported adopting energy-saving behaviors in 2023 compared to the control group.
- Over 70% of respondents are satisfied with the information presented in the HERs and about 70% of respondents are satisfied with the number of emails sent.
- Only 6% of respondents are using the Energy Management tool with a plurality of those who had not logged into the tool stating that they were not aware that it existed.

2.8.3 Home Weatherization

- Participant satisfaction remains high. Most participant survey respondents were satisfied with the program overall, the measures they received, and with PSO as their electric utility.
- The program offers an easy, straightforward enrollment and participation process for qualifying customers in PSO's territory. Overall, customers were satisfied with the sign-up and scheduling process. Survey findings also show that most customers were satisfied with the quality of the weatherization improvements and their experience with the program implementation contractor.
- The program is reaching customers throughout PSO territory. Tulsa County had the highest portion of homes that were weatherized through the program. However, Okmulgee and Comanche counties had higher relative participation rates when considering the total number of homes per county.
- A small amount of funding provided for "home readiness" has increased the number of homes that will be eligible to participate by making minor repairs prior to energy efficiency upgrades.

2.8.4 Power Hours

- Six DLC events were called in 2023 compared to eight in 2022 and six in 2021. Events in 2023 were all two hours compared to years past where some were three hours.
- Enrollment increased from 11,029 customers and 13,497 devices in 2022 to 12,953 customers and 16,513 devices in 2023. Increased thermostat offerings in residential programs are generating additional opportunities for demand response.
- Pre-cooling slightly increased the maximum peak demand reduction for all three events this measure was implemented, especially during the beginning of events when the reduction is the highest. ADM noticed that the effect of pre-cooling on increasing the average peak demand reduction was not always consistent and was small in magnitude, typically ~0.1 kW per device.
- Participants were satisfied with Power Hours. Satisfaction with the program varied among promoters, detractors, and passive respondents. Promoters of the Power Hours program commended it for its cost savings, ease of use, and positive impact on energy conservation, expressing a willingness to recommend it.

2.8.5 Peak Performers

- Enhancements in the programs QA/QC procedures are improving implementation processes.
- Survey participants had positive and effective communication experiences. Thirty-one percent of survey participants communicated with PSO staff upon program participation. All nine respondents who interacted with PSO staff reported being very satisfied with these interactions.
- Most participants (76%) did not opt out of any event, while 14% opted out of one event. Sixty-nine percent of respondents found the number of peak events aligned with their anticipations, while 21% experienced fewer and 3% reported more than expected.
- Peak Performers experienced strong overall positive experiences, underscoring the success of the program in meeting participant expectations. A substantial majority of participants expressed satisfaction with the Peak Performers program overall.

3 Energy-Efficiency Programs

This chapter reports on evaluation findings of the 2023 PSO energy-efficiency programs. Chapter 4 reports on the demand response programs. Energy-efficiency programs annual energy impacts are summarized in Table 3-1.

Table 3-1: Annual Energy Savings – Energy-Efficiency Programs

Program	Gross Peak Annual Energy Savings (MWh)					Net Impacts	
	Projected	Reported	Verified	Verified Lifetime Savings	Gross Realization Rate	NTG Ratio	Net Annual Energy Savings (MWh)
Energy-Efficiency Programs							
Business Rebates	39,209	38,733	40,799	525,547	105%	89%	36,173
Multifamily	1,717	3,227	3,152	45,310	98%	97%	3,054
Home Weatherization	2,527	4,535	4,535	77,280	100%	100%	4,535
Energy Saving Products	7,665	20,892	18,910	193,598	91%	77%	14,632
Home Rebates	5,057	8,682	9,226	168,908	106%	86%	7,977
Education	2,723	2,974	2,580	28,586	87%	100%	2,580
Behavioral	24,106	20,187	25,111	25,111	124%	100%	25,111
Conservation Voltage Reduction	35,726	29,757	35,108	877,703	118%	100%	35,108
Energy-Efficiency Totals	**118,729**	**128,988**	**139,422**	**1,942,043**	**108%**	**93%**	**129,169**

Program-level peak demand reduction (kW) for the energy-efficiency programs is summarized in Table 3-2.

Table 3-2: Peak Demand Reduction – Energy-Efficiency Programs

Program	Gross Peak Demand Reduction (MW)				Net Impacts	
	Projected	Reported	Verified	Gross Realization Rate	NTG Ratio	Net Peak Demand Reduction (MW)
Energy-Efficiency Programs						
Business Rebates	7.96	7.12	7.25	102%	85%	6.17
Multi-Family	0.40	0.64	0.65	100%	96%	0.62
Home Weatherization	0.91	2.40	2.40	100%	100%	2.40
Energy Saving Products	1.29	4.36	3.28	75%	63%	2.07
Home Rebates	1.59	3.68	3.86	105%	87%	3.36
Education	0.41	0.42	0.39	91%	95%	0.37
Behavioral	3.71	2.90	4.89	169%	100%	4.89
Conservation Voltage Reduction	9.25	7.42	10.82	145%	100%	10.82
Energy Efficiency Totals	**25.52**	**28.95**	**33.54**	**116%**	**92%**	**30.70**

The remainder of this section provides evaluation findings for each of the PSO energy-efficiency programs including program performance metrics, evaluation methodologies, energy and demand impacts, and process evaluation findings.

3.1 Residential Energy Services programs

This section presents findings from the impact and process evaluation of the 2023 Residential Energy Services program year. The Residential Energy Services Program includes the subprograms of Home Rebates, Energy Saving Products, Education Kits, Multifamily and Manufactured Homes, and Behavioral Modification. Program performance metrics are summarized in Table 3-3.

Table 3-3: Performance Metrics – Residential Energy Services Program

Metric	2023
Number of Participants	273,197
Budgeted Expenditures	$10,009,474
Actual Expenditures	$11,345,093
Energy Impacts (kWh)	
Projected Energy Savings	41,267,883
Reported Energy Savings	55,962,900
Gross Verified Energy Savings	58,979,440
Net Verified Energy Savings	53,353,272
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	7,400.92
Reported Peak Demand Savings	12,016.64
Gross Verified Peak Demand Savings	13,068.28
Net Verified Peak Demand Savings	11,312.34
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.98
Utility Cost Test Ratio	1.75

3.1.1 Home Rebates

This chapter presents findings from the impact and process evaluation of the 2023 program year for the Home Rebates Program.

3.1.1.1 Program Overview

The Home Rebates Program offered by the Public Service Company of Oklahoma (PSO) seeks to generate energy and demand savings for residential customers through the promotion of comprehensive efficiency upgrades to building envelope measures and HVAC equipment for both new construction homes and retrofits to existing homes. Offering PSO customers direct inducements for higher efficiency measures offsets the first cost obstacle, encouraging customers to choose the upgraded products. This evaluation will report on the program in its three components: New Homes, Multiple Upgrades, and Single Upgrade.

The New Homes component of the program provided prescriptive incentives to builders of single-family homes. Builders received $800 for construction that met the following standards:

- 95% LED Lighting
- Insulation (15 R-value blown insulation walls; 38 R-value blown insulation attic) or (13 R-value foam insulation walls; 21 R-value foam insulation attic)
- HVAC – SEER2 14.3 Air Conditioner
- Home infiltration (6 air changes per hour at 50 pascals)
- Duct infiltration (6 cfm25 /100 sq. ft. of conditioned floor area)
- 100% ENERGY STAR® certified windows

Additionally, bonus rebates were offered for:

- $200 for installing SEER2 15.2-17.1 Air Conditioner
- $600 for installing SEER2 17.2-19.0 Air Conditioner
- $800 for installing SEER2 19.1+ Air Conditioner
- $800 + $350/ton Ground Source Heat Pump
- $1000 for installing 19.1 SEER2 Ductless Minisplit
- $50 for installing minimum 32-amp devoted circuit attached to a NEMA 14-50 plug.

HERs raters received a $25 rebate per rated home. The program was promoted to builders of single-family dwellings and to customers buying new homes. Key program activities included:

- Training homebuilders, sales staff, trade contractors and other market allies.
- Increasing consumer awareness of and demand for ENERGY STAR® qualified homes through various consumer outreach channels.
- Increasing homebuilder promotion of Home Rebates or ENERGY STAR® qualified homes through program-provided collateral items and encouraging the use of the ENERGY STAR® brand.

The Multiple Upgrades component of the program focused on energy efficiency upgrades to existing residential homes. To qualify for the program in 2023, customers needed to install two or more eligible equipment upgrades. Eligible measures are shown in Table 3-4.

Table 3-4: Multiple Upgrades Rebates Offered

Upgrades	Multiple Upgrades Rebates
Attic/Ceiling Insulation (R-22 or less existing)	$600
Knee Wall Insulation	$500
Wall Insulation (R-0 existing)	$450
Floor/Crawlspace Insulation (R-0 existing)	$600
Exterior Wall Insulation	$500
Air Infiltration	10% of air sealing cost covered up to $1,000
Duct Replacement	30% of duct replacement cost covered up to $2,800
Duct Sealing	30% of duct sealing cost covered up to $1,400
Air Conditioner/Heat Pump Replacement*	-
ENERGY STAR® SEER2 15.2 – 17.1	$300
ENERGY STAR® SEER2 17.2 – 19	$900
ENERGY STAR® SEER2 19.1+	$1,200
Ductless Minisplit, 19.1 SEER2 Minimum*	$1,500
Geothermal/Ground Source Heat Pump	$1,200 + $525 per ton

** HVAC replacement in the Multiple Upgrades Program was combined with Duct Replacement or Duct Sealing.*

The Multiple Upgrades Program included a walk-through assessment from a PSO approved contractor to help identify energy-efficiency measures that could improve customers' comfort level while reducing energy costs. After the initial audit was complete, a PSO/ICF contracted employee, also referred to as PSO Third Party Verifier (TPV), performed a diagnostic test on the home after the upgrades were installed. This process measured and documented the efficiency gains from infiltration reduction and duct sealing measures along with HVAC equipment.

The Single Upgrade component of the program focused on energy-efficiency upgrades to existing residential homes. To qualify for this component of the program, customers needed to install one or two eligible equipment upgrades. Eligible measures are shown in Table 3-5.

Table 3-5: Single Upgrade Rebates Offered

Upgrades	Single Upgrade Rebates
Attic/Ceiling Insulation (R-22 or less existing)	$400
Air Conditioner/Heat Pump Replacement	-
ENERGY STAR® SEER2 15.2 – 17.1	$200
ENERGY STAR ® SEER2 17.2 – 19	$600
ENERGY STAR ® SEER2 19.1+	$800
Ductless Minisplit, 19.1 SEER2 Minimum	$1,000
Geothermal/Ground Source Heat Pump	$800 + $350 per ton
HVAC Tune-Up (based on existing HAVC unit)	$75 + $25 per pound of refrigerant*
ENERGY STAR® Swimming Pool Pump	$400
ENERGY STAR® Programmable Wi-Fi Thermostat	$75

**Up to 2 pounds of refrigerant per project*

Home Rebates performance metrics are summarized in Table 3-6.

Table 3-6: Performance Metrics – Home Rebates Program

Metric	2023
Number of Participants	5,424
Budgeted Expenditures	$4,926,693
Actual Expenditures	$8,635,936
Energy Impacts (kWh)	
Projected Energy Savings	5,056,867
Reported Energy Savings	8,682,067
Gross Verified Energy Savings	9,226,376
Net Verified Energy Savings	7,976,527
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	1,594.05
Reported Peak Demand Savings	3,683.41
Gross Verified Peak Demand Savings	3,856.73
Net Verified Peak Demand Savings	3,359.20
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.62
Utility Cost Test Ratio	1.29

The EM&V methodologies and findings for the Home Rebates Program are presented in the next sections. The New Homes, Multiple Upgrades, and Single Upgrade components are reported in Section 3.1.1.2, Section 3.1.1.3, and Section 3.1.1.4, respectively.

3.1.1.2 New Homes

This section presents the findings and results of the evaluation of the 2023 New Homes portion of the Home Rebates Program. Evaluation methodologies can be found in a supplemental document.

3.1.1.2.1 Impact Evaluation Activities

ADM employed a site-specific evaluation approach to quantify electric impacts for the New Homes Program. The impact evaluation for this program included the following steps:

- Program tracking data review for completeness, clerical errors, outliers, and accuracy.
- Establishing a sample design and selecting a random sample of homes for evaluation.

- Data collection activities (including on-site verifications, HERS rater documentation, building drawings, and builder provided documentation).
- Gross Impact analysis. Engineering analysis of site-level and program level impacts using energy simulation with post-installation consumption calibration.
- Net Impact analysis. ADM used survey results from online builder surveys to determine the level of free ridership in the program.

3.1.1.2.2 Process Evaluation Activities

ADM performed a process evaluation assessing the 2023 New Homes Program operations and delivery. The program design, operations, and delivery were assessed for the New Homes Program through builder surveys, home buyer surveys, and a facilitated discussion with program and implementation staff at PSO. Table 3-7 summarizes the data collection activities.

Table 3-7: New Homes - Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Program Materials Review	Review reports and support materials for clarity and consistency with program objectives
Program Staff Facilitated Discussion	Assess past program year recommendations and implementation strategies
Builder Survey	Assess program support, training, satisfaction, program influence on building practices, and suggestions for improvements
Home Buyer Survey	Investigate buyers' reasons for buying the home they did, importance of energy efficiency in their decision, as well as how well builders explained the energy-efficient characteristics of the homes

The process evaluation addressed the following research questions:

- Has the underlying program theory of how the program affects energy saving behaviors changed since the previous program years? If so, how and why?
- How have the program implementation and delivery changed, if at all, since the previous program years? How are these changes related to previous evaluation results and how are they expected to change program impacts going forward?
- Did the program implementation reflect its current design? In what ways did it deviate and how did that affect program success?
- Do program utility and implementation contractor staff effectively coordinate to deliver the program?
- Are there ways to improve the design or implementation process?

- Is the New Homes component of the program motivating builders to build energy efficient homes? Why or why not? What could be done to motivate them more?
- How are builders selling energy-efficiency benefits to buyers? Are they getting the training they need to do this effectively? How can the program help them?
- What are new home buyers' motives for buying these homes? How important is the homes' energy efficiency status in their decisions? How important are the homes' non-energy benefits in their decisions?

3.1.1.2.3 Program Material Review

An element of the evaluation includes a review of the program tracking data and program documentation. The program tracking data is reviewed for completeness, systematic issues, and inconsistencies prior to any evaluation work.

ADM reviewed program tracking data and found no data issues. In this review ADM found that one HERS rater accounted for 26% of program savings and the top six HERS raters accounted for 83% of program savings. Three of the four larger raters in previous years were bought out during this program year and fell under the 'other' raters for the year.

3.1.1.2.4 Sampling Plan

Samples are developed separately for the process and impact evaluations. Samples are developed in a manner such that results from analysis of the sample represent the population with ± 10% precision at the 90% confidence interval based on annual energy savings. In some instances, such as survey designs, a census of home buyers/builders is necessary to maximize the sample, which may not always meet the precision target. Table 3-8 summarizes the sample size for each primary data collection activity.

Table 3-8: New Homes - Sample Sizes for Data Collection Efforts

Data Collection Activity	Achieved Sample Size
Builder Surveys Completed	4
Home Buyer Surveys Completed	43
Facilitated Discussion with Program Staff	2
On-Site Verifications	7
Impact Evaluation Analysis Sample	29

The impact evaluation sample design employed reported annual energy savings estimates to determine sample sizes per stratum and precision. The population of projects is broken out into strata such that sampled projects represent like projects in the population when results are extrapolated. It was determined that the metric used to stratify the sample is based on the HERS rater as they are responsible for confirming and reporting the energy savings measures. Sampled projects are selected randomly.

Precision is then recalculated with verified annual energy savings to determine a verified precision. Sample design precision at the 90% confidence interval was ±8.86% for estimated annual energy savings. Table 3-9 below summarizes the sample framework exceeding the targeted 10% precision.

Table 3-9: New Homes - Sample Design

Strata	Measure	Reported Energy Savings (kWh)	Population Size	C.V.	Sample Size	Relative Precision
Stratum 1	Rater 1 Small	1,129,117	707	0.23	10	12%
Stratum 2	Rater 1 Large	1,018,619	386	0.28	10	15%
Stratum 3	Rater 2	262,618	81	0.34	3	33%
Stratum 4	Rater 3	228,266	89	0.62	4	51%
Stratum 5	Other	155,747	65	0.21	2	24%
Total	**-**	**2,794,367**	**1,328**		**29**	**8.86%**

3.1.1.2.5 Data Collection

Data collection activities supporting the evaluation included builder surveys, home buyer surveys, a facilitated discussion with PSO program staff and implementation staff, and primary data collection through on-site verifications.

Builder Survey

For the New Homes Program, contact information for all builders was requested from the implementation contractor. Any new builder who participated in the program in 2023 or builders who had previously participated in the program but did not complete an online survey in the previous program year was emailed a survey link in November 2023. A total of 13 homebuilders were emailed the online survey, which resulted in 4 survey completes.

Home Buyer Survey

For the New Homes Program, a sample of New Homes participants were pulled from the tracking data and included in the survey sample list. The home buyer contact information was requested from PSO and the home buyers in the survey sample list were emailed a survey link in August and September 2023. A total of 258 participants were emailed the online survey, which resulted in 43 survey completes.

Program Staff Facilitated Discussion

ADM conducted a facilitated discussion of the Home Rebates – New Homes Program with PSO program and implementation staff in June 2023. The facilitated discussion involved a group discussion with key personnel responsible for discussing past program year recommendations and brainstorming implementation strategies.

On-Site Verification Visits

On-site verification visits were performed through recruitment by the implementation team. On-Site visits occurred during post inspections with as many locations recruited as were feasible. Field data collection forms were completed to verify attic insulation thickness and type, percentage of LEDs installed, and appliance model numbers. Additionally, photographs were taken to confirm the collected data. This information provided verification for simulation model inputs.

3.1.1.2.6 Gross Impact Methodology

Energy impacts are calculated through energy simulation using Ekotrope.[13] The simulation tool determines the difference in energy consumption between a residence built to Oklahoma energy codes and the as-built residence. ADM uses information obtained from on-site visits and application documents to confirm the as-built conditions. Energy simulation consumption was compared and calibrated (as needed) to billing consumption data. A detailed description of this methodology can be found in a supplemental document.

3.1.1.2.7 Net-to-Gross (NTG) Estimation Methodology

Net impacts of the New Homes Program were evaluated using participating builder survey responses for free ridership. The surveyed builders responded to questions on the influence of the individual program components, the overall level of influence of the program on the construction practices incorporated into rebated homes, and the share of homes that would have been built to program standards if the program was not available. The scoring procedures align with industry standard methodology and can be found in a supplemental document.

3.1.1.2.8 Verified Gross Savings Results

This section details the verified gross and net savings impacts for the New Homes portion of the Home Rebates Program.

[13] https://www.ekotrope.com/

Program Activity

Participation and reported savings estimates by builder are shown in Table 3-10. The top six participating builders accounted for 83% of New Homes estimated annual energy savings.

Table 3-10: New Homes - Participation and Savings per Builder

Builder	Number of Homes	Reported Energy (kWh)	Reported Demand (kW)	Percent of Program Energy Savings
Executive Homes	264	735,118	285.63	26.3%
Rausch Coleman Homes	425	607,303	211.72	21.7%
Shaw Homes	147	277,805	100.77	9.9%
Sunview Construction, LLC	81	262,618	32.19	9.4%
Simmons Homes LLC	115	228,217	84.60	8.2%
Capital Homes Residential Grp., LLC	99	209,760	78.57	7.5%
Home Creations	61	111,802	41.49	4.0%
SPECTACULAR HOMES	40	99,586	34.65	3.6%
Concept Builders	24	61,034	20.16	2.2%
Cobblestone Homes, Inc.	6	36,293	14.97	1.3%
Homes By Classic Properties LLC	15	29,633	11.24	1.1%
TRADITION HOMES	12	23,175	8.86	0.8%
DMP Custom Homes Inc.	8	19,775	7.48	0.7%
Abbey Homes LLC	5	17,296	6.42	0.6%
True North Homes LLC	3	15,489	6.11	0.6%
Bgreen Homes, LLC	7	15,241	5.79	0.5%
Epic Custom Homes	3	10,511	3.67	0.4%
1st choice Quality Builders	4	8,903	3.22	0.3%
Malibu Homes	1	7,220	3.00	0.3%
Ideal Homes	3	6,898	2.45	0.2%
TCGH LLC	3	4,613	1.35	0.2%
Personal Builder 1	1	4,276	1.63	0.2%
Personal Builder 2	1	1,799	0.68	0.1%
Total	**1,328**	**2,794,367**	**966.65**	**100%**

Verified Gross Savings

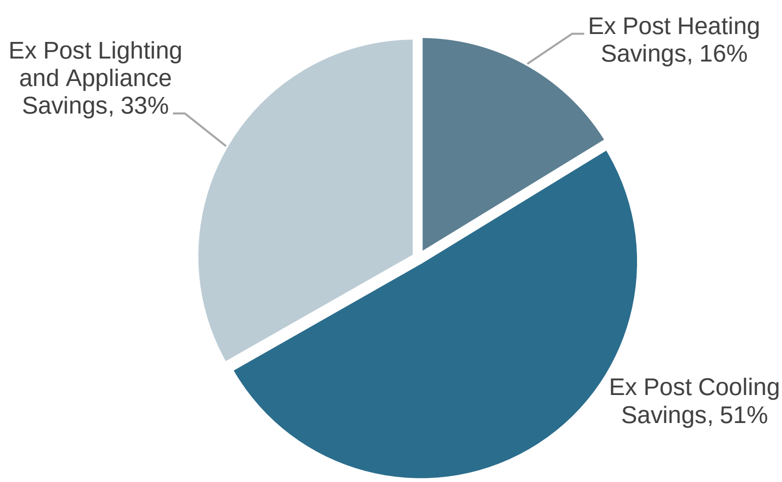
ADM performed on-site data collection for seven sampled projects. Findings from these data collection activities matched energy simulation inputs used by the HERs raters.

Differences Between Reported and Verified Simulation Inputs

The baseline conditions in Ekotrope are pre-determined for all models based on the Oklahoma energy code. The current Oklahoma energy code follows the 2009 International Residential Code. The impact analysis found reported simulation models reflected the building characteristics verified during engineering desk reviews.

The figure below (Figure 3-1) shows the annual energy savings by end-use from the evaluation sample. As shown, the highest energy savings are realized with energy efficiency upgrades to electric heating systems, followed by upgrades to lighting and appliances.

Figure 3-1: New Homes - Energy Savings of Aggregated Sample by End Use



Adjustments to mechanical systems were made to the models for verified savings resulting in a 1.1% difference from estimated savings. Evaluation sample results by strata and sample precision with verified annual energy savings is shown in Table 3-11.

Table 3-11: New Homes Evaluation Sample Results

Strata	Measure	Sample Reported Energy Savings (kWh)	Sample Evaluated Energy Savings (kWh)	Population Size	Sample Size	Relative Precision
Stratum 1	Rater 1 Small	17,048	17,048	707	10	12%
Stratum 2	Rater 1 Large	25,098	25,098	386	10	15%
Stratum 3	Rater 2	11,937	11,937	81	3	33%
Stratum 4	Rater 3	13,552	12,646	89	4	51%
Stratum 5	Other	5,249	5,249	65	2	24%
Total		**72,884**	**71,977**	**1,328**	**29**	**8.86%**

Due to the minor changes in the verified models, the program achieved a 99% realization rate for the program year 2023. Reported and verified energy impacts are presented in Table 3-12.

Table 3-12: New Homes - Gross Impact Results by Strata

Strata	Reported Annual Energy Savings (kWh)	Reported Peak Demand Reduction (kW)	Verified Annual Energy Savings (kWh)	Verified Peak Demand Reduction (kW)	Lifetime Energy Savings (kWh)	kWh Realization Rate	kW Realization Rate
Rater 1 Small	1,129,117	402.02	1,129,114	401.82	22,582,289	100%	100%
Rater 1 Large	1,018,619	388.72	1,018,616	388.56	20,372,311	100%	100%
Rater 2	262,618	32.19	262,618	32.22	5,252,361	100%	100%
Rater 3	228,266	88.29	213,001	85.46	4,260,026	93%	97%
Other	155,747	55.43	155,746	55.40	3,114,925	100%	100%
Total	**2,794,367**	**966.65**	**2,779,096**	**963.46**	**55,581,913**	**99%**	**100%**

Program level reported and gross annual energy savings are summarized in Table 3-13. An effective useful life (EUL) of 20 was applied to program lifetime savings. A 20-year EUL is based on typical measures installed in new home construction.

Table 3-13: New Homes - Reported and Gross Impacts

Reported Annual Energy Savings (kWh)	Reported Peak Demand Reduction (kW)	Verified Annual Energy Savings (kWh)	Verified Peak Demand Reduction (kW)	Lifetime Energy Savings (kWh)	kWh Realization Rate	kW Realization Rate
2,794,367	966.65	2,779,096	963.46	55,581,913	99%	100%

3.1.1.2.9 Net-to-Gross (NTG) Estimation Results

Four builders contributing 23% of the program's annual energy savings participated in online surveys for 2023. Builder surveys were used to estimate free ridership ratios for the New Homes Program. Free ridership ratios (ranging from zero to one, zero for complete free ridership and one for no free ridership) were determined for each surveyed homebuilder and applied to the verified annual energy savings and peak demand reduction for homes built by that homebuilder. If a homebuilder was not available for the survey in 2023, the previous free ridership scores were considered for the calculation of NTG. Average free ridership ratios for the program were weighted by the builder's verified savings contributions (shown in Table 3-14).

There was no energy savings that is considered spillover for the 2023 program. The magnitude of energy impacts due to free ridership and spillover are presented in Table 3-14.

Table 3-14: New Homes - Free Ridership and Spillover Impacts

Free Ridership (kWh)	Free Ridership kWh Ratio	Free Ridership (kW)	Free Ridership kW Ratio	Spillover (kWh)	Spillover (kW)
671,439	24.16%	233.66	24.25%	0	0.00

Based on impact evaluation results, the total verified net energy and demand savings are presented in Table 3-15 below.

Table 3-15: New Homes - Gross and Net Savings Impacts

Verified Annual Energy Savings (kWh)	Verified Peak Demand Reduction (kW)	NTG Ratio kWh	NTG Ratio kW	Net Annual Energy Savings (kWh)	Net Peak Demand Reduction (kW)	Net Lifetime Energy Savings (kWh)
2,779,096	963.46	75.84%	75.75%	2,107,656	729.80	42,153,128

3.1.1.3 Multiple Upgrades

This section presents the findings and results for evaluation of the Multiple Upgrades portion of the Home Rebates Program. Detailed evaluation methodologies are available in a supplemental document.

3.1.1.3.1 Impact Evaluation Activities

Data collection included online participant and trade ally surveys and a facilitated discussion with program and implementation staff. Additional sources of data to inform the impact evaluation were a census of program tracking data from the program implementor's tracking and reporting system, along with project documentation obtained from the implementation online tool. Program tracking data included customer contact information and descriptions of the measures installed with file storage for submitted applications, test-out photos and data, and contractor invoices for the work performed. The impact evaluation for this program included the following activities:

- Determination of the number of customers participating in the program by types of measures installed.
- Determination of the gross energy savings and peak demand reduction per project based on engineering algorithms.
- Estimation of the net-to-gross ratios to determine the percentage of gross savings directly attributable to the program.
- Documentation of incremental costs for benefit-cost analysis.

3.1.1.3.2 Process Evaluation Activities

ADM performed a process evaluation assessing the 2023 Home Rebates Program operations and delivery. The program design, operations, and delivery were assessed for the Multiple Upgrades Program through participant surveys, trade ally surveys, and a facilitated discussion with PSO program staff and implementation staff. Table 3-16 summarizes the data collection activities.

Table 3-16: Multiple Upgrades - Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Program Materials Review	Review reports and support materials for clarity and consistency with program objectives.
Program Staff Facilitated Discussion	Assess past program year recommendations and implementation strategies
Participant Survey	Assess participant experiences, including satisfaction.
Trade Ally Survey	Assess program support, training, satisfaction, program influence on trade ally practices, and suggestions for improvements.

The process evaluation addressed the following research questions:

- Has the underlying program theory of how the program affects energy saving behaviors changed since the previous program years? If so, how and why?
- How have the program implementation and delivery changed, if at all, since the previous program years? How are these changes related to previous evaluation results and how are they expected to change program impacts going forward?
- Did the program implementation reflect its current design? In what ways did it deviate and how did that affect program success?

- Do program utility and implementation contractor staff effectively coordinate to deliver the program?
- Are the program customer engagement materials effective at advertising the Single Upgrade and Multiple Upgrades components of the program? Could they be improved in any way?
- Are there ways to improve the design or implementation process?
- What is the experience of participants in the Single Upgrades and Multiple Upgrades components of the program?
- Is the program customer engagement content effective? What is working particularly well and what could be improved?
- Is the program reaching all segments of the target market? Is anyone under-represented or left out?

3.1.1.3.3 Sampling Plan

Sampling was conducted to ensure survey responses represent the program population. Table 3-17 summarizes the sample size for each primary data collection activity. The random sample for verification was designed to achieve ±10% relative precision or better at the 90% confidence interval.

Table 3-17: Multiple Upgrades - Sample Sizes for Data Collection Efforts

Data Collection Activity	Achieved Sample Size
Participant Surveys Completed	120
Trade Ally Surveys Completed	10
Facilitated Discussion with Program Staff	2

Online Participant Surveys

For the calculation of sample size for survey completes for the online participant survey, a sample size of 68 was desired for the results to represent the program within ±10% precision at the 90% confidence interval.

3.1.1.3.4 Data Collection

Data collection activities supporting the evaluation included participant surveys, trade ally survey, a facilitated discussion with PSO program staff and implementation staff, and collection of all program documentation to complete an engineering analysis.

Participant Survey

ADM conducted a participant survey of PSO customers who participated in the Multiple Upgrades Program in 2023. All Multiple Upgrades participants were pulled from the tracking data and included in the survey sample list. Any participant with a valid email address was sent a link to the online survey. The survey was emailed in monthly waves to participants from June through November 2023. Participants were offered a monetary incentive if they completed the questionnaire. ADM sent the online survey to a total of 699 participants, which resulted in 120 survey completes.

Trade Ally Survey

ADM conducted a survey of all trade allies who participated in the Single & Multiple Upgrades Program in 2023. All trade allies with contact information were pulled from the tracking data and included in the survey sample list. Any trade ally with a valid email address was emailed a link to the online survey in October and November 2023. ADM sent the online survey to a total of 48 Trade Allies, which resulted in 10 survey completes.

Program Staff Facilitated Discussion

ADM conducted a facilitated discussion of the Home Rebates - Single Upgrade and Multiple Upgrades Program with PSO program staff and implementation staff in June 2023. The facilitated discussion involved a group discussion with key personnel responsible for discussing past program year recommendations and brainstorming implementation strategies.

3.1.1.3.5 Gross Impact Methodologies

The method used to calculate energy savings (kWh) and demand savings (kW) consisted of:

- **Program tracking data census.** The tracking data was reviewed for a census of homes and measures. The data was verified for duplicate participation within the program and between programs.
- **Measure installation verification.** In-service rates (ISR) were calculated by measure for a sample of program participants using data collected from the online participant survey and on-site verifications.
- **Reported savings review.** Reported savings calculations were reviewed for all measures to determine the cause of savings discrepancies.
- **Standard for verification of savings.** The data collected from program tracking data were used as inputs to the savings algorithms as listed in the Arkansas Technical Reference Manual, Version 8.1 (AR TRM 8.1) and the Oklahoma Deemed Savings Document (OKDSD).

Detailed explanations of the prescriptive algorithms used to determine energy impacts can be found in a supplemental document.

Lifetime kWh Savings

Lifetime energy savings (kWh) were calculated by multiplying the gross annual kWh savings by the Estimated Useful Life (EUL) for each measure type. EUL values for each measure were based on the assumptions in the AR TRM and OKDSD. Table 3-24 shows the EUL and source for each measure type.

Table 3-18: Multiple Upgrades – Per Measure Estimated Useful Life (EUL)

Measure Type	EUL (Years)
Air Sealing Package	11
Duct Replacement	20
Duct Sealing	18
Central AC	19
Heat Pump	16
Ductless Mini-Split Heat Pump	13
Ground Source Heat Pump	25
Attic Insulation	20
Floor Insulation	20
Knee Wall Insulation	20
Wall Insulation	20

3.1.1.3.6 Net-to-Gross (NTG) Estimation Methodology

Net impacts of the program were determined through the methodology and calculations of free ridership and spillover as described in a supplemental document. The algorithms are based on self-claimed information gathered during participant survey efforts.

3.1.1.3.7 Verified Gross Savings Results

This section details findings from the impact evaluation of the Multiple Upgrades Program.

Program Activity

The Multiple Upgrades portion of Home Rebates in 2023 had 973 total applications. Final energy savings were based on a total of 2,165 energy-saving measures. See Table 3-19 below for a breakdown of total quantities for each energy-saving measure in the program.

Table 3-19: Multiple Upgrades - Per Measure Equipment Quantities

Measure	Quantity in Program
Air Sealing Package	13
Duct Replacement	220
Duct Sealing	814
Central AC	793
Heat Pump[14]	134
Ground Source Heat Pump	2
Attic Insulation	158
Floor Insulation	0
Knee Wall Insulation	30
Wall Insulation	1
Total	**2,165**

Reported and Verified Gross Savings

Table 3-20 presents the gross verified savings by measure, lifetime energy savings (kWh), and realization rates by measure.

Table 3-20: Multiple Upgrades - Reported and Verified Gross Energy & Demand Savings

Measure	Reported Energy (kWh)	Gross Verified Energy (kWh)	Reported Demand (kW)	Gross Verified Demand (kW)	Lifetime Energy Savings (kWh)	RR_{kWh}	RR_{kW}
Air Sealing Package	6,815	6,815	4.08	4.08	74,963	100%	100%
Duct Replacement	541,218	571,901	300.62	324.98	11,438,025	106%	108%
Duct Sealing	1,683,018	1,770,950	953.54	1,038.77	31,877,109	105%	109%
Central AC	648,999	723,391	226.31	296.76	13,744,429	111%	131%
Heat Pump	405,355	400,737	54.63	53.01	6,364,605	99%	97%
Ground Source Heat Pump	11,556	20,845	2.27	2.19	521,127	180%	97%
Attic Insulation	129,480	130,412	82.30	87.28	2,608,243	101%	106%
Floor Insulation	0	0	0.00	0.00	0	-	-
Kneewall Insulation	16,757	16,757	9.61	9.61	335,141	100%	100%
Wall Insulation	703	703	0.32	0.32	14,064	100%	100%
Total	**3,443,901**	**3,642,512**	**1,633.68**	**1,817.01**	**66,977,704**	**106%**	**111%**

[14] Measure includes air source heat pumps and ductless mini-split heat pumps.

The gross impact analysis consisted of verifying measure installation using self-reported data from the participant survey results and checking the program tracking data to ensure that deemed savings algorithms were appropriately applied. In-Service Rates (ISRs) for each measure type were developed based on the findings from the online participant survey data, and then extrapolated to the population. Findings from the participant survey determined a 100% ISR for all sampled measures in Multiple Upgrades. A description of verified gross findings for each measure type is included below.

Air Sealing (Infiltration Reduction): This measure reduces air infiltration into the residence, using pre- and post-treatment blower door air pressure readings to quantify the air leakage reduction. ADM utilized deemed values from the AR TRM 8.1 for all infiltration reduction projects. There were five air sealing projects in the Multiple Upgrades Program in 2023. The realization rates for air sealing were 100% for energy savings and 100% for the demand savings.

Duct Replacement (Insulation): This measure consists of replacing/adding duct insulation to uninsulated metal supply and return ductwork, located in unconditioned space that previously had no existing insulation. ADM utilized the method in the AR TRM 8.1 that requires duct leakage testing using either a duct pressurization device (e.g., Duct Blaster), or a combination duct pressurization and blower door. The realization rates for duct replacement were 106% for energy savings and 108% for the demand savings. Although the realization rates were close to 100%, the difference between the reported and verified savings was due to the verified savings calculations capping the pre-flow capacity at 40% of the post-flow capacity as per the AR TRM. The reported savings calculations are set up to accommodate non-tested scenarios and, in those cases, 5% is the default within the formula.

Duct Sealing: This measure involves sealing leaks in supply and return ducts of the distribution systems of homes or converted residences with either central air conditioning or a ducted heating system. The realization rates for duct sealing were 105% for energy savings and 109% for the demand savings. Although the realization rates were close to 100%, the difference between the reported and verified savings was due to the verified savings calculations capping the pre-flow capacity at 40% of the post-flow capacity as per the AR TRM.

Central Air Conditioners: This measure involves the installation of a new central air conditioning system in a residential home (packaged unit, or split system consisting of an indoor unit with a matching remote condensing unit). The right sizing of the unit, reducing the capacity of new unit to less than the baseline unit, was considered when the capacities were similar (i.e., a 1-ton mini split replacing a 1.5-ton unit, but not a 1-ton unit replacing a 4-ton unit). The realization rates for central air conditioners were 111% for energy savings and 131% for demand savings. The difference in energy and demand savings is due to the difference between the baseline SEER/EER values used in the reported and verified savings calculations. The baseline values are based on the installation year and the type of the unit (packaged, split <45,000 BTU/h, or split >45,000 BTU/h). The reported and verified savings calculations have baseline SEER/EER values that differ for some of the projects. This could have been from the reported savings calculations using different installation dates/type of unit than the verified savings calculations for the baseline SEER/EER values.

Heat Pumps:[15] This measure consists of the installation of a new central heat pump system in a residential home (central unit, packaged unit, split system consisting of an indoor unit with one or more matching remote condensing units, or mini-split system). The realization rates for heat pumps were 99% for energy savings and 97% for demand savings. The gross verified savings also included the "right sizing" for units that were similar in size (for example, a 1-ton heat pump replacing a 1.5-ton air conditioner). In those cases, the same capacity was used for the baseline and efficient capacity when upsizing. Projects for mini-split heat pump installation often replaced a room or window air conditioner but had the baseline capacity of a larger unit in the home listed. In those cases, the baseline capacity was set equal to the new mini-split heat pump, to only consider the mini-split heat pump energy savings. The difference in energy and demand savings is due to the difference between the baseline SEER/EER values used in the reported and verified savings calculations. The baseline values are based on the installation year, the type of the unit (packaged or split), and whether the unit was an air source heat pump or ductless mini-split heat pump. The reported and verified savings calculations have baseline SEER/EER/HSPF values that differ for some of the projects. This could have been from the reported savings calculations using different installation dates/type of unit than the verified savings calculations for the baseline SEER/EER/HSPF values.

Ground Source Heat Pumps: This measure involves the installation of a water-to-air ground source heat pump as a replacement for an existing air source heat pump (ASHP) or other combination of electric heating and air-to-air cooling system. The realization rates for ground source heat pumps were 180% for energy savings and 97% for demand savings. The difference in energy and demand savings is due to the difference between the baseline SEER/EER values used in the reported and verified savings calculations. The verified savings calculations are using the updated 2023 federal minimum, along with the SEER2/EER2 conversion for the baseline values. The difference in savings is a result of the reported savings calculations using baseline values of 13 SEER and 11.2/11.8 EER and the verified savings calculations using baseline values of 14.3 SEER2 and 11.7 EER2.

Attic Insulation: This measure requires adding ceiling insulation above a conditioned area in a residential home of existing construction to a minimum ceiling insulation value

[15] Measure includes air source heat pumps and ductless mini-split heat pumps.

of R-38. The realization rates for attic insulation were 101% for energy savings and 106% for demand savings. The verified savings calculations used deemed values from the AR TRM 8.1 based on whether the insulation was attic or roof deck. The reported savings calculations used deemed values for attic for all projects. The difference in energy and demand savings is due to the reported savings calculations not including extra inches of insulation that provide an R value beyond the R-49 table, as the heat transfer rate diminished with each extra R value past R-49. These extra savings in the verified savings calculations are from homes that had final insulation levels between R-38 and R 49. The verified savings calculations used the deemed values for R 38 while the reported savings calculations used the interpolated values.

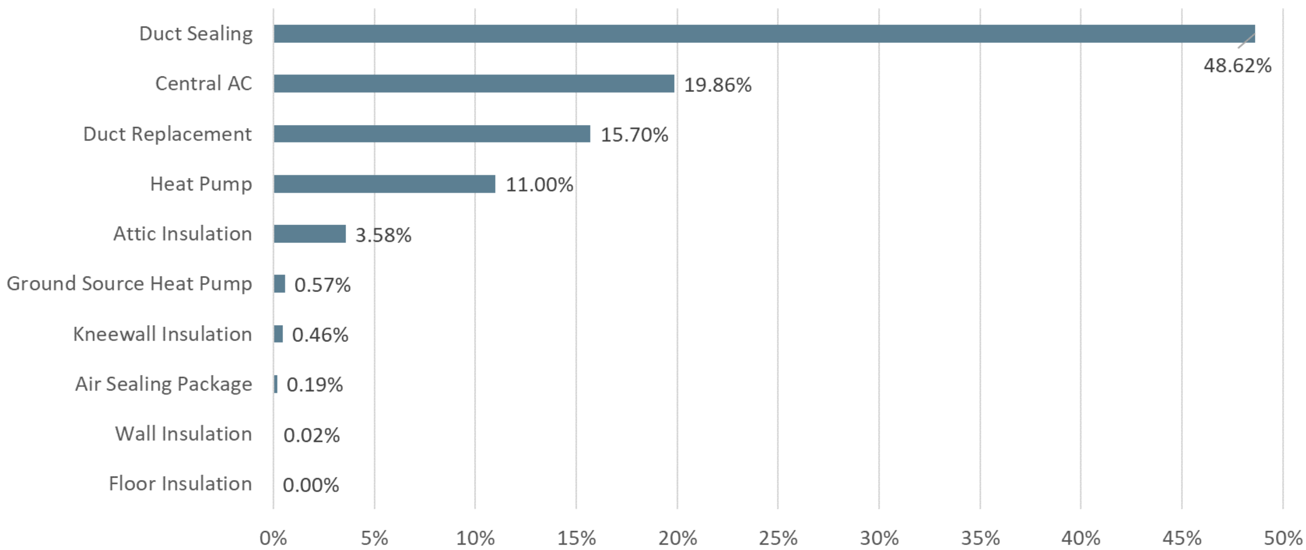
Floor Insulation: This measure presents two eligible scenarios for retrofitting a crawlspace underneath an uninsulated floor, one which includes insulating the underside of the floor (above the vented crawlspace), where the floor previously had no insulation, and the other includes "encapsulating" the crawlspace (sealing and insulating the vented perimeter skirt or stem wall between the ground (finished grade) and the first floor of the house, leaving the underside of the first floor structure uninsulated). There were no floor insulation projects in the Multiple Upgrades Program in 2023.

Knee Wall Insulation: This measure involves adding attic knee wall insulation to knee wall areas in a residential home of existing construction. The realization rates for knee wall insulation were 100% for energy savings and 100% for demand savings.

Exterior Wall Insulation: This measure consists of adding wall insulation in the wall cavity in a residential home of existing construction. There was one wall insulation project in the Multiple Upgrades Program in 2023. The realization rates for wall insulation were 100% for energy savings and 100% for demand savings.

The percent of gross verified energy savings reported by measure for the 2023 Multiple Upgrades Program are detailed in Figure 3-2 below.

Figure 3-2: Multiple Upgrades – Percent of Gross Verified Energy Savings per Measure



3.1.1.3.8 Net-to-Gross (NTG) Estimation Results

Survey data from a total of 120 Multiple Upgrades participants were used to determine the NTG ratio for this program. Survey respondents were asked a series of questions aimed at determining the program influence on the purchase and installation decisions for each installed measure. Each respondent was assigned a free ridership score (ranging from 0 for no free ridership to 1 for complete free ridership) based on their responses for each measure they installed. The measure-level free ridership of each survey participant was then weighted by the measure energy savings and averaged to determine the project-level free ridership score. This score was applied to the other measures where a survey response was not obtained.

Survey respondents were also asked a series of questions to determine if they had installed any additional, non-rebated, energy-efficiency measures as a direct influence of their participation in the program, which is referred to as spillover. Out of 120 survey completes, one respondent provided specific details of additional energy-efficient equipment[16] they purchased in 2023 that was directly influenced by their participation in the program. This one response was considered spillover as the participant rated the influence of the program high enough to claim added savings in the NTG estimation. This additional energy-efficient equipment resulted in 0.23% spillover for the Multiple Upgrades Program in 2023.

The average free ridership score was 8.46%. The measure score was weighted and rolled up into the project level score and applied to the verified gross savings for the projects

[16] The energy-efficient equipment reported on the participant survey was only included as spillover if it was similar to the measures offered in the Home Rebates Program.

without a survey response. The sum of the verified net project savings over the total verified gross savings resulted in a NTG ratio of 91.74% for energy and demand savings. Based on the impact evaluation results, the total verified net energy savings for the Multiple Upgrades Program are 3,341,653 kWh, and the total verified net peak demand savings are 1,666.90 kW. A summary of Multiple Upgrades net impact findings is shown in Table 3-21.

Table 3-21: Multiple Upgrades - Gross/Net Verified Energy & Demand Savings

Gross Verified Energy (kWh)	Gross Verified Demand (kW)	Net Verified Energy (kWh)	Net Verified Demand (kW)	NTG Ratio
3,642,512	1,817.01	3,341,653	1,666.90	91.74%

3.1.1.4 Single Upgrade

This section presents the findings and results for evaluation of the Single Upgrade portion of the Home Rebates Program. Detailed evaluation methodologies are available in a supplemental document.

3.1.1.4.1 Impact Evaluation Activities

The primary data collection activities for the impact evaluation of the Single Upgrade Program consisted of online participant and trade ally surveys and a facilitated discussion with program and implementation staff. Additional sources of data to inform the impact evaluation were a census of program tracking data from the program implementor's tracking and reporting system, along with project documentation obtained from the implementation online tool. Program tracking data included customer contact information and descriptions of the measures installed with file storage for submitted applications, and contractor invoices for the work performed. The impact evaluation for this program included the following activities:

- Determination of the number of customers participating in the program by types of measures installed.
- Determination of the gross energy savings and peak demand reduction per project
- Estimation of the net-to-gross ratios to determine the percentage of gross savings directly attributable to the program.
- Documentation of incremental costs for benefit-cost analysis

3.1.1.4.2 Process Evaluation Activities

ADM performed a process evaluation assessing the Home Rebates Program operations and delivery. The program design, operations, and delivery were assessed for the Single Upgrade Program through participant surveys, trade ally surveys, and a facilitated discussion with PSO program staff and implementation staff. Table 3-22 summarizes the data collection activities.

Table 3-22: Single Upgrade - Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Program Materials Review	Review reports and support materials for clarity and consistency with program objectives.
Program Staff Facilitated Discussion	Assess program strengths, weaknesses, opportunities, and threats
Participant Survey	Assess participant experiences, including satisfaction.
Trade Ally Survey	Assess program support, training, satisfaction, program influence on trade ally practices, and suggestions for improvements.

The process evaluation addressed the following research questions:

- Has the underlying program theory of how the program affects energy saving behaviors changed since the previous program years? If so, how and why?
- How have the program implementation and delivery changed, if at all, since the previous program years? How are these changes related to previous evaluation results and how are they expected to change program impacts going forward?
- Did the program implementation reflect its current design? In what ways did it deviate and how did that affect program success?
- Do program utility and implementation contractor staff effectively coordinate to deliver the program?
- Are the program customer engagement materials effective at advertising the Single Upgrade and Multiple Upgrades components of the program? Could they be improved in any way?
- Are there ways to improve the design or implementation process?
- What is the experience of participants in the Single Upgrades and Multiple Upgrades components of the program?
- Is the program customer engagement content effective? What is working particularly well and what could be improved?
- Is the program reaching all segments of the target market? Is anyone under-represented or left out?

3.1.1.4.3 Sampling Plan

Sampling was conducted to ensure survey responses represent the program population. Table 3-23 summarizes the sample size for each primary data collection activity. The random sample for survey verification was designed to achieve ±10% relative precision or better at the 90% confidence interval.

Table 3-23: Single Upgrade - Sample Sizes for Data Collection Efforts

Data Collection Activity	Achieved Sample Size
Participant Survey	144
Trade Ally Surveys Completed	10
Facilitated Discussion with Program Staff	2

Participant Survey

The sample size for the participant survey was determined by the minimum sample size algorithm with 90% precision and ±10% relative precision. With this assumption, a minimum sample size of 68 participants was needed based on participation levels. This minimum sample size of 68 was exceeded with 144 surveys completed.

3.1.1.4.4 Data Collection

Data collection activities supporting the evaluation included participant surveys, trade ally surveys, a facilitated discussion with PSO program staff and implementation staff, and collection of all program documentation to complete an engineering analysis.

Participant Survey

ADM conducted a participant survey of PSO customers who participated in the Single Upgrade Program in 2023. All Single Upgrade participants were pulled from the tracking data and included in the survey sample list. Any participant with a valid email address was sent a link to the online survey. The survey was emailed in monthly waves to participants from June through November 2023. Participants were offered a monetary incentive if they completed the questionnaire. ADM sent the online survey to a total of 1,660 participants, which resulted in 144 survey completes.

Trade Ally Survey

ADM conducted a survey of all trade allies who participated in the Single & Multiple Upgrades Program in 2023. All trade allies with contact information were pulled from the tracking data and included in the survey sample list. Any trade ally with a valid email address was emailed a link to the online survey in October and November 2023. ADM sent the online survey to a total of 48 Trade Allies, which resulted in 10 survey completes.

Program Staff Facilitated Discussion

ADM conducted a facilitated discussion of the Home Rebates - Single Upgrade and Multiple Upgrades Program with PSO program staff and implementation staff in June 2023. The facilitated discussion involved a group discussion with key personnel responsible for discussing past program year recommendations and brainstorming implementation strategies.

3.1.1.4.5 Gross Impact Methodologies

The method used to calculate energy savings (kWh) and demand savings (kW) consisted of:

- **Program tracking data census.** The tracking data was reviewed for a census of homes and measures. The data was verified for duplicate participation within the program and between programs.
- **Measure installation verification.** In-service rates (ISR) were calculated by measure for a sample of program participants using data from the online participant survey and on-site verifications.
- **Reported savings review.** Reported savings calculations were reviewed for all measures to determine the cause of savings discrepancies.
- **Standard for verification of savings.** The data collected from the program tracking data were used as inputs to the savings algorithms as listed in the Arkansas Technical Reference Manual, Version 8.1 (AR TRM 8.1) and the Oklahoma Deemed Savings Document (OKDSD).

Detailed explanations of the prescriptive algorithms used to determine energy impacts can be found in a supplemental document.

Lifetime kWh Savings

Lifetime energy savings (kWh) were calculated by multiplying the gross annual kWh savings by the Estimated Useful Life (EUL) for each measure type. EUL values for each measure were based on the assumptions in the AR TRM and OKDSD. Table 3-24 shows the EUL and source for each measure type.

Table 3-24: Single Upgrade – Per Measure Estimated Useful Life (EUL)

Measure Type	EUL (Years)
Central AC	19
Heat Pump	16
Ductless Mini-Split Heat Pump	13
Ground Source Heat Pump	25
Attic Insulation	20
Pool Pump	10
HVAC Tune-Up	10[17]
Wi-Fi Thermostat	11

3.1.1.4.6 Net-to-Gross (NTG) Estimation Methodology

Net impacts of the program were determined through the methodology and calculations of free ridership and spillover as described in a supplemental document. The algorithms are based on self-claimed information gathered during participant survey efforts.

3.1.1.4.7 Verified Gross Savings Results

This section details findings from the impact evaluation of the Single Upgrade program.

Program Activity

In 2023, the Single Upgrade portion of Home Rebates had 2,785 total applications as part of the program. Final energy savings were based on a total of 3,178 energy-savings measures. See Table 3-25 below for a breakdown of total quantities for each energy-saving measure in the program.

[17] Used default EUL of 10 years (refrigerant added) from AR TRM 8.1.

Table 3-25: Single Upgrade – Per Measure Equipment Quantities

Measure	Quantity in Program
Central AC	1648
Heat Pump[18]	108
Ground Source Heat Pump	24
Attic Insulation	417
Pool Pump	182
HVAC Tune-Up	785
Wi-Fi Thermostat	14
Total	**3,178**

Single Upgrade Reported and Verified Gross Savings

Table 3-26 presents the gross verified savings by measure, lifetime energy savings (kWh), and realization rates by measure.

Table 3-26: Single Upgrade - Reported and Verified Gross Energy and Peak Demand Savings

Measure	Reported Energy (kWh)	Gross Verified Energy (kWh)	Reported Demand (kW)	Gross Verified Demand (kW)	Lifetime Energy Savings (kWh)	RR_{kWh}	RR_{kW}
Central AC	999,717	1,000,146	548.58	549.60	19,002,774	100%	100%
Heat Pump[19]	219,900	219,567	34.57	34.92	3,187,070	100%	101%
Ground Source Heat Pump	171,824	308,449	33.43	30.20	7,711,218	180%	90%
Attic Insulation	321,552	329,448	191.16	193.96	6,588,953	102%	101%
Pool Pump	290,843	290,837	67.02	67.01	2,908,370	100%	100%
HVAC Tune-Up	425,987	445,974	208.32	200.56	4,459,741	105%	96%
Wi-Fi Thermostat	13,976	13,976	0.00	0.00	153,738	100%	100%
Total	**2,443,799**	**2,608,397**	**1,083.08**	**1,076.25**	**44,011,865**	**107%**	**99%**

The gross impact analysis consisted of verifying measure installation using self-reported data from the participant survey results and reviewing the program tracking data to ensure the deemed savings algorithms were appropriately applied. ISRs for each measure type were developed based on the findings from the online participant survey data, and then extrapolated to the population. Findings from the participant survey and verification visits determined a 100% ISR for all sampled measures in Single Upgrade for 2023. A description of verified findings for each measure type is included below:

Central Air Conditioner: This measure involves the installation of a new central air conditioning system in a residential home (packaged unit, or split system consisting of an indoor unit with a matching remote condensing unit). The right sizing of the unit, reducing the capacity of new unit to less than the baseline unit, was considered when the capacities were similar (i.e., a 1-ton mini split replacing a 1.5-ton unit, but not a 1-ton unit replacing a 4-ton unit). The realization rates for central air conditioners were 100% for energy savings and 100% for demand savings.

Heat Pumps:[20] This measure consists of the installation of a new central heat pump system in a residential home (central unit, packaged unit, split system consisting of an indoor unit with one or more matching remote condensing units, or mini-split system). The realization rates for heat pumps were 100% for energy savings and 101% for demand savings. Projects for mini-split heat pump installation often replaced a traditional window air conditioner but had the baseline capacity of a larger unit in the home listed. In those cases, the baseline capacity was set equal to the new mini-split heat pump, to only consider the mini-split heat pump energy savings. However, the gross verified savings did include the "right sizing" for units that were similar in size (for example, a 1-ton heat pump replacing a 1.5-ton air conditioner). The difference in demand savings is due to the difference between the baseline SEER/EER values used in the reported and verified savings calculations. The baseline values are based on the installation year, the type of the unit (packaged or split), and whether the unit was an air source heat pump or ductless mini-split heat pump. The reported and verified savings calculations have baseline SEER/EER/HSPF values that differ for some of the projects. This could have been from the reported savings calculations using different installation dates/type of unit than the verified savings calculations for the baseline SEER/EER/HSPF values.

Ground Source Heat Pump: This measure involves the installation of a water-to-air ground source heat pump as a replacement for an existing air source heat pump (ASHP) or other combination of electric heating and air-to-air cooling system. The realization rates for ground source heat pumps were 180% for energy savings and 90% for demand savings. The difference in energy and demand savings is due to the difference between the baseline SEER/EER values used in the reported and verified savings calculations. The verified savings calculations are using the updated 2023 federal minimum, along with the SEER2/EER2 conversion for the baseline values. The difference in savings is a result of the reported savings calculations using baseline values of 14 SEER and 11.2 EER and the verified savings calculations using baseline values of 14.3 SEER2 and 11.7 EER2 for any unit install in 2023.

Attic Insulation: This measure requires adding ceiling insulation above a conditioned area in a residential home of existing construction to a minimum ceiling insulation value of R-38. The realization rates for attic insulation were 102% for energy savings and 101%

[18] Measure includes air source heat pumps and ductless mini-split heat pumps.
[19] Measure includes air source heat pumps and ductless mini-split heat pumps.
[20] Measure includes air source heat pumps and ductless mini-split heat pumps.

for demand savings. The verified savings calculations used deemed values from the AR TRM 8.1 based on whether the insulation was attic or roof deck. The reported savings calculations used deemed values for attic for all projects. The difference in energy and demand savings is due to the reported savings calculations not including extra inches of insulation that provide an R value beyond the R-49 table, as the heat transfer rate diminished with each extra R value past R-49. These extra savings in the verified savings calculations are from homes that had final insulation levels between R-38 and R 49. The verified savings calculations used the deemed values for R 38 while the reported savings calculations used the interpolated values.

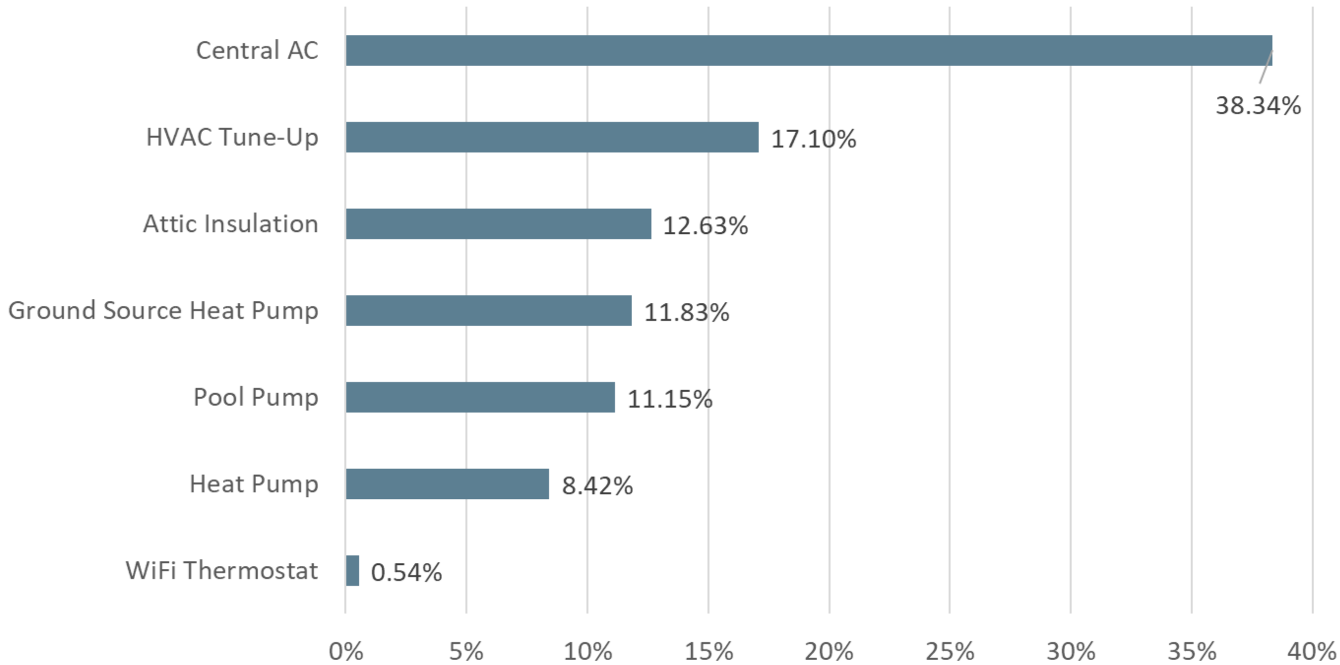
Variable Speed Drive Pool Pumps (Summer Only and Year-Round): This measure involves replacing a single-speed pool pump with a variable speed drive (VSD) pool pump in a residential pool (both summers only and year-round). The realization rates for pool pumps were 100% for energy savings and 100% for demand savings.

HVAC Tune-Ups: This measure applies to central air conditioners and heat pumps. An AC tune-up, in general terms, involves checking, adjusting and resetting the equipment to factory conditions, such that it operates closer to the performance level of a new unit. The realization rates for HVAC tune-ups were 105% for energy savings and 96% for demand savings. Deemed savings factors were based on the pre- and post-EER of the HVAC unit. The verified savings calculations utilized Method 2 from the AR TRM 8.1 algorithm and was based on a change in efficiency based on pre- and post-measurement of the system. The additional verified savings calculations include a heat pump savings credit for all heat pump tune-up projects, which lowered the baseline HSPF. Also, the average improvement of the EER (pre) to EER (post) is 113% even without having refrigerant added to each HVAC system in the program.

Wi-Fi Thermostats: This measure involves the replacement of a manually operated or programmable thermostat with a smart (Wi-Fi) programmable thermostat. The realization rates for Wi-Fi thermostats were 100% for energy savings and 100% for demand savings.

The percent of gross verified energy savings reported by measure for the 2023 Single Upgrade Program are detailed in Figure 3-3 below.

Figure 3-3: Single Upgrades – Percent of Gross Verified Energy Savings per Measure



3.1.1.4.8 Net-to-Gross (NTG) Estimation Results

Survey data from a total of 144 Single Upgrade participants were used to determine the NTG ratio for this program. Survey respondents were asked a series of questions aimed at determining the program influence on the purchase and installation decisions for each installed measure. Each respondent was assigned a free ridership score (ranging from 0 for no free ridership to 1 for complete free ridership) based on their responses for each measure they installed. The measure-level free ridership of each survey participant was then weighted by measure energy savings and averaged to determine the project-level free ridership scores. This score was applied to the other measures where a survey response was not obtained.

Survey respondents were also asked a series of questions to determine if they had installed any additional, non-rebated, energy-efficiency measures as a direct influence of their participation in the program, which is referred to as spillover. Out of 144 survey completes, two respondents provided specific details of additional energy-efficient equipment[21] they purchased in 2023 that was directly influenced by their participation in the program. These responses were considered spillover as the participants rated the influence of the program high enough to claim added savings in the NTG estimation. This

[21] The energy-efficient equipment reported on the participant survey was only included as spillover if it was similar to the measures offered in the Home Rebates Program.

additional energy-efficient equipment resulted in 2.26% spillover for the Single Upgrade Program in 2023.

The average free ridership score was 10.64%. The measure score was weighted and rolled up into the project level score and applied to the verified gross savings for the projects without a survey response. The sum of the verified net project savings over the total verified gross savings resulted in a NTG ratio of 89.36% for energy savings and demand savings. Based on the impact evaluation results, the total verified net energy savings for the Single Upgrade Program are 2,330,847 kWh, and the total verified net peak demand savings are 962.46 kW. A summary of Single Upgrade impact findings is shown in Table 3-27.

Table 3-27: Single Upgrade - Gross, Net Energy & Demand Savings

Gross Verified Energy (kWh)	Gross Verified Demand(kW)	Net Verified Energy (kWh)	Net Verified Demand (kW)	NTG Ratio
2,608,397	1,076.25	2,330,847	962.46	89.36%

3.1.1.5 Home Energy Check-Ups

The Public Service Company of Oklahoma (PSO) offers Home Energy Check-ups (HECs) as requested by customers. From the energy audit, PSO recommends ways for customers to save energy. For example, customers have participated in the Home Rebates program after completing an energy audit. However, completing an audit does not necessarily mean that a customer will take additional actions to save energy. A review of the HECs was conducted to determine whether savings have been realized through energy audit recommendations.

3.1.1.5.1 EM&V Methodology

This section presents a detailed methodology for the evaluation of the HECs.

Data Preparation

To determine annual energy savings (kWh), ADM performed an analysis of the billing data for participants in the program using panel regression modeling. The following data was used in the analysis:

- Raw daily billing data for HEC participants
- Regional temperature obtained from the National Oceanic and Atmospheric Administration (NOAA) for Tulsa International Airport in Tulsa, OK.
- Participant information, including participation in other PSO programs.

Cross-participation was considered to account for savings from other programs, specifically Home Rebates and Energy Saving Products (ESP). A total of 338 accounts have completed an HEC. Out of those accounts, 64 have participated in Home Rebates, and 15 participated in ESP. Customers have requested HECs after recently participating in Home Rebates. Of the 20 customers who participated in the Home Rebates program first, 15 of them completed an HEC inspection within 3 months of their upgrade. HECs could also lead to Home Rebates participation. Of the 318 accounts that have not already participated in Home Rebates, 15 signed up within 3 months, and 28 signed up within a year.

After collecting the necessary data, ADM performed the following data cleaning and filtering steps:

- Only include participants with an inspection date between October 2020 and July 2022 due to limited billing data.
- Drop daily measurements below 10 kWh.
- Remove audits for participants who have already recently completed one.
- Remove participants who have participated in the Home Rebates program within one year of the HEC inspection date.
- Remove participants who have participated in the ESP program within one year of the HEC inspection date.

After data preparation, 35 accounts remained for the regression model.

Regression Approach

ADM used a mixed effects panel regression model to determine daily average electricity savings in the post-period. Electricity consumption is modeled by the equation below.

Where the subscript i denotes individual customers and $t = 1$. $T_{(i)}$ serves as a time index, where $T_{(i)}$ is the number of measurements available for customer i. The model is defined as “mixed effects” because the model decomposes its parameters into fixed-effects (i.e., Heating Degree Days (HDD), Cooling degree days (CDD), Post-Installation period (Post), and interactive terms) and random effects (i.e., the individual customer’s baseline period usage). A fixed effect is assumed to be constant and independent of the sample, while random effects are assumed to be sources of variation (other than natural measurement error) that are uncorrelated with the fixed effects.

After an audit, customers may make changes that affect energy consumption. The period between the HEC inspection date and when such change may occur is considered the “commissioning period.” The commissioning period is unknown for each sample, so it is treated as a fixed variable at multiple durations. Observations that occur in the commissioning period are not included in the mixed effects panel regression as they contain a mix of pre-treatment and post-treatment data. The post variable is defined as 0 before the inspection date and a 1 for measurements following the commissioning period.

Heating degree day (HDD) and cooling degree day (CDD) were used in the model to control energy demand based on outside temperature. HDD is defined as the difference between 65 degrees (the outside temperature above which it is assumed that a building needs no heating) and the actual outside air temperature. CDD is defined as the difference between the actual outside air temperature and 65 degrees (the outside temperature under which it is assumed that a building needs no cooling). A minimum value of 0 is used for both HDD and CDD. A description of the variables used in the regression model is shown in Table 3-28.

Table 3-28: Description of Variables Used in the Regression Model

Variable	Variable Description
Average Electricity Consumption ()	Average daily use of electricity (kWh)
Customer	A panel of dummy variables that is a 1 for customer or a 0 if not
Cooling Degree Day (CDD)	The difference between actual outside air temperature and 65 degrees
Heating Degree Day (HDD)	The difference between 65 degrees and the actual outside air temperature
Post	Post is a dummy variable that is 1 if the measurement is after the commissioning period and 0 for the periods before the audit
E_t	E_t is the error term

Table 3-29 describes the coefficients that were determined by using the mixed effects panel model.

Table 3-29: Description of the Coefficients Estimated by the Regression Model

Coefficient	Coefficient Description
α_i	is a coefficient that represents the grand mean of the customer-specific intercepts used to control for any customer-specific differences
β_1	is a coefficient that adjusts for the main effect of cooling
β_2	is a coefficient that adjusts for the main effect of heating
β_3	is a coefficient for the main effect of time, i.e., whether an observation falls in the pre-period or post-period
β_4	is a coefficient that adjusts for the interactive effect between the post-period and cooling
β_5	is a coefficient that adjusts for the interactive effect between the post-period and heating

The estimated coefficient for the post-term will be used to determine whether HECs yield energy savings. The two interactive effects for heating and cooling with the post-period are included because HECs have an indirect effect on energy savings. During audits, customers are provided with recommendations to reduce consumption, but these may not result in actions that contribute to energy savings. Therefore, temperature in the post-period should be accounted for since it is not known for certain that temperature has a direct effect on energy savings.

3.1.1.5.2 Verified Gross Savings Results

This section reviews the findings from the regression model. Estimated regression coefficients are displayed below in Table 3-30.

Table 3-30: Estimated Daily Savings (kWh) per Residence

Commissioning Period (Days)	Number of Accounts	Post Coefficient	T-Statistic	Standard Error†	90% Lower	90% Upper
0	35	**-2.45**	-2.32	1.74	-4.19	-0.71
30	33	**-2.08**	-1.90	1.80	-3.88	-0.28
60	32	**-1.51**	-1.40	1.78	-3.29	0.27
90	26	**-0.21**	-0.17	1.98	-2.18	1.77

†*This value is the adjusted standard error value obtained from the regression model, multiplied by 1.645 (the statistical z value for the 90% confidence interval).*

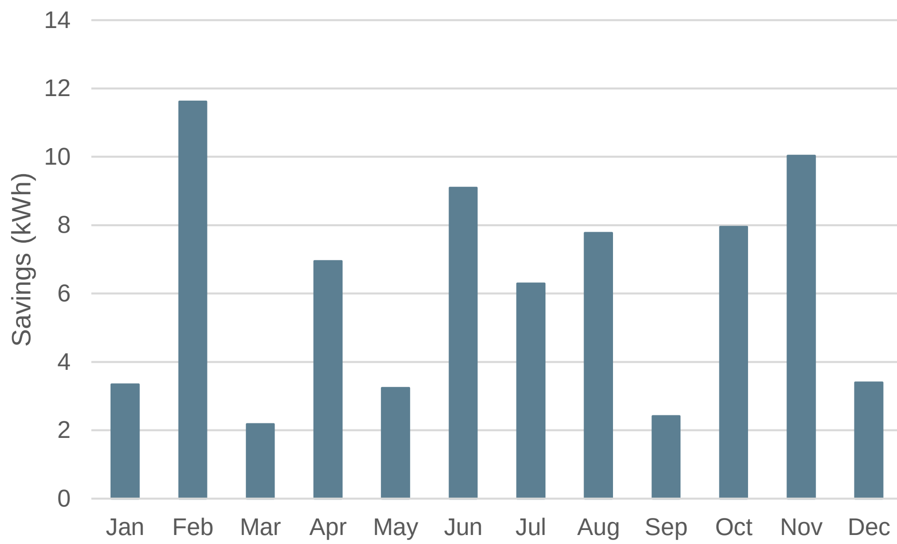
The Post coefficient suggests that HECs generate energy savings if no commissioning period is considered and for a commissioning period of 30 days. For commissioning periods of 60 and 90 days, the model indicates there are energy savings. However, the coefficients for models with longer commissioning periods are not significant at the 90% confidence level. The small sample sizes due to limited billing data could be a factor for the statistically insignificant savings. The Post coefficient for the model with a commissioning period of 30 days was used to calculate average residence annual savings in Table 3-31 as that is most likely representative of the period in which energy savings actions have taken place.

Table 3-31: Estimated HEC Savings per Residence

Daily Savings (kWh)	Annual Savings (kWh)	Percent Savings	Peak Demand Savings (kW)
2.08	758.19	6.16%	0.00018

The estimated annual savings per customer is approximately 760 kWh annually or about a 6% average daily reduction. The peak demand reduction is 0.00018 kW with a 90% interval between 0.000035 kW and 0.00033 kW. Note that demand reduction was calculated from daily measurements rather than hourly data. Figure 3-4 illustrates the average daily savings by month. The plot does not show any obvious seasonal trends in savings.

Figure 3-4: Average Daily Savings by Month



Not including those who participated in Home Rebates and Energy Savings Products leaves 259 residences who received Home Energy Checkups. Extrapolating savings results from the 33 residences in the analysis samples results in the total energy impacts shown in Table 3-32.

Table 3-32: Verified HEC Savings

Annual Savings (kWh)	Peak Demand Savings (kW)
196,371	0.047

3.1.1.6 Home Rebates Impact Evaluation Findings

Program level results for the Home Rebates are listed below with the verified gross energy and demand savings in Table 3-33.

Table 3-33: Program Level Gross Energy and Demand Savings

Program	Reported Energy (kWh)	Reported Demand (kW)	Gross Verified Energy (kWh)	Gross Verified Demand (kW)	Lifetime Energy Savings (kWh)
New Homes	2,794,367	966.65	2,779,096	963.46	55,581,913
Multiple Upgrades	3,443,901	1,633.68	3,642,512	1,817.01	66,977,704
Single Upgrade	2,443,799	1,083.08	2,608,397	1,076.25	44,011,865
Home Energy Check-Ups	0	0.00	196,371	0.047	1,967,710
Total	**8,682,067**	**3,683.41**	**9,226,376**	**3,856.73**	**168,539,192**

Table 3-34 and Table 3-35 summarize the verified net impacts of the complete Home Rebates Program.

Table 3-34: Verified Gross and Net Energy Savings

Program	Free Ridership	Participant Spillover	NTG Ratio	Gross Verified Energy (kWh)	Net Verified Energy (kWh)
New Homes	24.16%	0.00%	75.84%	2,779,096	2,107,656
Multiple Upgrades	8.46%	0.23%	91.74%	3,642,512	3,341,653
Single Upgrade	10.64%	2.26%	89.36%	2,608,397	2,330,847
Home Energy Check-Ups	0.00%	0.00%	100.00%	196,371	196,371
Total				**9,226,376**	**7,976,527**

Table 3-35: Verified Gross and Net Peak Demand Reduction

Program	Free Ridership	Participant Spillover	NTG Ratio	Gross Verified Demand (kW)	Net Verified Demand (kW)
New Homes	24.25%	0.00%	75.75%	963.46	729.80
Multiple Upgrades	8.46%	0.23%	91.74%	1,817.01	1,666.90
Single Upgrade	10.64%	2.26%	89.43%	1,076.25	962.46
Home Energy Check-Ups	0.00%	0.00%	100.00%	0.047	0.047
Total				**3,856.73**	**3,359.20**

3.1.1.7 Process Evaluation Findings

A process evaluation was performed to assess the program year's operations and delivery. The evaluation of the Home Rebates Program included a review of program materials, a facilitated discussion with program staff, participant surveys, trade ally survey, home buyer survey, and builder survey. A detailed process evaluation memo was provided to PSO after the completion of the program year.

3.1.1.7.1 New Homes

The New Homes process evaluation included a facilitated discussion with program staff, new home buyer surveys, and a home builder survey.

New Homes Facilitated Discussion

ADM conducted a facilitated discussion of the Home Rebates – New Homes Program with program and implementation staff in June 2023. The facilitated discussion involved a group discussion with key personnel responsible for discussing past program year recommendations and brainstorming implementation strategies. The following summarizes key findings of the facilitated discussion of the Home Rebates – New Homes Program.

- Program staff have ongoing discussions with the Home Energy Raters (HERs). As part of the New Homes Program, ICF meets with new HERs raters that may be interested in joining the program. ICF noted that these conversations are going well but remain competitive between different HERs raters.
- Relationships with builders are important for the program. Builder attrition has decreased overall over the past couple of years. This is due to builder saturation in the program, specifically smaller builder companies. However, PSO noted the program is still looking to acquire large builders in the Tulsa area. One of the largest builders (DR Horton) has not yet joined the program due to program requirements. PSO conducts builder training though for any new builders that join the program. It was noted that there were no builder training/events held for existing builders (only new builders).

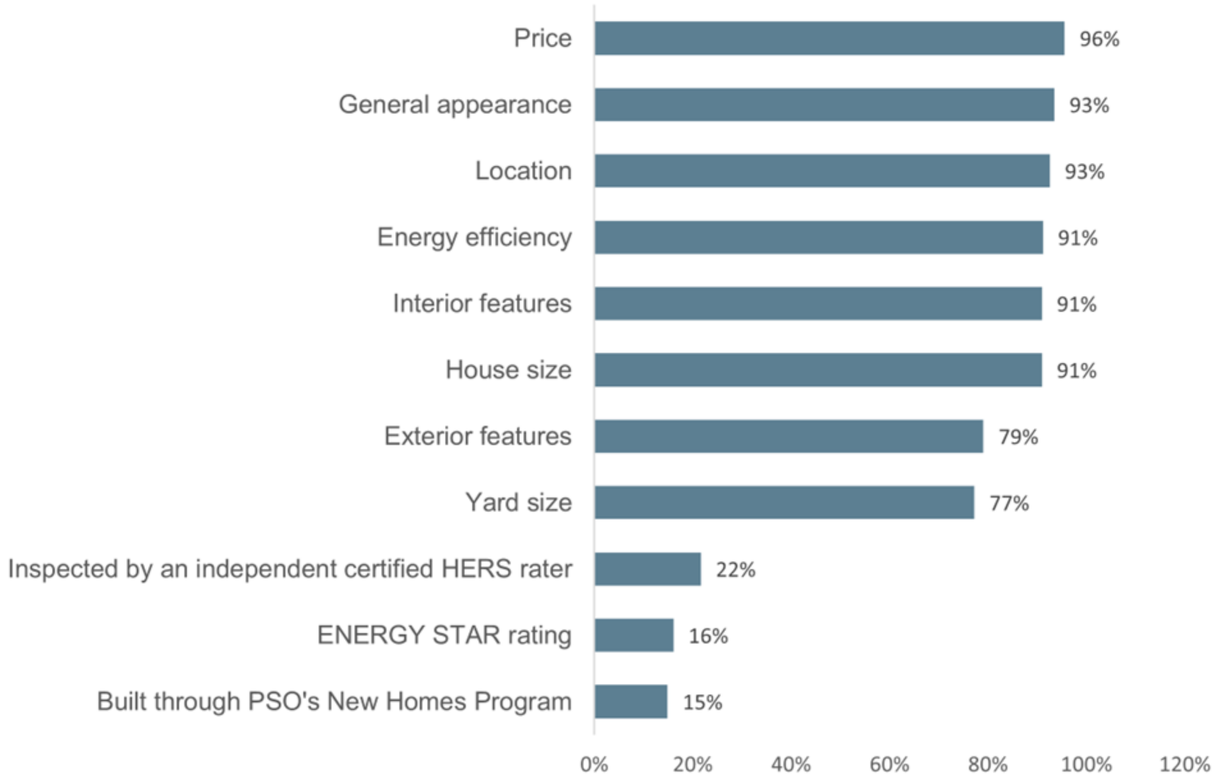
Home Buyer Survey

ADM conducted a home buyer survey of PSO customers who purchased an energy efficient home as part of the New Home Program in 2023. Home buyers were sent an email to complete an online survey using an online survey platform (Qualtrics) during August and September 2023 and were entered a raffle for a digital $50 gift card if they completed the questionnaire. ADM sent the online survey to a total of 258 home buyers, which resulted in 43 survey completes.

In 2023, survey respondents dealt directly with either the home builder (47%) or a real estate agent (12% used the builder's real estate agent and 37% used a different real estate agent) when buying their home. Most survey participants (88%) did not know about the PSO New Homes Program prior to being invited to take the survey. Those that did know about the program (n = 4) learned of it from the home builder (50%), from a real estate agent (25%), or through an email from PSO (25%).

Survey participants rated several factors in their decision to buy their home on a scale of zero to ten, where zero is "Not at all important" and ten is "Very important". Important features in a home, as well as their rating, are shown in Figure 3-5.

Figure 3-5: Importance of Features for Purchasing a Home (n = 43)



Most respondents (60%) reported that the person they dealt with to purchase the home (the home builder or real estate agent) did not describe any differences between homes sponsored by PSO's New Homes Program and other homes. The survey respondents that had differences communicated with them (n = 9) mentioned they were informed that homes sponsored by PSO's New Homes Program were more energy efficient, had better electrical outlets, appliances, insulation, and HVAC equipment, and consequently would have lower monthly utility costs.

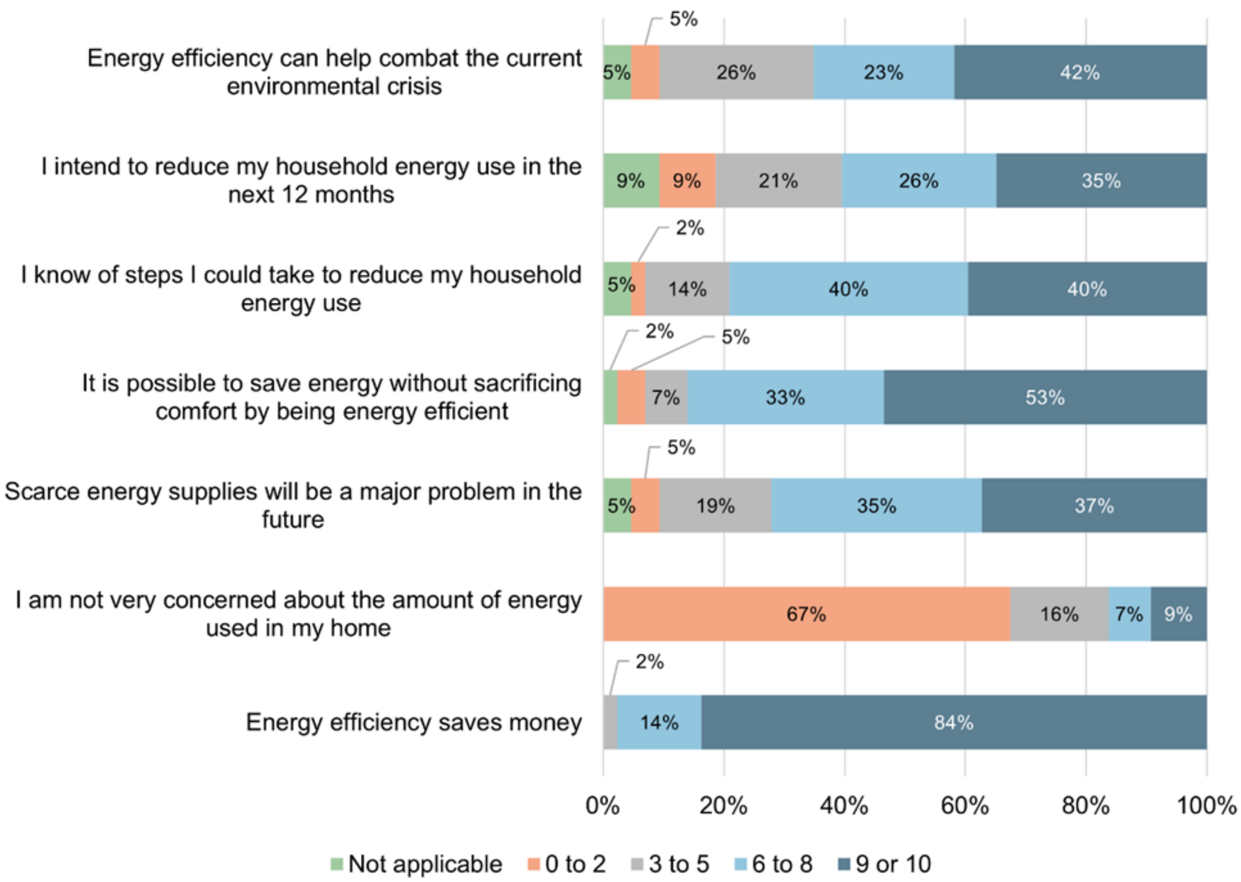
Survey respondents provided feedback on how clearly the person they dealt with when purchasing their home explained the energy-efficient characteristics of the homes sponsored by PSO's New Homes Program. On a scale of one to five, with one being "Not clearly at all" and five being "Very clearly", almost half of respondents (44%) reported that it was explained to them clearly, providing a rating of four or higher.

Survey respondents provided feedback on how well informed they are about energy efficiency practices and energy-efficient options for their household. On a scale of one to five, with one being "Not at all informed" and five being "Extremely informed", only a little more than a quarter respondents (28%) reported they were informed, providing a rating of four or higher.

Most survey respondents (67%) reported PSO as a trustworthy source of information about saving energy in their home, providing a rating of four or higher on a scale of one to five, where one is “Not at all trustworthy” and five is “Extremely trustworthy”.

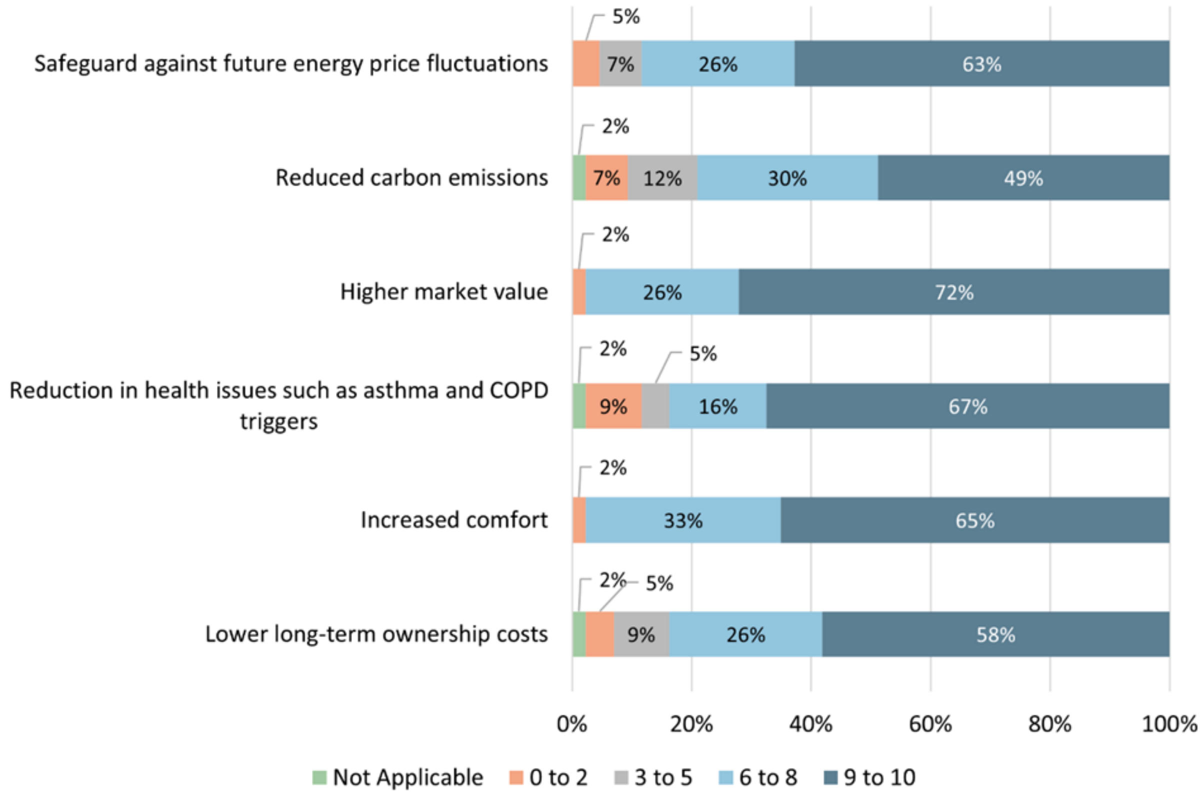
When asked to rate their level of agreement with different statements regarding energy efficiency, survey participants provided responses on a scale of zero to ten, where zero is “Strongly disagree” and ten is “Strongly agree”. The results of that question are shown in Figure *3-6*.

Figure 3-6: Home Buyer Agreement with Energy Efficiency Statements (n = 43)



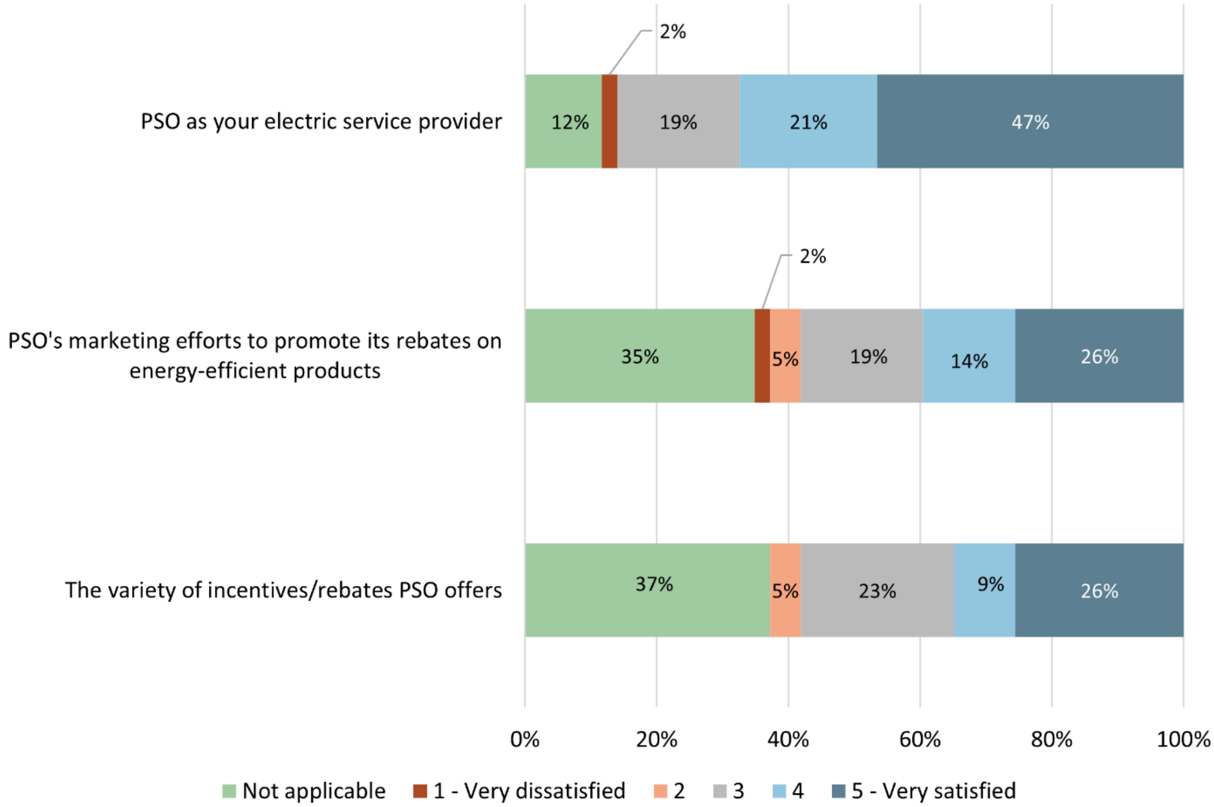
When asked to rate the importance of non-energy benefits when purchasing their new energy-efficient home, survey respondents provided responses on a scale of zero to ten, where zero is “Not at all important” and ten is “Very important”. The results of that question are shown in Figure 3-7.

Figure 3-7: Importance of Non-Energy Benefits for Purchasing a Home (n = 43)



When asked to rate their level of satisfaction with various aspects of PSO, survey respondents provided responses on a scale of one to five, where one is "Very dissatisfied" and five is "Very satisfied". The results of that question are shown in Figure *3-8*. Most respondents reported being satisfied with PSO overall as their electricity service provider (67%), rating it as a four or higher. Furthermore, one respondent with low satisfaction scores (giving a rating of one or two for some aspects on the same scale) noted they were dissatisfied with their rates continuing to increase. However, less than half of respondents reported being satisfied (rated as a four or higher) with PSO's marketing efforts to promote its discounts on energy-efficient products (40%), and the variety of incentives/rebates PSO offers (35%).

Figure 3-8: Home Buyer PSO Satisfaction (n = 43)



Home Builder Survey

ADM conducted a builder survey of PSO customers who participated in the New Homes Program in 2023. Builders that participated in the Home Rebates – New Homes Program in 2023 and did not complete a survey in 2022 were sent an email to complete an online survey using an online survey platform (Qualtrics) in November 2023. A total of 13 builders were contacted, which resulted in 4 survey completes. The survey collected data on the builders' organizations, program awareness and involvement, program procedures, customer market and interaction, satisfaction with PSO, and overall satisfaction with the program.

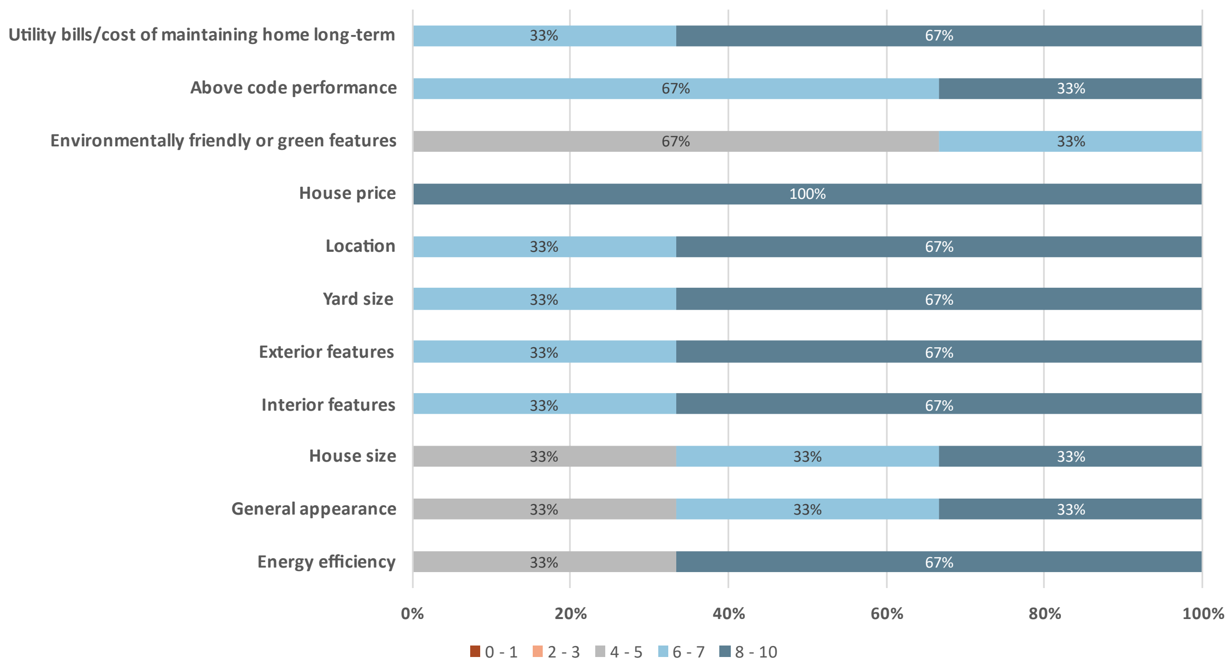
Builders that completed the survey indicated having a significant amount of experience with the program. Most builders (67%) indicated they participated for more than one year. The other 33% of builders did not know how long they participated in the program. Builders primarily learned about the program through previous program participation (33%) or a PSO representative (33%). One builder could not recall how they first learned about the program.

Customer Program Awareness and Marketing

All the builders (100%) reported that less than 50% of their customers knew about PSO's New Homes Program before they began working with them to build or purchase a new home. All builders (100%) indicated they actively encourage home buyers who were not looking for energy-efficient homes to buy a home built to PSO's energy efficiency standards. Builders reported convincing all their customers (100%) to build to PSO program standards.

Builders reported that the most important aspect home buyers consider when purchasing a home is a home's price. Home buyers also find a home's location, energy efficiency, and utility bills/cost of maintaining home long-term important when purchasing a home. See Figure 3-9 for all home aspects as rated by builders.[22]

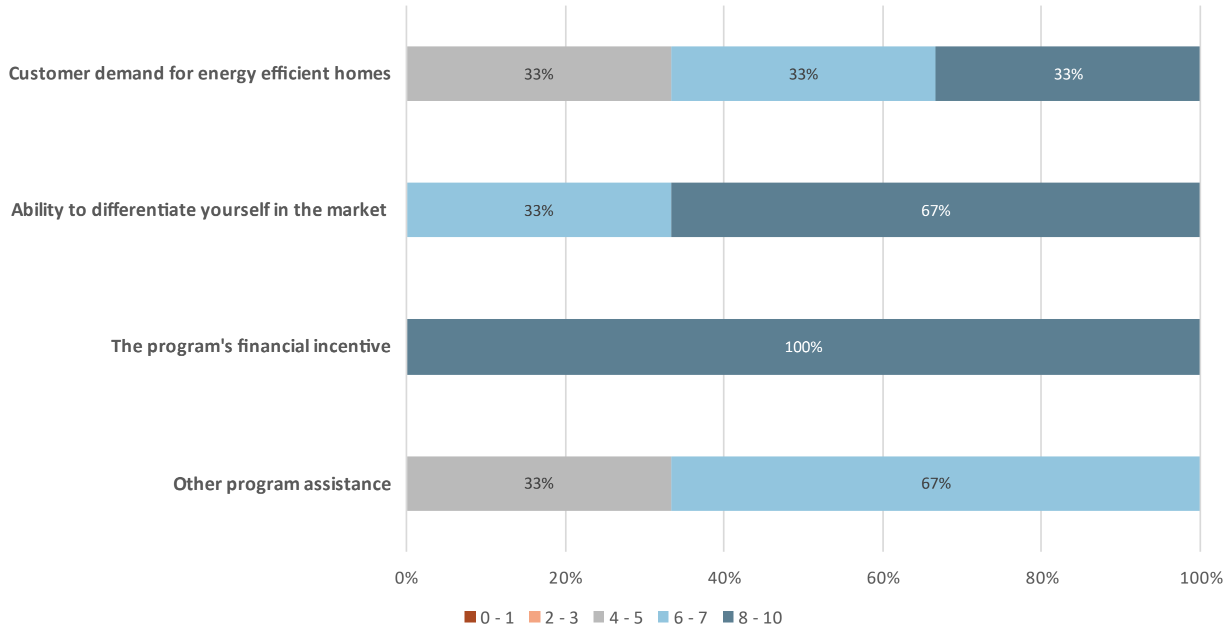
Figure 3-9: Builder Perspective on Importance of Home Aspects to Buyers (n = 3)



Builders were asked to rate the importance of several factors in their decision to build homes to program standards in 2023.[23] The most important factor for builders participating in the program is the program's financial incentive. See Figure 3-10 for all factors as rated by builders.

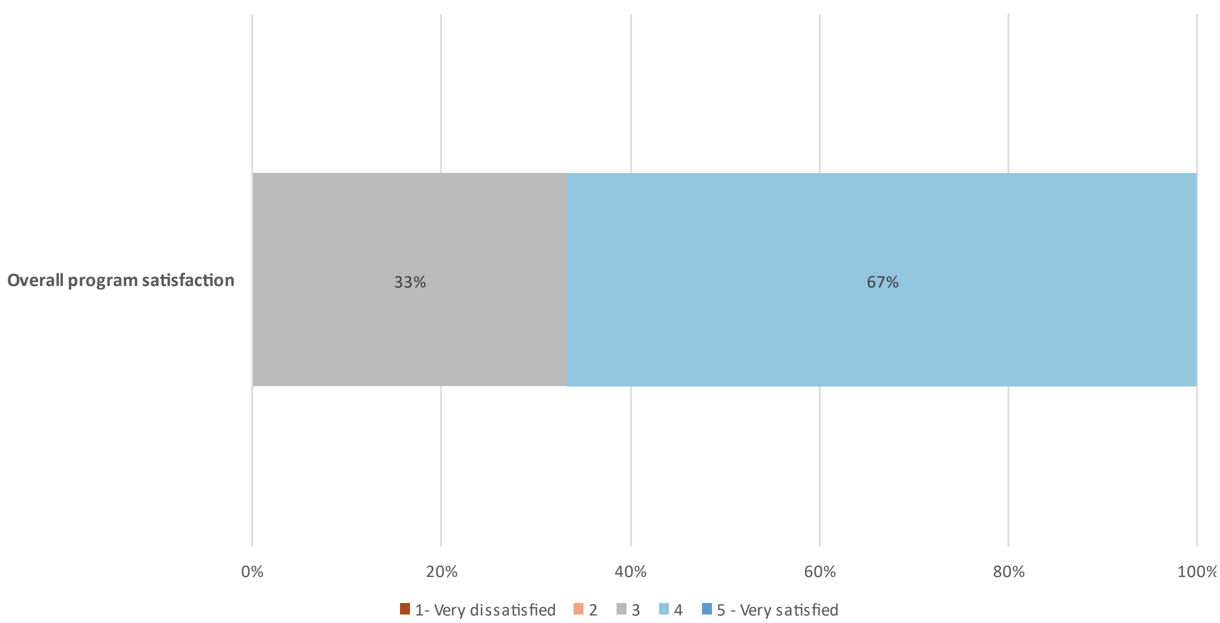
[22] Using a scale of zero to ten, where zero is "Not at all important to customers" and ten is "Extremely important to customers".
[23] Using a scale of zero to ten, where zero is "Not at all important" and ten is "Very important".

Figure 3-10: Importance of Factors in Decision to Build Energy-Efficient Homes (n = 3)



Builders indicated that they were satisfied with the program. Overall program satisfaction was positive with most builders (67%) giving a rating of four or higher on a scale of one to five where one is “Very dissatisfied” and five is “Very satisfied”. Builder satisfaction with the program overall is shown in Figure 3-11.

Figure 3-11: Builder Satisfaction with the New Homes Program Overall (n = 3)



The following summarizes the key findings of the process evaluation of the New Homes component:

- There was an increase in the overall number of homes that were rebated in 2023. There was an approximately 15% increase in the number of homes rebated in 2023 compared to 2022.
- Energy efficiency ranks among the most essential elements for home buyers. These include price, appearance, location, energy efficiency, interior features, and house size.
- Most home buyers were not aware of the program before taking the survey and reported the home builder did not describe any advantages to program-eligible homes. This contradicts builders stating that they explain energy efficiency and the program to buyers. Home builders reported convincing their customers to build to program standards.
- While many non-energy benefits are important to home buyers, the most important non-energy benefits are home value and comfort.

3.1.1.7.2 Single and Multiple Upgrades

The process evaluation included a facilitated discussion with program staff, a participant survey, and a trade ally survey.

Single and Multiple Upgrades Facilitated Discussion

ADM conducted a facilitated discussion of the Home Rebates - Single Upgrade and Multiple Upgrades Program with program and implementation staff in June 2023. The following summarizes key findings of the facilitated discussion for the Home Rebates – Single & Multiple Upgrades Program.

- Process improvements were implemented in 2023 which reduced the time between the completion of the equipment installation to conducting the test out; resulting in third-party verifiers (TPVs) reporting success with customers agreeing to schedule test outs compared to previous years.
- A dedicated webpage along with educational and promotional material was developed to educate customers on heat pumps.
- There is less trade ally participation for the Single Upgrade Program than desired. PSO is looking to improve program marketing to increase regional diversity. Additional marketing material is needed (specifically for the rural areas outside of Tulsa) to expand the awareness of the program to potential trade allies, which helps increase customers participation.

Multiple Upgrades Participant Survey

ADM conducted a monthly participant survey of PSO customers who participated in the Multiple Upgrades Program in 2023. Multiple Upgrades participants provided feedback about how they first learned about the rebates that PSO offers for energy-saving upgrades to their homes (summarized in Table *3-36*).

Table 3-36: Sources of Multiple Upgrades Program Awareness

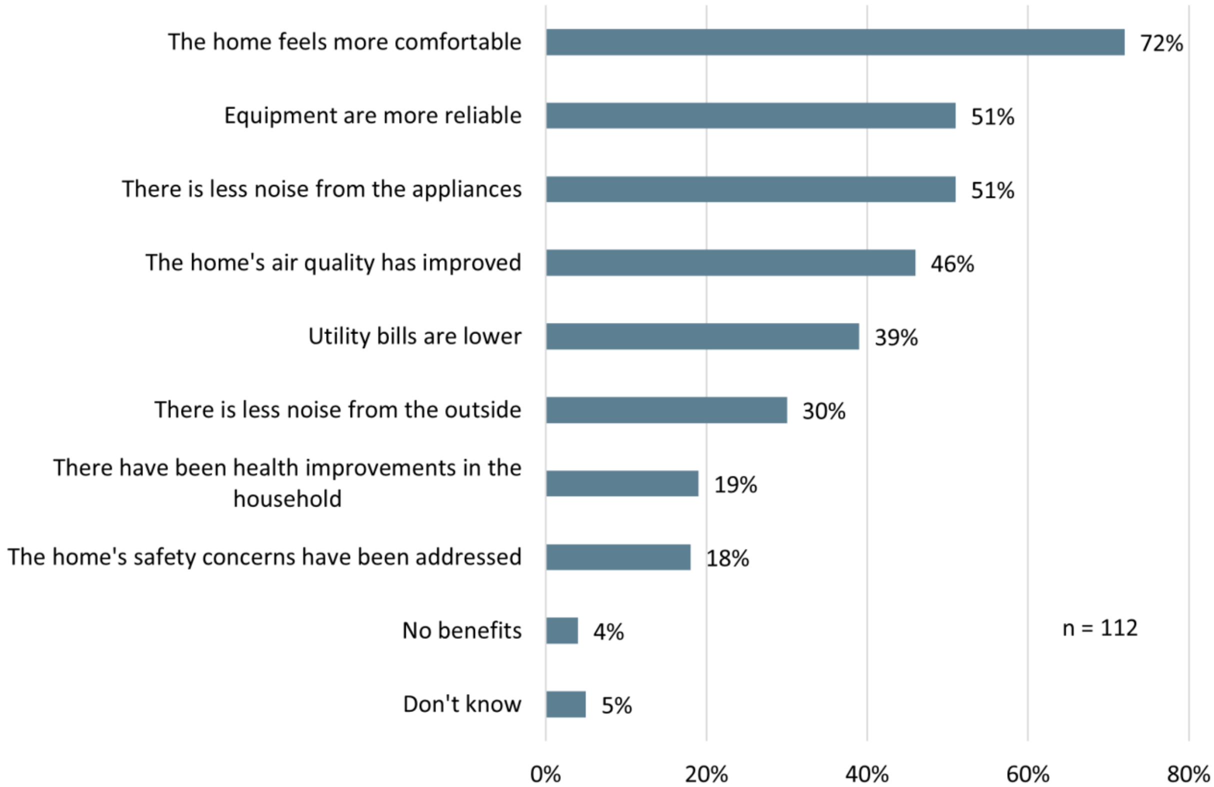
Response	Percentage of Participants (n = 112)*
Contractor	85%
PSO website	5%
Bill inserts	2%
PSO monthly e-newsletter	2%
General online search	2%
Word-of-mouth	2%
PSO customer service representative	1%

**The sum of percentages may not equal 100% due to rounding.*

A customer must utilize a program-certified contractor, or trade ally, to participate in the Home Rebates Program. Eighteen percent of participants first contacted their trade ally because they were interested in energy efficiency, while 81% had a specific issue or concern they wanted to address. The other one percent of respondents could not recall why they first contacted their contractor. Specific issues mentioned included fixing or replacing broken equipment (70%), increasing home comfort (19%), health or safety concerns (3%), fixing or replacing older, inefficient equipment (7%), and attempting to reduce bills (1%).

Participants provided feedback about their experience with the program and the efficiency improvements they made. Respondents reported improved home comfort (72%), higher reliability of heating and cooling appliances (51%), and reduced noise from appliances (51%) as the most perceived benefits from their energy saving upgrades. For all other responses, refer to Figure 3-12.

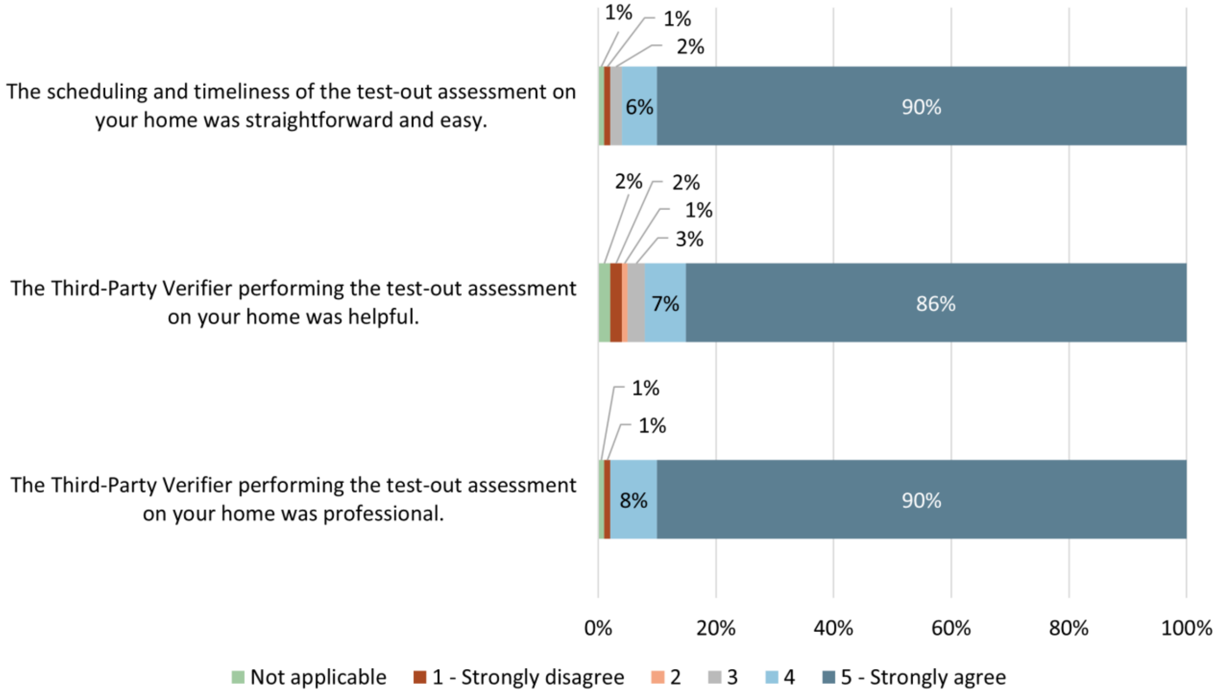
Figure 3-12: Benefits of Energy Saving Upgrade Improvements



Note: Percentages exceed 100% because participants could select more than one response for multi-select questions.

To receive the rebate as part of the Multiple Upgrades Program, a third-party verifier TPV) is required to perform a test-out assessment. Participants were asked to rate their satisfaction with the TPVs. The satisfaction rates are shown in Figure 3-13.

Figure 3-13: Satisfaction with Third-Party Verifiers (n = 112)

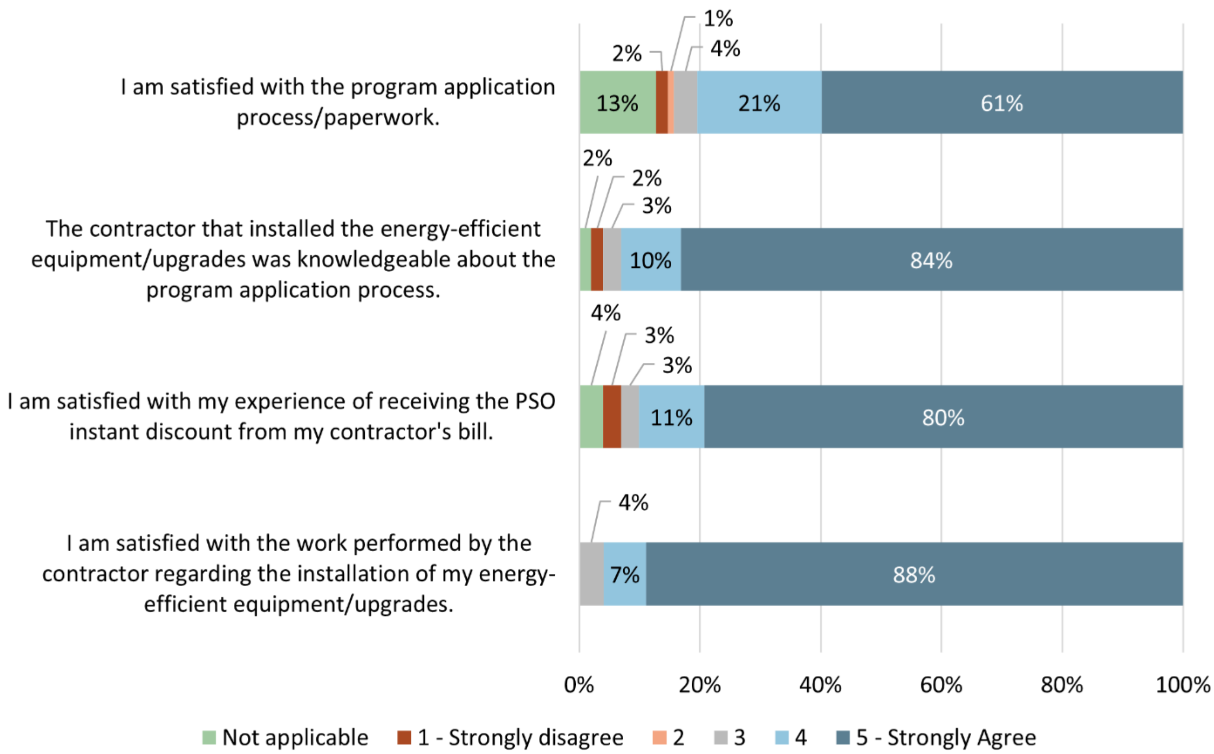


Participants provided feedback about their satisfaction with program staff, the contractor who installed the upgrades, and the Multiple Upgrades Program overall. About one-third of respondents (n = 35) reported interacting with program staff as part of receiving the rebate through the program. Almost all these respondents reported being somewhat or very satisfied with their interactions with program staff.

Ninety-six percent of respondents indicated satisfaction with their overall experience.[24] Those who were dissatisfied with the program overall explained their reasoning for the lower score was because of the rebate amount. Figure 3-14 displays respondents' level of agreement with various statements about their program experience.

[24] Rated their satisfaction a 4 or 5 on a scale from 1 (very dissatisfied) to 5 (very satisfied).

Figure 3-14: Multiple Upgrades Program Satisfaction (n = 112)



Single Upgrades Participant Survey

ADM conducted a monthly participant survey of PSO customers who participated in the Single Upgrade Program in 2023. Single Upgrade participants provided feedback about how they first learned about the rebates that PSO offers for energy-saving upgrades to their home (summarized in Table 3-37).

Table 3-37: Sources of Single Upgrade Program Awareness

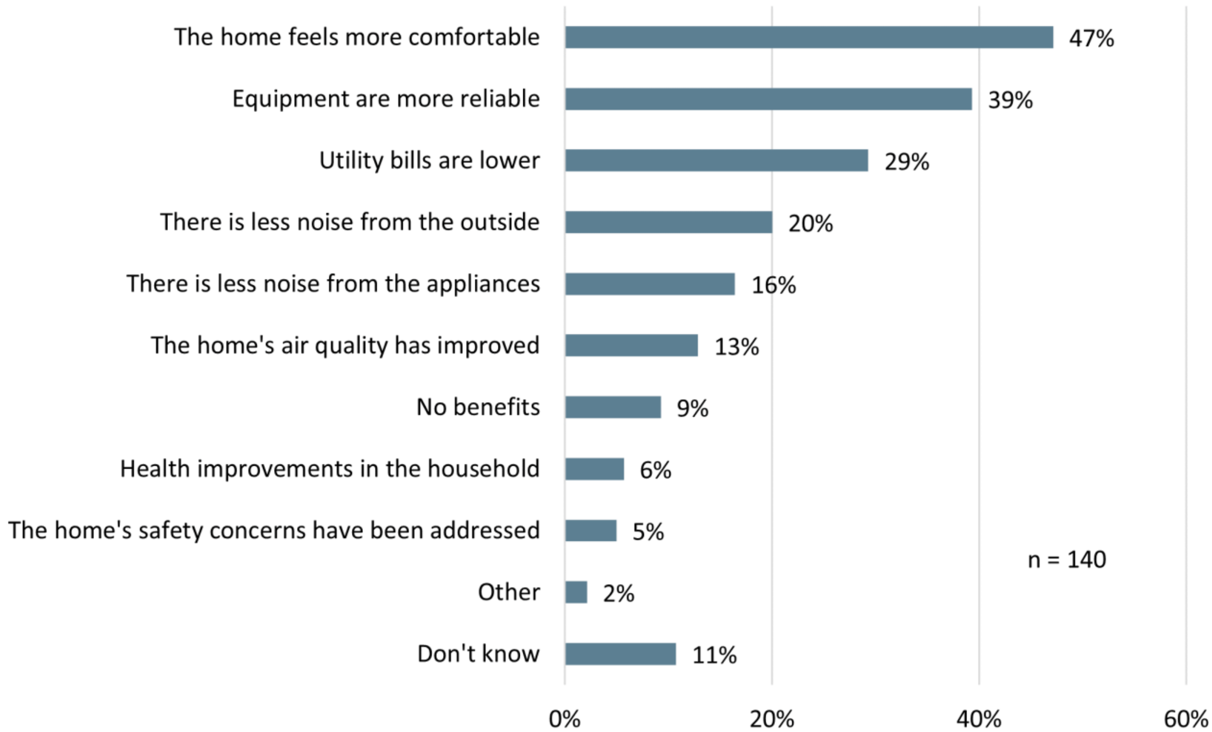
Response	Percentage of Participants (n = 141)*
Contractor	67%
PSO website	9%
Family, friend, or neighbor (word-of-mouth)	7%
Monthly e-newsletter	6%
Bill inserts	3%
TV ad	3%
General online search	1%
PSO customer service representative	1%
Social media	1%
Various sources (not specified)	4%

**The sum of percentages may not equal 100% due to rounding.*

A customer must utilize a program-certified contractor, or trade ally, to participate in the Home Rebates Program. Twenty-nine percent of participants first contacted their trade ally because they were interested in energy efficiency, while 63% had a specific issue or concern they wanted to address. The other eight percent of respondents could not recall why they first contacted their contractor.

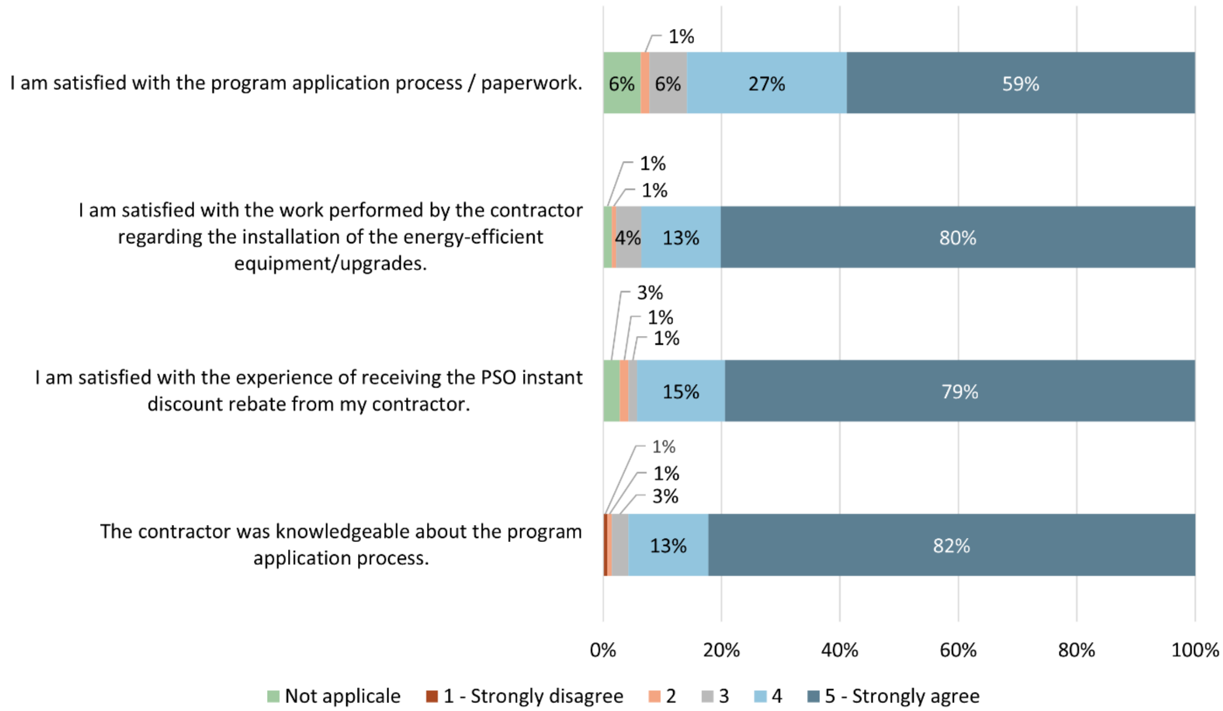
Participants provided feedback about their experience with the program and their efficiency improvements (See Figure 3-15).

Figure 3-15: Benefits of Energy Saving Upgrade Improvements



Participants provided feedback about their satisfaction with program staff, the contractor who installed the upgrades, and their satisfaction with the Single Upgrade Program overall. Figure 3-16 shows respondents' level of agreement with various statements about their program experience.

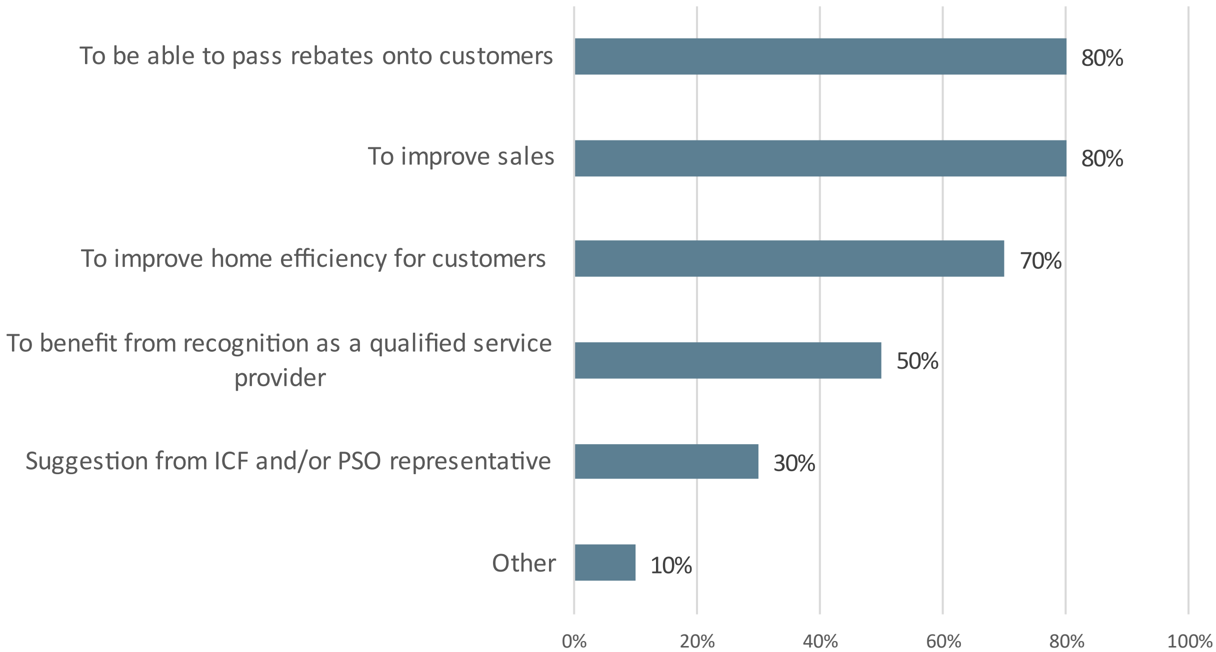
Figure 3-16: Single Upgrade Program Satisfaction (n = 141)



Single and Multiple Upgrades Trade Ally Survey

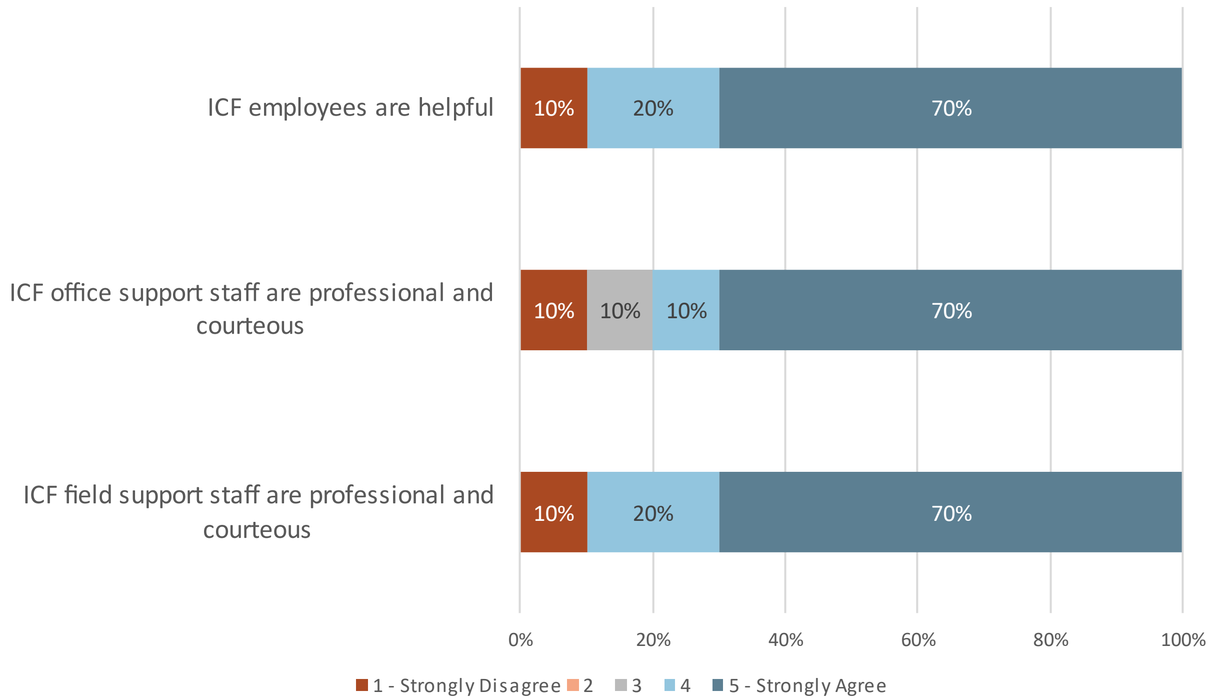
ADM conducted a survey of trade allies who participated in the Single & Multiple Upgrade Program in 2023. This section summarizes program feedback received from a sample (21 responses) of Home Rebates trade allies. Trade allies were surveyed about their involvement with PSO's Home Rebates Program, including their decision to participate in the program. A full list of reasons for participating in the program as reported by the trade allies are listed in Figure 3-17.

Figure 3-17: Trade Ally Reasoning for Joining the Home Rebates Program



Trade allies were asked to rate their level of agreement with statements regarding their satisfaction with ICF program staff on a scale of one to five, where one is “Strongly disagree” and five is “Strongly agree”. As outlined in Figure 3-18, 90% of survey respondents strongly agreed that ICF field support staff are professional and courteous, rating the statement as a four or higher.

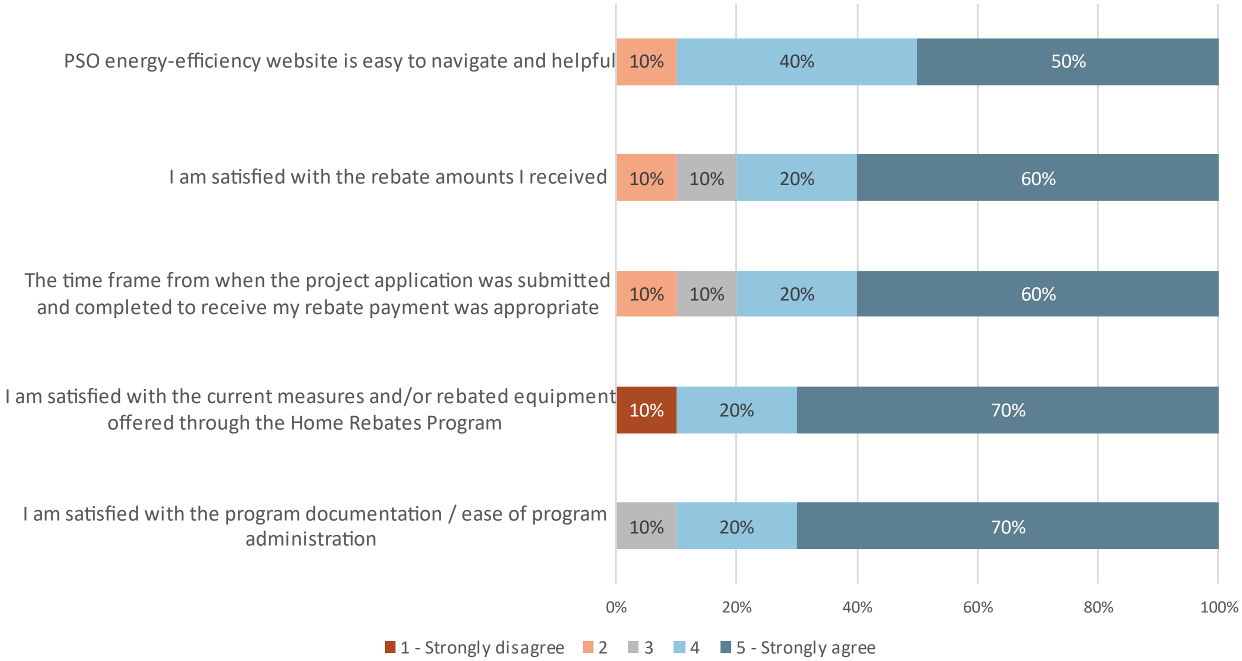
Figure 3-18: Trade Ally Satisfaction with ICF Program Staff



Ninety percent of the trade allies reported it was easy to reach ICF with questions. Trade allies reported that ICF program staff responded quickly to their emails/phone calls (90%) and kept them well informed about the program (90%).

Trade allies were asked to rate their level of agreement with statements regarding their satisfaction with the various aspects of the Home Rebates Program on a scale of one to five, where one is “Strongly disagree” and five is “Strongly agree”. Most trade allies reported satisfaction with different aspect of the program from the survey, rating each statement as a four or higher using the same scale mentioned above (see Figure 3-19).

Figure 3-19: Trade Ally Satisfaction with Home Rebates Program



The trade allies were surveyed about the program training they received. Eighty percent of the surveyed trade allies participated in program training. Of those trade allies (n = 10), 80% reported their program training to be either helpful (25%) or very helpful (63%). One Trade Ally did, however, mention that the training was incomplete and boring.

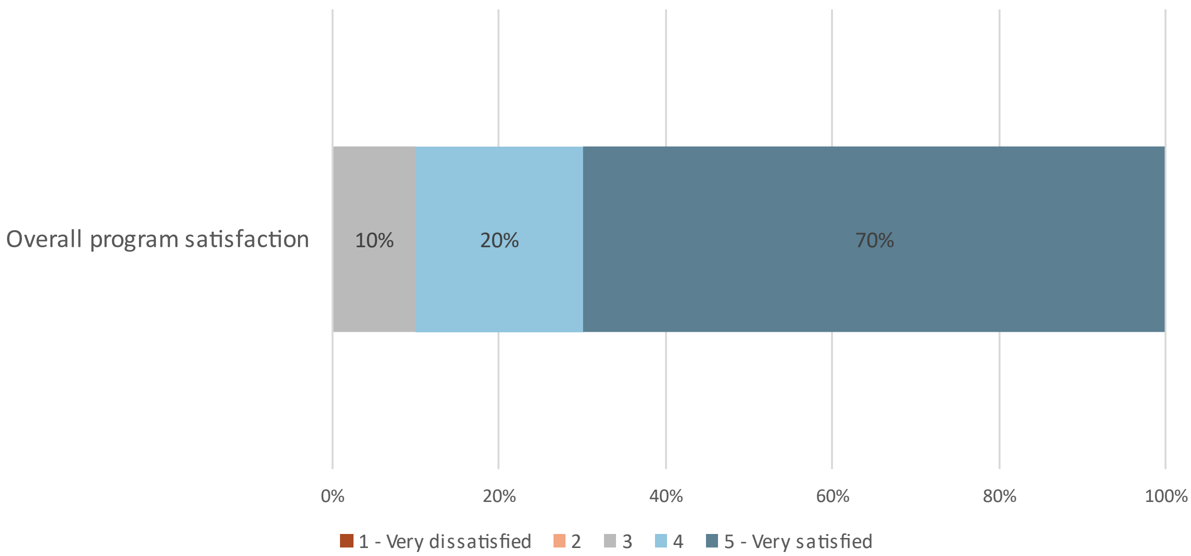
According to trade allies, the primary barrier for customers not adopting high-efficiency equipment included cost of equipment (70%), return on investment timeline (10%), and the discount/rebate amount (10%). To overcome these barriers with customers, trade allies reported explaining the benefits of energy efficient equipment (80%), offering a range of energy efficiency equipment (70%), and estimating the return on investment (70%). Thirty percent of trade allies reported being able to overcome customer resistance to adopting energy efficient equipment about half the time (see Table 3-38).

Table 3-38: Overcoming Customer Resistance

Percentage of Customers	Percentage (n = 10)
Almost never	0%
About a quarter of the time	10%
About half the time	30%
About three-quarters of the time	20%
Almost always	20%
Don’t know	20%

Overall, the majority of trade allies (90%) were satisfied with PSO's Home Rebate Program, rating it a four or higher on a scale of one to five, where one is "Strongly disagree" and five is "Strongly agree" (see Figure 3-20).

Figure 3-20: Trade Ally Overall Satisfaction with the Program



The following summarizes the key findings of the process evaluation of the Multiple Upgrades component:

- Multiple Upgrades test-out completion rates improved in 2023. In previous program years, test out completion rates caused by customer hesitancy affected the overall number of participants in the Multiple Upgrades Program. Customer hesitancy towards the test-out process was caused by a delay from when the energy-efficient equipment was installed to when they were contacted by the TPVs. If a test-out is not completed, the project is automatically disqualified from the program and the customer does not receive a rebate for the energy-efficient equipment.
- Most multiple upgrades respondents reported positive experiences with program staff, contractors, and the overall program. Participants reported significant benefits from the energy-saving upgrades, including improved home comfort, enhanced reliability of heating and cooling appliances, and reduced noise from appliances.
- Most participants expressed satisfaction with TPVs, with only a small minority reporting dissatisfaction related to communication and professionalism issues.

The following summarizes the key findings of the process evaluation of the Single Upgrade component:

- Single Upgrades survey results indicate an elevated level of participant satisfaction with the program. Most respondents expressed satisfaction with program staff interactions, the application process, and the overall program experience. Furthermore, participants reported tangible benefits from the energy-saving upgrades, including improved home comfort, increased reliability of heating and cooling appliances, and lower utility bills.

- There is less trade ally participation for the Single Upgrade Program than desired. PSO is looking to improve program marketing to increase regional diversity. Additional marketing material is needed (specifically for the rural areas outside of Tulsa) to expand the awareness of the program to potential trade allies, which helps increase customers participation.

3.1.1.8 Conclusions and Recommendations

The following recommendations are offered for continued improvement of the New Homes component:

- Consider developing a campaign to educate the public on homes built to PSO's energy-efficiency standards and the benefits of owning one of these homes.
- Ensure that homebuilders are knowledgeable on the lifetime cost and energy savings from energy efficiency. Providing examples of quantified lifetime cost savings may help builders promote the program further.
- Consider recent federal changes to baseline conditions that will impact the program. Efficiency requirements for HVAC systems will have an impact on the energy savings generated by the program. These changes should be considered in program delivery.

The following recommendations are offered for continued improvement of the Multiple Upgrades component:

- Consider ways to streamline the rebate process to increase satisfaction with Multiple Upgrade Program participants.

The following recommendations are offered for continued improvement of the Single Upgrade component:

- Consider improving varied awareness channels for the program. While overall satisfaction is high, some participants expressed dissatisfaction with the rebate amount, the quality of contractor work, or perceived lack of benefits from the upgrades. These concerns could be mitigated by ensuring contractors are fully knowledgeable about the program and rebates. Targeting outreach efforts and collaborating with contractors may maximize program visibility.

3.1.2 Energy Saving Products Program

This chapter presents the findings from the impact and process evaluation of the 2023 Energy Saving Products Program (ESP).

3.1.2.1 Program Overview

PSO's Energy Saving Products (ESP) program seeks to generate energy and demand savings for residential customers through the promotion of a variety of energy efficient measures. The overall purpose of this program is to provide PSO residential customers with financial incentives for purchasing products that meet high efficiency standards.

The ESP program consisted of retail price discounts, an online limited time marketplace, downstream measure rebates, and energy efficiency measures distributed at food banks and local pantries. The retail offering included price discounts for qualifying room air purifiers, advanced power strips, bathroom ventilation fans, spray foam, door sweeps and seals, room air conditioners, and air filters. The online Limited Time Offer (LTO) program included discounts for online purchases of light bulbs, room air purifiers, and smart thermostats. In addition, the program included the distribution of free LEDs in partnership with food banks and local food pantries within the PSO service territory.

The program offered downstream rebates from PSO for qualifying heat pump water heaters, clothes dryers, clothes washers, Wi-Fi Thermostats, and level 2 electric vehicle chargers. This downstream portion of the program accounted for approximately 4% of the reported energy savings realized through the program.

The number of participants in the ESP lighting component of the program is unknown, however a total of 2,491 packages of LEDs and 135,312 individual bulbs were distributed through the LTO program or in partnership with local food pantries. The total number of all other verified upstream measures purchased through the ESP program was 130,678, while the total number of verified measures rebated through the downstream portion of the program was 2,132. Overall, the ESP program supported the purchase of 268,122 energy efficient measures during 2023.

Table 3-39 provides a summary of program metrics for the 2023 program year.

Table 3-39: Performance Metrics – Energy Saving Products Program

Metric	2023
Number of Known Participants[25]	2,091
Budgeted Expenditures	$1,430,116
Actual Expenditures	$1,137,963
Energy Impacts (kWh)	
Projected Energy Savings	7,664,587
Reported Energy Savings	20,891,867
Gross Verified Energy Savings	18,910,312
Net Verified Energy Savings	14,631,707
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	1,287.13
Reported Peak Demand Savings	4,361.37
Gross Verified Peak Demand Savings	3,283.21
Net Verified Peak Demand Savings	2,072.33
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	3.92
Utility Cost Test Ratio	4.40

3.1.2.2 Impact Evaluation Activities

This section presents the evaluation activities conducted for the Energy Saving Products program. Evaluation methodologies can be found in a supplemental document.

3.1.2.2.1 Data Collection

Several primary and secondary data sources were used for the evaluation. Tracking data and supporting documentation for the program was obtained from the program implementor. This tracking data was used as the basis for quantifying participation and assessing program impacts. Tracking data included the following information for each combination of retailer, model number, and discount level for upstream lighting:

- Package sales per week (program sales only)
- Number of bulbs per package
- Rated wattage
- Rated lumens

[25] The actual total number of customers that purchased an energy savings product is unknown. Instead, this table reports the count of unique customers that received rebates for qualifying downstream measures.

- Rated lifetime (in hours)

Additional documentation including retailer agreements, retailer/manufacturer invoices, promotional event documentation, and general program materials were reviewed as part of the evaluation.

Primary data collection activities included an online Limited Time Offer survey, two surveys of downstream rebate participants, one survey of upstream rebate participants, and interviews with program staff members. The Limited Time Offer survey was administered in two waves, one in the summer of 2023 (July) and a second during the fall of 2023 (October). The final sample size for each primary data collection activity is presented in Table 3-40 below.

Table 3-40: ESP Data Collection Activities

Data Collection Activities		N
General Population Survey (LTO)		247
General Population Survey (Upstream)		257
Downstream Rebate Participant Survey	Appliance Survey	213
	Electric Vehicle Level 2 Charger Survey	21

3.1.2.2.2 Verified Gross Savings Methodology

Energy impacts for the program were calculated using prescriptive methods from the Arkansas TRM v8.1, the Texas TRM v8.0, and the Oklahoma Deemed Savings Document (OKDSD). Inputs to savings algorithms as well as in-service rates were determined through self-claimed survey responses. Evaluation methodologies can be found in a supplemental document.

3.1.2.2.3 Net-to-Gross (NTG) Estimation Methodology

Free ridership was determined for each program delivery mechanism. The spillover was determined by the LTO delivery method. For downstream and upstream, spillover was indeterminant based on primary data collection through participant surveys. Participant survey responses were used to determine free ridership for downstream measures, upstream measures, and LTO offerings. A NTG of 100% was applied to measures distributed through Foodbanks. Detailed explanations of the NTG methodologies can be found in a supplemental document.

3.1.2.3 Process Evaluation Activities

ADM evaluators completed a process evaluation to assess the Energy Saving Products (ESP) Program. The evaluators assessed program design, operations, and delivery through a facilitated discussion and participant surveys. Recommendations for refining and improving the program for next year are located at the end of the memo.

The evaluation addressed the following research questions to better understand the program’s effectiveness and efficiency:

- How effective were the marketing efforts for the program? Which marketing methods were most effective? How aware of the program are PSO customers?
- How well did PSO staff, implementation staff, and participating customers/retailers work together?
- Did the channel’s implementation reflect its design? Are there underlying assumptions about channel implementation and design that are being made about how the program will unfold? Are there ways to improve the design or implementation process?
- How do participants hear about the program? What portion of participants hear about the discounts before entering a participating retail location?
- Were the program participants satisfied with their experience? What are the perceived benefits associated with the program?
- How satisfied are customers with the variety of incentives? Are customers satisfied with the quality of measures available through the ESP program (including downstream, upstream, and online limited time offering LTO)?
- Is the program adequately serving different types of PSO customers (e.g., by homeownership, income level, and geography)?
- Were there any significant changes or new obstacles during the program year? Were there any outside or external obstacles that influenced the program?
- Looking forward, what are key barriers and drivers to program success within PSO’s market?

To inform the process evaluation, ADM also conducted an in-depth interview with program staff at PSO and the implementation contractor. This interview provided insight into various aspects of the program and its organization, but also focused on changes to the program that occurred during 2023. Interviewees also discussed aspects of the program operations that they considered to be successful as well as the challenges faced over the course of the program year. These results, along with program feedback collected via the participant surveys, have been consolidated in a separate memo. A summary of process evaluation activities is shown in Table 3-41.

Table 3-41:ESP Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Program Materials Review	Review reports and support materials for clarity and consistency with program objectives.
Staff Interviews	Evaluate the viewpoints of program staff concerning program operations, its strengths, weaknesses, obstacles to success, and areas for enhancement.
Participant Survey	Assess participant's reasons for participating and experience with the program, including satisfaction.
General Population Survey	Evaluate customer purchasing and decision-making processes while estimating the net-to-gross ratio and gauging customer satisfaction with recent program-promoted measure purchases.

3.1.2.4 Verified Gross Savings Results

This section reports findings from the impact evaluation of the ESP program.

Lighting Gross Energy Savings and Peak Demand Impact

The tracking data provided for evaluation identified a total of 1,236 packages of LEDs were discounted through the LTO program. An additional 1,255 packages of LEDs were distributed free-of-charge through local food banks Table 3-42 shows the reported quantities and impacts of measures discounted or distributed free-of-charge through the ESP program during 2023.

Table 3-42: ESP Reported Measure Quantities and Impacts – Lighting Only

Distribution Type	Measure Type	Package Quantity	Bulb Quantity	Reported kWh	Reported kW
LTO	Reflector LED – 15W	1,236	14,832	487,170	79.21
Food Bank	A19 LED - 8.5W or 9W	1,255	120,480	988,337	160.69
Totals		**2,491**	**135,312**	**1,475,508**	**239.90**

Verification

Verified energy and demand impacts were calculated based on OKDSD, using an adjusted value for hours of use (960.61 hours) and survey derived ISR's. ADM found that for all light bulbs, reported impacts were calculated in accordance with the deemed savings algorithms. There were no discrepancies identified through the database review that required adjustment for the actual wattages and/or baseline wattages used in the calculation of energy and demand impacts for some bulbs.

In-Service Rate Adjustments

The in-service rate for LED bulbs sold through the LTO delivery was based on survey responses, resulting in an ISR's of 87%. ISR for the foodbank offering was set at 100% due to the difficulties in collecting participant information. For the LTO offering, these ISR's were applied to the first-year annual energy savings. For the remaining lifetime savings an ISR of 97% is applied, as it was assumed that 97% of the bulbs are installed within three years based on the stipulations in the deemed savings document.

Verified Gross Savings Estimates

The realization rate factors impacting lighting measures included annual hours of use, and the application of ISR's. The application of higher hours of use outweighed the reduction in savings due to the application of ISR's. Table 3-43 compares reported and verified impact estimates for this program component following verification.

Table 3-43: ESP Program Impact Findings –Gross Verified Lighting Savings

Distribution Type	Measure Type	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
LTO	Reflector LED – 15W	14,832	487,170	529,568	413.23	71.04
Food bank	A19 LED - 8.5W or 9W	120,480	988,337	1,234,885	87.50	165.66
Total		**135,312**	**1,475,508**	**1,517,905**	**239.90**	**236.70**

Air Filter Gross Energy Savings and Peak Demand Impacts

ADM's review of program tracking data identified that a total of 1,725 qualifying air filters were sold at participating retail stores during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for air filters sold through the program. This review found that there were no discrepancies between reported and verified parameters.

Verified Gross Savings Estimates

Verified gross savings includes the application of an ISR. An ISR was sourced from ADM's 2021 and 2023 general population survey (71%). Table 3-44 compares reported and verified impact estimates for air filters rebated through the program in 2023.

Table 3-44: ESP Program Impact Findings – Air Filters

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Retail Discounts	Air filters	20,540	1,068,925	758,937	3,728.47	2,647.22

Advanced Power Strip Gross Energy Savings and Peak Demand Impact

ADM's review of program tracking data identified that a total of 8,325 qualifying advanced power strips (APS) were sold at participating retail stores during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for APS sold through retailers and provided through the LTO program. This review found that all measures were assigned the correct savings in the program tracking data.

Verified Gross Savings Estimates

Table 3-45 compares reported and verified impact estimates for APS discounted through the program in 2023. ADM found no discrepancies between the reported and verified savings calculations. Results from the LTO survey indicated an ISR of 90%. This is ISR was applied to the upstream offering.

Table 3-45: ESP Program Impact Findings – Advanced Power Strips

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Retail Discounts	APS	8,325	696,803	627,122	79.09	71.18

Bathroom Ventilating Fan Gross Energy Savings and Peak Demand Impact

ADM's review of program tracking data identified that a total of 389 qualifying bathroom ventilation fans (BVF) were sold at participating retail stores during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for BVF's sold through the program. This review found no discrepancies between reported and verified measure parameters.

Verified Gross Savings Estimates

Table 3-46 compares reported and verified impact estimates for BVF rebated through the program in 2023. An ISR was sourced from ADM's 2021 and 2023 general population survey (81%).

Table 3-46: ESP Program Impact Findings – Bathroom Ventilating Fans

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Retail Discounts	BVF	389	9,791	7,931	1.21	0.98

Clothes Dryer Gross Energy Savings and Peak Demand Impacts

ADM's review of program tracking data identified that a total of 409 clothes dryers (CD) were rebated during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for clothes dryers sold through the program. ADM was unable to verify 3 clothes dryers in the program tracking data using the ENERGYSTAR® ID's. All 3 of the clothes dryer ENERGYSTAR® IDs were identified as clothes washers, as a result, no verified energy savings were attributed to these measures.

Higher verified kWh and kW savings were a result of using model specific Combined Energy Factor (CEF) efficient parameters while the reported CEF efficient was a deemed value of 3.8. The CEF efficient value across all verified clothes dryer models in the 2023 program year ranged from 3.45 to 6.00 with an average of 3.94.

Verified Gross Savings Estimates

Table 3-47 compares reported and verified impact estimates for clothes dryers rebated through the program in 2023. Combined survey results from 2021 – 2023 were used to determine an ISR of 100%

Table 3-47: ESP Program Impact Findings – Clothes Dryers

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Downstream Rebates	CD	406	57,211	66,894	5.86	6.85

Clothes Washer Gross Energy Savings and Peak Demand Impact

ADM's review of program tracking data identified that a total of 636 clothes washers (CWs) were rebated during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for clothes washers sold through the program. This review found that 22 clothes washers discounted through the program were not eligible to receive energy efficiency savings[26]; as a result, no verified energy savings were attributed to these models.

Higher verified energy savings was a result of ADM attributing savings to some clothes washers with existing front load type and efficient top load type. Further details on clothes washer energy savings methodology can be found in a supplemental document.

Verified Gross Savings Estimates

Table 3-48 compares reported and verified impact estimates for clothes washers rebated through the program in 2023. Combined survey results from 2021 – 2023 were used to determine an ISR of 100%

Table 3-48: ESP Program Impact Findings – Clothes Washers

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Downstream Rebates	CWs	614	65,472	69,158	15.54	16.43

Electric Vehicle Charger Gross Energy Savings and Peak Demand Impacts

ADM's review of program tracking data identified that a total of 110 qualifying electric vehicle chargers (EVC) were rebated through the program during the program year. Of these, 5 EVC were installed to support the charging of 2 electric vehicles. Reported energy savings for these EVC were higher than EVC's supporting only 1 electric Vehicle. The current energy saving methodology does not factor in the number of electric vehicles being supported by an EVC, therefore higher verified energy savings were not applied to these 5 measures. Further details on EVC energy savings methodology can be found in a supplemental document.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for EV Chargers rebated through the program. This review found that all EV Chargers were assigned the correct kWh and kW savings.

A review of available electric vehicles sold in 2021 to 2023 informed the average efficiency MPGe (kWh/100miles). After including 2023 data, the MPGe used in the verified savings calculation remained at 36 MPGe. Higher verified energy savings were a result of reported savings estimates using 32 MPGe.

[26] 20 CW's reported having existing front load type to top load efficiency type with gas dryer fuel, one CW was not ENERGYSTAR® certified, and one CW ENERGYSTAR® ID resulted in a clothes dryer.

Verified Gross Savings Estimates

Table 3-49 compares reported and verified impact estimates for EV Chargers rebated through the program in 2023. Combined survey results from 2021 – 2023 were used to determine an ISR of 100%

Table 3-49: ESP Program Impact Findings – Electric Vehicle Chargers

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Downstream Rebates	EVC	110	28,822	31,340	0.00	0.00

Heat Pump Water Heater Gross Energy Savings and Peak Demand Impact

ADM's review of program tracking data identified that a total of 21 heat pump water heaters (HPWHs) were rebated during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for HPWHs sold through the program. This review found that 16 HPWHs reported parameters did not match the verified parameters, including tank storage volume and ambient temperature. As a result, reported and verified energy savings do not match.

Verified Gross Savings Estimates

Table 3-50 compares reported and verified impact estimates for HPWHs rebated through the program in 2023. Combined survey results from 2022 – 2023 were used to determine an ISR of 100%

Table 3-50: ESP Program Impact Findings – Heat Pump Water Heaters

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Downstream Rebates	HPWH	21	67,983	61,227	8.96	5.37

Room Air Conditioner Gross Energy Savings and Peak Demand Impacts

ADM's review of program tracking data identified that a total of 1,872 qualifying room air conditioners (RAC) were sold at participating retail stores during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for RAC sold through the program. The reported Equivalent Cooling Full Load Hours (EFLHc) and energy efficiency ratio (EER) did not match the verified parameters. ADM followed guidance from the AR TRM v8.1 to estimate kWh and kW savings.

Verified Gross Savings Estimates

ADM's 2021 and 2023 general population survey indicated an ISR of 76%. Table 3-51 compares reported and verified impact estimates for Room Air Conditioners rebated through the program in 2023.

Table 3-51: ESP Program Impact Findings – Room Air Conditioners

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Retail Discounts	RAC	1,872	47,627	50,939	55.78	88.60

Room Air Purifier Gross Energy Savings and Peak Demand Impact

ADM's review of program tracking data identified that a total of 1,725 room air purifiers (RAP) were sold at participating retail stores and provided through the LTO program during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for room air purifiers sold through retailers and provided through the LTO program. This review found that all air purifiers were assigned the correct energy savings in the program tracking data.

Verified Gross Savings Estimates

The in-service rate for room air purifiers sold through the LTO delivery was based on survey responses, resulting in an ISR's of 100%. For measures discounted at participating retail stores, an ISR was sourced from ADM's 2021 and 2023 general population survey (86%). Table 3-52 compares reported and verified impact estimates for RAP rebated through the program in 2023.

Table 3-52: ESP Program Impact Findings – Room Air Purifiers

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Retail Discounts	RAP	442	227,474	195,628	26.10	22.44
LTO	RAP	1,283	705,061	705,061	80.89	80.89
Total		**1,725**	**932,535**	**900,689**	**106.99**	**103.33**

Smart Thermostats Gross Energy Savings and Peak Demand Impact

ADM's review of program tracking data identified that a total of 3,950 Wi-Fi Thermostats were available through the downstream program and provided through the LTO program during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for Wi-Fi Thermostats sold through retailers and provided through the LTO program. ADM followed the AR TRM v8.1 to estimate kWh savings.

Sufficient survey data was available from both the LTO participant survey and the downstream participant survey to develop independent ISR's. ISR for thermostats sold through the LTO offering was 94% and through the downstream rebate offering was 95%.

Verified Gross Savings Estimates

Table 3-53 compares the total reported and verified impact estimates for this program component.

Table 3-53: ESP Program Impact Findings – Smart Thermostats

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Downstream Rebates	Wi-Fi Thermostat	956	520,672	578,297	N/A	N/A
LTO	Wi-Fi Thermostat	2,994	2,188,518	2,057,207	N/A	N/A
Total		**3,950**	**2,709,190**	**2,635,504**	**N/A**	**N/A**

Weatherization Measure Gross Energy Savings and Peak Demand Impacts

In the context of this report, "weatherization measures" (WMs) include door seals, door sweeps, and spray foam. These three measures are discussed collectively in this report as ADM used the same savings algorithm to evaluate them. ADM's review of program tracking data identified that a total of 5,553 door seals and sweeps, and 89,280 cans of spray foam were sold at participating retail stores during the 2023 program year.

Verification

To verify the types, quantities, and savings associated with distributed measures, ADM performed a census review of the program tracking data for all WMs sold through the program. This review found that all the WMs were assigned the correct energy savings.

Verified Gross Savings Estimates

Results from the 2021 and 2023 general population survey indicated that door seals and sweep resulted in an ISR of 82%, while spray foam resulted in an ISR of 87%. Table 3-54 compares reported and verified impact estimates for WMs rebated through the program in 2023.

Table 3-54: ESP Program Impact Findings – Weatherization Measures

Distribution	Measure	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW
Retail Discounts	Door Seals and Sweeps	5,553	214,394	175,803	1.91	1.57
Retail Discounts	Spray Foam	89,280	13,517,604	11,760,316	120.66	104.98
Total		**94,833**	**13,731,998**	**11,936,119**	**122.57**	**106.54**

Summary of Impact Evaluation Findings

Verified gross savings are determined through an engineering review of the measure level savings calculations with an In-Service Rate (ISR) applied. Results for all measures are shown in Table 3-55.

Table 3-55: Verified Gross and ISR Impacts – ESP Program

Distribution Type	Measure Type	Gross Verified kWh	Gross Verified kW	ISR	ISR Gross Verified kWh	ISR Gross Verified kW
Retail Discounts	Advanced Power Strip	696,803	79.09	0.900	627,122	71.18
	Air Filter	1,068,925	3,728.47	0.710	758,937	2,647.22
	Bathroom Ventilation Fans	9,791	1.21	0.810	7,931	0.98
	Door Seals and Sweeps	214,394	1.91	0.820	175,803	1.57
	Room AC	67,025	116.58	0.760	50,939	88.60
	Room Air Purifier	227,474	26.10	0.860	195,628	22.44
	Spray Foam	13,517,604	120.66	0.870	11,760,316	104.98
Retail Discount Subtotals		**15,802,016**	**4,074.03**	**N/A**	**13,576,676**	**2,936,.97**
Downstream Rebates	Clothes Dryer	66,894	6.85	1.000	66,894	6.85
	Clothes Washer	69,158	16.43	1.000	69,158	16.43
	EV Charger	31,340	N/A	1.000	31,340	N/A
	HPWH	61,227	5.37	1.000	61,227	5.37
	Wi-Fi Thermostat	608,733	N/A	0.950	578,297	N/A
Downstream Rebate Subtotals		**837,352**	**28.65**	**N/A**	**806,916**	**28.65**
LTO Program	Reflector LED	608,699	81.66	0.870	529,568	71.04
	Room Air Purifier	705,061	80.89	1.000	705,061	80.89
	Wi-Fi Thermostat	2,188,518	N/A	0.940	2,057,207	N/A
LTO Program Subtotals		**3,502,278**	**162.55**	**N/A**	**3,291,836**	**151.93**
Foodbank	A19 LED - 8.5W or 9W	1,234,885	165.66	1.000	1,234,885	165.66
Foodbank Subtotals		**1,234,885**	**165.66**	**N/A**	**1,234,885**	**165.66**
Program Totals		**21,376,531**	**4,430.88**	**0.906**	**18,910,312**	**3,283.21**

Table 3-56 provides a detailed summary of ADM’s impact evaluation findings for all measures included in the ESP program in 2023.

Table 3-56: ESP Summary of Impact Evaluation Findings

Distribution Type	Measure Type	Verified Quantity	Reported kWh	Verified kWh	Reported kW	Verified kW	RR kWh	RR kW
Retail Discounts	Advanced Power Strip	8,325	696,803	627,122	79.09	71.18	90%	90%
	Air Filter	20,540	1,068,925	758,937	3,728.47	2,647.22	71%	71%
	Bathroom Ventilation Fans	389	9,791	7,931	1.21	0.98	81%	81%
	Door Seals and Sweeps	5,553	214,394	175,803	1.91	1.57	82%	82%
	Room AC	1,872	47,627	50,939	55.78	88.60	107%	159%
	Room Air Purifier	442	227,474	195,628	26.10	22.44	86%	86%
	Spray Foam	89,280	13,517,604	11,760,316	120.66	104.98	87%	87%
Retail Discount Subtotals		**126,401**	**15,782,619**	**13,576,676**	**4013.23**	**2,936.97**	**86%**	**73%**
Downstream Rebates	Clothes Dryer	406	57,211	66,894	5.86	6.85	117%	117%
	Clothes Washer	614	65,472	69,158	15.54	16.43	106%	106%
	EV Charger	110	28,822	31,340	N/A	N/A	109%	N/A
	HPWH	21	67,983	61,227	5.96	5.37	90%	90%
	Wi-Fi Thermostat	956	520,672	578,297	N/A	N/A	111%	N/A
Downstream Rebate Subtotals		**2,107**	**740,161**	**806,916**	**27.36**	**28.65**	**109%**	**105%**
LTO Program	Reflector LED	14,832	487,170	529,568	79.21	71.04	109%	90%
	Room Air Purifier	1,283	705,061	705,061	80.89	80.89	100%	100%
	Wi-Fi Thermostat	2,994	2,188,518	2,057,207	N/A	N/A	94%	N/A
LTO Program Subtotals		**19,109**	**3,380,750**	**3,291,836**	**160.10**	**151.93**	**97%**	**95%**
Foodbank	A19 LED	120,480	988,337	1,234,885	160.69	165.66	125%	103%
Foodbank Subtotals		**118,848**	**988,337**	**1,234,885**	**160.69**	**165.66**	**125%**	**103%**
Program Totals		**268,097**	**20,891,867**	**18,910,312**	**4,361.37**	**3,283.21**	**91%**	**75%**

3.1.2.5 Net-to-Gross Estimation Results

The NTG analysis for the ESP program was conducted using industry standard methodologies described in a supplemental document, accounting for free ridership as well as spillover. NTG ratios for the LTO offering were based on participant survey results, as shown in Table 3-57.

Table 3-57: Survey Responses and Free-Ridership Score: ESP LTO

Measure	Survey Responses	Free Ridership Score	Spillover Score	Net-to-Gross Score
Room Air Purifier	91	2%	4%	102%
Wi-Fi Thermostat	77	6%	3%	99%
Reflector LED – 15W	73	0%	4%	104%

Note: NTG ratios may be greater than 1.00 due to the addition of spillover ratios.

NTG ratios for in-store markdowns (upstream) were sources from PSO's portfolio planning. Ratios are shown in Table 3-58.

Table 3-58: ESP In-Store Markdown NTG

Measure	Net-to-Gross Score
Advanced Power Strip	64%
Air Filter	58%
Bathroom Ventilation Fans	72%
Door Seals and Sweeps	72%
Room AC	69%
Room Air Purifier	69%
Spray Foam	72%

NTG ratios for downstream rebates were determined through participant survey responses. Survey results from 2021 – 2023 were used to represent NTG ratios for clothes dryers, clothes washers, and EV chargers. NTG ratios for Wi-Fi thermostats only used results from 2023 since there were sufficient survey responses. Survey results from 2022 and 2023 were used to represent NTG ratios for heat pump water heaters. Results are shown in Table 3-59.

Table 3-59: Survey Responses and Free Ridership Scores: ESP Downstream Measures

Measure	Survey Responses				Evaluation Cycle Average Free Ridership	Net-to-Gross Score for 2023
	2021	2022	2023	Total		
Clothes Dryers	67	25	42	134	56%	44%
Clothes Washers	106	46	62	214	54%	46%
Heat Pump Water Heater	-	2	6	2	13%	88%
Electric Vehicle Chargers	8	12	21	41	28%	72%
Wi-Fi Thermostat	-	-	79	79	41%	59%

Surveys were not feasible for the foodbank light bulb offering. As these bulbs are provided directly to income eligible customers a NTG ratio of 100% was assigned.

3.1.2.5.1 Final Net-to-Gross Ratio

The measure level net-to-gross ratios are calculated as 1 - estimated free ridership + spillover[27]. Net to gross is applied to verified gross savings to determine verified net savings. The final net-to-gross ratios and associated net savings for each measure in the ESP program are shown in Table 3-60. Program level net verified savings results in an overall realization rate of 86% for annual energy savings.

Table 3-60: Verified ISR Gross and Net Impacts – ESP Program

Distribution Type	Measure Type	ISR Gross Verified kWh	ISR Gross Verified kW	NTG	Net kWh	Net kW
Retail Discounts	Advanced Power Strip	627,122	71.18	0.640	401,358	45.55
	Air Filter	758,937	2,647.22	0.580	440,183	1,535.39
	Bathroom Ventilation Fans	7,931	0.98	0.720	5,710	0.71
	Door Seals and Sweeps	175,803	1.57	0.720	126,578	1.13
	Room AC	50,939	88.60	0.690	35,148	61.14
	Room Air Purifier	195,628	22.44	0.690	134,983	15.49
	Spray Foam	11,760,316	104.98	0.720	8,467,427	75.58
Retail Discount Subtotals		**13,576,676**	**2,936.97**	**0.680**	**9,611,389**	**1,734.98**
Downstream Rebates	Clothes Dryer	66,894	6.85	0.440	29,433	3.02
	Clothes Washer	69,158	16.43	0.460	31,813	7.56

[27] Spillover was calculated for LTO measures, resulting in NTG ratios greater than 1.00.

Distribution Type	Measure Type	ISR Gross Verified kWh	ISR Gross Verified kW	NTG	Net kWh	Net kW
	Electric Vehicle Charger Level 2	31,340	N/A	0.720	22,565	N/A
	Heat Pump Water Heater	61,227	5.37	0.880	53,880	4.73
	Wi-Fi Thermostat	578,297	N/A	0.590	341,195	N/A
Downstream Rebate Subtotals		**806,916**	**28.65**	**0.618**	**478,886**	**15.30**
LTO Program	Reflector LED - 15W	529,568	71.04	1.040	550,750	73.88
	Room Air Purifier	705,061	80.89	1.020	719,162	82.51
	Wi-Fi Thermostat	2,057,207	N/A	0.990	2,036,635	N/A
LTO Program Subtotals		**3,291,836**	**151.93**	**1.017**	**3,306,548**	**156.39**
Foodbank	A19 LED	1,234,885	165.66	1.000	1,234,885	165.66
Foodbank Subtotals		**1,234,885**	**165.66**	**N/A**	**1,234,885**	**165.66**
Program Totals		**18,910,312**	**3,283.21**	**0.744**	**14,631,707**	**2,072.33**

3.1.2.6 Lifetime Savings

Lifetime energy savings for all measures in the ESP program are shown in Table 3-61.

Table 3-61: Total Lifetime Energy Savings – ESP Program

Measure Type	Net Total Lifetime Savings (kWh)
Spray Foam	84,674,270
Smart Thermostats	26,156,130
A19 LED	24,697,698
Reflector LED	12,217,797
Room Air Purifiers	7,687,310
Advanced Power Strips	4,013,582
Door Seals and Sweeps	1,898,677
Heat Pump Water Heaters	538,802
Clothes Washers	445,378
Clothes Dryers	382,631
Room Air Conditioners	369,050
Electric Vehicle Chargers	225,648
Air Filters	74,831
Bathroom Ventilation Fans	68,524
Total	**163,450,328**

3.1.2.7 Process Evaluation Findings

A process evaluation was completed to assess the Energy Saving Products (ESP) Program which included a review of program documentation, a facilitated discussion with program staff, participant surveys, and a general population survey. A detailed process evaluation memo was delivered to PSO in December of 2023.

3.1.2.7.1 Program Operations Findings

There were several changes to the program in 2023. One major change was the revamp of the online intake tool for appliance rebates. This tool allows customers to request rebates for items such as clothes washers, clothes dryers, EV chargers, heat pump water heaters, and thermostats. The entire online intake tool underwent a complete overhaul and was migrated to a new software platform.

The LTO schedule is determined based on available budget and sales forecasts for each measure, with an emphasis on aligning with the overall marketing strategy of the utility. The timing of the LTOs is carefully coordinated with the utility's marketing department. Consideration is given to significant events or seasons that align with customer interest and engagement. Examples include tying the lighting LTO to the Super Bowl, the air purifiers to allergy season in March, and aligning with Earth Day and other milestones throughout the year. Social media and the residential newsletter are leveraged to enhance the marketing strategy and ensure cohesive messaging.

The program discontinued offering LED light bulbs through an LTO campaign that coincided with the Super Bowl. This change was made to meet a deadline before July 1st, ensuring some form of lighting provision.

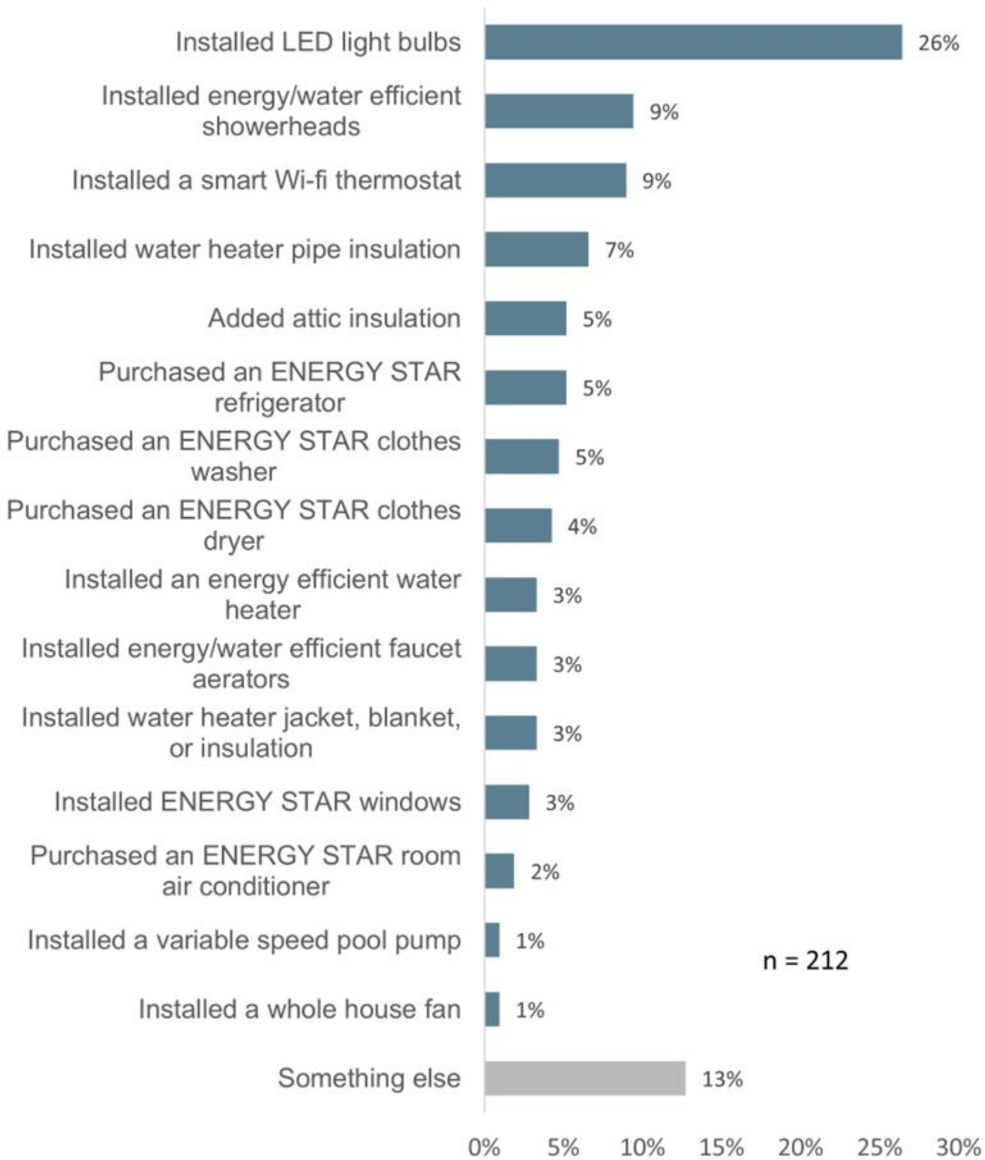
LTO Participant Findings

ADM administered an online survey to customers who purchased measures that PSO promoted through their email campaigns of the LTO website. A total of 247 responses were collected. The following highlights findings affecting all the LTO measures component of the program.

- Room air purifiers were the most common measure purchased through the LTO. Other measures rebated through the LTO included reflector/recessed LED light bulbs and Wi-Fi smart thermostats. Most customers stated they decided to purchase the measure after viewing the promotion on PSO’s LTO website and that the instant discount or price of the product led them to finalize the purchase.
- Most survey respondents were satisfied with the LTO. Overall, 90% were satisfied with their purchase experience. Most survey respondents were satisfied with the measure they purchased with a satisfaction of at least 81% (Room air purifiers), and a high of 89% (LED light bulbs). Additionally, many respondents indicated that their experience with the LTO offering was important when making the decision to take additional energy savings actions. This suggests that customers’ experience with PSO’s LTO was important in their decision to take energy saving actions.
- The overall net promoter score was highest for LEDs and lowest for room air purifiers. The overall net promoter score of the LTO among survey respondents was 66%. Most survey respondents (66%) were considered promoters, 20% were passive, and 14% were detractors. When analyzed by measure, the score was highest among people who purchased LED light bulbs and lowest among those who purchased a room air purifier. Most detractors explained that they simply do not make recommendations to others.
- LTO survey respondents experienced non-energy benefits, specifically lower long-term ownership costs and reduced carbon emissions. Increased comfort in the home and improvements in health issues, such as asthma and COPD triggers, were also reported. However, there were limited reports of increased market value for homes or a positive impact on indoor air quality. Additionally, some respondents felt these products safeguarded against future energy price fluctuations and decreased maintenance and repair costs, though these effects were moderate.

- Since making their energy efficient purchase and receiving an instant discount through PSO's LTO in 2023, 35% of respondents stated they had taken energy savings actions compared to 65% who had not. Installing LED light bulbs, water efficient showerheads, and Wi-Fi thermostats were the most common actions taken among survey respondents. Figure 3-21 provides a summary of all the different energy saving actions survey respondents have conducted.

Figure 3-21: ESP LTO Energy Saving Actions

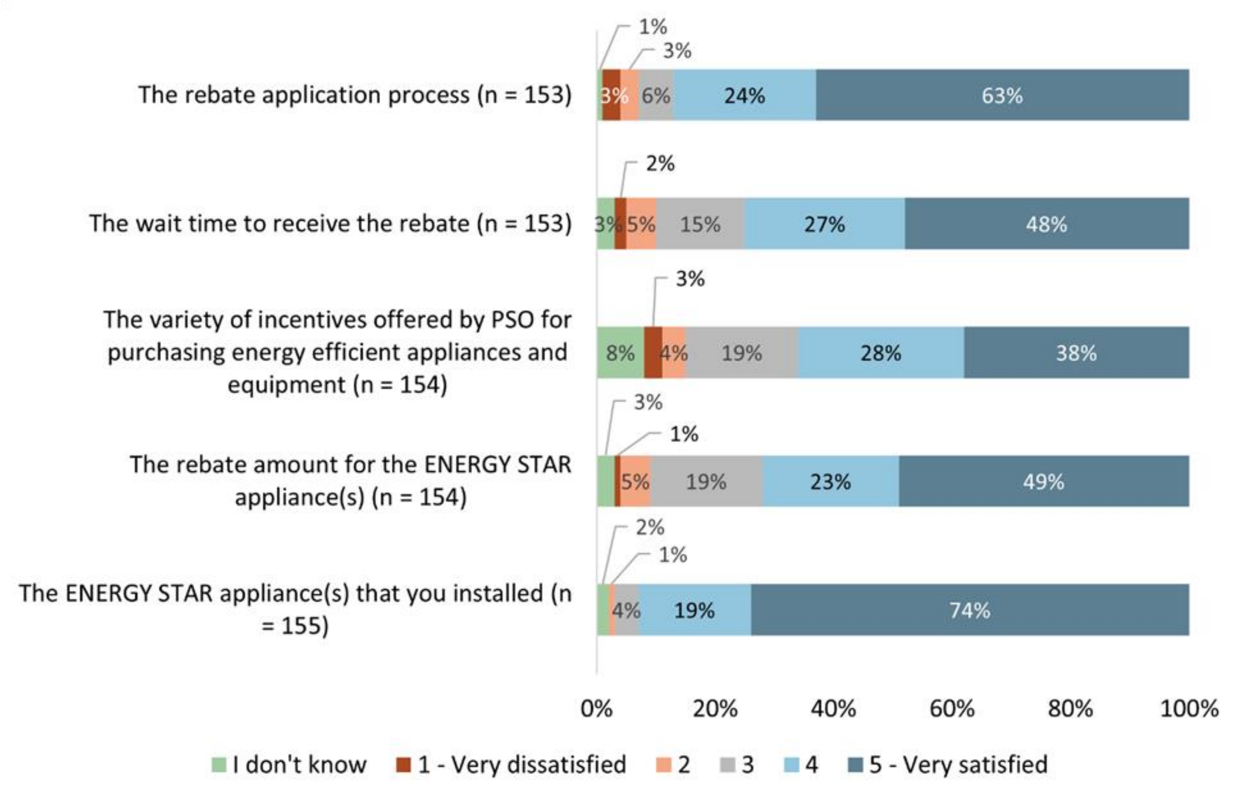


3.1.2.7.2 Downstream Offerings Findings

The downstream participant survey was launched to 3,311 participants with 213 surveys completed. The following highlights findings affecting all the downstream measures component of the program.

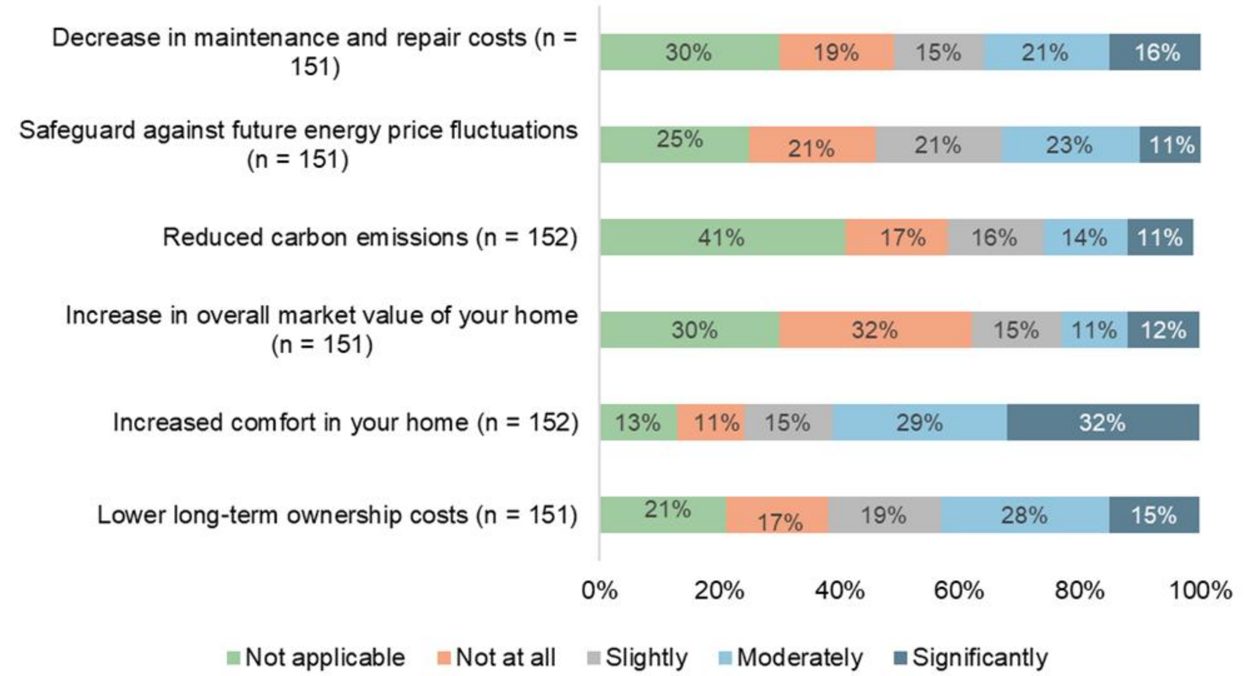
- Half of the downstream survey respondents were aware of a rebate before purchasing the equipment. Most survey respondents learned of the program through the PSO PowerForward website, the retailer's website, signage at the retailer, an internet search, or an email from PSO.
    - Most survey respondents purchased the equipment to save money on energy bills and replace existing appliances.
- Downstream participants were satisfied with the equipment and the program overall. Overall, the program participants were satisfied with the ENERGY STAR® appliances they installed, the application process, the rebate wait time, the rebate amount, and the variety of measures incentivized. The overall net promoter score of the downstream channel was particularly good at 63%. When analyzed by measure, the NPS was highest among people who purchased ENERGY STAR® heat pump water heaters (67%) and lowest among those who purchased a clothes washer or Wi-Fi thermostat (63%). Participant satisfaction is shown in Figure 3-22

Figure 3-22: ESP Downstream Channel Participant Satisfaction



- Respondents provided their feedback on the non-energy benefits of their purchased measure(s) on their homes. Ratings were given on a scale from 1 (not at all) to 4 (significantly) for various aspects (shown in Figure 3-23)

Figure 3-23: ESP Downstream Non-Energy Benefits



3.1.2.7.3 Level II EV Charger Offering Findings

A survey was administered to 53 program participants with 21 completing the survey. The following highlights findings from the process evaluation of the EV Level 2 Chargers component of the program.

- All participants indicated they were satisfied with the EV charger rebate and the program had a remarkably high net promoter score. In addition to the overall program, participants indicated their satisfaction with various components of the level 2 EV charger rebate program. In general, most were satisfied with the charger they purchased, the rebate amount, the rebate turnaround time, and the application process. The net promoter score of the EV charger among survey respondents was exceptional at 90%. Most survey respondents were considered promoters of the EV charger rebate program.
- Most survey respondents purchased the ENERGY STAR® level 2 charger to charge their new electric vehicle and to charge it faster. Fifty-seven percent learned about the rebate through the PSO website, 14% learned about the rebate through an electric vehicle salesperson, and another survey 14% learned from a friend or relative. The ability to charge their car quicker was the top reason for respondents to purchase a level 2 charger. Additionally, many stated the rebate PSO offered was especially important as well as saving money on energy bills was also important in their decision to buy the charger.

- Most customers tend to charge their EVs a few times per day or just once per day. Survey participants stated that they either used the level 2 charger once a day (38%), a few times a week (43%), once a week (14%), or the charger was not installed (5%). Most customers are using an app to set charging times for their EV and the frequency of use tended to correlate with the frequency of charging. Charging duration varied, with over half (58%) indicating they typically charge their EV between 3 and 8 hours. Sixty-seven percent of respondents reported charging their vehicles between 12 and 7 am.
- EV charger rebates led to various non-energy benefits for participants, including significant reductions in long-term ownership costs and carbon emissions. Additionally, increased comfort in the home and improvements in the overall market value of homes were also notable, though to a slightly lesser extent. These findings highlight the multifaceted benefits that Level 2 EV chargers can offer, ranging from financial savings to environmental impact and enhanced living conditions.

3.1.2.7.4 Upstream Offering Findings

A survey was conducted to residential customers to gain an understanding of energy efficiency purchases. The survey was completed by 257 customers who purchased energy efficient equipment with retail discounts. The following highlights findings affecting all the upstream measures component of the program.

- A considerable proportion of participants (88%) were unaware of any discounts on purchased items. Twelve percent of respondents were aware of a discount, with just two respondents that purchased air filters remembering that PSO was the one that provided the discount.
- Respondents indicated a willingness to pay more for energy-saving versions of air filters, door seals, and door sweeps. Respondents were less likely to purchase ENERGY STAR® room air conditioners, ENERGY STAR® room air purifiers, and advanced power strips if they had cost more. This indicates that without the discounts, respondents would have likely still bought air filters, door seals, and door sweeps, but may not have bought room air conditioners, room air purifiers, and advanced power strips.
- Respondents reported non-energy benefits of energy saving products, with the highest ratings for indoor air quality (55%) and increased home comfort (47%). Comparatively, carbon emissions and an increase in overall market value of the home had the least impact.

3.1.2.8 Conclusions and Recommendations

The following summarizes the key findings and recommendations from the evaluation of the Energy Saving Products Program.

- Consider additional energy saving measures in the upstream component of ESP. Although program year 2023 savings were like previous years, the upstream savings are driven by spray foam insulation. Spray foam reported savings made up 86% of the upstream savings and 65% of the total ESP reported savings.
- Continue to invest in, improve the program's website, and video links to enhance customer education. Ensure that the dedicated pages for eligible items include comprehensive installation guides and usage instructions. One of the more effective methods of communication between PSO and the customers was through the PSO website. Look for unique ways to drive more traffic to the PSO website to promote discounts and where they are offered, rebate offers, and LTO offerings.
- Encourage participants to apply for rebates on multiple measures, spotlighting the benefits of comprehensive energy efficiency upgrades.
    - Strengthen promotion of the EV charger rebate program, underscoring participant satisfaction and its advantages. Amplify education on the merits of Level 2 chargers and their role in faster charging.
    - Maintain and enhance promotional strategies for popular measures like room air purifiers, spray foam, door sweeps, furnace filters, advanced power strips, and Wi-Fi smart thermostats.
    - Continue additional promotional strategies on comprehensive awareness for heat pumps and heat pump water heater discounts to increase participation for that measure. Extend the reach of these efforts through a variety of channels, including the program website, newsletters, and home energy report.

3.1.3 Education Program

This chapter presents findings from the impact and process evaluation of the 2023 PSO Education program, also known as the Energy Saver Kits Program.

3.1.3.1 Program Overview

The PSO Education Program, known by teachers, students, and parents as the PSO Energy Saver Kits Program, provides educational materials and energy-efficient products to 5th grade students in the PSO service territory. The program provides students with the opportunity to learn about energy efficiency through hands-on classroom activities and gives each student a kit with energy efficient products to reduce their home energy use. Table 3-62 summarizes the overall performance of the program in Program Year 2023.

Table 3-62: Performance Metrics – Education Program

Metric	2023
Number of Customers	12,182
Budgeted Expenditures	$961,595
Actual Expenditures	$681,603
Energy Impacts (kWh)	
Projected Energy Savings	2,722,718
Reported Energy Savings	2,974,457
Gross Verified Energy-savings	2,579,674
Net Verified Energy-savings	2,579,674
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	411.56
Reported Peak Demand Savings	423.92
Gross Verified Peak Demand Savings	387.71
Net Verified Peak Demand Savings	368.57
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.91
Utility Cost Test Ratio	1.74

The Education program consists of four components. (1) Education materials provided to teachers, (2) kits with energy saving measures for students to install at home, (3) An educational take-home workbook for students providing hands-on learning such as exercises assessing energy usage habits, and (4) the PSO Education Program webpage which includes videos, games, and activities on energy efficiency in the home.[28]

Educational materials were developed by the implementer to form a five-day curriculum designed to support the Oklahoma Academic State Standards for 5th graders. The curriculum was designed to be easily integrated into the teacher's curriculum at no cost to the school district, teachers, or students. The ready-made curriculum includes documentation explicitly outlining the Oklahoma Academic Standards supported through the program in language arts, mathematics, and science.

To enhance visual learning, classes receive a colorful poster depicting various energy sources, a brief PSO history, and a character from the curriculum. The program also incorporates quizzes and surveys for students to evaluate knowledge acquisition and encourage family engagement and understanding of the curriculum. A detailed teacher survey assesses the program, and its results are used to verify effectiveness, clarity of materials, and satisfaction with the materials.

Each student is then provided with an Energy Saver Kit containing 4 LED lightbulbs, an LED nightlight, a smart power strip, a furnace whistle, and a digital thermometer (used to adjust refrigerator and water heater temperature settings). Students are given instructions on how to install the measures in the kit and instructed to install them in their homes. The measures provide energy savings to participating families and reinforce concepts taught through the curriculum.

The PSO Education program website provides additional resources for teachers, students, and parents. Teachers can access additional resources and educational materials to enrich the students' experience in the program. Students can access additional information about kit contents and links to educational activities through sites such as the Department of Energy Kids, the Energy Information Administration (EIA) Kids, NASA Climate Kids, GetWise and Smithsonian Kids. Parents can access installation instruction for kit contents and other energy-saving tips.

Some of the available program literature for parents was developed in English and Spanish to add to the program's penetration and efficacy. A "parent pack" was included in the kit that includes a bilingual "Quick Start Guide" to help parents with product installation and other energy-savings tips.

Surveys and quizzes are given to all teachers and students. Over the past three years, at least 81% of teachers reported high student engagement with the lessons. Also, over 80% of teachers in this period found the curriculum to be current, relevant, and a beneficial learning tool, attesting to its effectiveness. The student survey involves a pre-

[28] https://www.pso-education.com/

and post-lesson knowledge test. The average quiz score increased by more than 17% after teachers utilized the provided curriculum.

3.1.3.2 Evaluation Activities

This section presents the evaluation activities conducted for the PSO Education Program. Detailed methodologies are provided in a supplemental document.

3.1.3.2.1 Data Collection

Data sources for the evaluation of the program include:

- Program Tracking Data
- Implementation Invoices
- Student Survey Results
- Student Quiz Results
- Teacher Survey Results
- Staff Facilitated Discussion

The program tracking data and implementation invoices are used for the calculation of verified energy savings through confirmation of kit quantities and components. These documents are reviewed for completeness and consistency.

Two quizzes and two surveys are completed by students as part of the implementation strategy of the program. The quizzes assess the student's knowledge about electricity and energy use before and after participation in the program. The surveys collect information about the home, such as heating fuel and air conditioning system type, and information about program-related activities, including measure installation and behavioral changes. Impact calculations use survey responses to inform the savings analysis.

Program surveys do not collect student contact information. Collecting any student contact information beyond the student's first name would be in violation of the Personal Information Protection Act (PIPA) and Family Educational Rights and Privacy Act (FERPA).

A survey of teachers was conducted to collect information on teacher's perceptions of the program, past participation, how teachers used the curriculum, and their perception of PSO and the Education program.

Finally, a facilitated discussion was conducted with program staff to gain insight into the program execution. Interviews were completed in July 2023 with key personnel responsible for the program and discussed past program year recommendations and brainstormed implementation strategies for future changes. Table 3-63 summarizes the data collection activities and purpose.

Table 3-63: Education Data Collection and Sample Size Effort by Survey

Data Collection Activity	Data Use	Achieved Sample Size
Program Tracking Data	Impact/Process	12,463
PSO Student Survey	Impact/Process	1,677
ADM Teacher Survey	Process	95
Implementation Staff Interviews	Process	1

3.1.3.2.2 Gross Impact Methodologies

To calculate annual energy-savings (kWh) and peak demand impacts (kW), the following evaluation activities were conducted:

- **Reviewed a census of program tracking data**: the tracking data for a census of kits were reviewed. The review looked for data completeness, data entry errors, duplicates, and outlier savings values. Review of program tracking data was conducted periodically during the program year.
- **Reviewed program invoices**: a review of program invoices was conducted to verify shipment of kits reported in program tracking data and reconcile program costs.
- **Calculated gross verified savings**: gross savings were verified using engineering algorithms from industry standard references. The sources for deemed savings algorithms are the 2021 Pennsylvania Technical Reference Manual (PA TRM), Arkansas Technical Reference Manual v8.2 (AR TRM), and Illinois Technical Reference Manual V11 (IL TRM). The Residential Energy Consumption Survey (RECS) was also used to estimate power consumption and energy sources for some measures.
- **Determined measure installation for gross savings adjustments**: the ISR for ENERGY STAR® LEDs, FilterTone® alarms, LED night lights, advanced power strips, water heater temperature setback, and refrigerator temperature increase was calculated using data collected from a sample of program participants in the student surveys.

Detailed descriptions of energy savings methodologies for each measure can be found in a supplemental document. The survey questions and the evaluation inputs for which they were used, are shown in Table 3-64.

Table 3-64: Student Survey Questions and Uses

Survey Question	Question Use
There were four 9-watt LED light bulbs included in your kit. How many of the LED Light Bulbs did your family install on the inside of your home? AND How many of the four LED Light Bulbs did your family install on the outside of your home?	LED Bulbs ISR, Interactive Effects, and Coincidence Factor
Did you or someone else install the Advanced Power Strip in your home? (Yes, I did; Yes, my family and I did; Yes, someone else did; No, it isn't installed)	Advanced Power Strip ISR
If you answered "yes" to question 2, where did you install your Advanced Power Strip?	Advanced Power Strip Savings
Did you or someone else install the FilterTone Alarm in your home? (Yes, I did; Yes, my family and I did; Yes, someone else did; No, it isn't installed)	Furnace Whistle ISR
Did your family install the LED Night Light?	LED Night Light ISR

3.1.3.2.3 Net-to-Gross Estimation

The Education Program has a net-to-gross (NTG) ratio of 100%. The fifth-grade students and parents of the students do not have the option to opt out of the program. The teachers decide whether to participate. As students are presented a series of surveys and quizzes, it is not desirable to add an additional line of questioning.

3.1.3.2.4 Lifetime Savings

Lifetime annual energy savings were calculated by multiplying the verified annual energy savings by the Effective Useful Life (EUL) for each measure type. EUL values for each measure were based on the assumptions in the AR TRM and PA TRM. Table 3-65 shows the EUL and source for each measure type. The lifetime savings for ENERGY STAR® 9W LEDs uses the ISR calculated from the survey for the first year and a rate of 100% for the rest of the EUL. This assumes that unused LEDs from the kit will eventually be installed.

Table 3-65: Education Per-Measure Estimated Useful Life (EUL)

Kit Contents	EUL	Source
ENERGY STAR® 9W LED	19[29]	AR TRM
Advanced Power Strip	10	AR TRM
FilterTone® Alarm	14	PA TRM
LED Night Light	8	PA TRM
Water Heater Temperature Setback	2	IL TRM
Refrigerator Temperature Increase	1	-

3.1.3.2.5 Process Evaluation

The process evaluation was designed to assess program design, operations, and delivery through a discussion with the staff as well as through student and teacher surveys. The evaluation addressed the following research questions to better understand the program's effectiveness and efficiency.

- Were any changes made to the program in the specific program year? If so, why were these changes made and did they accomplish their intended objectives?
- Did implementation of the program reflect its current design? In what ways did it deviate and how did that affect program success?
- Is there effective coordination between program utility and implementation contractor staff to ensure the seamless delivery of the program?
- Were there any notable successes, challenges, or other program developments?
- What quality control processes, if any, have been implemented to guarantee the reliable delivery of kits?
- Is the program progressing towards achieving its kit distribution goals, and if not, what are the obstacles hindering the fulfillment of these objectives?
- Does the program serve all areas of the PSO service territory and all segments of PSO's residential customer population?
- What actions, if any, do participants report taking to save energy and what factors may affect that?
- What is the feedback from teachers regarding the program, educational materials, and kits? To what extent do teachers integrate educational materials into their

[29] ADM followed the AR TRM algorithms for LED bulbs and used EISA Tier 1 baselines for the first year of the measure life (2021-2022), and EISA Tier 2 baselines thereafter.

curriculum, and what subjects or topics would they cover if they did not have access to these materials?

- Are there ways to improve the design or implementation process?

3.1.3.3 Verified Gross Savings Results

Using the methodology described in this chapter, the impact evaluation determines verified annual energy savings (kWh), lifetime energy savings, and peak demand reductions (kW).

3.1.3.3.1 Program Tracking Data

The final program tracking data was reviewed at the end of the year and verified to not contain any issues such as duplicate entries or missing data.

3.1.3.3.2 Measure In-Service Rates (ISR)

Gross energy impacts were adjusted for ISR to determine verified energy impacts based on student survey results. In total, 1,677 student surveys were completed. Table 3-66 displays the in-service rates by measure.

Table 3-66: Education School Kit In-Service Rates

Measure	Number of Measures	ISR
7-Plug Advanced Power Strip	12,182	57%
LED Night Light	12,182	62%
FilterTone® Furnace Filter Alarm	12,182	33%
9-watt LED	48,728	40%[30]
Water Heater Temperature Setback	12,182	22%
Refrigerator Temperature Increase	12,182	19%

3.1.3.3.3 Advanced Power Strip

The student survey was used to determine the proportion of distributed power strips that were installed, and the proportion of installed advanced power strips controlling home offices, home entertainment systems, or other devices. The verified average energy savings and demand reductions were found to be 105 kWh and 0.01 kW per power strip, resulting in a realization rate for advanced power strips of 92% for both energy and demand savings due to a verified in-service rate that was lower than assumed.

3.1.3.3.4 LED Night Light

Verified energy savings differ from reported energy savings due to the differences between the assumed in-service rate (68%) and verified in-service rate (62%). The resulting kWh realization rate is 92%. There is no demand reduction for LED night lights.

3.1.3.3.5 FilterTone® Alarm

Reported energy savings were found to accurately represent verified energy savings with a minor change in ISR. Both the energy and demand savings realization rates are 99%.

3.1.3.3.6 ENERGY STAR® LED

The program tracking data and student survey was used to determine LED in-service rates, interactive effects, and coincidence factors. The differences in savings and demand reductions between ADM and the implementer were due to differences between the verified and assumed values for these inputs as well as a lighting baseline wattage assumption change compared to 2022. As the kits were constructed with bulbs purchased prior to the federal baseline change, lighting savings are warranted for 2023, but may not be considered in 2024. Differences in savings inputs are shown in Table 3-67. The resulting realization rates for energy and demand savings are both 30%.

[30] Average in-service rate across all 4 bulbs. Per bulb in-service rates varied from 56% for the first bulb to 25% for the fourth bulb, like the rates from the previous year, which varied from 60% to 29%. The 2023 average in-service rates decreased from the 2022 in-service rate of 43%.

Table 3-67: Differences Between Assumed and Verified Inputs for LED Light Bulb Calculations – Education Program

Calculation Input	Reported/Previous Value	Verified Value
In-Service Rate	43%	40%
Interactive Effect (Energy)	0.94	0.93
Interactive Effect (Demand)	1.23	1.23
Coincidence Factor (CF)	0.075	0.072
Baseline Wattage (W)	43	20

3.1.3.3.7 Water Heater Temperature Setback

Energy savings for this measure has not been previously reported. A deemed savings value from the Illinios TRM was adjusted by student survey results for the water heater fuel source and ISR to determine verified savings values.

3.1.3.3.8 Refrigerator Temperature Setting

The AR TRM was used to determine a deemed savings value based on a weighted average of pre-existing refrigerator temperature assumptions. The efficient condition refrigerator temperature is assumed to be at the curriculum proposed value of 38°F. Savings were adjusted based on the student survey results for ISR.

3.1.3.3.9 Verified Kit Energy Savings

Verified annual energy savings and peak demand reduction are based on unit-level gross energy impacts adjusted for ISR for each energy efficiency measure. Table 3-68 details the education kit contents and savings impacts per measure.

Table 3-68: Summary of Kit Contents and Verified Energy Savings and Demand Reduction– Education Program

Kit Contents	Quantity	Verified kWh Savings Per Measure	Verified kW Reduction Per Measure	Verified kWh Savings Per Kit	Verified kW Reduction Per Kit
7-Plug Advanced Power Strip	1	104.62	0.0120	104.62	0.0120
LED Night Light	1	16.39	0.0000	16.39	0.0000
FilterTone® Furnace Filter Alarm	1	60.44	0.0164	60.44	0.0164
9-watt LED	4	3.93	0.0004	15.73	0.0016
Water Heater Temperature Setback	1	9.59	0.0011	9.59	0.0011
Refrigerator Temperature Increase	1	4.99	0.0007	4.99	0.0007
Total				**211.76**	**0.0034**

Table 3-69 and Table 3-70 show a comparison of the verified gross annual energy-savings (kWh) and peak demand reduction (kW) of the 2023 Education Program, by measure to the reported savings estimates.

Table 3-69: Gross Energy-Savings (kWh) Summary by Measure for 2023

Measure	Reported Energy (kWh) Savings	Verified Energy (kWh) Savings	Realization Rate (kWh)	Verified Lifetime Energy Savings (kWh)
7-Plug Advanced Power Strip	1,378,336	1,274,465	92.5%	12,744,646
LED Night Light	217,510	199,634	91.8%	1,597,070
FilterTone® Furnace Filter Alarm	742,265	736,282	99.2%	10,307,947
9-watt LED	636,346	191,676	30.1%	8,828,160
Water Heater Setback	-	116,844	-	233,688
Refrigerator Temperature Increase	-	60,774	-	60,774
Total	**2,974,457**	**2,579,674**	**86.7%**	**33,772,284**

Table 3-70: Gross Demand Reductions (kW) Summary by Measure for 2023

Measure	Reported Demand (kW) Reduction	Verified Demand (kW) Reduction	Realization Rate (kW)
7-Plug Advanced Power Strip	158.51	146.49	92.4%
LED Night Light	0.00	0.00	-
FilterTone® Furnace Filter Alarm	201.50	199.91	99.2%
9-watt LED	63.91	19.14	29.9%
Water Heater Setback	0.00	13.32	-
Refrigerator Temperature Increase	0.00	8.85	-
Total	**423.92**	**387.71**	**91.5%**

Reported savings are based on the verified program savings from 2022, meaning differences between the reported and verified program savings are due to differences in installation locations (indoor vs. outdoor for LEDs and system type for the advanced power strip) from 2022 results (used for reported estimates) LED baseline wattage changes, including water heater and refrigerator temperature changes as new measures, and a verified in-service rate that was lower than assumed.

3.1.3.4 Process Evaluation Findings

ADM's process evaluation activities included student and teacher surveys as well as a structured conversation with key personnel responsible for the program. ADM provided a detailed process evaluation memo to PSO after the completion of the 2023 program year.

3.1.3.4.1 Program Activity

A total of 12,463 kits were sent to 342 fifth-grade teachers in 2023. This is down from the 15,926 and 455 teachers from last year and lower than previous years. The fewer kits are reflected in lower overall energy savings.

3.1.3.4.2 Facilitated Discussion Findings

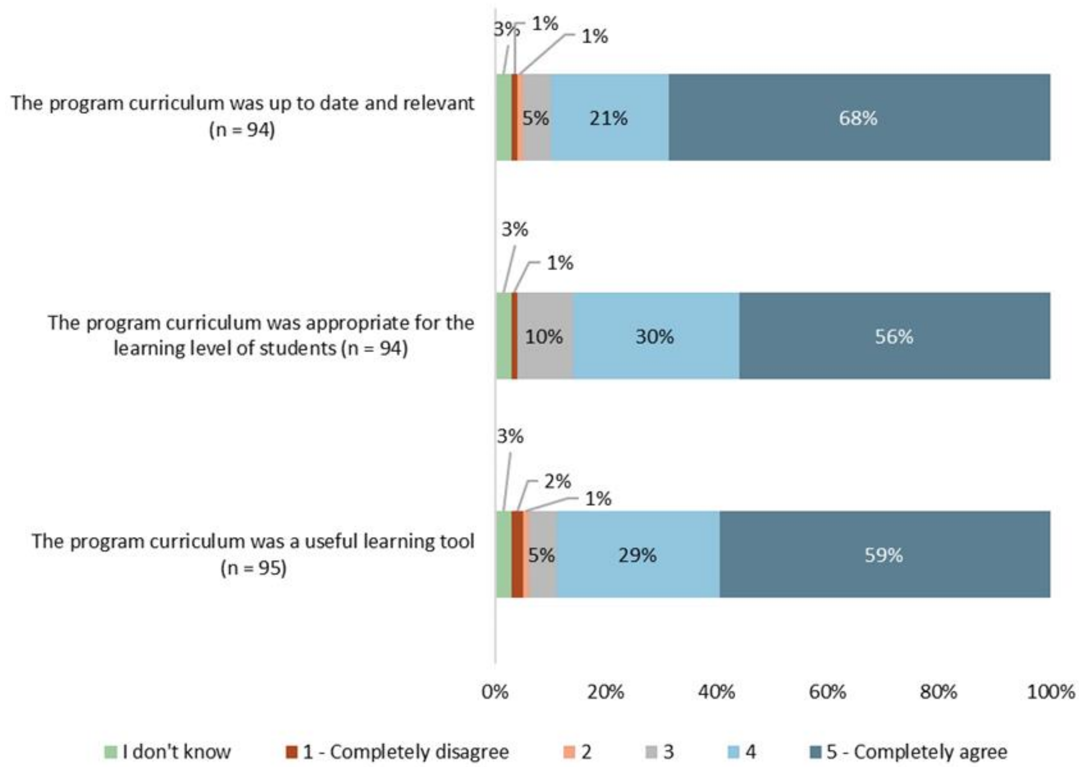
Digital and interactive materials are now available for teachers and students, offering a new method of delivery while maintaining the same content as the previous paper-based materials. Additionally, internal process improvements were implemented to streamline outreach efforts. The program has transitioned to a new email platform, HubSpot, which allows for more efficient communication and tracking of touch points with teachers. The program has been successful in reaching approximately 80% of the total market potential.

3.1.3.4.3 Teacher Survey

ADM distributed an electronic survey among 299 participating teachers to gauge their experience with the curriculum, assess its implementation in their classrooms, and measure overall satisfaction. Ninety-five teachers completed the survey.

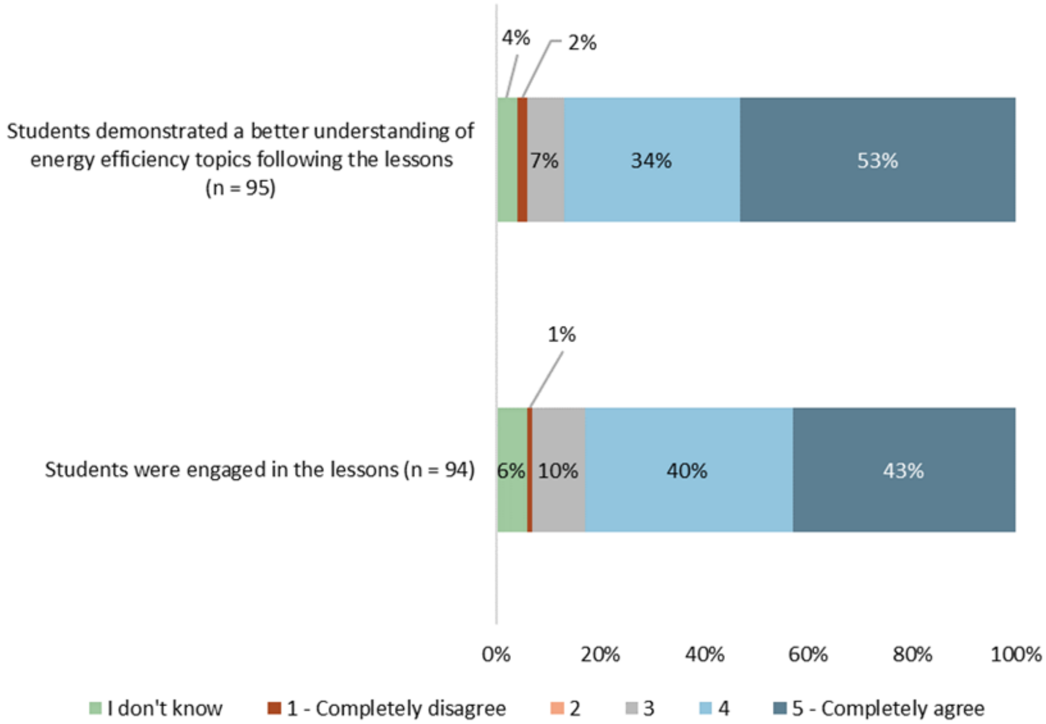
Most teachers agreed that the program curriculum was up-to-date and relevant, appropriate for the learning level of their students, and a useful learning tool (Figure 3-24).

Figure 3-24: Teacher Perceptions of the Program Curriculum



Teachers agreed that students were engaged with lessons and that they demonstrated a better understanding of energy efficiency topics following the lessons (Figure 3-25).

Figure 3-25: Perception of Student Experience



Most teachers (73%) reported that the program-provided lesson plans teach concepts that they normally teach in their regular curriculum. If educators had not enrolled in the PSO Energy Saver Kit program, their energy efficiency courses would have differed in several ways. Some mentioned that without the program, live demonstrations would have been omitted, and there would be fewer hands-on activities due to material constraints. Several educators expressed gratitude for the PSO materials, stating that their curriculum would have been shorter and less hands-on without the program. Many emphasized the value of PSO as a supplement to their existing curriculum, providing a unique and informative perspective on energy efficiency. Overall, educators noted that the absence of PSO would result in less relevant, less detailed, and less relatable content with fewer resources for their students.

3.1.3.4.4 Student Results

Evaluators compared students pre- and post-test scores. Of the completed tests analyzed, the pre-test scores averaged 58%, while the post-test averaged 75%. The difference between pre- and post-test scores was 17 percentage points and was statistically significant (Table 3-71). The change in pre/post-quiz scores indicates an improvement in overall test scores.

Table 3-71: Analysis of Test Scores – Education Program

Measurements	Pre-Survey (n = 1,423)	Post-Survey (n = 1,536)	P-value
Mean of test scores	58%	75%	<0.0001

3.1.3.5 Conclusions and Recommendations

The following are the key conclusions from the evaluation of the Education program.

- Overall participation and ISR are lower than in previous years. The number of kits sent out and number of participating teachers decreased by over 20%. Additionally, the ISRs for the Advanced Power Strip, 9-watt LEDs, and LED nightlight each dropped by approximately 5%.
- The program's strength lies in its significant impact on teachers and students, providing valuable resources that are integral to lesson plans. Students demonstrated a 17% increase in knowledge of the energy efficiency content and 88% of teachers found the content to be useful training material towards their required curriculum.
- Teachers praised the Energy Saver Kit program curriculum for its relevance, suitability, and effectiveness as a teaching tool. Educators emphasized the program's essential role in providing depth, engagement, and hands-on experiences, enhancing their energy courses compared to traditional methods.

The following recommendations are offered for continued improvement of the Education Program.

- Consider developing press releases focused on highlighting success stories and underscoring the program's strengths in positively impacting students. Additionally, consider inviting local news outlets to visit schools, displaying students actively engaging with the kit contents as part of the success narrative.
- Continue enhancing digital materials and teacher training to modernize the program's resources and to keep students and teachers engaged with the curriculum. Organize targeted training for teachers to integrate refined content into lesson plans. This ensures the program stays current and effective.
- Consider additional Spanish translations for program materials aimed to enhance inclusivity, catering to a broader audience. This initiative would help to break down any potential language barriers, allowing Spanish-speaking students, parents, and educators to fully engage with the curriculum.

3.1.4 Multifamily and Manufactured Homes Program

This chapter presents findings from the impact and process evaluation of the Multifamily and Manufactured Homes Program. The impact evaluation consists of verification of annual energy savings (kWh) and peak demand reduction (kW) with the inclusion of in-service rates, and net savings impacts. The process evaluation provides insights into program design and implementation.

3.1.4.1 Program Overview

The Multifamily Program is in its fifth year in the Public Service Company of Oklahoma (PSO) portfolio during program year 2023. Table 3-72 illustrates performance metrics for the Multifamily and Manufactured Homes Program.

To be eligible for the Program, the property must be composed of three or more dwelling units within the service territory or a manufactured home with electric heat. Energy efficiency equipment is eligible within dwelling units, in common areas, and in office spaces. Measures for manufactured homes include direct installation measures (LED screw-in light bulb, low-flow showerheads, and faucet aerators) as well as duct sealing and air sealing.

Table 3-72: Performance Metrics - Multifamily Program

Metric	2023
Number of Customers	760
Budgeted Expenditures	$1,501,070
Actual Expenditures	$931,229
Energy Impacts (kWh)	
Projected Energy Savings	1,717,460
Reported Energy Savings	3,227,131
Gross Verified Energy Savings	3,151,790
Net Verified Energy Savings	3,054,075
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	399.53
Reported Peak Demand Savings	644.38
Gross Verified Peak Demand Savings	647.34
Net Verified Peak Demand Savings	618.98
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	2.89
Utility Cost Test Ratio	2.53

The Program provides comprehensive energy efficient measures for qualifying Multifamily properties and Manufactured Homes in the PSO service territory. The program offers direct installation measures (ENERGY STAR® LEDs, faucet aerators, and low-flow showerheads) at no cost to the participating property. Tenant dwellings that receive direct installation measures are eligible for an energy survey. The energy survey is turned into a report that compares the energy use of the property to similar properties in the neighborhood, recommends ways to be more energy efficient, and shows potential savings of energy upgrades. The program offers commercial energy efficiency measures in addition to the residential measures. The commercial measures include LED lamps and fixtures, air infiltration, ceiling insulation, duct sealing, HVAC system replacements, water heaters, ENERGY STAR® windows, ENERGY STAR® pool pumps, ENERGY STAR® washing machines, ENERGY STAR® dryers, vending machine controls, and ice machines.

The program combines the provision of financial inducements with access to technical expertise. The aim is to maximize Program penetration across a range of potential customers. The Program has the following goals:

- Increase owner/operator awareness and knowledge of applicable energy-saving measures and their benefits.

- Increase the market share of Commercial-grade high-efficiency technologies sold through market channels.
- Increase the installation rate of high-efficiency technologies in Multifamily facilities by businesses that would not have done so absent the Program.
- Provide energy efficiency offerings to underserved manufactured home settings.

The Program defines prescriptive rebate amounts to participating customers for some measures, including certain types of lighting, lighting controls, HVAC equipment, water-related equipment, and other equipment. The Program pays rebates for custom projects (e.g., chillers) that do not fall into prescriptive measure categories by annual energy savings and peak demand impact basis. Table 3-73 summarizes Program activity by the percentage of reported savings by measure type.

Table 3-73: Percentage of Reported Savings by Measure Type – Multifamily and Manufactured Homes Program

Measure Type	Percent of Program
HVAC	59.24%
Lighting	29.94%
Building Envelope	9.40%
Water Heating	1.07%
Appliances	0.35%

Air sealing, duct sealing, faucet aerators, LEDs, and low-flow showerheads were all offered for manufactured homes. A breakout of measure implemented for manufactured homes and multifamily homes is shown in Table 3-74.

Table 3-74: Installed Measures for Multifamily and Manufactured Homes

Measure	Manu. Home Measure Count	Multifamily Measure Count	Manu. Home Reported kWh	Multifamily Reported kWh
Duct Sealing	33	593	196,903	1,490,310
Lighting	N/A	28	N/A	580,386
LED Screw-In Lamp	25	17	7,039	355,250
Heat Pump	N/A	36	N/A	220,596
Attic Insulation	N/A	23	N/A	115,667
Air Sealing	30	166	46,810	107,285
Window	N/A	2	N/A	33,465
Whole Building Approach (NC Lighting)	N/A	2	N/A	23,664
Low Flow Shower Head	16	2	8,418	21,924
ENERGY STAR Refrigerator	N/A	4	N/A	7,503
Air Conditioner	N/A	4	N/A	3,503
Faucet Aerator	20	2	1,942	2,264
Pool Pump	N/A	1	N/A	2,183
ENERGY STAR Clothes Washer	N/A	2	N/A	1,520
AC Tune-Up	2	N/A	498	N/A
Total	**126**	**921**	**261,610**	**2,965,521**

3.1.4.2 Evaluation Activities

This section presents the evaluation activities conducted for the program. Detailed methodologies can be found in a supplemental document.

Data Collection

Data collection activities for the evaluation consisted of a review of program materials, on-site verification visits, a facilitated discussion with program staff, service provider interviews, and interviews with participating owners/managers.

Program information and documentation was obtained for the census of projects within the program. Documentation included energy savings algorithms and inputs, project invoices, equipment specification sheets, and any available implementation documents such as inspection reports. Information on equipment was also acquired from industry references such as the Air Conditioning, Heating, and Refrigeration Institute (AHRI) and the Design Lighting Consortium (DLC).

Multiple on-site inspections were performed to confirm measure installation and gather information to better inform the program analysis. Data collection activities included property owner/manager surveys, service provider interviews, and a program staff facilitated discussion. There was no monitoring equipment deployed during site visits, instead site visits were used to gather baseline conditions and efficient equipment conditions such as quantities, specifications, locations, and operating conditions. The property owner/manager surveys provided self-reported data for the net-to-gross (NTG) analysis as well as process evaluation input. Table 3-75 shows the achieved sample sizes for the different types of data collection activities utilized for this study.

Table 3-75: Multifamily and Manufactured Homes Sample Sizes for Data Collection Efforts

Evaluation Activity	Achieved Sample Size
On-Site Visit	2
Property Owner/Manager Survey	4
Facilitated Discussion with Program Staff	1
In-depth Interviews with Service Providers	2
Engineering Desk Review	Census

3.1.4.2.1 Gross Energy Impacts Methodology

A census review of program tracking data was performed to determine gross energy savings program results. The following steps were used to evaluate the Program's gross energy savings and peak demand reduction:

- Program tracking data was reviewed throughout the year to determine the scope of the Program and to ensure there were no data issues such as duplicate entries or missing data.
- A detailed engineering desk review was conducted for each project completed in the Multifamily program. The desk review process includes a thorough examination of all project documents, including invoices, equipment cut sheets, pre, and post-inspection reports, and estimated savings calculators. The review process led to further requests for information and/or project documents for corresponding projects determined to have potential for savings realization discrepancies.
- Verified gross savings impacts were calculated. The sources for deemed savings algorithms are the 2013 Oklahoma Deemed Savings Document, Arkansas Technical Reference Manual v.8 (AR TRM), and Mid-Atlantic Technical Reference Manual v.8 (Mid-Atlantic TRM).
- Data collected through site visits and surveys was used to revise any savings calculations, as necessary. For example, if the reported savings calculations relied

on operating hours for a given measure that was inaccurate based on the on-site verification and data collection, changes are made to reflect actual operating conditions more accurately.

- Net energy impacts are determined through survey results of property owners/managers to assess the impact of free ridership.
- Lifetime energy savings are determined through application of industry standard effective useful life (EUL) references by equipment type such as the AR TRM.

Table 3-76 below illustrates the references used to calculate annual energy savings, peak demand reductions, and lifetime energy savings for the various measures included in the Multifamily Program.

Table 3-76: Multifamily References for Energy Savings Calculations

Measure	Methodology References
Air Conditioner	Arkansas TRM v.8.1, Section 2.1.6
Air Conditioner Tune-Up	Arkansas TRM v.8.1, Section 2.1.5
Air Infiltration	Arkansas TRM v.8.1, Section 2.2.9
Ceiling Insulation	Arkansas TRM v.8.1, Section 2.2.2
Duct Sealing	2013 OKDSD, Section 5
Faucet Aerators	Arkansas TRM v.8.1, Section 2.3.4
Heat Pumps	2013 OKDSD, Section 12
Pool Pumps	Arkansas TRM v.8.1, Section 2.4.5
Low-Flow Showerheads	Arkansas TRM v.8.1, Section 2.3.5
ENERGY STAR® Refrigerator	Arkansas TRM v.8.1, Section 2.4.3
ENERGY STAR® Windows	2013 OKDSD, Section 6
Lighting Efficiency	Arkansas TRM v.8.1, Section 2.5.1.4
	Arkansas TRM v.8.1, Section 2.5.1.3
	Arkansas TRM v.8.1, Section 3.6.2
	Arkansas TRM v.8.1, Section 3.6.3
ENERGY STAR® Dryer	Mid-Atlantic TRM v8.0
ENERGY STAR® Washing Machine	Arkansas TRM v8.1 2.4.1
Water Heater	Arkansas TRM v8.1 2.3.1

3.1.4.2.2 Net-to-Gross Estimation (NTG) Methodology

Net-to-Gross estimation (NTG) was used to determine what portion of gross savings achieved by PSO customers is the direct result of program influence. A survey was administered to owners/managers of Multifamily properties to assess free ridership and spillover for the calculation of NTG. The survey responses were reviewed to assess the likelihood that participants were free riders. The free ridership methodologies used for determining what portion of a customer's savings are attributable to the program varied by whether measures were direct installation or non-direct install. Details on the methodology can be found in a supplemental document.

3.1.4.2.3 Lifetime Energy Savings

Lifetime energy savings (kWh) is the product of annual energy savings (kWh) multiplied by the Effective Useful Life (EUL). The EUL considers the technical lifespan of the equipment as well as the change in energy savings over time. The EUL is determined by measure for each measure within each project of the evaluation sample. The EUL for prescriptive measures is sourced from the AR TRM v8.0. If a measure is not listed in the AR TRM, then a different industry standard reference, such as another technical reference manual, is considered.

3.1.4.2.4 Process Evaluation Methodology

The process evaluation is designed to answer the following research questions:

- What motivates owners/property managers to participate in the program? What barriers prevent participation?
- How well did PSO staff, service providers, implementation contractors, and property managers/owners work together? Is there rebate processing, data tracking, and/or communication efficiencies that can be gained?
- Did the program implementation reflect its design? Are there underlying assumptions about program implementation and design that are being made about how the program will unfold? Are there ways to improve the design or implementation process?
- Were property managers/owners satisfied with their experience? What was the level of satisfaction with the rebate amount, the application process, the rebated measures, and other aspects of program participation?
- What are PSO staff and implementation staff perspectives on the program? What are the reactions to program design choices that have been implemented?
- What are the key indicators of program success? Is the program achieving success? Do various stakeholders perceive the program to be successful?
- Were there any significant obstacles during the 2023 program year?
- Looking forward, what are the key barriers and drivers to program success within PSO's market?

To address these questions, the process evaluation activities included a survey of decision makers and interviews with service providers and program staff (facilitated discussion) to gain insight into program design and implementation. Table 3-77 details the data collection activities performed for this program's evaluation.

Table 3-77: Multifamily Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Program Staff Facilitated Discussion	Discuss decisionmaker journey to create a common understanding of participation experience and identify key touchpoints to create a journey map.
Review Program Materials	Review program design or implementation materials, customer engagement materials, program procedure manuals, program websites, and other program documentation as it becomes available. This includes application forms, savings calculation spreadsheets, databases, and tracking systems to verify relevant information needed for the evaluation is being collected.
Property Owner/Manager Survey	Gather data on participant knowledge and awareness of the program, business practices, satisfaction, reasons for participating, decision-making process, as well as general attitudes and behaviors regarding energy efficiency, PSO's Multifamily program, and PSO as their utility.
Service Provider Interviews	Assessment of program changes, barriers to participation, satisfaction with program procedures and how it compares to other programs in the region; and assessment of program customer engagement materials, training, and communications with program staff.

3.1.4.3 Impact Evaluation Findings

Impact evaluation findings determine net annual energy savings (kWh) and net coincident peak demand reduction (kW). Net impact results are determined through the application of net-to-gross ratios applied to the verified gross energy impacts through evaluation activities. Gross energy impacts have been determined through a census desk review of all projects accompanied by data collection of surveys and site visit verification.

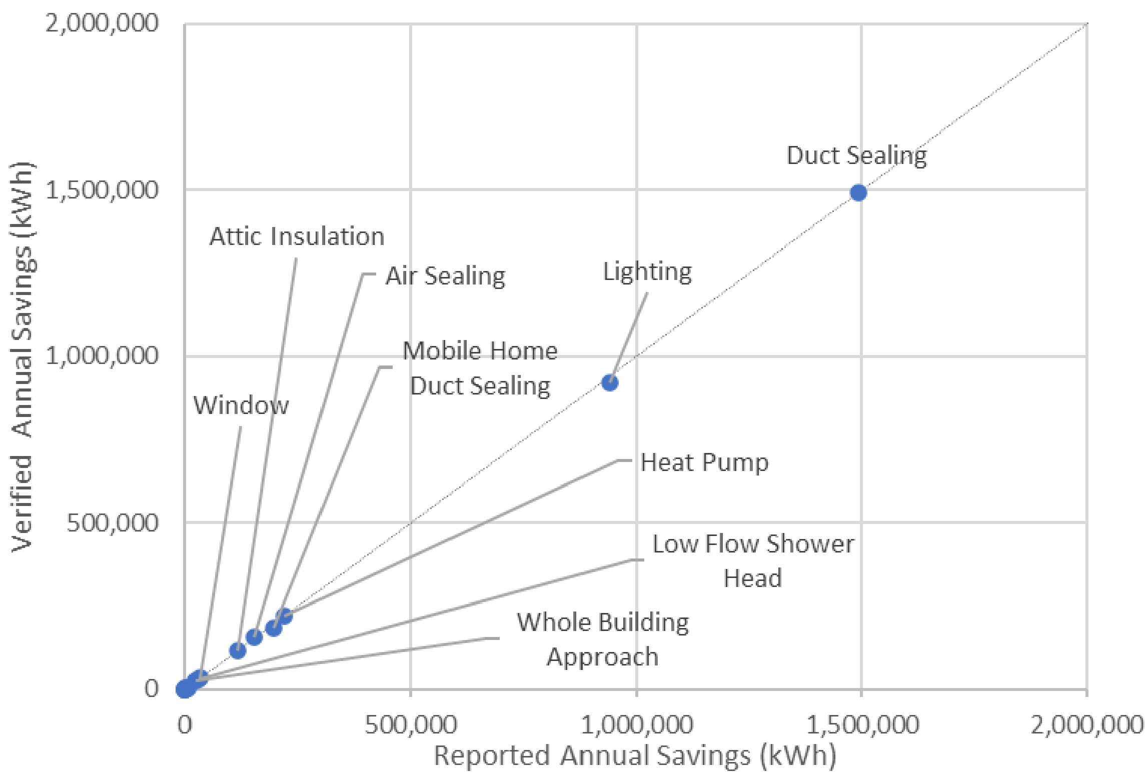
3.1.4.3.1 On-Site Verification

Field work was performed to verify baseline and efficient equipment installation, quantities, and efficiencies. The test-in/test-out values for blower door testing were confirmed during the site visits with implementation staff. Additionally, the use of incandescent bulbs as the baseline for the "LED Screw-In Bulb" measure was confirmed during the site-visits. One of the projects was a new construction facility where ADM staff was present for the test-out blower door testing. There was no documentation for the test-in blower testing, however the reported values were compared to maximum values from the TRM and were found to be reasonable.

3.1.4.3.2 Verified Gross Savings

The program in 2023 consisted of 15 measure types spanning both direct install measures and non-direct install measures. A graphical representation of the relative contribution of measures to the Program's reported savings. Verified savings and realization rates are shown in Figure 3-26. The solid line in the figure indicates a theoretical 100% realization rate. As shown in the figure, duct sealing, lighting, and heat pumps are the measures with the largest impact on the program. Duct sealing contributes 46% of program savings, followed by lighting with 29%. The top contributing measures are labeled while measures with minimal impact are not labeled. Those not labeled include air conditioners, ENERGY STAR® washing machines, refrigerators, faucet aerators, and AC tune-ups.

Figure 3-26: Multifamily and Manufactured Homes Reported vs. Verified Measure Level Energy Savings



The program level realization rate for gross annual energy savings is 98% with measure level variation from 35% to 113%. Figure 3-27 below illustrates the factors causing savings discrepancy and the frequency in which they occurred, while Figure 3-28 illustrates the change in savings affected due to these different factors.

Figure 3-27 Multifamily and Manufactured Homes Factors Affecting Realization Rates, Measures Affected

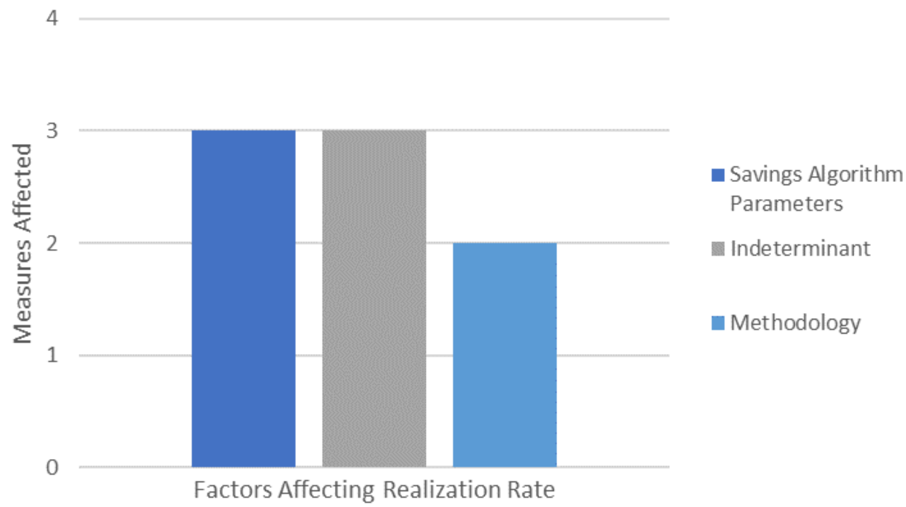
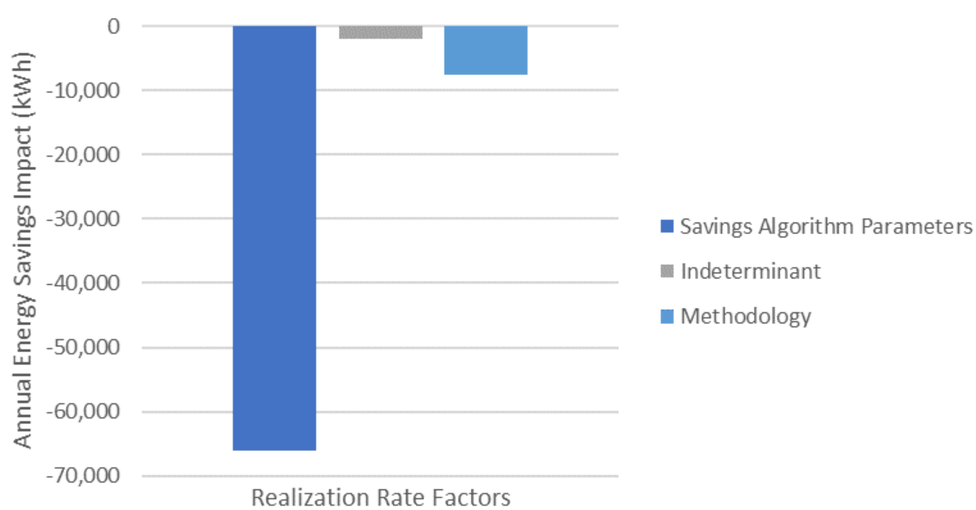


Figure 3-28 Multifamily and Manufactured Homes Factors Affecting Realization Rates, Savings



There were no discrepancies found in energy savings calculations for most of the energy efficiency measures in the program. Measures with any sort of savings discrepancy are detailed below.

Savings Algorithm Parameters

For the measures where "Savings Algorithm Parameters" was the reason for the savings discrepancy, the methodology to calculate savings was determined to be correct, but there was found to be an issue with the savings inputs used to determine savings. For these measures, the input difference could be anything from interactive effects, hours of use, or from spec sheets reflecting different efficiencies than what was reported. The measures where “Input” affected realization rates were lighting, pool pumps, air conditioners, ENERGY STAR® Refrigerators, and retrofit lighting.

Indeterminant

For the measures where “Indeterminant” was the reason for the savings discrepancy, the exact reason for the savings discrepancy could not be determined. The measures where this was chosen were whole building approach, air conditioners, and pool pumps. Savings for these measures were determined using the provided values and TRM inputs. The claimed savings could not be recreated to explain the reason for the discrepancy.

Methodology

For the measure where “Methodology” was chosen as the reason for the savings discrepancy, it was determined that there was a difference in the methodology used for the reported and verified savings calculations. This was the reason for discrepancy for attic insulation and mobile home duct sealing. Both the reported and verified savings calculations for attic insulation utilized the AR TRM for determining savings, however, the verified savings were determined using an optional, more precise method.

A more detailed explanation for the savings discrepancies of the installed measures is included in the following section.

3.1.4.3.3 Measure Level Verified Savings

Table 3-78 details gross annual energy savings for each measure present in the program. Findings for measure types that deviated from reported estimates are explained below.

Table 3-78: Verified Gross Annual Energy Savings by Measure – Multifamily and Manufactured Homes Program

Equipment	Reported kWh	Verified kWh	kWh RR
Duct Sealing	1,490,310	1,490,556	100%
Lighting	942,675	837,648	89%
Heat Pump	220,596	263,612	120%
Mobile Home Duct Sealing	196,903	188,166	96%
Air Sealing	154,095	154,095	100%
Attic Insulation	115,667	116,874	101%
Window	33,465	33,465	100%
Low Flow Shower Head	30,342	30,341	100%
Whole Building Approach (NC Lighting)	23,664	23,908	101%
ENERGY STAR Refrigerator	7,503	3,454	46%
Faucet Aerator	4,207	4,228	100%
Air Conditioner	3,503	1,227	35%
Pool Pump	2,183	2,196	101%
ENERGY STAR Clothes Washer	1,520	1,520	100%
AC Tune-Up	498	498	100%
Total	**3,227,131**	**3,151,790**	**98%**

Approximately 92% of program savings were attributed to multifamily facilities and 8% to manufactured homes compared to a two-thirds and one-third split from the previous program year. Reported and verified savings by building type is shown in Table 3-79.

Table 3-79: Multifamily and Manufactured Homes Reported and Verified Gross Savings by Building Type

Building Type	Reported kWh	Reported kW	Verified kWh	Verified kW
Manufactured Home	261,610	46.69	247,315	42.25
Multifamily Building	2,965,521	597.69	2,904,475	602.09
Program Total	**3,227,131**	**644.38**	**3,151,790**	**647.34**

Mobile Home Duct Sealing

The annual energy savings realization rate for mobile home duct sealing is 96%. The reason for the discrepancy is due to a line item where the reported savings exceed the maximum savings of 6,000 kWh that had been previously set for the measure. Verified savings is based on savings methodologies from the AR TRM.

Pool Pump

The annual energy savings and demand reduction realization rate for pool pumps are 101% and 99%, respectively. There was a single line item for this measure with savings that made up less than 1% of program savings. Savings were determined using the AR TRM, the factor causing the savings discrepancy was deemed indeterminant.

Retrofit Lighting

The annual energy savings and demand reduction realization rates for retrofit lighting measures are 89% and 90%, respectively. The primary factor driving the realization rate is an update to baseline wattages for applicable projects. Savings inputs were otherwise taken from the AR TRM as applicable.

Attic Insulation

The annual energy savings and demand reduction realization rates for attic insulation are both 101%. Both the reported and verified calculations utilized the AR TRM for determining savings. The TRM offers default savings values per square foot. of installation along with an option to interpolate the savings value using the as-found R-value for more accurate savings calculations. The reported calculations used the default values associated with an efficient R-value of 38 in savings calculations, whereas the verified calculations determined savings per square foot of installation by interpolating the reported R-value. The difference in the interpolated savings vs. the default is the reason for the discrepancy.

Whole Building Approach

The program tracking data included two projects under Whole Building Approach which made up ~1% of program savings. The annual energy savings realization rate for this measure is 101% with a realization rate of 431% for demand reduction. The projects were New Construction Lighting projects, so a lighting power density (LPD) savings approach was considered. The baseline condition was determined to be based on ASHRAE 90.1-2007; consistent with the AR TRM v8.1. The efficient condition was determined based on provided project documentation. Algorithm inputs used in this calculation were based on the provided project documentation and assumptions from the AR TRM. The factors affecting the realization rates for this measure were deemed indeterminant.

Heat Pump

The annual energy savings and demand reduction realization rates are 120% and 65%, respectively. Review of the program tracking data reveals there are inconsistencies in the reported efficient equipment specifications and baselines, specifically instances where reported baselines are coming from different sources such as the OKDSD or previous versions of the AR TRM. The efficient condition was determined from provided project documentation, while the baseline efficiencies were based on updated federal standards that became effective on January 1, 2023.

ENERGY STAR® Refrigerator

The annual energy savings and demand reduction realization rates for this measure were 46% and 7%, respectively. Project documents were reviewed to determine the type of refrigerator that was installed and confirm the savings inputs provided in the project documentation match the TRM. The inputs were taken from the TRM based on the equipment type installed, it was confirmed that the values match with what was presented in project documents. The realization rate is being driven by a single line item with per-unit reported savings that are around a magnitude of 10 times greater than typical deemed savings.

Air Conditioner

The annual energy savings realization rate for this measure is 35% with four line-items contributing less than 1% of program savings. Verified savings impacts are based on efficiency ratings and capacities from the AHRI directory, based on the installed equipment, whereas the claimed savings impacts utilize the spec sheet ratings of the installed equipment. All instances for this measure utilized the same equipment, however one of the line-items had a per-unit reported savings that was eight times the other line items.

3.1.4.3.4 Coincident Peak Demand Reduction (kW)

The overall realization rates for the peak demand reduction are 98%. Factors affecting the realization rate were discussed for the listed measures in the previous section. The biggest factor that affected the demand reduction realization rate was some inconsistencies in baseline efficiencies used to determine the reported savings values for heat pumps. The next largest factor was from retrofit lighting, where some line items required an update to baseline wattages. Demand reduction by measure is shown in Table 3-80.

Table 3-80: Verified Gross Peak Demand Reduction by Measure – Multifamily and Manufactured Homes Program

Equipment	Total Reported kW	Total Verified kW	kW RR
Duct Sealing	404.97	404.97	100%
Lighting	70.31	77.11	110%
Heat Pump	44.02	28.56	65%
Mobile Home Duct Sealing	40.40	39.85	99%
Attic Insulation	32.29	32.55	101%
Air Sealing	19.75	19.75	100%
Window	11.04	11.04	100%
ENERGY STAR Refrigerator	7.09	0.50	7%
Whole Building Approach (New Construction Lighting)	6.29	27.07	431%
Low Flow Showerhead	3.16	3.16	100%
Air Conditioner	2.84	0.55	19%
Pool Pump	1.17	1.16	99%
Faucet Aerator	0.44	0.44	100%
ENERGY STAR Clothes Washer	0.36	0.36	100%
AC Tune-Up	0.27	0.27	100%
Total	**644.38**	**647.34**	**100%**

3.1.4.3.5 Net-To-Gross Estimation Findings

ADM estimated an overall NTG score of 0.97 for the Multifamily and Manufactured Homes Program in 2023. NTG was determined independently for non-direct installation measures (referred to as major measures) and direct installation measures.

- For the "major measure" segment of the program, ADM found a weighted NTG score of 0.97. Three of the four decision-makers said they did not have prior plans to install the major measures ADM asked about in its survey. One of these decisionmakers specifically stated that their organization would not have had the financial ability to make the improvements without the program. Another stated that they were unable to make upgrades to another one of their properties because incentives were not enough to offset the cost of those improvements. One of the four decision makers indicated that they had plans to make the improvements before hearing about the program and would have made the improvements within the same year without the program.

- Findings from the 2023 decisionmaker surveys led to the assignment of a NTG score of 0.75 for “direct install” water-saving measures (low-flow showerheads and faucet aerators). ADM utilized its 2022 survey results to assign a NTG score of 1.0 for screw-in LEDs as insufficient information was gathered in 2023 to calculate a score. ADM spoke to two decisionmakers about the low-flow showerheads they received through the program. Both indicated that their organization had purchased low-flow showerheads in the past and had plans to purchase and install more within one year, before they had heard about the program. They stated that they would have installed the same number of low-flow showerheads, though only a portion of them would have been installed within the same year. None of the respondents to ADM’s 2023 decision-maker survey provided decision-making information related to LED screw-in lamps.

The NTG ratios are calculated as 1-free-ridership plus spillover. Results are shown in Table 3-81 for annual energy savings and Table 3-82 for peak demand reduction.

Table 3-81: Multifamily and Manufactured Homes Net Energy Savings

Program	Expected kWh Savings	Verified Gross kWh Savings	Free Ridership (kWh)	Verified Net kWh Savings	Net to Gross Ratio
Multifamily	3,227,131	3,151,790	97,716	3,054,074	96.90%
Total	**3,227,131**	**3,151,790**	**97,716**	**3,054,074**	**96.90%**

Table 3-82: Multifamily and Manufactured Homes Net Peak Demand Savings

Program	Expected Peak kW Reductions	Verified Gross kW Reductions	Free Ridership (kW)	Verified Net kW Reductions	Net to Gross Ratio
Multifamily	644.38	647.34	28.09	618.98	95.52%
Total	**644.38**	**647.34**	**28.09**	**618.98**	**95.62%**

3.1.4.3.6 Lifetime Energy Savings

Lifetime energy savings were calculated by multiplying the annual energy savings by the effective useful life (EUL) from the corresponding AR TRM section. Lifetime energy savings and average EUL by measure type are shown in Table 3-83.

Table 3-83: Multifamily and Manufactured Homes Measure EUL's and Lifetime Energy Savings

Equipment	EUL	Gross Lifetime Savings (kWh)	Net Lifetime Savings (kWh)
Duct Sealing	18	26,830,021	25,963,411
Lighting	7	5,434,806	5,295,234
Heat Pump	16	4,217,792	4,081,557
Mobile Home Duct Sealing	18	3,386,993	3,277,593
Attic Insulation	20	2,337,480	2,261,979
Air Sealing	11	1,695,045	1,640,295
Window	20	669,300	647,682
Low Flow Showerhead	10	303,410	227,558
Whole Building Approach (NC Lighting)	11	262,988	254,493
ENERGY STAR Refrigerator	17	58,718	56,821
Faucet Aerator	10	42,280	31,710
Air Conditioner	19	23,313	22,560
Pool Pump	10	21,960	21,251
ENERGY STAR Washing Machine	14	21,280	20,593
AC Tune-Up	10	4,980	4,819
Total		**45,310,366**	**43,807,556**

3.1.4.4 Process Evaluation Findings

Process evaluation activities included a survey for property owners/managers, service provider interviews, and a facilitated discussion with program staff. A detailed process evaluation memo was provided to PSO after the completion of the 2023 program year.

3.1.4.4.1 Service Provider Perspectives

The two primary service providers that participated in the Program were interviewed. Respondents noted that participation in the Program has increased the volume of their home energy efficiency improvement projects. One respondent observed that the program's key strengths were that it helped property owners and managers reduce their utility costs and to increase their properties' value. Staff at both service provider organizations noted property owners and managers viewed the Program as an excellent opportunity to improve their buildings and potentially extend equipment operating life.

- The service providers are satisfied with the program's design and implementation. Both contacts were satisfied with the program overall, including the measures offered through the program, the timeliness of rebate payment, and the required program paperwork. The multifamily service provider noted that rebate payment had been delayed earlier in the program and attributed the delays to implementor staff turnover. She stated that the delays had been resolved.
- The manufactured home service provider observed that land and home ownership arrangements often determine whether homes participate in the program. The manufactured home service provider estimated a 90% success rate recruiting homes occupied by renters, in which the improvement decisions are made by a central property owner or manager. This contrasts with a success rate of about 10% with individual homeowners. He indicated that the success rate is similar for both homeowners that own the land their manufactured home is on, and for homes located on land owned by someone else, though there may be slightly more success in cases in which a landowner informs homeowners of the program.
- The electric space heating eligibility requirement was noted as a primary barrier to manufactured home program recruitment success. The manufactured home service provider estimated that about 70% of manufactured homes in PSO territory have gas-fired space heating and are therefore ineligible to participate in the program.
- Eligibility requirements may lead to customer complaints at manufactured home parks. In some manufactured home parks only a portion of tenants live in eligible homes that receive improvements through the program. The manufactured home service provider said that some tenants residing at ineligible homes had inquired about participation in the program and voiced frustration at their ineligibility as they may still be PSO customers that have had high bills in the past.

3.1.4.4.2 Owner/Manager Survey

In August and September 2023, ADM conducted a telephone survey of decision-makers at properties that participated in the PSO Multifamily and Manufactured Homes Program.

- All four decisionmakers said the PSO rebate helped their project receive approval.
- Service providers are providing enough project summary information to decision-makers.
- Decisionmakers were satisfied with the program overall. All four of the decision-makers were satisfied with the program overall and their interactions with PSO staff.

3.1.4.4.3 Program Staff Facilitated Discussion

ADM facilitated a discussion with program staff in July 2023. The purpose of the discussion was to investigate the status of the program's implementation and design. The following are key findings for the program.

- Two service providers are responsible for most program savings. One focuses on traditional multifamily facilities, the other on manufactured homes. About 30% of the budget is allocated to the service provider focused on manufactured homes; the other 70% is allocated to a service provider focused on traditional multifamily properties.
- The geographic distribution of projects is determined by the multifamily service provider's reach. Implementation staff stated that the program limits manufactured home improvements to homes outside of the Tulsa metro area. They noted that this decision was made primarily because the multifamily service provider was based in Tulsa and most of their projects through the program had been in the metro area. PSO staff suggested that a higher portion of the budget could be allocated to manufactured homes in the future.
- The program focuses on providing improvements to groups of manufactured homes that are owned and/or managed by a single individual or entity. PSO staff specified that independently owned manufactured homes typically participate through the Home Weatherization program, whereas an owner with multiple manufactured homes under their purview would participate through the manufactured homes portion of the Multifamily and Manufactured Homes Program.

3.1.4.5 Conclusions and Recommendations

The following conclusions were developed from the evaluation findings.

- The program exceeded its savings goals and maintained high realization rates with NTG ratios indicating the program has a strong influence on energy efficiency improvements.
- Participating decision makers were satisfied with the program overall. All four of the decisionmakers were satisfied with the program overall and their interactions with PSO staff.
- Properties that agree to inspections typically participate in the program. Both service providers observed a high success rate in implementing energy efficiency improvements at properties that had completed inspections.

- Program staff perceive the manufactured home portion of the program to have significant growth potential, though the manufactured home service provider communicated concern about the long-term viability of the program.
- Findings from ADM's interview with the manufactured home service provider suggest two main barriers to program success: the electric eligibility requirement and land/home ownership arrangements. The manufactured home service provider stated that about 70% of manufactured homes in PSO territory have gas-fired space heating and are therefore ineligible to participate in the program. Additionally, he estimated a recruitment success rate of about 10% with individual homeowners, observing that these customers may feel suspicious of the program offerings and that it may be "too good to be true" or a scam.

The following recommendations were developed for the Multifamily Program.

- Create program brochures to highlight available multifamily and manufactured home improvement offerings. Both service providers observed that a program brochure would help market the program and give their staff legitimacy.
- Continue to provide project recruitment support for participating service providers. Both service providers voiced appreciation for the implementers' support in recruiting homes to participate in the program.
- Consider ways to include participants with gas heating. Though homes with gas space and water heating may offer less opportunity for electric savings, there are still opportunities to reduce electricity usage by improving home air sealing and/or the efficiency of HVAC equipment.
- Ensure there is sufficient communication with participating decision-makers regarding the timeline for improvements and improvements made through the program. The decisionmaker survey findings indicate there may be an opportunity to improve communication regarding the timeline to receive services. Behavioral Modification

3.1.5 Behavioral Modification Program

This chapter presents findings from the impact and process evaluation of the 2023 Behavioral Modification program.

3.1.5.1 Program Overview

The Behavioral Modification Program provides customers with individualized energy reports to generate greater awareness of energy use and educate customers on ways they can reduce energy consumption. The energy report recommends energy saving behaviors and provides customers with a comparison of energy use at similar homes in their area, and across multiple years. It is expected the regular tips and reminders will encourage customers to adopt energy saving behaviors that will lead to more efficient energy use in their homes. In addition, participants are also encouraged to go to an online portal where they can input information about their home to receive specific tips addressing their home energy use.

In developing the program, a pool of potential participants was identified that had emails associated with their accounts. Participants were randomized into treatment and control groups and the equivalency of their pre-program-year data was verified. Opower has been the implementer for this program since 2022.

As of 2023, five separate cohorts of PSO customers have received reports through the program. The first group of participants (Wave 1) began receiving reports on October 25, 2017. A second wave (Wave 2) commenced on May 22, 2018. Both Wave 1 and Wave 2 participants initially only received emailed reports. Mailed paper reports were delivered to a subset of customers starting in 2019.

Wave 3 of the program was added on March 20, 2019, via paper reports, and email reports when email contact information is available. A fourth wave (Wave 4) was added for 2020, and this group began receiving paper and emailed reports on March 1, 2020.

Wave 5 customers were added on a rolling basis beginning January 1, 2022. Paper energy reports were mailed to treatment participants every odd-numbered month. Additionally, monthly emailed energy reports were sent to participants in each wave where email addresses were available.

Table 3-84 shows the performance metrics achieved by the program.

Table 3-84: Performance Metrics – Behavioral Modification Program

Metric	2023
Number of Customers	252,740
Budgeted Expenditures	$1,190,000
Actual Expenditures	$932,273
Energy Impacts (kWh)	
Projected Energy Savings	24,106,250
Reported Energy Savings	20,187,377
Gross Verified Energy Savings	25,111,289
Net Verified Energy Savings	25,111,289
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	3,708.65
Reported Peak Demand Savings	2,903.53
Gross Verified Peak Demand Savings	4,893.24
Net Verified Peak Demand Savings	4,893.24
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.46
Utility Cost Test Ratio	1.46

PSO's Behavioral program serviced 252,740 households during the 2023 program year. Table 3-85 shows the annual energy savings (kWh) per wave for 2023.

Table 3-85: Behavioral Verified Energy Savings per Wave

Wave	Number of Treatment Customers	Daily kWh Savings per Customer	Average Annual kWh Savings per Customer	Verified Gross kWh Savings	Verified Net kWh Savings
1	55,533	0.44	160.1	8,890,833	8,890,833
2	23,158	0.43	158.4	3,668,227	3,668,227
3	30,921	0.30	110.1	3,404,402	3,404,402
4	27,314	0.26	94.5	2,581,173	2,581,173
5	115,814	0.16	56.7	6,566,654	6,566,654
Total	**252,740**	**0.27***	**99.4***	**25,111,289**	**25,111,289**

**Reflects an average value weighted by the count of treatment group participants.*

3.1.5.2 Evaluation Activities

This section provides an overview of the data collection activities, gross and net impact calculation methodologies, and process evaluation activities that ADM employed in the evaluation of the Behavioral Modification program.

To determine annual energy savings (kWh) and peak demand reduction (kW), ADM performed an analysis of the billing data for participants in the program using panel regression modeling. The data cleaning steps and methodology for the panel regression approach are presented in the following section.

3.1.5.2.1 Data Collection

ADM incorporated several types of data into the preparation of the dataset that was used in the regression analysis outlined in this section:

- Pre-program and program year raw monthly billing data for all treatment and control group participants.
- Regional temperature obtained from the National Oceanic and Atmospheric Administration (NOAA) for Tulsa International Airport in Tulsa, OK.
- Participant information, including the associated account number and whether the participant was still a part of the program.
- Date each treatment participant received their first energy report.
- A dataset compiled by ADM of participants in PSO's other residential programs used to control cross-program participation.
- Treatment and control surveys to determine differences in LED purchasing patterns, energy savings actions, and customer satisfaction.
- In-depth interviews with program staff to support the process evaluation.

Additionally, a survey was conducted to participants and non-participants to gain insights into energy efficiency behaviors and the effectiveness of the home energy reports.

3.1.5.2.2 Survey Sampling Plan

To ensure proper extrapolation of survey results to program participants, ADM surveys a statistically representative sample of both participants and non-participants. A minimum sample size of 68 participants per wave is desired to represent results with ±10% precision at the 90% confidence interval.

3.1.5.2.3 Survey Objective

The objective of the program survey is to assess participants' overall satisfaction with the program, perceptions of the reports, actions taken to reduce energy consumption, and compare treatment and control group behaviors, household characteristics, and energy efficiency purchases.

The survey was administered online using an emailed link to a randomly selected group of participants and controls. Reminder emails were sent as needed to increase the number of responses. The number of customers contacted, and number of surveys completed, by wave, is shown in Table 3-86.

Table 3-86: Behavioral Summary of Customers Contacted and Response Rates

Wave	Control Group		Treatment Group	
	Number of Customers Contacted	Number of Completed Surveys	Number of Customers Contacted	Number of Completed Surveys
1	1,071	58	1,074	61
2	1,083	68	1,050	56
3	1,094	47	1,067	45
4	1,083	58	1,069	46
5	1,074	52	1,070	40
Total	**5,405**	**283**	**5,330**	**248**

3.1.5.2.4 Preparation of Data

ADM performed the following steps to prepare the dataset that was utilized to determine the verified energy savings for the Behavioral Modification Program.

- Verified that participants were sent energy reports during 2023.
- Calendarized the billing data provided by PSO.
- Cleaned the data by removing duplicate bills and string characters in the monthly consumption column.
- Removed billing months with negative consumption on their monthly bill.
- Removed billing readings with consumption less than 10 kWh or greater than 10,000 kWh.
- Removed billing months with reported lengths of fewer than 9 days or more than 60 days. It is assumed that these values are in error.
- Removed customers without sufficient pre-program and post-program billing data. Pre-Program data was defined as January 1, 2016 – December 31, 2016, for Wave 1, and the 400 days preceding the start date for Waves 2-5.

- Removed data for November 1, 2023 – December 31, 2023. During this period, most customers did not receive reports.[31]

3.1.5.2.5 Cross Participation and Uplift

Cross participation occurs when a participant in the Behavioral program also participates in any of PSO's other residential energy-efficiency programs during the program year. These programs included the down-stream measures for Energy Saving Products, Home Rebates, Home Weatherization, and Power Hours, as well as upstream measures from the Energy Saving Products lighting program. Although one of the goals of the Behavioral program is to educate participants on other PSO programs, these programs are all evaluated independently and must be considered to avoid double counting of savings.

A two-sample t-test was used to determine if there was a statistically significant difference between the rate of cross-participation among those who received reports (participants), and those who did not (controls). For programs and waves where there was a statistically significant difference in the rate of cross participation (p-value < 0.1), ADM removed all cross participants from both the treatment and control groups to avoid double-counting savings from other programs.

Because the participants in the upstream lighting program are unknown, ADM asked participants and controls about the number of bulbs that they purchased during the year. ADM evaluated if there was a statistically significant difference between the number of bulbs purchased by participants and controls using a two-sample t-test.

3.1.5.2.6 Methodology for Regression Approach

ADM utilized a mixed effects panel regression model specified in a supplemental document to determine daily average electricity savings for treatment group members.

3.1.5.2.7 Calculation of Annual Energy Savings

The average daily annual energy savings for the post-period treatment group is defined as a coefficient in the regression model. Note that the daily savings are calculated only using data from January through October since most customers did not receive HER reports at the end of the year. To determine per participant annualized savings, the average daily energy savings value is multiplied by 365. The verified annual energy savings for the program is determined by multiplying the annualized energy savings by the number of participants in the treatment group who had existing accounts in 2023.

[31] An issue with PSO system-wide AMI data led to errors in report generation for November and December resulting in reports not delivered.

3.1.5.2.8 Calculation of Coincident Peak Demand Reduction

The peak demand reduction was determined by applying the program annual energy savings to a normalized residential hourly load shape that represents typical residential energy consumption, resulting in an 8,760 hourly annual savings curve. The selected load shape was the same one used to determine estimates for the Behavioral Modification Program during portfolio planning. An average value across the peak demand window was drawn from the energy savings curve. The peak demand window is defined as consumption on non-holiday weekdays between 2 PM and 6 PM in the months of June through September.

3.1.5.2.9 Net-to-Gross Estimation

The Behavioral Modification Program was administered using a Randomized Control Trial (RCT) design, allocating participants to either the treatment or control group randomly. As a result, free riders are equally likely to be distributed in both the treatment and control groups. The NTG ratio is assumed to be 1 because the RCT design minimizes selection bias and the only assumed difference between the treatment and control groups is the receipt of energy reports.

3.1.5.2.10 Lifetime Savings

The Behavioral program is considered to have an effective useful life (EUL) of 1 year. This is consistent with behavioral practices and the recommended value from the energy efficiency portfolio plan, as all participants are evaluated each year. Therefore, the lifetime savings total is equivalent to the annual verified energy savings.

3.1.5.2.11 Process Evaluation

The evaluation addressed the following research questions to better understand the program’s effectiveness and efficiency:

- Has the underlying theory of how the program affects energy-saving behaviors changed since the previous program years? If so, how, and why?
- Did the program implementation reflect its current design? In what ways did it deviate and how did that affect program success? Are there ways to improve the design or implementation process?
- What information is presented in the HERs? Is the information presented clearly or are there opportunities for improvement? Could altering the order in which the information is presented affect energy efficiency?
- Were the reports delivered according to the planned schedule and frequency, by enrolled participants, and by program design?

- Do program utility and implementation contractor staff effectively coordinate to deliver the program?
- What is the utilization rate of the additional engagement tools (e.g., customer portals)?
- What share of report recipients read the reports? Do recipients find the reports to be clear and useful? Do report recipients believe what the reports say? Why did participants decide not to read the reports?
- Were the program participants satisfied with the reports and the frequency of receiving them?
- What actions, if any, do participants report taking to save energy?
- How much does the program affect energy-saving actions and purchases?

Table 3-87 below summarizes the data collection activities and corresponding process evaluation research objectives used to complete the process evaluation.

Table 3-87: Process Evaluation Data Collection Activities Summary – Behavioral Program

Data Collection Activity	Process Evaluation Research Objectives
Program Materials Review	Review reports and support materials for clarity and consistency with program objectives.
Participant Online Survey	Assess experience with and perceptions of the reports and other information on home energy use, actions taken to reduce energy use, satisfaction, and efficient equipment purchases (including LEDs).
Non-participant Online Survey	Assess actions taken to reduce energy and efficient equipment purchases (including LEDs).
Program Staff Facilitated Discussion	Assess program staff perspectives regarding program operations, strengths, or barriers to success.

3.1.5.3 Impact Evaluation Findings

The following section reports the findings of annual energy savings and coincident peak demand reduction.

3.1.5.3.1 Data Review

ADM calculated the average daily pre-treatment consumption for both the treatment and control group participants with current billing data. This step was performed to ensure that the average daily pre-treatment consumption was similar for both the treatment and control groups. The results are reported in Table 3-88. Even with control matching, the control and treatment groups have different pre-treatment energy consumption for Wave 2. As a result, the Wave 2 savings estimate is not reliable.

Table 3-88: Pre-Treatment Average Daily Consumption – Behavioral Program

Wave	Control Group		Treatment Group		t-test p-value
	Number of Customers in Regression Model	Average Daily Pre-Treatment kWh	Number of Customers in Regression Model	Average Daily Pre-Treatment kWh	
1	12,622	42.54	55,081	42.47	0.33
2	7,679	48.50	23,033	48.86	0.01*
3	15,475	35.07	30,905	35.10	0.55
4	7,919	40.10	27,299	40.23	0.22
5	28,080	35.34	114,899	35.32	0.68

* *Control matching was performed on this wave. Without control matching, the t test p-value was <0.001.*

3.1.5.3.2 Cross Participation

ADM assessed whether members of the treatment and control groups participated in PSO's other residential energy-efficiency programs at the same rate by comparing participation in treatment and control groups using a two-sample t-test. ADM determined that there was a statistically significant difference in the rate at which Wave 2, and Wave 5 treatment and control group customers participated in the Home Weatherization program. Members of the treatment and control groups for Waves 2 and 5 who participated in the program were eliminated from the model to avoid double counting savings from the program. No other statistically significant differences were found between participation rates among treatment and control groups for any wave.

Table 3-89 shows the results of the t-tests for each program and wave. The p-values showing evidence of a statistically significant difference are bolded.

Table 3-89: Behavioral Cross Participation with other PSO Residential Programs

ESP program					
Behavioral Program Wave	Control Group		Treatment Group		t-test
	n	%	n	%	p-value
1	80	0.63%	297	0.54%	0.220
2	29	0.30%	101	0.44%	0.547
3	40	0.26%	71	0.23%	0.609
4	23	0.29%	84	0.31%	0.912
5	68	0.24%	300	0.26%	0.608

Home Weatherization					
Behavioral Program Wave	Control Group		Treatment Group		t-test
	n	%	n	%	p-value
1	51	0.40%	288	0.52%	0.103
2	17	0.17%	87	0.38%	**0.055**
3	77	0.50%	147	0.48%	0.787
4	39	0.49%	109	0.40%	0.292
5	94	0.33%	467	0.40%	**0.091**
Home Rebates, Multiple Upgrades					
Behavioral Program Wave	Control Group		Treatment Group		t-test
	n	%	n	%	p-value
1	26	0.21%	130	0.24%	0.597
2	14	0.14%	35	0.15%	0.677
3	34	0.22%	53	0.17%	0.303
4	12	0.15%	41	0.15%	1.000
5	22	0.08%	128	0.11%	0.150
Home Rebates, Single Upgrade					
Behavioral Program Wave	Control Group		Treatment Group		t-test
	n	%	n	%	p-value
1	54	0.43%	227	0.41%	0.861
2	22	0.23%	88	0.38%	0.273
3	47	0.30%	118	0.38%	0.218
4	21	0.27%	83	0.30%	0.671
5	76	0.27%	257	0.22%	0.169
Multifamily					
Behavioral Program Wave	Control Group		Treatment Group		t-test
	n	%	n	%	p-value
5	2	0.01%	6	0.01%	1.000
Power Hours					
Behavioral Program Wave	Control Group		Treatment Group		t-test
	n	%	n	%	p-value
1	42	0.33%	226	0.41%	0.243
2	24	0.25%	72	0.31%	1.000
3	22	0.14%	58	0.19%	0.326
4	28	0.35%	107	0.39%	0.717
5	164	0.58%	642	0.56%	0.662

ADM performed a two-sample t-test on the treatment and control survey data results regarding lighting purchases to account for cross-participation with the ESP retail offerings (upstream). The results are provided in Table 3-90. The t-test shows that there was no significant program uplift in LED purchases due to the Behavioral Modification program.

Table 3-90: Behavioral Cross Participation with ESP's Upstream Lighting Program

Control Group		Treatment Group		t-test p-value
Mean Number of LEDs Purchased	n	Mean Number of LEDs Purchased	n	
11.7	12	17.0	5	0.62

3.1.5.3.3 Data Cleaning

Table 3-91 shows the number of accounts left after each step of data cleaning to determine the participants to be used in the model. The steps and rationale for removing participants were based on whether they were cross-participants in other residential PSO programs, if there was no active billing data in the program year, billing records were abnormal or outliers, or participants had insufficient data to include in the panel regression analysis.

Table 3-91:Number of Accounts After Each Data Cleaning Step – Behavioral Program

Cleaning Step	**Wave 1**		**Wave 2**		**Wave 3**		**Wave 4**		**Wave 5**	
	Control Group	**Treat Group***	**Control Group**	**Treat Group**	**Control Group**	**Treat Group**	**Control Group**	**Treat Group**	**Control Group**	**Treat Group**
Original participant list	23,999	104,999	17,830	41,689	25,000	50,000	13,000	45,000	39,716	162,143
Participants not listed in billing data	13,403	58,627	10,378	24,646	16,495	32,943	8,589	29,735	34,224	139,952
Participants not active PSO customers in the program year	12,730	55,534	9,763	23,158	15,485	30,921	7,925	27,314	28,249	115,814
Filter to participants with actual billing readings	12,730	55,533	9,763	23,158	15,485	30,921	7,925	27,314	28,249	115,814
Removed outliers	12,727	55,503	9,750	23,126	15,477	30,908	7,920	27,300	28,186	115,519
Accounts before Control Matching and Cross Participant Removal	12,622	55,081	9,746	23,120	15,475	30,905	7,919	27,299	28,169	114,927
Number of accounts in final model:	12,622	55,081	7,679	23,033	15,475	30,905	7,919	27,299	28,080	114,899

* *“Treatment Group”*

3.1.5.3.4 Verified Energy Savings (kWh)

Table 3-92 provides the results of the mixed-effects panel regression model. A negative coefficient indicates daily savings attributable to the program.

Table 3-92: Behavioral Results of Mixed Effect Panel Regression Modeling

Wave	Post × Treat Coefficient	Standard Error	T-Statistic	P-Value	R-Squared
1	-0.44	0.06	-7.19	<0.001	0.70
2	-0.43	0.10	-4.37	<0.001	0.73
3	-0.30	0.05	-6.10	<0.001	0.60
4	-0.26	0.09	-3.01	0.003	0.68
5	-0.16	0.04	-4.21	<0.001	0.72

3.1.5.3.5 Total Verified Annual Energy Savings (kWh)

Annual energy savings per customer were determined by multiplying the daily energy savings value by 365 days. Then, the verified annual energy savings total for the program was determined by multiplying the annualized annual energy savings by the number of participants that were in the treatment group. The annual energy savings by wave are reported in Table 3-93.

Table 3-93: Behavioral Program Annual Energy Savings, by Wave

Wave	Number of Treatment Customers	Daily kWh Savings per Customer	Average Annual kWh Savings per Customer	Verified Gross kWh Savings	Verified Net kWh Savings
1	55,533	0.44	160.1	8,890,833	8,890,833
2	23,158	0.43	158.4	3,668,227	3,668,227
3	30,921	0.30	110.1	3,404,402	3,404,402
4	27,314	0.26	94.5	2,581,173	2,581,173
5	115,814	0.16	56.7	6,566,654	6,566,654
Total	**252,740**	**0.27***	**99.4***	**25,111,289**	**25,111,289**

**Reflects an average value weighted by the count of treatment group participants.*

The average daily savings in 2023 are comparable to the average savings from 2022. The average daily savings for each wave from 2020 through 2023 are shown in Table 3-94.

Table 3-94: Behavioral Program Average Daily Savings, by Wave, from 2019-2023

Wave	Daily kWh Savings per Customer, PY2020	Daily kWh Savings per Customer, PY2021	Daily kWh Savings per Customer, PY2022	Daily kWh Savings per Customer, 2023	2022 to 2023 Change
1	0.29	0.31	0.32	0.44	+0.12
2	0.47	0.42	0.56	0.43	-0.12
3	0.24	0.20	0.25	0.30	+0.05
4	0.24	0.23	0.26	0.26	-0.01
5	-	-	0.12	0.16	+0.03
Weighted Average	**0.30**	**0.29**	**0.25**	**0.27**	**-0.04**

3.1.5.3.6 Coincident Peak Demand Reduction (kW)

The peak demand reduction results by wave are reported in Table 3-95.

Table 3-95: Behavioral Program Coincident Peak Demand Reduction, by Wave

Wave	Number of Treatment Customers	Verified Net kW Peak Reduction
1	55,533	1,732.49
2	23,158	714.80
3	30,921	663.39
4	27,314	502.97
5	115,814	1,279.59
Total	**252,740**	**4,893.24**

3.1.5.3.7 Verified Net Savings Impacts

Verified and reported annual energy savings (kWh) as well as peak demand reduction (kW) are shown in Table 3-96.

Table 3-96: Behavioral Reported and Verified Annual Energy Savings and Peak Demand Reduction

Reported Energy Savings (kWh)	Reported Peak Demand Savings (kW)	Verified Gross Energy Savings (kWh)	Verified Gross Peak Demand Savings (kW)	kWh Realization Rate	kW Realization Rate
20,187,377	2,903.53	25,111,289	4,893.24	124%	169%

3.1.5.3.8 Net and Lifetime Evaluation Impacts

As described in the methodology section, net impacts are equivalent to gross impacts for the Behavioral Modification Program. The effective useful life of the Behavioral Modification Program is 1 year, making the lifetime energy savings equivalent to the annual energy savings.

3.1.5.4 Process Evaluation Findings

This section presents findings from the facilitated discussion with program staff as well as the participant and non-participant surveys. The survey yielded 531 participant and control survey responses, an interview with the PSO Program manager, and an interview with the implementer. ADM provided a process evaluation memo to PSO in December of 2023 with detailed findings. The following summarizes the key findings from the process evaluation of the Program. The PSO Behavioral Program remained consistent with previous years.

3.1.5.4.1 Program Operations Perspective

According to program staff, the overarching goal of the Behavioral Program is to support PSO's efforts in educating customers on how they can modify their behaviors to save energy in their homes and which energy-efficient investments they can make (e.g., purchasing energy-efficient items or completing an energy-efficient upgrade). Through the Behavioral Program, PSO staff strive to motivate customers to choose more energy-efficient products over standard ones and to incorporate no or low-cost actions to save energy in their households through personalized tips and recommendations. The more customers adopt energy efficiency practices, the more they impact market transformation within the PSO service territory.

3.1.5.4.2 Behavioral Survey Findings

Satisfaction with the information provided on home energy use, number of emails received regarding energy usage, frequency of receiving a HER, and the method of receiving a HER are shown in Table 3-97. From 2020 to 2023, there has been a decrease in satisfaction (selecting a 4 or 5 on a 5-point scale) with the information provided on home energy use, frequency of receiving HERs, and the methods of receiving HERs.

Table 3-97: Behavioral Program Year Comparison of Satisfaction with HERs Aspects

Satisfaction	2020	2021	2022	2023
Information Provided on Home's Energy Use				
1 – Very dissatisfied	1%	3%	5%	4%
2	1%	3%	6%	4%
3	14%	13%	13%	19%
4	22%	28%	24%	22%
5 – Very satisfied	60%	52%	50%	46%
Don't know	2%	1%	2%	5%
Number of Emails Received on Home's Energy Use				
1 – Very dissatisfied	1%	1%	3%	3%
2	4%	3%	5%	4%
3	19%	17%	14%	18%
4	23%	26%	22%	22%
5 – Very satisfied	48%	47%	48%	42%
Don't know	5%	7%	8%	12%
Frequency of Receiving HER				
1 – Very dissatisfied	1%	1%	3%	4%
2	4%	5%	5%	3%
3	9%	14%	14%	16%
4	26%	22%	18%	20%
5 – Very satisfied	56%	56%	53%	50%
Don't know	4%	2%	6%	8%
Method of Receiving HER				
1 – Very dissatisfied	1%	2%	3%	3%
2	2%	2%	2%	3%
3	8%	11%	15%	15%
4	26%	24%	15%	20%
5 – Very satisfied	63%	59%	60%	55%
Don't know	0%	2%	4%	5%
Note: percentages may exceed or be less than 100% due to rounding errors.				

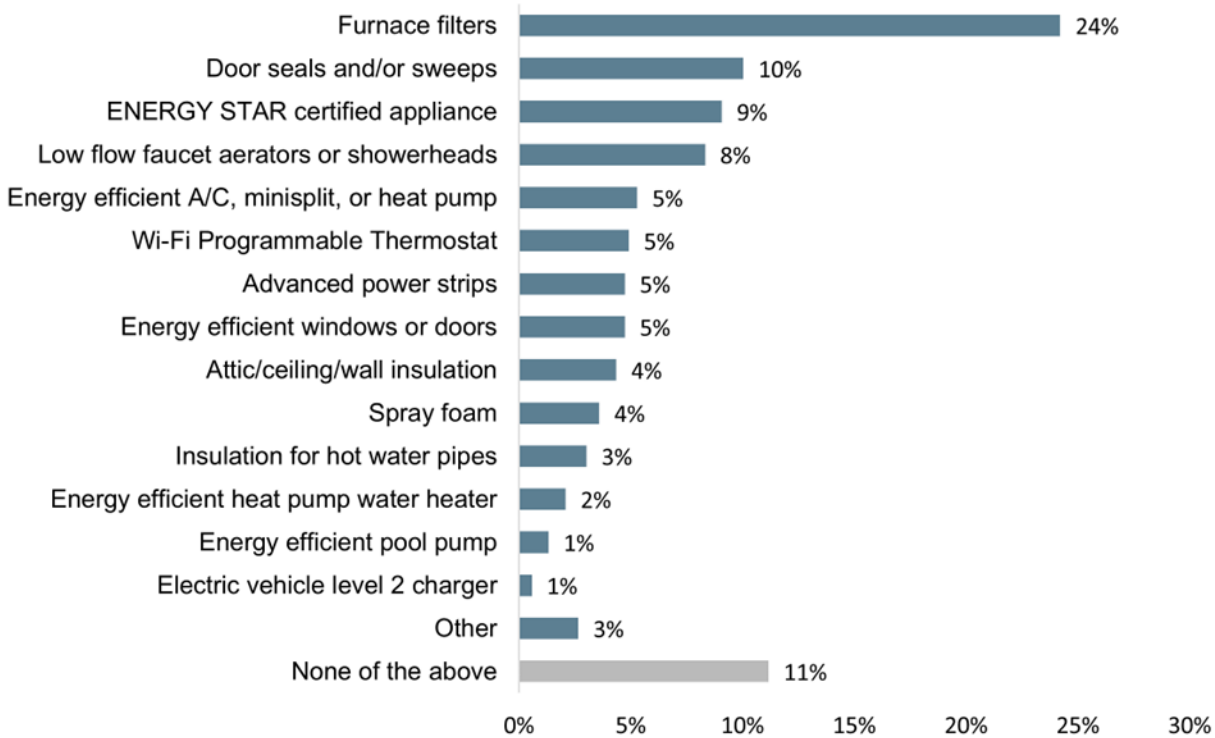
Coincidentally, participants found value in the home energy report information (see Table 3-98).

Table 3-98: Rated Value of HER Information

Rating	Comparison to Similar Homes (n = 205)	Comparison to Last Year (n = 204)	Energy Use Benchmark (n = 204)	Energy Saving Tips and Recommendations (n = 205)
5 - Very valuable	41%	47%	44%	28%
4	24%	28%	28%	22%
3	16%	13%	15%	25%
2	8%	4%	6%	12%
1 - Not at all valuable	7%	5%	6%	6%
Not applicable	0%	<1%	0%	2%
Don’t know	2%	2%	2%	4%

Fifty-seven percent of respondents reported that they adopted new energy saving behaviors in their homes in 2023. Among those who adopted new behaviors, 66% indicated the information they learned from their HERs was an important factor of their decision. Homeowners reported adopting new energy saving behaviors at a higher rate than renters (84% versus 13%, respectively). Many HERs participants made one or more energy efficient purchases in 2023. Furnace filters, ENERGY STAR® certified appliances, door seals/sweeps, and low flow faucet aerators were the most common purchases in 2023 (see Figure 3-29).

Figure 3-29: Energy Efficient Purchases in 2023 Among Participants



The amount of participant interactions with available online tools can be used as an indicator of interest in performing energy efficiency actions. Of the survey respondents, 6% recalled logging onto the Energy Management Tool web portal, lower than 11% in 2022. Among those who accessed the portal, a large majority (93%) stated they viewed information about their home's energy use.

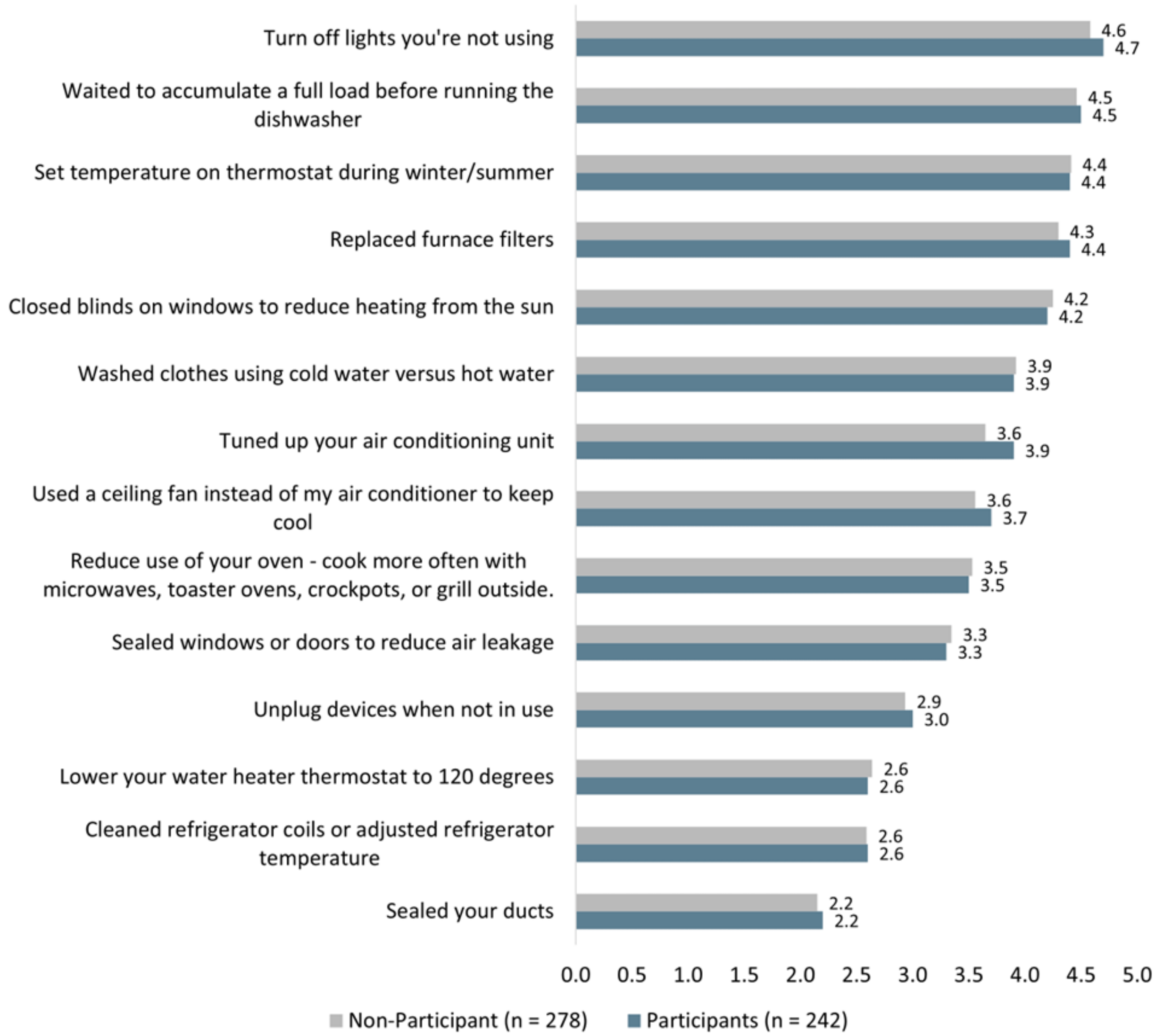
Most respondents who said they had not logged on to Energy Management Tool indicated they were not aware of the portal (47%) or were getting all the information they needed from the HERs (20%), (see Table 3-99).

Table 3-99: Primary Reason why Customers had not logged onto the Energy Management Tool – Behavioral Program

Reason	Percent of Respondents (n = 215)
Was not aware of the Energy Management Tool	47%
Was getting all the information needed from the Home Energy Reports	20%
Not interested	14%
Do not have the time	7%
Unable to log onto My Energy Advisor (technical difficulties)	1%
Other	6%
Don't know	6%

Participants and non-participants were compared on self-claimed energy-saving actions taken (e.g., turning off lights, changing thermostat settings, changing dish and clothes washing practices) and the number of energy efficient items installed. A scale from 1 to 5 was used, where 1 was “never considered doing this” and 5 was “doing this all the time” to compare customers who receive a HER and those who do not. Figure 3-30 summarizes the average score of all energy saving actions among participants and non-participants. The higher the score, the more likely the respondent was to take that action more frequently. Non-participants and participants had similar average scores for most actions, except for five actions where participants had a higher average than non-participants.

Figure 3-30: Average Scores among Participants and Non-Participants for Energy Saving Actions



3.1.5.5 Discussion of Findings

Waves 3, 4, and 5 showed similar savings as in previous years. The daily savings for Wave 1 increased by 0.12 kWh compared to last year and has the highest average daily energy savings per customer in 2023. The distribution of home types could be a factor for greater savings in Wave 1. Of the survey respondents, the Wave 1 treatment group is more inclusive of mobile homes and townhouses compared to the Wave 1 control group (Pearson's Chi-square test, $p < 0.1$).

On the other hand, Wave 2, which had the highest savings in previous years, had lower savings this year. From 2022 to 2023, the daily savings per customer decreased by 0.12. kWh. Additionally, control and treatment groups for Wave 2 had statistically different energy consumption in the pre-treatment period. This means that the control group can no longer be compared to the treatment group to estimate energy savings.

In 2019-2021, the previous implementor excluded multifamily homes as part of their data cleaning process. Because Opower did not implement a similar data cleaning step, Wave 5 was the only wave to have multifamily cross-participants and had a higher proportion of both multifamily residents and renters compared to the other waves (Pearson's Chi-squared test, $p < 0.1$). In 2023, Wave 5 continued to have the lowest daily savings and a larger proportion of renters. Because previous waves are mostly homeowners in single-family homes, splitting Wave 5 by home type may yield results like the other waves.

3.1.5.6 Conclusions and Recommendations

This section presents conclusions and recommendations based on evaluation of the program for the 2023 program year.

3.1.5.6.1 Conclusions

The following conclusions were developed from the evaluation findings:

- Final verified PSO Behavioral Program energy savings and demand reduction were above-reported energy savings.
- Significantly more treatment group participants reported adopting energy-saving behaviors in 2023 compared to the control group.
- Wave 1 had the highest average daily energy savings per customer (0.54 kWh). Wave 5 had the lowest average daily energy savings per customer (0.16 kWh), which is a slight increase from last year. The lower savings for Wave 5 compared to other waves could be attributed to its lower percentage of homeowners.
- Over 70% of respondents are satisfied with the information presented in the HERs and about 70% of respondents are satisfied with the number of emails sent.
- Only 6% of respondents are using the Energy Management tool with a plurality of those who had not logged into the tool stating that they were not aware that it existed.

3.1.5.6.2 Recommendations

The following recommendations are offered for improvement of the Behavioral Program.

- Promote the Energy Management tool more extensively, as only 6% of participants currently utilize it. Increased promotion of the tool, enabling customers to better understand their energy use, could increase awareness of the positive impacts of energy-efficient behaviors.

- The plan to introduce new modules focused on encouraging customers to complete their home energy profile survey, as well as the plan to roll out audience-specific reports, has the potential to enhance satisfaction with the information provided and drive behavioral energy savings. Presenting energy savings into metrics that participants easily understand could increase understanding and satisfaction with the home energy reports.
- Retire the Wave 2 control group. Energy consumption in the pre-treatment period is statistically different for the treatment and control groups, meaning that energy savings estimates are no longer reliable.
- Break out customer information by single-family and multifamily. The Wave 5 survey showed significantly more residents in multifamily buildings compared to other waves. An exploratory analysis could demonstrate if this difference is affecting the savings coefficient for this wave.

3.2 Business Rebates Program

This chapter presents findings from the impact and process evaluation of the 2023 Business Rebates program year. The Business Rebates Program includes incentives for Custom and Prescriptive measures, Small Business Energy Solutions measures, Midstream Lighting measures, and Midstream Heating, Ventilation, and Air Conditioning (HVAC) measures.

3.2.1 Program Overview

PSO's Business Rebates Program provided a range of energy efficiency measures for small businesses, large businesses, schools, municipalities, and industrial businesses to participate in receiving an incentive to reduce energy consumption. The Business Rebates Program offered subprograms of Small Business Energy Solutions (SBES), Midstream, and Custom and Prescriptive (C&P). The program offers incentives for many commercial and industrial measures including lighting, plug load & controls, building envelope, appliance & equipment, HVAC, agricultural, strategic energy management, custom measures, and refrigeration.

To participate in the Small Business Energy Solutions (SBES) subprogram, businesses must use 320,000 kWh or less annually and use a PSO-approved service provider. Current energy efficiency offerings in this subprogram include lighting and refrigeration measures.

The Midstream subprogram is designed to influence distributor stocking practices, as well as promote the sale of higher efficiency equipment, such as light bulbs, air conditioners, and heat pumps. This subprogram allows customers to receive instant rebates on qualifying equipment through distribution channels. The program is focused on lighting and HVAC distributors.

The Custom & Prescriptive path allows all business types and sizes to participate through a large offering of energy efficiency measures. In addition to the wide range of prescriptive measures, as listed on the Power Forward website[32], customers have additional options to receive incentives through custom applications. Custom applications include a channel for Oil & Gas and Agriculture projects as well as Strategic Energy Management (SEM). PSO has partnered with GridPoint to provide commercial customers with an innovative technology platform that helps with automating energy and facility management. Using artificial intelligence, the platform will learn your building's energy patterns and communicate via installed controls to help it be more efficient.

[32] https://powerforwardwithpso.com/rebates/#rebatebusiness

3.2.2 Evaluation Summary

The Business Rebates Program exceeded annual energy savings goals within budget for the 2023 program year. Table 3-100 summarizes projected, reported, and verified demand impacts as well as other program performance metrics. Detailed Business Rebate program results by subprogram and measure are presented in this chapter.

Table 3-100: Performance Metrics – Business Rebates Program

Metric	2023
Number of Projects	890
Budgeted Expenditures	$11,828,414
Actual Expenditures	$10,596,028
Energy Impacts (kWh)	
Projected Energy Savings	39,208,600
Reported Energy Savings	38,732,810
Gross Verified Energy Savings	40,798,833
Net Verified Energy Savings	36,172,541
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	7,995.13
Reported Peak Demand Savings	7,117.42
Gross Verified Peak Demand Savings	7,245.84
Net Verified Peak Demand Savings	6,165.45
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.62
Utility Cost Test Ratio	1.96

The evaluation included both process and impact components. Evaluation activities included surveying, in-depth interviews, program tracking data review, field verification visits, gross energy savings analysis, and net energy savings analysis. Table 3-101 summarizes the achieved sample sizes for the various data collection activities for the Business Rebates Program evaluation.

Table 3-101: Sample Sizes for Data Collection Efforts

Data Collection Activity	Achieved Sample Size		
	Custom/Prescriptive	SBES	Midstream
On-Site M&V Visits & Engineering Analysis	39	25	-
Engineering Desk Reviews Only (including billing regression analysis and provided system trend data)	1	-	Census
Customer Decision-Maker Surveys/Interviews	39	56	20
Program Staff Facilitated Discussions	1	1	1
Trade Ally Surveys	11	3	1
Midstream Distributor Interviews	N/A	N/A	4

The evaluation determined overall gross annual energy savings were higher than estimated. Differences at the project level can be attributed to the estimate of annual operating hours, HVAC interactive factors, baseline/efficient wattages, efficient equipment specifications, and an analytical approach. When accounting for the effects of free-ridership and spillover, the net program savings are approximately 7% below the reported annual energy savings. Free ridership was determined based on participant responses to questions regarding the influence of the Business Rebates program on their decision to install energy efficient equipment.

3.2.3 Custom and Prescriptive

PSO's Business Rebates Program seeks to generate energy savings for custom and prescriptive projects by promoting high-efficiency electric end-use products. The program allows PSO's customers to participate by either self-sponsoring or by working through a third-party service provider to leverage technical expertise. The program seeks to combine the distribution of financial incentives with access to technical expertise to maximize program penetration across the range of potential commercial and industrial customers. Additionally, the program aims to accomplish the following:

- Increase customer awareness and knowledge of applicable energy-saving measures and their benefits,
- Increase the market share of commercial-grade high-efficiency technologies sold through market channels,
- And increase the installation rate of high-efficiency technologies in Commercial and Industrial (C&I) facilities by businesses that would not have done so in absence of the program.

3.2.3.1 Impact Evaluation Overview

PSO's prescriptive and custom projects provided rebates for a total of 419 projects. Lighting system retrofit projects continued to be the main source of program savings with approximately 42% of reported annual energy savings (kWh). Agriculture projects represented 27% of reported savings and had a slight decrease when compared to last year (30% in 2022). Custom projects accounted for approximately 9% of reported savings (up from 8% in 2022), and projects with multiple measures account for approximately 3%. Individual measures within this category differed across 8 different projects and all had a lighting component. A breakdown of measure type (aggregated by category based on the provided measure type) by the percentage of program savings is shown in Table 3-102.

Table 3-102: Measure Type as Percentage of Reported Annual Energy Savings

Aggregated Measure List	Percent of Program
Retrofit Lighting	41.5%
Agriculture	26.8%
Custom	9.1%
New Construction Lighting	8.3%
Oil & Gas	6.7%
Multiple	2.5%
SEM	2.5%
HVAC VFD	1.5%
Refrigeration & Kitchen Equipment	<1%
Business Appliances	<1%
Total	**100%**

Overall, the number of rebated projects decreased from 440 in 2022 to 419 in 2023, additionally, the magnitude of reported annual energy savings decreased by approximately 15%. Compared to 2022, Retrofit lighting and Agriculture saw a substantial decrease of -23% and -25% respectively, in reported savings. Table 3-103 provides a summary of Custom and Prescriptive project savings in the program.

Table 3-103: Performance Metrics – Custom & Prescriptive

Metric	2023
Number of Projects	419
Energy Impacts (kWh)	
Reported Energy Savings	26,767,519
Gross Verified Energy Savings	28,803,354
Net Verified Energy Savings	24,559,772
Peak Demand Impacts (kW)	
Reported Peak Demand Savings	4,512.75
Gross Verified Peak Demand Savings	4,920.70
Net Verified Peak Demand Savings	3,922.02
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.53
Utility Cost Test Ratio	2.67

3.2.3.2 Process Evaluation Overview

The process evaluation consisted of participant surveys, trade ally surveys, and a facilitated discussion with program staff. The objective of the participant survey was to assess sources of program awareness, factors that influenced project decision-making, experience with the participation process, and program satisfaction. A total of 39 customer decision-makers responded to the participant survey and 11 Prescriptive and Custom trade allies were interviewed by ADM. A detailed process evaluation memo was provided to PSO in December 2023.

Table 3-104 summarizes the share of reported savings by district. As with past program years, a large amount of savings comes from the Tulsa region; however, compared to the previous program year, the Tulsa Northern District saw a significant increase (+16%) in annual energy savings.

Table 3-104: District Share of Reported kWh Savings

Region	Sum of Reported Energy Savings (kWh)	Percentage of Program kWh	Reported Rebate Dollars Paid	Percent of Reported Rebate Dollars Paid
Eastern District	3,550,110	13%	$376,509	16%
Tulsa District	14,919,902	56%	$1,193,976	51%
Tulsa Northern District	5,045,056	19%	$469,180	20%
Western District	3,252,451	12%	$324,082	14%
Total	**26,767,519**	**100%**	**$2,363,746**	**100%**

3.2.3.3 Evaluation Activities

This section provides a brief overview of the data collection activities, impact evaluation methodologies, and process evaluation activities that were employed in the evaluation of the program. Detailed energy savings methodologies are provided in a supplemental document.

3.2.3.3.1 Data Collection

Data for analysis is collected through a review of program materials, on-site inspections, end-use metering, provided site trend data (such as energy management system data), advanced meter infrastructure (AMI) data, and interviews with participating customers and service providers. Based on program tracking data provided by PSO through the online reporting tool, a random sample is developed for the evaluation sample to statistically represent the population with verified energy impacts.

Site-specific verifications are performed for projects selected in the random sample. Site verification visits are used for the verification of baseline conditions, energy efficiency equipment specifications, quantities, and operating conditions. When available, data from energy monitoring is collected to support the energy savings analysis. A subset of sampled projects (grow lighting) was monitored to obtain accurate operational profiles. Data is collected through building automation systems, equipment control systems, or facility tracking systems.

All available project documentation is acquired for sampled projects. Project documentation includes reported energy savings analysis, invoices, specification sheets, trend data, and pre-and-post implementation inspection reports. Advanced Meter Infrastructure (AMI) data provided daily through a secure transfer for data visualization and consumption analysis is used. In the situation where observations and information are not available during on-site verification, these project documents may be relied on to support verified energy savings. Projects evaluated in which only partial information was collected from the site contact are to be considered desk reviews.

In addition to the on-site collection, customer surveys provide self-reported data for the Net-To-Gross (NTG) analysis and process evaluation. Service provider, or trade ally interviews, were conducted to gain feedback on program participation, barriers, and satisfaction from a stakeholder perspective. Trade ally interviews were conducted with eleven program contractors. ADM researchers facilitated a discussion with program staff in June 2023. Table 3-105 shows the achieved sample sizes for the different types of data collection utilized for this evaluation.

Table 3-105: Sample Sizes for Data Collection Efforts

Data Collection Activity	Achieved Sample Size
On-site M&V Verification	39
Engineering Desk Review with AMI Data	1
Customer Decision-Maker Surveys	39
Trade Ally Surveys	11
Program Staff Facilitated Discussion	1

3.2.3.3.2 Impact Evaluation Sampling Plan

A stratified random sample based on the amount of annual energy savings and the type of measure installed in each project was created. Ratio estimation is used to determine precision (better than ±10% based on annual energy savings) at a 90% confidence interval across all Custom and Prescriptive strata. Sample strata are bound by measure type and magnitude of annual energy savings such that realization rates (the ratio of verified to reported savings) for projects sampled in each stratum are only extrapolated to other projects within that stratum. Verification of sample precision, using each stratum's contribution to variance, is then performed on the verified extrapolated annual energy savings (kWh) for the program. Table 3-106 shows the sample design that was used for custom and prescriptive projects. The 40 projects that were sampled for evaluation verification account for approximately 36% of reported program annual kWh savings.

Table 3-106: Sample Design for Prescriptive and Custom

Stratum Name	Reported kWh Savings	Strata Boundaries (kWh)	Population of Projects	Design Sample Size
Agriculture 1	810,062	53,039 – 140,737	5	2
Agriculture 2	4,154,872	215,116 – 641,885	10	4
Agriculture 3	2,213,554	1,093,026 – 1,120,528	2	2
Custom & Other 1	246,985	308 – 16,380	36	2
Custom & Other 2	2,520,552	17,078 – 130,135	45	3
Custom & Other 3	1,608,124	132,074 – 317,040	9	2

Stratum Name	Reported kWh Savings	Strata Boundaries (kWh)	Population of Projects	Design Sample Size
Custom & Other 4	2,610,314	757,341 – 1,049,694	3	2
New Const. Light	1,426,147	2,001 – 176,223	22	3
Prescriptive 1	59,007	180 – 2,925	52	3
Prescriptive 2	196,414	3,066 – 25,827	32	2
Retrofit Lighting 1	923,304	1,245 – 28,565	77	2
Retrofit Lighting 2	2,743,408	28,597 – 97,830	68	4
Retrofit Lighting 3	3,992,308	105,588 – 303,623	25	4
Retrofit Lighting 4	3,262,467	355,261 – 627,021	7	5
Total	**26,767,519**		**393**	**40**

3.2.3.3.3 Gross Savings Analysis Methodology

The verification of gross annual energy savings and peak demand reduction from projects rebated through the program can be broken down into the following steps:

- The program tracking database is reviewed to determine the scope of the program and to ensure there are no duplicate project entries, missing data, or data entry errors. The tracking database is used to define a discrete set of rebated projects that make up the program population. A sample of projects is then drawn from the population established in the tracking system review.
- A detailed desk review is conducted for each project sampled for On-site verification and data collection. The desk review process includes a thorough examination of all project materials including invoices, equipment cut sheets, pre- and post-inspection reports, and estimated savings calculators. This review process informs on-site fieldwork by identifying potential uncertainties, missing data, and sites where monitoring equipment is needed to verify key inputs to the reported savings calculations.
- After reviewing project materials, On-site verification/data collection interviews are scheduled for sampled projects. If sufficient information and data were provided that represented verification, then a desk review may be considered to reduce participant fatigue. The interviews are used to collect data for savings calculations, verify measure installation, and determine measure operating parameters.
- The data collected during the On-site verification visits are used to revise savings calculations, as necessary. For example, if the reported savings calculations relied on operating hours for a given measure that was found to be inaccurate

based on the On-site verification and data collection, changes are made to reflect actual operating conditions more accurately.

- After determining the verified savings impacts for each sampled project, results are extrapolated to the program population using project-specific sampling weights. This allows for the estimation of program level gross verified annual energy (kWh) savings with a given amount of sampling precision and confidence.

3.2.3.3.4 Net-to-Gross Estimation (NTG)

The purpose of net savings analysis is to determine what portion of gross savings achieved by PSO customers is the direct result of program influence. Information collected from program participants through a customer decision-maker survey is used for the net-to-gross analysis. These survey responses are reviewed to assess the likelihood that participants were free riders or whether there were spillover effects associated with non-rebated purchases by program participants.[33] The Custom and Prescriptive and SBES Programs utilized the same NTG methodology. The methodology is described in a supplemental document.

3.2.3.3.5 Lifetime Energy Savings

Lifetime energy savings (kWh) is the product of annual energy savings (kWh) multiplied by the Effective Useful Life (EUL). The EUL considers the technical lifespan of the equipment as well as the change in energy savings over time. The EUL is determined by measure for each measure within each project of the evaluation sample. The EUL for prescriptive measures is sourced from the Arkansas TRM v8.1. If a measure is not listed in the AR TRM, then a different industry standard reference, such as another technical reference manual, is considered. For custom equipment, the EUL is determined based on the lifespan of the equipment or if that cannot be determined then the industry standard of 20 years is applied. Energy savings for any behavioral measures in the program is only granted one year of EUL.

3.2.3.3.6 Process Evaluation Methodology

The process evaluation was designed to research and document the program delivery mechanisms and collective experiences of program participants, partners, and staff. The process evaluation was designed to answer the following research questions:

- How did PSO market this program?
- How effective were marketing efforts for the program?
- Which marketing methods were most effective?

[33] The spillover analysis is limited to participant spillover. Non-participant spillover effects may exist for the program, but they are not estimated and therefore assumed to be zero.

- How well do PSO staff, service providers, and distributors work together? Is there rebate processing, data tracking, and/or communication efficiencies that can be gained?
- Did the program implementation reflect its design? Are there underlying assumptions about program implementation and design that are being made about how the program will unfold? Are there ways to improve the design or implementation process?
- Were participants, service providers, and distributors satisfied with their experience? What was the level of satisfaction with the rebate amount, the application process, the rebated measures, and other aspects of program participation?
- How is the program working to meet its regional and measure diversity goals? Are new measures or pilot programs being explored?
- What are PSO staff and implementation staff perspectives on the program? What are the reactions to program design choices that have been implemented?
- What types of buildings/facilities participated in the program? Could certain facility types be targeted more effectively?
- What customer barriers to participation do distributors see? How can these be mitigated?
- What share of projects are associated with specific distributors? How are savings distributed across them? Are there any differences in opinion between active and less active distributors?
- Were there any significant obstacles during each program year?
- Looking forward, what are the key barriers and drivers to program success within PSO's market?
- What changes, if any, were made to the program design or implementation procedures?

To address these questions, the process evaluation activities included surveys to program participants as well as in-depth interviews with program staff and trade allies. Table 3-107 provides a summary of data collection activities for the process evaluation.

Table 3-107: Custom and Prescriptive Research Questions

Data Collection Activity	Process Evaluation Research Objectives
Program Staff Facilitated Discussions	Assess program staff perspectives regarding program operations, strengths, or barriers to success. Discuss customer journey to create a common understanding of participation experience and identify key touchpoints to create a journey map.
Participant Surveys	Source of program awareness, factors that influenced project decision-making, experience with the application process, energy consultant, and program satisfaction.
Trade Ally Surveys	Assess program changes, barriers to participation, satisfaction with program procedures and how it compares to other programs in the region, assessment of program customer engagement materials, training, and communications with program staff

3.2.3.4 Impact Evaluation Findings

Impact evaluation findings determine net annual energy savings (kWh) and net coincident peak demand reduction (kW). Program level results are achieved by extrapolation of verified (verified) project level savings; known as gross results. Gross results are adjusted for program free-ridership and participant spillover to determine net results.

3.2.3.4.1 Verified Gross Annual Energy Savings

The verified gross annual energy savings for Prescriptive and Custom projects are summarized, by sampling stratum, in Table 3-108.

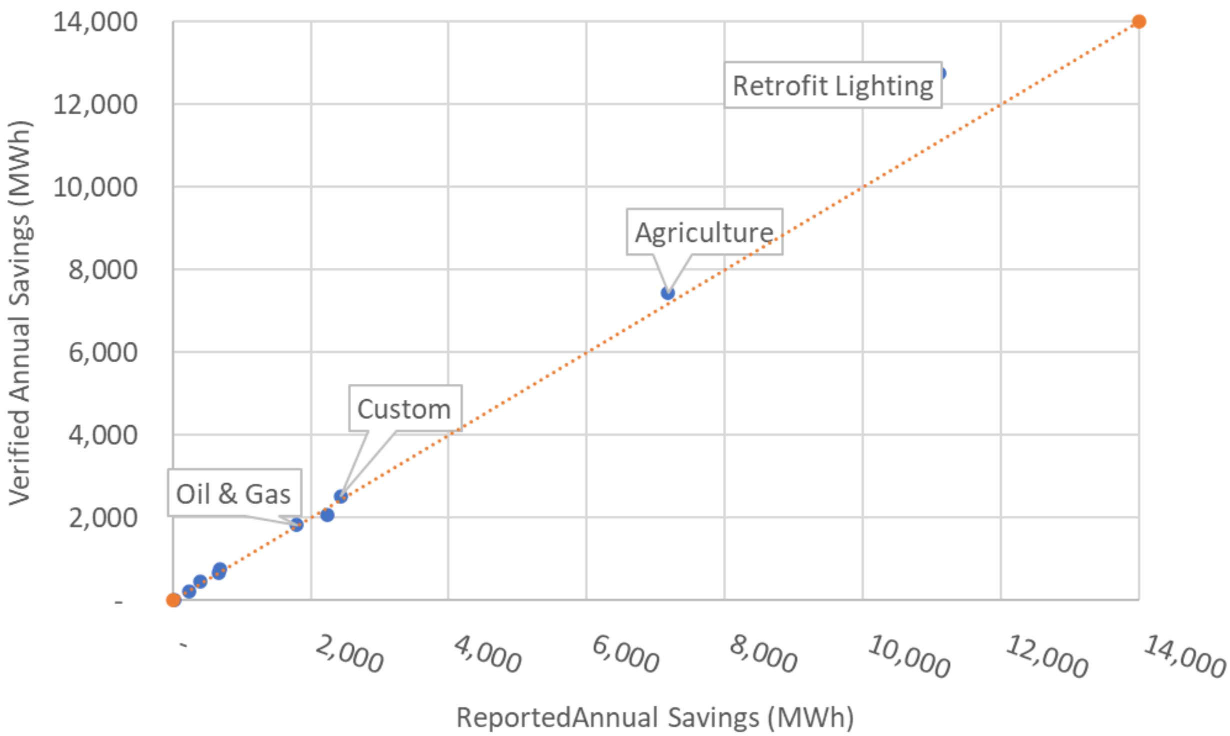
Table 3-108: Reported and Verified Gross kWh Savings by Sampling Stratum – Prescriptive and Custom

Stratum	Reported kWh Savings	Verified Gross kWh Savings	Gross kWh Realization Rate
Agriculture 1	810,062	801,050	99%
Agriculture 2	4,154,872	3,756,762	90%
Agriculture 3	2,213,554	2,901,131	131%
Custom & Other 1	246,985	246,986	100%
Custom & Other 2	2,520,552	2,699,536	107%
Custom & Other 3	1,608,124	1,588,953	99%
Custom & Other 4	2,610,314	2,759,818	106%
New Const. Light	1,426,147	1,247,858	87%
Prescriptive 1	59,007	59,007	100%
Prescriptive 2	196,414	191,554	98%
Retrofit Lighting 1	923,304	1,686,846	183%
Retrofit Lighting 2	2,743,408	3,672,617	134%
Retrofit Lighting 3	3,992,308	3,808,618	95%
Retrofit Lighting 4	3,262,467	3,382,616	104%
Total	**26,767,519**	**28,803,354**	**108%**

The achieved sample design results in reported gross annual energy savings estimates with ±9.7% relative precision at the 90% confidence interval, and ±8.5% in verified gross annual energy savings.[34] Variability was found within individual projects, with realization rates ranging from 62% to 249%. Figure 3-31 demonstrates the impact of measure type realization rates for the program. The dotted line represents a theoretical realization rate of 100%. As can be seen, retrofit lighting has the largest impact based on the magnitude and is at an 115% realization rate. Agriculture represented the second largest impact based on magnitude. Agriculture measures commonly included horticultural lighting and humidifiers.

[34] That is, we are 90% confident that the true verified gross savings are between 26,343,856 and 31,262,852 kWh based on the uncertainty introduced by sampling.

Figure 3-31: Custom and Prescriptive Realization Rate Impact



The following sections discuss the results based on specific measure types from the evaluation sample.

Lighting Projects

Dedicated lighting projects were included in two strata: retrofit lighting (RL 1-4), and new construction lighting (New Const. Light). Due to the difference in energy savings methodologies, new construction lighting is extrapolated separately from retrofit lighting. Project level realization rates ranged from 71% to 249%.

Retrofit Lighting Projects

Differences between reported and verified energy savings can be explained by differences in reported and verified hours of use (HOU), and a difference in HVAC interactive effects. Verified savings used lighting schedules from detailed interviews with facility staff as well as deemed hours of use when applicable. Lighting settings from Energy Management Systems (EMS), timers, and photocells were used, where appropriate, based on on-site verification. When an accurate HOU was not available, or the HOU varied, deemed values from the Arkansas TRM v8.1 were used.

The driver of evaluation risk for retrofit lighting projects was HOU and interactive effects. On-site verifications indicated that as-found HOU were greater than or less than the HOU the reported utilized. Table 3-109 below shows the frequency of realization rate factors for retrofit lighting sampled projects.

Table 3-109: Frequency of Realization Rate Factors, Retrofit Lighting

Sample Size	Impact of Factor	Differing HOU	Differing IEFe	Differing CF	Other
15	Positive	7	5	10	-
	Negative	4	-	1	3

New Construction Lighting Projects

Energy savings analyses for new construction lighting projects require a lighting power density (LPD) approach to determine the proper baseline condition. The LPD baseline condition is based on allowable building codes and is stipulated by space type. Project realization rates ranged from 83% to 212%. The variation in realization rates was due to some variation in the hours of use, interactive effects, and other factors. The overall realization rate was 87% and was driven by the largest new construction site in the sample. The reported savings utilized a baseline LPD of 1.5 for a retail building, the verified savings used an exercise center LPD of 1.0 as this was a fitness center. Table 3-110 below shows the frequency of realization rate factors for new construction lighting sampled projects.

Table 3-110: Frequency of Realization Rate Factors, NC Lighting

Sample Size	Impact of Factor	Differing HOU	Differing IEFe	Differing CF	Other
3	Positive	1	1	2	-
	Negative	-	-	-	1

Custom & Other Projects

The variance in realization rates for custom and other equipment projects varies by measure and savings algorithm implemented. Custom analyses were performed for measures such as refrigeration, BAS/EMS controls, RCx, and whole facility new construction. These measure types were grouped in the sample due to the nature of the measure, multiple measures at the same site, and the annual energy savings (kWh). Some larger projects underwent pre-reviews to help mitigate evaluation risk. Additionally, AMI data was utilized on two custom projects that incorporated HVAC controls and equipment optimization.

All sampled projects fell within a realization rate of 62% to 125%. Projects representing a higher level of risk included:

- Three multi-measure sites that included retrofit lighting, new construction lighting, and kitchen equipment. These sites had energy savings kWh realization rates ranging from 110% to 125%. The discrepancy in energy savings is mostly attributed to a difference in hours of use found on the site. The verified savings calculations rely on interviews with the staff on-site and their description of the lighting operation. This resulted in the verified hours of use being greater than the values used by the reported savings.
- A mixed used facility consisting of 20% religious space and 80% office space. This site installed a BAS along with additional sensor and controls to implement 7 ECMs involving scheduling, DCV, and optimized controls strategies. The energy savings realization rate for this custom project was 62%. The primary reason for the discrepancy is a difference in the analytical approach used to determine savings. The reported energy savings for this project were calculated using a proprietary spreadsheet-based calculation software. The reported savings tool uses Commercial Building Energy Consumption Survey (CBECS) as a source of benchmarking and other industry standards for deemed plus site inputs like approach. Verified savings used IPMVP Option C: a whole facility billing regression analysis. This approach was utilized due to the interactive effects between the implemented measures and typically recommended for a RCx/BAS/EMS upgrade project. The consumption from the utility meter associated with this facility was used in the verified savings billing regression. The daily pre/post-implementation regression mathematically describes the impact of implemented measures on facility energy consumption (kWh), using influential variables, including NOAA weather data for Tulsa International Airport.
- An office building of approximately 35,000 square feet that installed a BAS to implement an HVAC schedule as well as implementing a Supply Air Temperature Reset and a Static Pressure Reset. The kWh savings realization rate was 109%. There are slight differences in the analytical approach between reported and verified leading to the realization discrepancy. The reported savings calculations used a baseline data period and post-period of ~9 months, while the evaluator's analysis used a monthly baseline data period of 11 months and a post-period of 21 months. It is recommended by both IPMVP and ASHRAE Guideline 14 that whole-year data be used for the baseline (12, 24, 36 months, etc.) when possible. The evaluator's analysis was completed after the reported savings analysis, allowing for more data to accumulate in the post-period. The reported normalized the savings to TMY3 weather data. The verified results do this as well and agree with this approach, but the reported savings used Peoria Oklahoma weather in lieu of Tulsa Oklahoma.

Overall, custom projects represented a realization rate of 104%.

Agriculture

Differences between reported and verified energy savings can be explained by differences in reported and verified hours of use (HOU). Verified savings used lighting schedules from detailed on-site interviews with facility staff as well as monitoring hours of use when applicable. Some larger projects underwent pre-reviews to help mitigate evaluation risk. Monitoring was conducted on three agriculture projects, all three were indoor grow lighting sites.

All sampled projects fell within a realization rate of 72% to 249%. Projects representing a higher level of risk included:

- An indoor agricultural grow lighting projects where intensity lighting loggers were installed and collected monitored data. The loggers were installed to verify hours of use and dimming schedules. This site had an energy savings kWh realization rate of 249%. The discrepancy in energy savings is mostly attributed to a difference in hours of use found on the site. The reported calculations rely on interviews with the staff on-site and their description of the dimming cycles for each room. The verified hours of use relied on installed lighting loggers which logged lumens for 3 months. These lumen outputs were analyzed using verified tools and the resulting hours of use were calculated.
- An indoor agricultural grow lighting projects where intensity lighting loggers were installed and collected monitored data. The loggers were installed to verify hours of use and dimming schedules. This site had an energy savings kWh realization rate of 167%. The discrepancy in energy savings is mostly attributed to a difference in hours of use found on the site. The reported calculations rely on interviews with the staff on-site and their description of the dimming cycles for each room. The verified hours of use relied on installed lighting loggers which logged lumens for ~ 4 months. These lumen outputs were analyzed using verified tools and the resulting hours of use were calculated.
- A third indoor agricultural grow lighting project was monitored but the evaluator was unable to retrieve the loggers after multiple attempts. This project and the remainder of grow lighting projects relied on schedules confirmed with site contacts during field verification which differed from what the reported utilized.

Overall, agriculture projects represented a realization rate of 104%.

Measure-Level Results

The realization rate by measure type for the program is presented in Table 3-111.

Table 3-111: C&P Annual Energy Savings Realization Rate by Project Type

Project Type	Realization Rate	Percent of Custom and Prescriptive
Retrofit Lighting	115%	41.5%
Agriculture	104%	26.8%
Custom	104%	9.1%
New Construction Lighting	93%	8.3%
Oil & Gas	103%	6.7%
Multiple	110%	2.5%
SEM	101%	2.5%
HVAC VFD	113%	1.5%
Refrigeration & Kitchen Equipment	98%	<1%
Business Appliances	97%	<1%

3.2.3.4.2 Gross Coincident Peak Demand Reduction (kW)

The verified gross coincident peak demand reduction (kW) is summarized by the sampling stratum in Table 3-112. The peak demand reduction realization rate for prescriptive and custom projects is 109%.

Table 3-112: Reported and Verified Gross Peak Demand Reduction by Sampling Stratum

Stratum	Reported Peak kW Reduction	Verified Gross Peak kW Reduction	Verified Gross kW Realization Rate
Agriculture 1	141.62	162.37	115%
Agriculture 2	649.14	652.52	101%
Agriculture 3	380.91	382.92	101%
Custom & Other 1	48.21	55.79	116%
Custom & Other 2	406.78	410.11	101%
Custom & Other 3	180.28	183.15	102%
Custom & Other 4	249.48	277.20	111%
New Const. Light	289.77	279.94	97%
Prescriptive 1	6.95	6.95	100%
Prescriptive 2	27.28	35.69	131%
Retrofit Lighting 1	214.82	288.30	134%
Retrofit Lighting 2	549.33	568.31	103%
Retrofit Lighting 3	863.39	993.53	115%
Retrofit Lighting 4	504.79	623.91	124%
Total	**4,512.75**	**4,920.70**	**109%**

The achieved sample design resulted in reported gross peak demand reduction estimates with ±16.5% relative precision at the 90% confidence interval and 16.1% for verified peak demand reduction.[35] Peak demand reduction was variable from project to project, resulting in a high precision value. Differences between reported and verified demand reduction may be attributed to:

- Instances where the reported did not calculate demand reduction, but the verified found demand reduction savings present. This was the main driver for the greater than 100% realization rate.
- Use of stipulated coincidence factors (CF) that did not align well with actual equipment schedules.
- Instances where the reported did not apply demand interactive effects (IEFd) for sites that were found to have air conditioning.

For lighting projects, the verified lighting calculators generate an hourly curve (8760 hours) to determine the average peak demand value across the peak demand period for each lighting schedule. Custom calculations and energy simulations provide similar

[35] That is, we are 90% confident that the verified gross peak demand reduction is between 4,128 and 5,714 kW based on the uncertainty introduced by sampling.

results. For other prescriptive measures, the verified calculators used the deemed coincidence factors provided in the AR TRM v8.1.

3.2.3.4.3 Net-to-Gross Estimation

The data used to assign free ridership scores were collected through a survey of customer decision-makers for 2023 Prescriptive and Custom projects. The calculation of NTG was determined based on the ridership criteria (four areas of questions) and spillover described in a supplemental document.

Table 3-113 shows percentages of total gross verified annual energy savings associated with different combinations of free ridership indicator variable values for the custom and prescriptive incentive component. Results are based on 31 of the 39 Prescriptive and Custom survey respondents, each representing a unique project. The magnitude of free ridership was determined by the amount of annual energy savings and peak demand reduction attributed to free ridership within each project.

Table 3-113: Estimated Annual Energy Savings Free Ridership for Custom and Prescriptive

Had Plans and Intentions to Install Measure Without C&I Program? (Definition 1)	Had Plans and Intentions to Install Measure Without C&I Program? (Definition 2)	C&I Program had Influence on Decision to Install Measure?	Had Previous Experience with Measure?	Percentage of Total Gross kWh Savings	kWh Free Ridership Score
Y	Y	Y	Y	0%	100%
Y	Y	N	N	7%	100%
Y	Y	N	Y	4%	100%
Y	Y	Y	N	2%	67%
N	Y	N	Y	0%	67%
N	Y	N	N	5%	33%
N	Y	Y	N	0%	0%
N	Y	Y	Y	0%	33%
N	N	N	Y	1%	33%
N	N	N	N	66%	0%
N	N	Y	N	13%	0%
N	N	Y	Y	1%	0%
The project would have been deferred by one year or more in the absence of a program				32%	0%
Total				**100%**	**15%**

Overall, the estimated percentage of program free ridership is 15%. Project specific free ridership was determined on a measure level basis. Regarding spillover, one survey respondent indicated that they had installed additional un-incented energy-efficient equipment. However, this respondent did not provide sufficient response information to attribute spillover savings to the program.

The NTG for the program is calculated as 1 – free-ridership + participant spillover. This results in an NTG of 85% for annual energy savings and 80% for peak demand reductions. Table 3-114 shows the amount of savings and peak demand reduction impacted by free ridership and spillover.

Table 3-114: 2023 Free-Ridership and Spillover for Custom and Prescriptive

Savings	Free Ridership	Spillover
Annual Energy Savings (kWh)	754,654	-
Peak Reduction (kW)	187.43	-

The gross and net verified annual energy savings and peak demand reduction for Custom and Prescriptive projects are summarized in Table 3-115.

Table 3-115: Summary of Verified Gross and Net Impacts

Program	Verified Gross kWh Savings	Verified Net kWh Savings	Net-to-Gross Ratio	Verified Gross kW Reduction	Verified Net kW Reduction
Custom and Prescriptive	28,803,354	24,559,772	85% - kWh 80% - kW	4,920.70	3,922.02

Lifetime Energy Savings

Lifetime savings were determined for each equipment type or line item incentivized within each project. Lifetime savings were aggregated for all projects within each stratum to determine strata level lifetime savings. Sample level EUL's by strata as well as total population lifetime energy savings are shown in Table 3-116.

Table 3-116: C&P EUL's and Lifetime Energy Savings

Stratum	EUL	Gross Program Lifetime Energy Savings (kWh)	Net Program Lifetime Energy Savings (kWh)
Agriculture 1	13.18	10,556,788	9,001,463
Agriculture 2	12.99	48,802,952	41,612,841
Agriculture 3	11.41	33,114,503	28,235,762
Custom & Other 1	15.40	3,803,571	3,243,193
Custom & Other 2	13.08	35,321,140	30,117,297
Custom & Other 3	14.25	22,634,657	19,299,906
Custom & Other 4	15.00	41,397,270	35,298,234
New Const. Light	7.81	9,747,331	8,311,262
Prescriptive 1	4.00	236,028	201,254
Prescriptive 2	4.33	830,181	707,871
Retrofit Lighting 1	10.96	18,490,022	15,765,898
Retrofit Lighting 2	12.61	46,319,375	39,495,168
Retrofit Lighting 3	12.79	48,723,446	41,545,049
Retrofit Lighting 4	11.86	40,128,631	34,216,503
Total	**12.50**	**360,105,894**	**307,051,700**

3.2.3.5 Process Evaluation Findings

The process evaluation consisted of a participant survey, a trade ally survey, and a program staff facilitated discussion. ADM provided a detailed process evaluation memo to PSO after the completion of the 2023 program year.

3.2.3.5.1 Program Operations Perspective

ADM led a facilitated discussion with PSO and ICF staff in June 2023. The purpose of the discussion was to inquire with PSO staff regarding the status of the Prescriptive and Custom offerings' implementation and design.

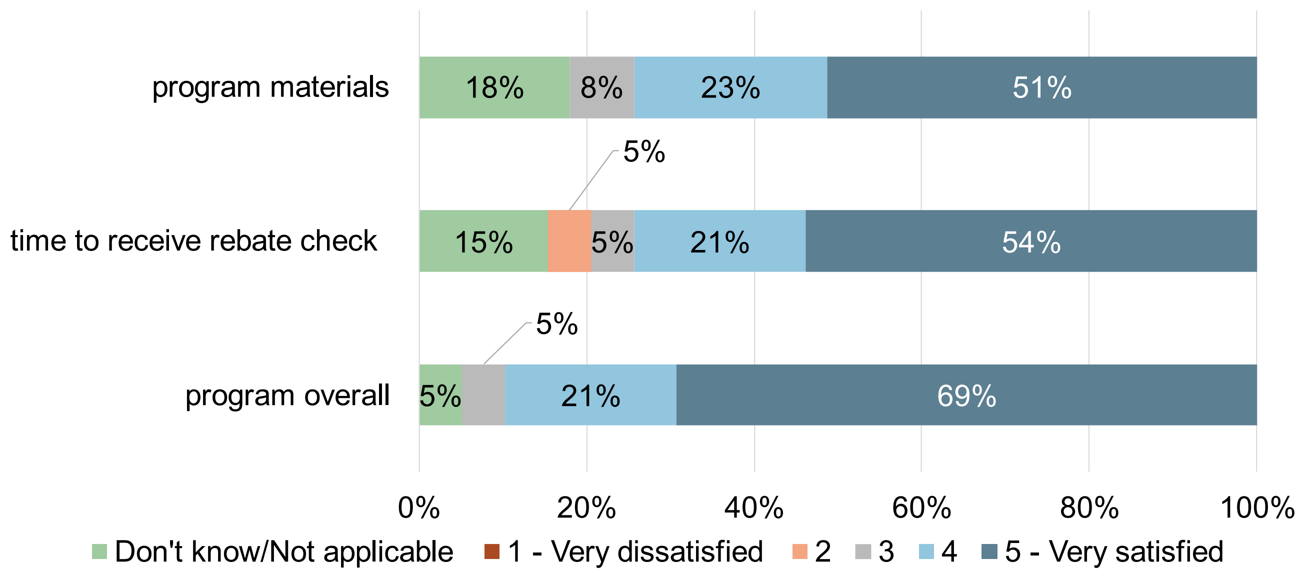
Implementation staff confirmed that lighting measures would continue to make up the bulk of savings. Increasing participation in non-lighting measures was an ongoing challenge. They noted that though non-lighting measures have lower participation, there is higher participation in refrigeration and kitchen equipment measures, compared to lower participation in the building envelope and plug load control measures. Staff also mentioned there was lower participation with some measures because they are less popular in Oklahoma (e.g., electric tankless water heaters) and there were fewer contractors to install them, compared to HVAC and lighting.

Indoor agricultural lighting projects are expected to continue. Program staff stated that though lighting is the highest saving measure, dehumidification measures are also common and there is growing interest in VFDs for irrigation systems.

3.2.3.5.2 Prescriptive and Custom Customer Survey

ADM conducted a mixed-mode survey (email/phone) of Prescriptive and Custom participants in September and October 2023. Most respondents were satisfied with their overall experience as well as the program materials and the time it took to receive their rebate payment (Figure 3-32).

Figure 3-32: Custom and Prescriptive Overall Respondent Satisfaction with Aspects of Program Participation (n=39)



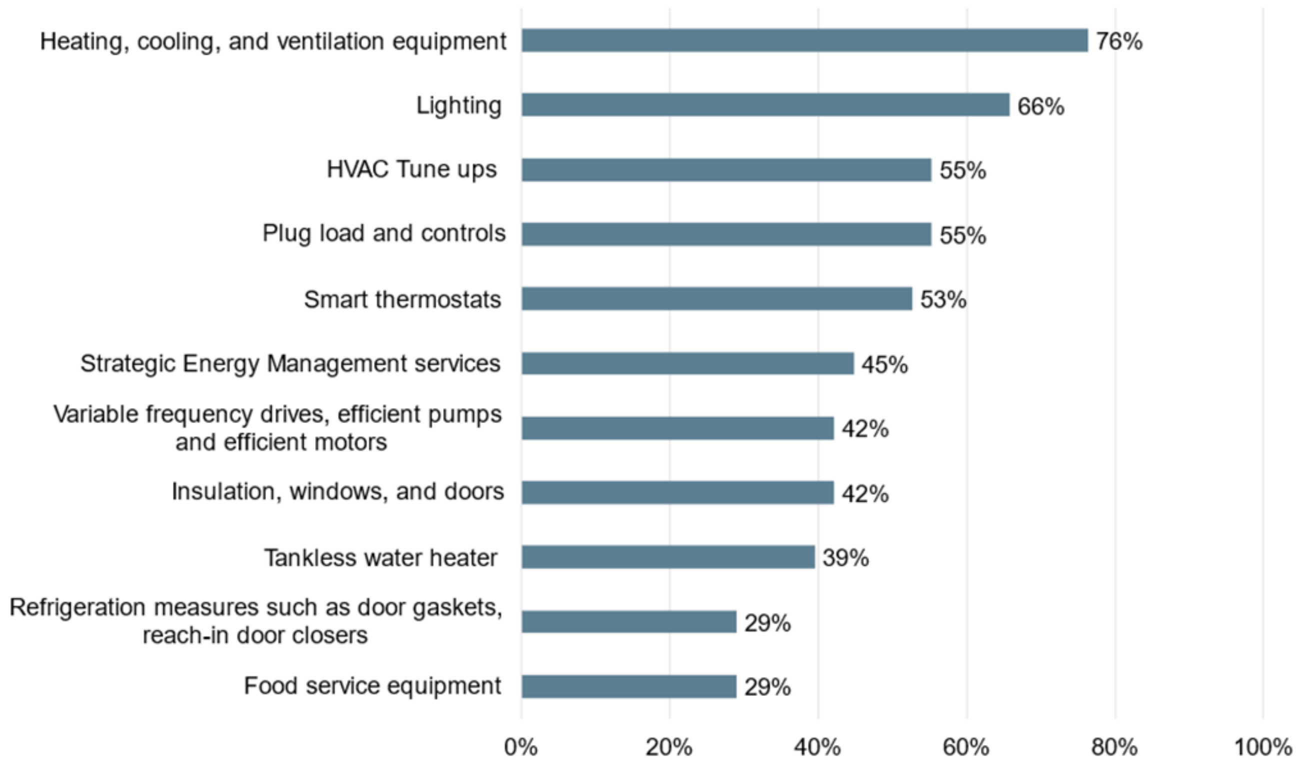
Fifty-one percent of survey respondents said that they had recommended the program to someone else. Of those who had not yet recommended the program, 88% said they would be likely to recommend it to a friend or colleague.[36] All of the respondents also noted being satisfied with PSO as their electric utility.[37]

ADM also asked participant survey respondents about their interest in incentives (or additional incentives) for other energy efficiency improvements. About three-quarters of respondents indicated interest in incentives for HVAC equipment. Figure 3-33 displays Prescriptive and Custom participant survey respondent interest in additional measures.

[36] Rated their likelihood of recommending the program a 7 or higher on a scale from 0 (not at all likely) to 10 (extremely likely).

[37] Rated their satisfaction a 4 or 5 on a scale from 1 (very dissatisfied) to 5 (very satisfied).

Figure 3-33: Prescriptive and Custom Respondent Interest in Additional Measures



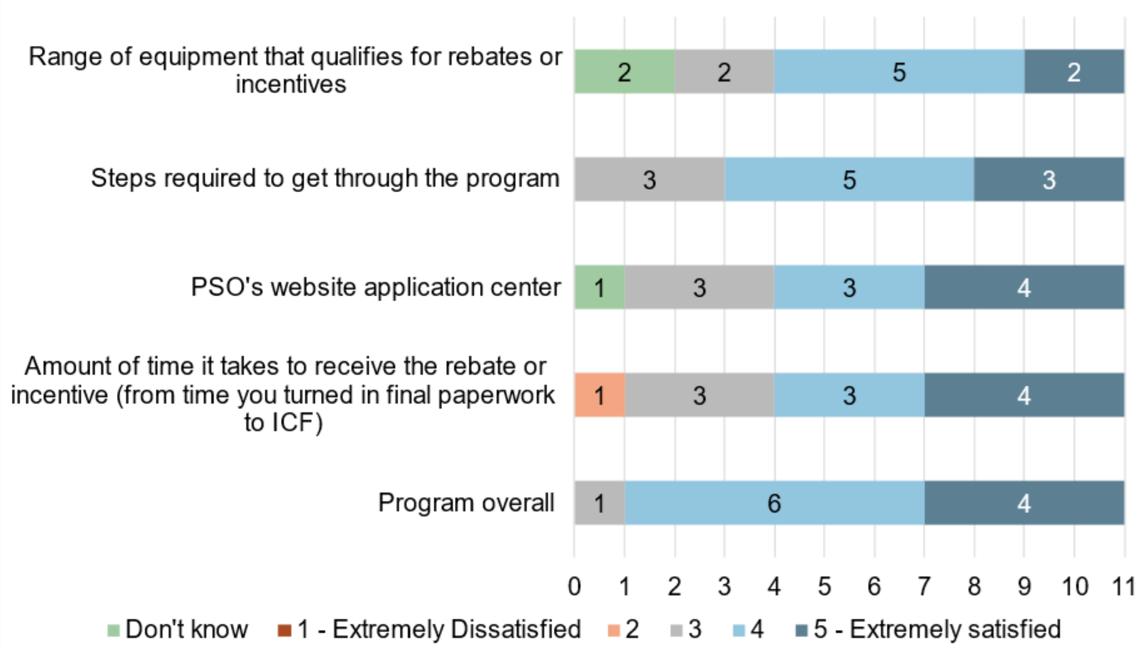
3.2.3.5.3 Prescriptive and Custom Trade Ally Survey

In October 2023, ADM collected survey responses from nine Prescriptive and Custom rebate trade allies. The following are key takeaways from the Prescriptive and Custom trade ally interviews:

- Trade allies are satisfied with their Prescriptive and Custom experience. Figure 3-34 displays trade ally satisfaction.[38]

[38] A rating of 4 or 5 on a scale from 1 (very dissatisfied) to 5 (very satisfied).

Figure 3-34: Custom and Prescriptive Trade Ally Satisfaction



- Trade allies consider the range of incentives offered to be appropriate. Seven of the trade allies said they were satisfied with the range of measures that PSO offered incentives for. The other four trade allies provided responses indicating they were unaware of the range of measures offered through the Prescriptive and Custom segment of the Business Rebates Program; this finding suggests there are opportunities to increase awareness of available PSO's Prescriptive and Custom Rebates.[39]
- ICF and PSO staff provide strong communications and sufficient trade ally support. Nine of the respondents had some sort of interaction with ICF staff in 2023, and all of them were satisfied with the staff's professionalism, courteousness, and ability to explain participation rules and customer eligibility.

3.2.3.6 Custom and Prescriptive Conclusions and Recommendations

This section presents conclusions and recommendations for the Custom and Prescriptive subprogram based on the 2023 evaluation.

Conclusions

- Verified gross savings were found to be higher than reported savings, with net savings resulting in a 7% reduction from reported annual energy savings.

[39] Two rated the range of measures a 3 on a scale from 1 (very dissatisfied) to 5 (very satisfied) and two did not know how to rate the range of measures offered through the program. The two that provided a rating recorded other responses that indicated they were unaware of PSO's offerings.

    - Most of the program's annual energy savings were from lighting and agricultural projects.
- Custom and Prescriptive participants and trade allies rated their overall satisfaction with the program at over 90%. Participants are most interested in future offerings related to their HVAC systems.
- Additional support and/or updates to program tools could improve or ease the participation process for Prescriptive and Custom trade allies. Suggestions included adjusting or improving the file upload process, providing trade allies with a phone or iPad app, reducing required fields for the application, making it easier to track projects' review process/progress, and enabling trade allies to delete old applications that have not been submitted.

Recommendations

- Consider a pre-screening questionnaire for new construction and large-scale replacement projects. A pre-screening questionnaire would enable the program to better determine the impact of incentive dollars on equipment choices and better capture its influence. This could be used to vet projects before incentive allocation.
- Continue to develop the SEM for mid-sized businesses subcomponent of the Business Rebates program.
- Continue to provide participants with information on additional ways to save energy and PSO's other energy efficiency programs. Survey responses indicate there may be opportunities to continue to engage with participants to improve their organization's energy efficiency.
- Ensure trade allies are aware of PSO's range of energy efficiency offerings and are leveraging the Prescriptive and Custom participation process to promote other ways for customers to engage in PSO's programs (e.g., Peak Performers).

3.2.4 Small Business Energy Solutions (SBES)

This section reports findings from the Small Business Energy Solutions (SBES) evaluation. ADM performed an impact and process evaluation. The verified annual energy savings estimates for SBES resulted in a 98% realization rate for net energy savings and an 88% realization rate for net peak demand reduction.

SBES seeks to generate energy savings for small commercial and industrial customers by promoting high-efficiency electric end-use lighting and refrigeration products. It seeks to combine provision of financial inducements with access to technical expertise to maximize program penetration across the range of potential small business customers. SBES has the following additional goals:

- Increase customer awareness and knowledge of applicable energy saving measures and their benefits.
- Increase the market share of commercial grade high-efficiency technologies sold through market channels.
- Increase the installation rate of high-efficiency technologies in small businesses by customers that would not have done so absent the program.

Direct installation rebates are available to customers that qualify. To qualify for businesses must use 320,000 kWh or less annually and use a PSO approved service provider. Customers may request an exemption of these requirements.

3.2.4.1 Impact Evaluation Overview

The impact evaluation of SBES consisted of gross and net annual energy savings and peak demand reduction determination. Gross energy savings were determined through M&V practices with on-site data collection. Net-to-gross was determined through survey efforts of participants and trade allies to calculate values of free ridership and spillover.

PSO provided rebates for a total of 314 SBES projects. The number of rebated projects increased from 272 in 2022 to 314 in 2023. The reported energy savings increased from 7,665 MWh (2022) to 8,757 MWh (2023). As with previous years, program energy savings were driven by lighting projects.

Table 3-117 provides projected and verified energy and demand impacts, as well as other program performance metrics for SBES projects.

Table 3-117: Performance Metrics – Small Business Energy Solutions

Metric	2023
Number of Projects	314
Energy Impacts (kWh)	
Reported Energy Savings	8,756,945
Gross Verified Energy Savings	8,684,625
Net Verified Energy Savings	8,614,307
Peak Demand Impacts (kW)	
Reported Peak Demand Savings	2,057.46
Gross Verified Peak Demand Savings	1,859.75
Net Verified Peak Demand Savings	1,820.64
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.83
Utility Cost Test Ratio	1.30

3.2.4.2 Process Evaluation Overview

The process evaluation consisted of participant surveys, trade ally surveys, and facilitated discussions with program staff. The objective of the participant survey was to assess sources of program awareness, factors that influenced project decision-making, experience with the participation process, and program satisfaction. A total of 56 customer decision-makers responded to the participant survey and 3 SBES trade allies were interviewed by ADM. A detailed process evaluation memo was provided to PSO in December 2023.

Table 3-118 summarizes program activity by service provider. Four lighting service providers represented most of the energy savings. National Resource Management (NRM) represented 3% of energy savings with refrigeration equipment.

Table 3-118: SBES Summary by Service Provider

Service Provider	Sum of Reported Energy Savings (kWh)	Percentage of Projects kWh
Bridgepoint Electric	1,992,816	23%
Entegrity Partners	1,872,812	21%
First Light Systems	3,616,489	41%
Luminous of OK	1,006,514	11%
National Resource Management	268,314	3%
Total	**8,756,945**	**100%**

3.2.4.2.1 Project Activity by Location

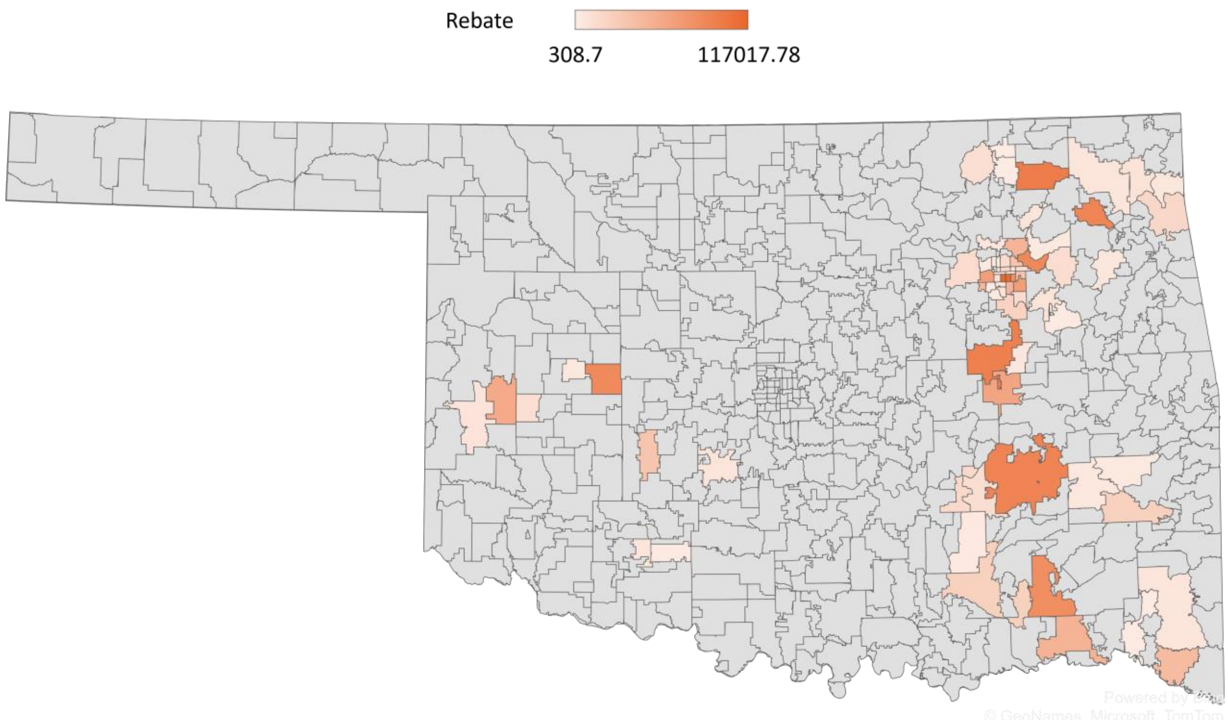
Table 3-119 displays the share of SBES savings by district. The distribution of savings is consistent with program goals. As expected, savings are associated with regions that have a higher density of businesses.

Table 3-119: SBES District Share of Reported Annual Energy Savings

Region	Sum of Reported Total Energy Savings (kWh)	Percentage of Projects kWh
Eastern District	1,657,625	19%
Tulsa District	5,332,107	61%
Tulsa Northern District	579,478	7%
Western District	1,187,735	14%
Total	**8,756,945**	**100%**

Figure 3-35 shows a heat map of the location of SBES projects across the service territory based on zip code. The density of projects increases as the color darkens; based on the number of projects. Zip codes represented in grey indicate that no incentives were achieved.

Figure 3-35: Distribution of Small Business Energy Solutions Projects



*Grey zip code did not receive funding. Sunset colored zip codes received funding.

Three projects consisting of reported annual energy savings over 320,000 kWh represented 13.27% of SBES projects annual energy savings. Two projects were in the Tulsa District and the largest in the Western District.

3.2.4.3 Evaluation Activities

This section provides an overview of the data collection activities, gross and net impact calculation methodologies, and process evaluation activities that ADM employed.

3.2.4.3.1 Data Collection

Data for the analysis was collected through review of program materials, on-site inspections, surveys with participating customers, and interviews with service providers and program staff. A sample was developed for on-site collection based on tracking data obtained via the tracking and reporting database.

Participating contractors used an online proposal tool called Audit Direct Install (ADI) software. Within ADI, space-by-space inventories are created for each project. The implementation team can generate reports directly from ADI which contain enough information to conduct desk reviews. Additional project materials including invoices, equipment cut sheets, pre- and post-inspection reports, and estimated savings calculators assist in preparing for visits and during analysis. On-site visits were used to collect data for gross impact calculations, to verify measure installation, and to determine measure operating parameters. Facility staff members were interviewed to determine the operating hours of the installed systems and provide any additional operational characteristics relevant to calculating energy savings.

In addition to the on-site data collection effort, customer surveys provided self-report data for the net-to-gross analysis and process evaluation. The customer survey was administered to a census of participants who had completed projects at the time of surveying. A total of 56 customer decision-makers who completed SBES incentive projects completed the survey. Trade ally interviews were conducted to gain feedback on program participation, barriers, and satisfaction from a stakeholder perspective. Trade ally interviews were conducted with four program contractors.

Table 3-120 shows the achieved sample sizes for the different types of data collection employed for this study.

Table 3-120: Sample Sizes for Data Collection Efforts – SBES

Data Collection Activity	Achieved Sample Size
On-Site M&V Visits & Engineering Analysis	25
Customer Decision-Maker Survey	56
Program Staff Facilitated Discussion	1
Trade Ally interviews	4

3.2.4.3.2 Impact Evaluation Sampling Plan

As with Custom and Prescriptive projects, ADM created a stratified sample based on the amount of estimated annual energy savings and type of measure installed in each project. Sample sizes were designed to meet ±10% precision at the 90% confidence level for annual energy savings. Table 3-121 below shows the sample design that was used for SBES projects. The 25 projects sampled for measurement and verification account for approximately 27% of reported program annual energy savings. One project was found to have a unique circumstance, based on its occupancy, and therefore was placed into its own strata such that its results were not extrapolated to unlike projects.

Table 3-121: Sample Design for the Business Rebates Program Small Business

Stratum Name	Reported kWh Savings	Strata Boundaries (kWh)	Population of Projects	Design Sample Size
Lighting 1	406,785	0-7,500	102	2
Lighting 2	1,146,281	7,500-20,000	90	2
Lighting 3	2,521,480	20,000-55,000	76	6
Lighting 4	2,186,614	55,000-150,000	24	6
Lighting 5	1,673,746	150,000-350,000	7	3
Lighting 6	512,545	350,000+	1	1
Refrigeration	268,314	0-37,000	11	4
Certainty	41,181		1	1
Total	**8,756,945**		**312**	**25**

3.2.4.3.3 Gross Savings Analysis Methodology

The evaluation of gross verified annual energy savings and peak demand reduction from projects rebated through the SBES Program can be broken down into the following steps:

- The program tracking database was reviewed to determine the scope of the program, check for data completeness, data entry errors, outlier values, and to ensure there were no duplicate project entries. The tracking database was used to define a discrete set of rebated projects that made up the program population. A sample of projects was then drawn from the population established in the tracking system review.
- A detailed desk review was conducted for each project sampled for in person verification and data collection. The desk review process included a thorough examination of all project materials including invoices, equipment cut sheets, pre- and post-inspection reports, and estimated savings calculators. This review process informed ADM's on-site fieldwork by identifying potential uncertainties and

missing data. Additionally, the review process involved assessing the reasonableness of deemed savings values and calculation input assumptions.

- After reviewing the project materials, on-site verification visits for data collection were scheduled for sampled projects. The on-site visits were used to collect data for savings calculations, to verify measure installation, and to determine measure operating parameters.
- The data collected during the on-site verification visits was used to revise reported savings calculations, as necessary. For example, if the reported savings calculations relied on certain measure operating hours that were determined inaccurate based on the facilities' actual schedule, changes were made to reflect actual operating conditions more accurately.
- After determining the verified savings impacts for each sampled project, results were extrapolated to the program population using project-specific sampling weights. This allows for the estimation of program level gross verified annual energy (kWh) savings with a given amount of sampling precision and confidence. For the SBES projects, the sample was designed to ensure ±10% or better relative precision at the 90% confidence level for kWh reductions.

3.2.4.3.4 Net-to-Gross Estimation (NTG)

The purpose of net savings analysis is to determine what portion of gross savings achieved by PSO customers is the direct result of program influence. This methodology includes both free ridership and participant spillover. The methodology for SBES is the same as Custom and Prescriptive and described in a supplemental document.

3.2.4.3.5 Lifetime Energy Savings

Lifetime energy savings (kWh) is the product of annual energy savings (kWh) multiplied by the Effective Useful Life (EUL). The EUL considers the technical lifespan of the equipment as well as the change in energy savings over time. The EUL is determined by measure for each measure within each project of the evaluation sample. The EUL for prescriptive measures is sourced from the Arkansas TRM v8.1. If a measure is not listed in the AR TRM, then a different industry standard reference, such as another technical reference manual, is considered. For custom equipment, the EUL is determined based on the lifespan of the equipment or if that cannot be determined then the industry standard of 20 years is applied. Energy savings for any behavioral measures in the program is only granted one year of EUL.

3.2.4.3.6 Process Evaluation Methodology

The strategy and design for the process evaluation for SBES mirrored the Custom and Prescriptive program. For a description, see the Custom and Prescriptive Evaluation Methodology section.

3.2.4.4 Impact Evaluation Findings

Impact evaluation findings determine net annual energy savings and net coincident peak demand reduction. Net energy impacts are achieved through several steps of evaluation, starting from M&V on a statistically representative sample of projects in which gross energy impacts are extrapolated to the population. The effects of free ridership and spillover are then applied to the population (on a project level basis) to determine program level net energy impacts.

3.2.4.4.1 Verified Gross Annual Energy Savings

The verified gross annual energy savings for SBES projects are summarized by sampling stratum in Table 3-122. Projects saw an overall realization rate of 99%. Ninety-eight percent of verified annual energy savings for the SBES Program resulted from lighting projects.

Table 3-122: Reported and Verified Gross Annual Energy Savings by Sampling Stratum – SBES

Stratum	Reported kWh Savings	Verified Gross kWh Savings	Gross kWh Realization Rate
Lighting 1	406,785	422,367	104%
Lighting 2	1,146,281	1,189,162	104%
Lighting 3	2,521,480	2,439,059	97%
Lighting 4	2,186,614	2,211,020	101%
Lighting 5	1,673,746	1,692,247	101%
Lighting 6	512,545	470,377	92%
Refrigeration	268,314	257,914	96%
Certainty	41,181	2,478	6%
Total	**8,756,945**	**8,684,625**	**99%**

The achieved sample design resulted in reported gross annual energy savings estimates with ±9.38% relative precision at the 90% confidence interval and verified gross annual energy savings at ±9.48% for kWh.[40] Realization rates varied from project to project and stratum to stratum.

[40] That is, we are 90% confident that the true verified gross savings are between 7,861,477 and 9,507,772 kWh based on the uncertainty introduced by sampling.

Differences from reported to verified energy savings stem from annual hours of operation and baseline wattage assumptions. In cases where baseline wattage was not able to be determined during verification visits, ADM used default baseline wattages as presented in the Arkansas TRM v8.1 (AR TRM). Annual hours of use for verified calculations were determined either through on-site verification interviews or referenced the AR TRM. There were no differences between reported fixture quantities and verified fixtures.

For Small Business lighting projects, linear tubes are the highest percentage of equipment type retrofitted through the program as can be seen from Table 3-123 at around 73% of the lighting program.

Table 3-123: SBES Percentage of Lighting by Type

Lighting Type	Percent of Program Lighting kWh
LED Linear Tubes	73.24%
LED Fixture	10.12%
LED Exterior Lights	7.79%
LED Screw-ins	3.90%
LED Exit Sign	2.52%
Occupancy Sensor	1.20%
LED Case Lights	0.53%
Abandoned Fluorescent	0.26%
Abandoned CFL	0.23%
Abandoned HID	0.21%
Total	**100%**

For the 11 Small Business non-lighting projects, evaporator/ compressor controls accounted for the highest percentage of reported annual energy savings (kWh). Equipment type retrofitted through the program can be seen in Table 3-124.

Table 3-124: SBES Percentage of Non-Lighting by Measure Type

Measure Type	Percent of Program Non-Lighting kWh
Evaporative/Compressor Controls	37%
EC Motors	32%
Cooler Door Heater Controls	22%
Novelty Setback Controls	9%
Total kWh for Non-Lighting	**100%**

3.2.4.4.2 Gross Coincident Peak Demand Reduction (kW)

The verified gross peak demand reduction is summarized by sampling stratum in Table 3-125. Overall, the verified gross peak demand reduction is equal to 90% of the reported reduction for SBES projects.

Table 3-125: SBES Reported and Verified Gross kW Reduction by Sampling Stratum

Stratum	Reported Peak kW Reduction	Verified Gross Peak kW Reduction	Verified Gross kW Realization Rate
Lighting 1	138.31	140.91	102%
Lighting 2	351.95	276.67	79%
Lighting 3	652.61	622.34	95%
Lighting 4	523.74	520.96	99%
Lighting 5	345.89	272.61	79%
Lighting 6	0.00	0.00	-
Refrigeration	28.08	26.26	94%
Certainty	16.88	0.00	0%
Total	**2,057.46**	**1,859.75**	**90%**

The achieved sample design resulted in reported gross peak demand reduction estimates with ±20.04% relative precision at the 90% confidence interval and verified at ±20.19%.[41] Much of the difference between reported and verified demand reduction, as in past program years, is explained by either 1) variation of annual operating hours, or 2) use of stipulated coincidence factors (CF) that did not align well with actual equipment schedules. For lighting projects, the ADM verified lighting calculators generate an hourly savings curve (8,760 hours) to determine the average peak demand reduction value across the peak demand period for each lighting schedule within a project.

3.2.4.4.3 Net-to-Gross Estimation

The data used to assign free ridership scores were collected through a survey of SBES customer decision-makers for projects rebated. Free ridership was estimated using the methodology described in a supplemental document, consistent with the Custom and Prescriptive Program. NTG Results are based on 48 of the 56 SBES survey respondents, each representing a unique project. The percentage of free ridership was then applied to each project's verified annual energy savings. The overall results were then extrapolated to the remaining projects in the program.

[41] That is, we are 90% confident that the verified gross peak demand reduction is between 1,484.23 and 2,235.27 kW based on the uncertainty introduced by sampling.

Table 3-126 shows percentages of total gross verified savings associated with different combinations of free ridership indicator variable values for the SBES incentive component.

Table 3-126: Estimated Free-Ridership for SBES

Had Plans and Intentions to Install Measure Without SBES Program? (Definition 1)	Had Plans and Intentions to Install Measure Without SBES Program? (Definition 2)	SBES Program had Influence on Decision to Install Measure?	Had Previous Experience with Measure?	Percentage of Total Gross kWh Savings	Free Ridership Score
Y	0%	Y	Y	0%	100%
Y	1%	N	N	1%	100%
Y	0%	N	Y	0%	100%
Y	0%	Y	N	0%	67%
N	0%	N	Y	0%	67%
N	0%	N	N	1%	33%
N	0%	Y	N	0%	0%
N	0%	Y	Y	0%	33%
N	0%	N	Y	0%	33%
N	83%	N	N	78%	0%
N	13%	Y	N	12%	0%
N	2%	Y	Y	5%	0%
Project would have been deferred by one year or more in the absence of the program				9%	0%
Total				**99%**	**0.81%**

Overall, the estimated percentage of program free ridership is 0.81%. Project specific free ridership was determined on a measure level basis.

Two SBES survey respondents indicated that they had installed additional un-incented energy-efficient equipment. However, neither of these respondents provided sufficient response information to attribute spillover savings to the program. Table 3-127 displays free-ridership and spillover for SBES projects.

Table 3-127: Free-Ridership and Spillover for SBES Projects

Savings	Free Ridership	Spillover
Annual Energy Savings (kWh)	70,317	0
Peak Reduction (kW)	39.11	0

The NTG for the program is calculated as 1 – free-ridership + participant spillover. This results in an NTG of 99.2% for annual energy savings and 97.9% for peak demand reductions. The SBES gross and net verified energy savings and peak demand reduction are summarized in Table 3-128.

Table 3-128: Summary of SBES Verified Gross and Net Impacts

Program	Verified Gross kWh Savings	Verified Net kWh Savings	Net-to-Gross Ratio	Verified Gross kW Reduction	Verified Net kW Reduction
SBES	8,684,625	8,614,307	99.2% - kWh 97.9% - kW	1,859.75	1,820.64

3.2.4.4.4 Lifetime Energy Savings

Lifetime savings were determined for each equipment type or line item incentivized within each project. Lifetime savings were aggregated for all projects within each stratum to determine a strata level lifetime savings. These lifetime savings were divided by the aggregated annual gross and net energy savings for each stratum to determine and EUL to be extrapolated to the population by strata. For the certainty project since the site contact stated in 2 years the interior lights will be used ADM determined to give this project an EUL of 13 years. Sample level EUL's by strata as well as total population lifetime energy savings are show in Table 3-129.

Table 3-129: SBES EUL's and Lifetime Energy Savings

Stratum	EUL	Gross Program Lifetime Energy Savings (kWh)	Net Program Lifetime Energy Savings (kWh)
Lighting 1	14.91	6,299,069	6,248,066
Lighting 2	13.91	16,539,313	16,405,398
Lighting 3	11.32	27,605,535	27,382,019
Lighting 4	14.87	32,870,441	32,604,296
Lighting 5	11.09	18,758,961	18,607,074
Lighting 6	15.00	7,055,657	6,998,529
Refrigeration	12.26	3,161,375	3,135,778
Certainty	13.00	531,494	527,191
Total	**12.99**	**112,821,845**	**111,908,352**

3.2.4.5 Process Evaluation Findings

The process evaluation consisted of a participant survey, trade ally interviews, and program staff facilitated discussions. ADM provided a process evaluation memo to PSO presenting detailed findings from all activities of the process evaluation.

3.2.4.5.1 Program Operations Perspective

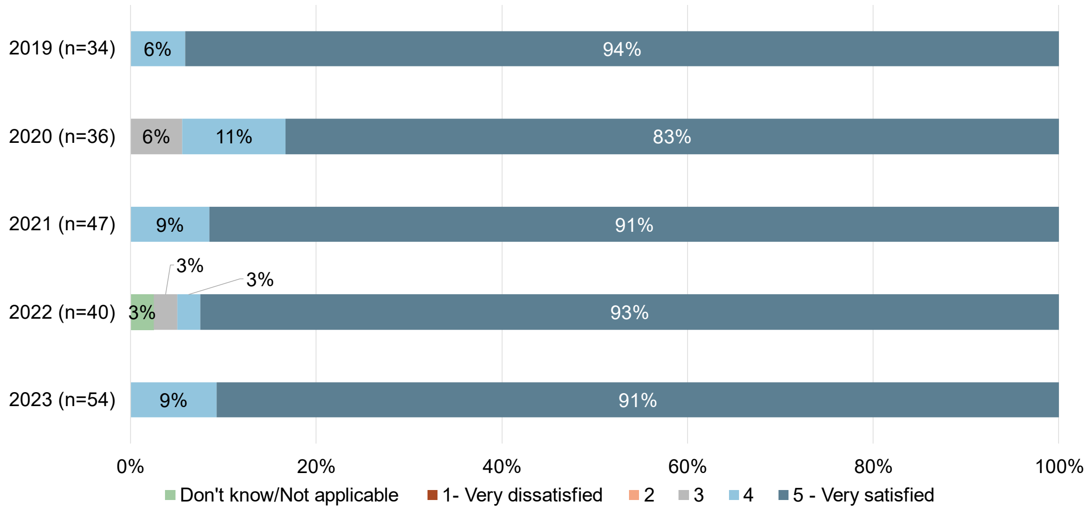
ADM led a facilitated discussion with PSO and ICF staff in July 2023. The purpose of the discussion was to inquire with PSO staff regarding the status of the program's implementation and design.

Implementation staff confirmed that lighting measures would continue to make up the bulk of the SBES offering's savings. The program will continue to utilize its closed network of trade allies to provide discounted lighting retrofits to small businesses. There are no concrete plans to update the SBES' design, though PSO staff stated that there had been discussions regarding a small business demand response offering with smart thermostats to be added in the future.

3.2.4.5.2 SBES Participant Survey

ADM conducted a mixed-mode survey (email/phone) of Small Business Energy Solutions participants in August, September, and October 2023. ADM sent an email survey invitation and one reminder to all potential respondents with valid email addresses. To collect additional responses, ADM contacted customers with up to three phone calls. Nineteen customers completed the survey through an email invitation link and 37 completed the survey over the phone. Overall satisfaction was high and consistent with past program years (see Figure 3-36 for SBES customer satisfaction from 2019-2023).

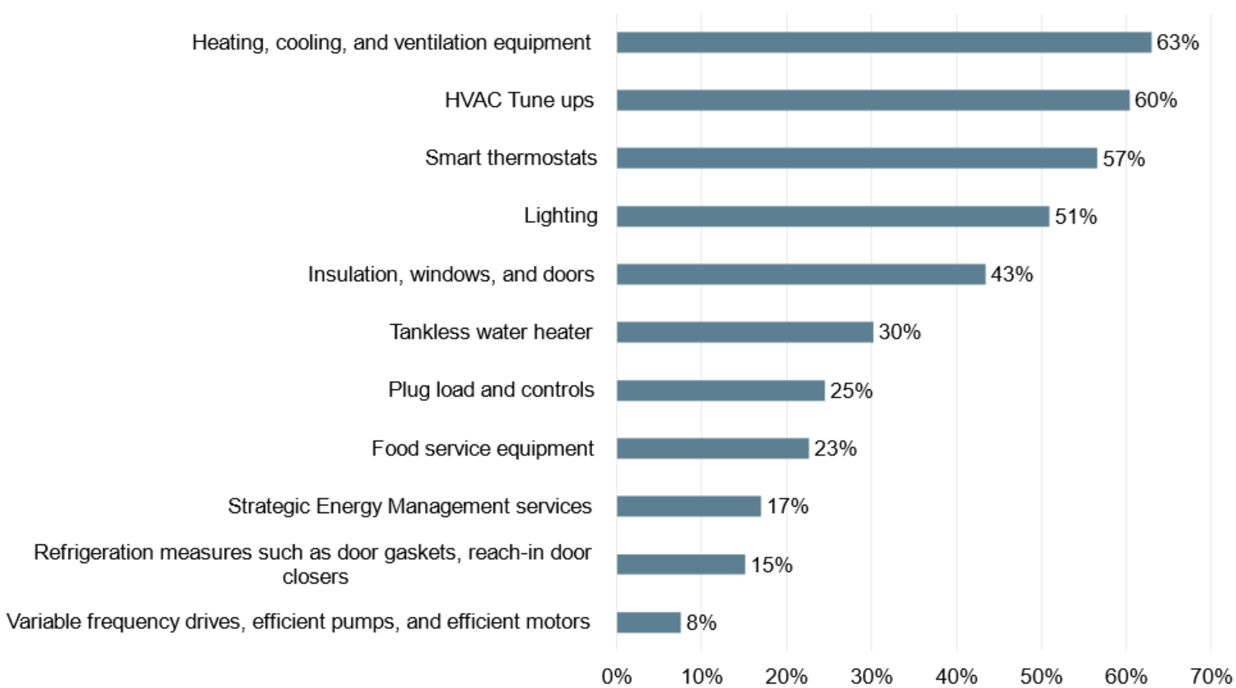
Figure 3-36: Overall SBES Respondent Satisfaction 2019-2023



Sixty-three percent of survey respondents said that they recommended the program to someone else. All of those who had not yet recommended the program said they would be likely to recommend it to a friend or colleague. Ninety-three percent of respondents said they were satisfied with PSO as their electric utility.

Survey respondents were asked about their interest in incentives (or additional incentives) for other energy efficiency improvements. Over half of respondents indicated interest in incentives for HVAC equipment, tune-ups, smart thermostats, and lighting. Figure 3-37 displays SBES survey respondent interest in additional measures.

Figure 3-37: SBES Respondent Interest in Additional Measures



3.2.4.5.3 SBES Trade Ally Survey

In November 2023 ADM solicited and received feedback from four participating SBES trade allies. Three respondents represented trade allies that assist PSO customers with lighting projects and the other represented a trade ally that provides refrigeration improvements. These are the key takeaways from the interviews:

- SBES trade allies are satisfied overall. All four of the trade allies said they were satisfied with the steps required to participate in the offering, the range of equipment that qualifies, the amount of time it takes to receive the rebate, and SBES overall.
- Program staff are professional and courteous and provide sufficient program support for successful program implementation. All the SBES trade ally respondents interacted with the implementation team in 2023 and were satisfied with the program staff's level of professionalism and courteousness, knowledge about energy efficiency and energy-efficient products, response time to answer questions, and ability to explain program rules and customer eligibility.
- SBES incentive levels are perceived by the trade allies to be sufficient to induce small business customers in PSO territory to buy high-efficiency equipment.

3.2.4.6 SBES Conclusions and Recommendations

This section presents conclusions and recommendations for the SBES Program based on the 2023 process and impact evaluation findings.

Conclusions

- The SBES Program continues to be driven by lighting energy efficiency measures with a small contribution from refrigeration measures.
- Implementation practices resulted in program level estimated energy savings aligned with verified energy savings. Overall realization rates for annual energy savings and coincident peak demand reduction were high.
- SBES participant satisfaction was 100%, higher than it has been in years past. Most participants are likely to recommend the program to others.
- SBES could ease or improve trade allies' participation process with additional support and/or updates to program tools. Two SBES trade allies noted opportunities to improve the participation process.
- SBES customer survey findings suggest there is interest in additional measure offerings. Over half of respondents indicated interest in incentives for HVAC equipment, tune-ups, smart thermostats, and lighting.

Recommendations

- Maintain and continue to improve available support for SBES trade allies to ease participation process. SBES trade ally survey findings suggest program staff should continue to work with trade allies to inform them of participation best practices for verifying customer eligibility and using required program tools.
- Continue to provide participants with information on additional ways to save energy and PSO's other energy efficiency programs. Survey responses indicate there is interest in HVAC measures, additional lighting improvements, as well as several other measure types.

3.2.5 Commercial Midstream

This section reports findings from the Commercial Midstream lighting and HVAC program. The commercial midstream program aims to influence stocking practices to promote energy efficient equipment for various commercial lighting and HVAC equipment. An impact and process evaluation specific to this subprogram was performed. The gross verified annual energy savings estimates for midstream projects resulted in a 103% realization rate for gross energy savings and an 85% realization rate for gross peak demand reduction. Net energy impacts were determined through survey efforts of program participants. Separate net-to-gross ratios (NTG) for both annual energy savings and peak demand reduction were determined for lighting and HVAC. The lighting NTG is 84.68% for annual energy savings and 85.54% for peak demand reduction. The HVAC NTG is 98.51% for annual energy savings and 100.00% for peak demand reduction.

The midstream portion of the Business Rebates Program, started in 2019, is designed to generate long-term energy savings for PSO business customers. The goal of the program is to influence distributor stocking practices, as well as promotion and sales of higher efficiency equipment to encourage energy efficiency. The program provides rebates and support directly to qualifying distributors who then work directly with service providers or customers to promote the sale of higher efficiency equipment.

3.2.5.1 Impact Evaluation Overview

The goal of the impact evaluation is to determine net savings impacts of annual energy savings (kWh), coincident peak demand reduction (kW), and lifetime energy savings. Net savings are achieved through verification of gross savings estimates which are adjusted for program influence to determine net savings impacts.

PSO's midstream program provided rebates for a total of 159 projects. 145 projects consisted of lighting measures and 14 projects consisted of HVAC equipment. Table 3-130 provides projected, reported, and verified energy and demand impacts, as well as other program performance metrics for midstream projects.

Table 3-130: Performance Metrics – Midstream Lighting and HVAC

Metric	2023
Number of Projects	159
Energy Impacts (kWh)	
Reported Energy Savings	3,208,345
Gross Verified Energy Savings	3,310,854
Net Verified Energy Savings	2,998,461
Peak Demand Impacts (kW)	
Reported Peak Demand Savings	547.21
Gross Verified Peak Demand Savings	465.39
Net Verified Peak Demand Savings	422.79
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.86
Utility Cost Test Ratio	1.24

3.2.5.2 Process Evaluation Overview

The process evaluation consisted of a facilitated discussion with program staff, interviewing distributors, and surveying end use customers. The objective of the customer survey was to assess the source of program awareness, factors that influenced project decision-making, experience with the application process or energy consultant, program satisfaction, and inform the calculation of a Net-to-Gross ratio.

3.2.5.3 Evaluation Activities

This section provides an overview of the data collection activities, gross and net impact calculation methodologies, and process evaluation activities that were employed in the evaluation of the midstream projects.

3.2.5.3.1 Data Collection

Data for the analysis was collected through provided program and project documentation, program staff facilitated discussion, distributor and service provider interviews, and end-use customer surveys. These materials were supplemented with information from manufacturers as well as the Air Conditioning, Heating and Refrigeration Institute (AHRI).

3.2.5.3.2 Gross Savings Analysis Methodology

The overall objective of the impact evaluation is to develop statistically valid estimates of gross and net annual energy savings (kWh), lifetime energy savings (kWh), and peak demand reductions (kW). A census review of all midstream projects and line items was performed. Verified savings from the Midstream Lighting program channel are determined through a review of the implementation database, end-use customer surveys, and distributor interviews. For lighting measures, engineering analysis was conducted to determine the verified energy savings for each lamp type sold through the program. The verified energy savings per fixture or lamp was calculated with methods consistent with chapter 6 of The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. For both the lighting and HVAC analyses the methodologies from the Arkansas TRM v.8.1 and the Mid-Atlantic v.10 were employed.

Knowledge of baseline conditions is often not available in midstream applications. Baseline assumptions were determined with the implementation team following the AR TRM as well as other industry standards where the AR TRM is not applicable.

Determination of gross impacts from the Midstream channel will consist of several activities used to verify savings associated with the program. Those activities include:

- Verification of Equipment Counts: The number of units sold through the program will be verified through a review of distributor invoices.
- Verification of Fixture/Lamp Wattage and Lumen Output: Fixture and lamp wattages are reported in the program database and/or in the Point-of-Sale (POS) data provided by participating distributors. We will verify the reported values are correct by reviewing manufacturer specification sheets, Design Lighting Consortium (DLC), and/or ENERGY STAR® certifications for a census of all fixtures/lamps sold through the program. The verified lumen output of the sold lamps will then be compared to the reported baseline model to determine an appropriate baseline wattage.
- Verification of HVAC equipment: Equipment will be verified against the AHRI database.
- Categorize Building Types: The program data provided by the implementation contractor includes end user contact name, business name, and installation address. This data will be used to categorize the facility type where the fixtures/lamps were installed. The facilities will be categorized according to the definitions provided in the AR TRM. The deemed Hours of Use (HOU) and Coincident Factors (CF) provided in the TRM for each facility will be used in the verified energy savings calculations.
- Gross annual energy savings, peak demand reduction, and lifetime energy savings will be determined through industry standard methodologies. The AR TRM methodologies will be followed when applicable, with assumptions replaced by verifiable known conditions.

3.2.5.3.3 Net-to-Gross Estimation (NTG)

The purpose of net savings analysis is to determine what portion of gross savings achieved by PSO customers is the direct result of program influence. As a result, evaluating the net effects of the price discounts requires estimating free ridership without non-program sales data. The PSO Midstream Program's net-to-gross ratio (NTGR) were investigated separately for Lighting and Non-Lighting (HVAC).

Midstream Lighting NTG

The PSO Midstream lighting net-to-gross ratio (NTGR) was investigated through a survey of end-use customers as well as through distributor interviews. Only end user scores were used to assign a NTG score. Self-reported responses were used from end-use customers who purchased efficient lighting from the Midstream offering during the current program year to estimate lighting discount free ridership.

The survey aimed to elicit information from which to estimate the number of bulbs that the customer would have purchased in the counterfactual scenario where the efficient light bulbs were not discounted. Survey respondents were asked a series of questions to elicit feedback regarding influences on their light bulb purchasing decisions. Each respondent was assigned a free ridership score based on a consistent free ridership scoring algorithm. The scoring algorithm used is based on the methodology in the AR TRM and described in a supplemental document.

The spillover was not assessed for the Midstream Lighting program. The final respondent net-to-gross score is calculated as 1 minus free ridership.

Midstream Non-Lighting NTG

Free ridership was calculated using only data collected through the end-user survey. Scores were only developed from end-use customers who responded affirmatively to the question "Were you aware that you received a discount on that equipment?"

The methodology for end-user Midstream Non-Lighting free ridership is the same as Custom and Prescriptive and described in a supplemental document.

3.2.5.3.4 Lifetime Energy Savings

Lifetime energy savings (kWh) is the product of annual energy savings (kWh) multiplied by the Effective Useful Life (EUL). The EUL considers the technical lifespan of the equipment as well as the change in energy savings over time. The EUL is determined by measure for each measure within each project of the evaluation sample. The EUL for prescriptive measures is sourced from the AR TRM. If a measure is not listed in the AR TRM, then a different industry standard reference, such as another technical reference manual, is considered.

3.2.5.3.5 Process Evaluation Methodology

The process evaluation was designed to research and document the program delivery mechanisms and collective experiences of program participants, partners, and staff. The process evaluation was designed to answer the following research questions:

- How was this program marketed? How effective were the marketing efforts?
- How well did PSO staff and distributors work together? Is there rebate processing, data tracking, and/or communication efficiencies that can be gained?
- Did the program implementation reflect its design? Are there underlying assumptions about program implementation and design that are being made about how the program will unfold? Are there ways to improve the design or implementation process?
- What do distributors like about the Midstream model? Why? What would they like to change about the program? Why?
- What are PSO staff and implementation staff perspectives on the program? What are the reactions to program design choices that have been implemented?
- What share of projects are associated with specific distributors? How are savings distributed across them? Are there any differences in opinion between active and less active distributors?
- What types of buildings/facilities participated in the program? Could certain facility types be targeted more effectively?
- What customer barriers to participation do distributors see? How can these be mitigated?
- Were there any significant obstacles during the 2023 program year?
- Looking forward, what are the key barriers and drivers to program success within PSO's market?

To address these questions, the process evaluation activities included a review of program materials, staff interviews, distributor and service provider interviews, and end-use customer surveys. Table 3-131 provides a summary of data collection activities for the process evaluation.

Table 3-131: Commercial Midstream Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Review Program Materials	Review customer engagement materials, program procedure manuals, program websites, and other program documentation as it becomes available.
Program Staff Facilitated Discussion	Assess staff perspectives regarding the strengths, weaknesses, opportunities, and threats to program success.
Distributor Interviews (HVAC & Lighting)	Investigate benefits of program participation, satisfaction with program training, feedback on the program provided customer engagement support and program direct customer engagement to customers, feedback on program materials and guidelines; information for calculation of a Net-to-Gross ratio, and satisfaction with program processes and the program overall.
Service Provider Interviews (HVAC)	Investigate benefits of program participation, satisfaction with program training, feedback on the program provided customer engagement support and program direct customer engagement to customers, feedback on program materials and guidelines; information for calculation of a Net-to-Gross ratio, and satisfaction with program processes and the program overall.
End Use Customer Surveys (HVAC & Lighting)	Gather data on participant knowledge and awareness of the program, motivation, business practices, satisfaction, reasons for participating, decision-making process, as well as data that will help to inform the calculation of a Net-to-Gross ratio.

3.2.5.4 Impact Evaluation Findings

Impact evaluation findings determine net annual energy savings and net coincident peak demand reduction. Gross energy impacts are assessed through M&V efforts on the total population of projects. The effects of free ridership are then applied to the population (on a project level basis) to determine program level net energy impacts.

3.2.5.4.1 Midstream Lighting Gross Impacts

The Midstream lighting program included 20,435 items sold. A summary of the program level savings is shown in Table 3-132.

Table 3-132: Summary of Midstream Lighting Savings

Reported kWh Savings	Verified kWh Savings	Gross kWh Realization Rate	Reported kW Savings	Verified kW Savings	Gross kW Realization Rate
1,905,476	1,902,592	100%	356.71	294.67	83%

A summary of savings by facility type can be seen in Figure 3-38. Lodging (Hotel/Motel/Dorm) Rooms and Common Areas are the first and second largest facility types contributing to program savings with 864,921 kWh, making up 45% of overall savings. The “Office” space type is the third largest contributing space type with savings of 274,589 kWh, 15% of overall savings.

Figure 3-38: Commercial Midstream Reported kWh Savings by Facility Type

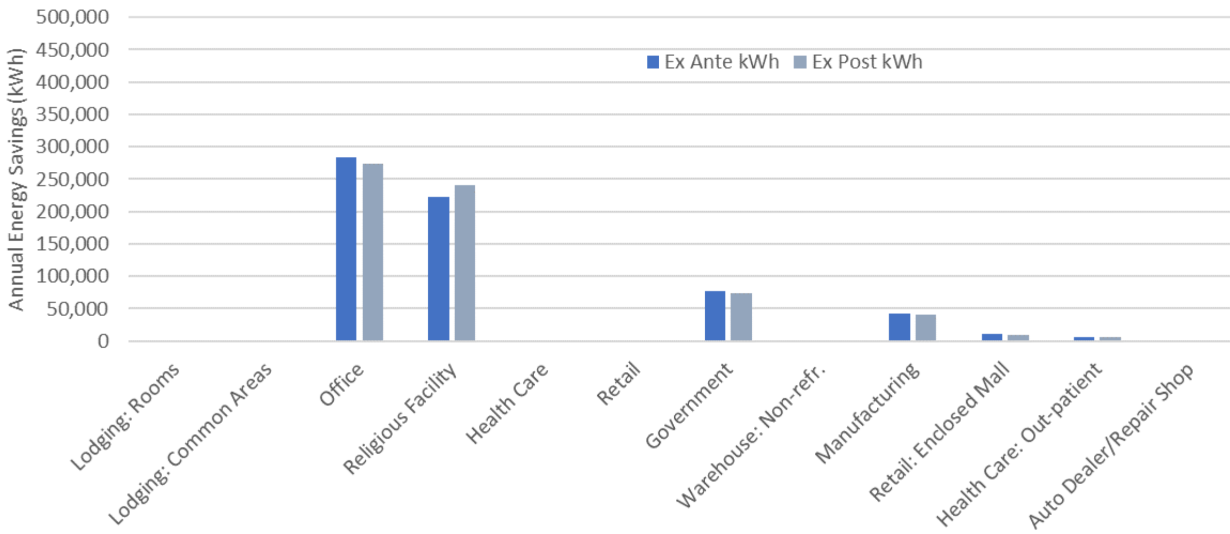
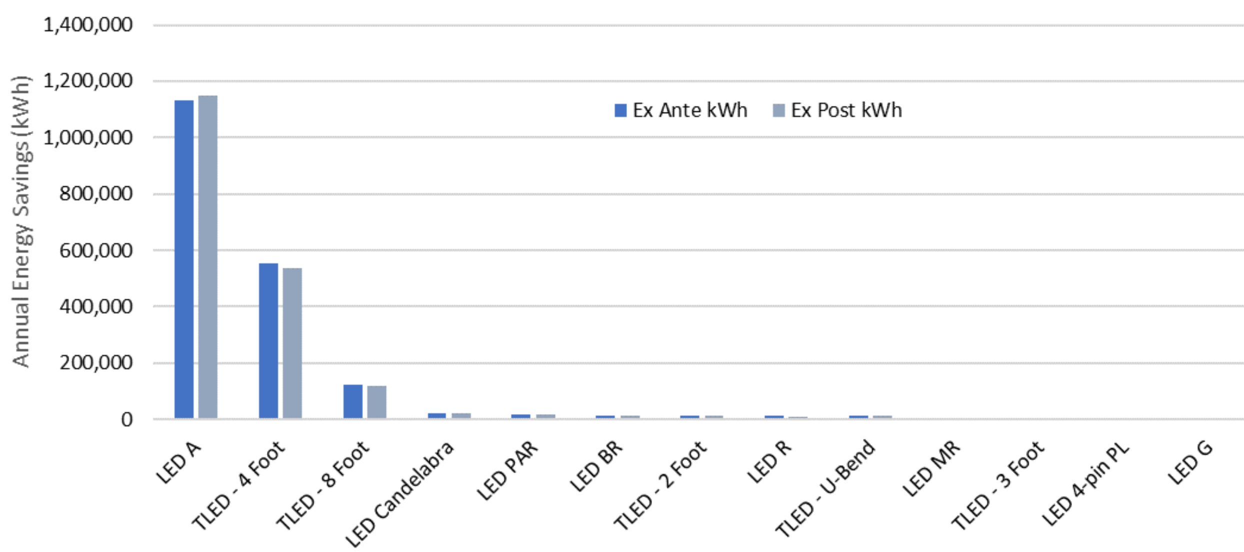


Figure 3-39 illustrates the relationship between reported and verified savings for lighting measures.

Figure 3-39: Commercial Midstream kWh Savings per Lamp Type



Discrepancies in the reported and verified program energy savings can mostly be attributed to a difference in the baseline and efficient wattages between the two calculations. The verified efficient wattages were determined by reviewing the specification sheets of the installed equipment. 25% of line items had a difference in the efficient wattage when comparing the reported and verified data, the range of difference goes from -0.8 to 3W. 12% of line items had a difference in the baseline wattage when comparing the reported and verified data, with a range of -10.2W to 1.08W.

Another discrepancy affecting the demand reduction savings was due to a difference in the coincidence factor (CF) utilized for the “Government” facility type. The reported savings calculation utilized a CF value of 0.7 sourced from the Mid-Atlantic TRM for an “Office” facility type, whereas the verified savings calculations utilized a CF value of 0.54 from the AR TRM for an “Office” building type. The “Government” facility type is not an official facility type in the TRM’s, so “Office” is used as a general approximation. This difference in coincidence factor is the primary factor affecting the demand reduction realization rate. This discrepancy was present in the previous year’s program evaluation and is the primary factor causing the demand reduction realization rate discrepancy.

Midstream Lighting ISR

In-Service Rate questions have been included in the end-use survey for the past three years. Low survey participation has resulted in the use of industry standard references in place of survey results. The combined survey results over the past three years have resulted in 34 responses for non-tube lighting for an ISR of 96.66% and 54 results for tube lights for an ISR of 95.46%. As questions were not asked about the lifetime install rate of the measures, all non-tube LEDs were given an ISR of 100% for 2023 and all tube lighting was given an ISR of 95.48%.

3.2.5.4.2 Midstream Lighting NTG

A mixed-mode survey was administered to customers that purchased lighting through the PSO Midstream Lighting program. Thirty-eight customers were invited to take the survey and 17 replied (response rate of 45%). All customers included in the program tracking data through mid-September 2023 were sent an email invitation and one reminder message. Six survey responses were collected via email invitation, and eleven were collected via follow-up phone call. Customers who responded to the survey confirmed purchasing LED linear lamps, A-Line lamps, MR lamps, Globe, Candelabras, and/or PAR lamps.

Self-reported responses from customers who had purchased efficient lamps and fixtures over the past three program years were used to estimate a NTG score of 85% for Midstream Lighting.[42] The NTG score was driven by respondents with the greatest savings indicating the incentive and participation in the offering was an important factor in their decision-making process. See Table 3-133 and Table 3-134 for a summary of net savings impacts for the Midstream lighting program.

[42] Responses received in 2023 alone did not yield a statistically significant sample size.

Table 3-133: Summary of Net kWh Savings - Midstream Lighting

Gross Reported Savings kWh	Gross Verified Savings kWh	Gross Realization Rate	Gross Lifetime Savings kWh	kWh NTG Ratio	Net Verified Savings kWh	Net Lifetime Savings kWh
1,905,476	1,902,592	100%	17,129,665	84.68%	1,611,183	14,506,014

Table 3-134: Summary of Net kW Savings – Midstream Lighting

Reported kW Savings	Gross Verified Savings kW	Gross Realization Rate	kW NTG Ratio	Net Verified Savings kW
356.71	294.67	83%	85.54%	252.07

3.2.5.4.3 Midstream Non-Lighting Gross Impacts

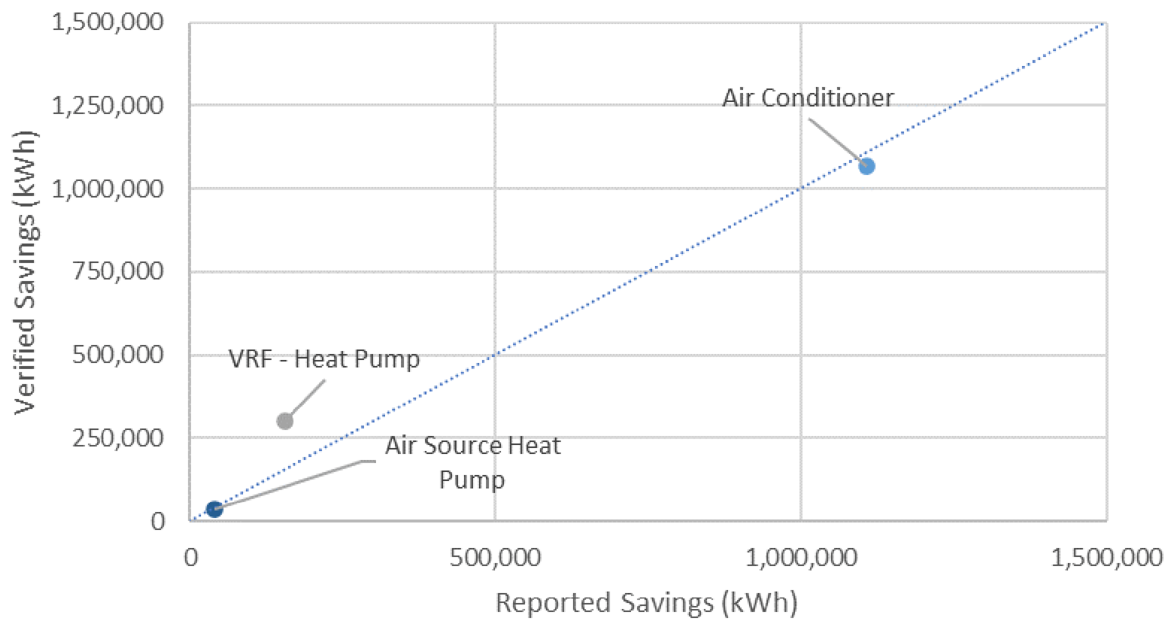
The Midstream Non-Lighting subprogram involved the installation of 418 units through 14 projects consisting of unitary and split system air conditioners, air source heat pumps, and variable refrigerant flow heat pumps. A summary of the program level savings is shown in Table 3-135.

Table 3-135: Summary of Midstream Non-Lighting Savings

Reported kWh Savings	Gross Verified kWh Savings	Gross kWh Realization Rate	Reported kW Savings	Gross Verified kW Savings	Gross kW Realization Rate
1,302,869	1,408,262	108%	190.50	170.72	90%

A summary of savings by equipment type is shown in Figure 3-40. The figure plots the reported annual energy savings versus the verified annual energy savings for the installed equipment types. The "Air Conditioner" equipment type was the largest contributing equipment type.

Figure 3-40: Commercial Midstream Non-Lighting Reported Savings vs Gross Verified Savings (kWh) by Equipment Type



The primary factor affecting the gross verified savings realization rate of 108% is a difference in the effective full load hours (EFLH) utilized for equipment installed at a casino. Tracking data listed the building type as "Entertainment", which is not a building type listed in the TRM. The tracking data lists the projects as using the EFLHs corresponding to the "School" building type. For the verified analysis, a custom EFLH was developed for the facility based on the CDD/HDD of the project location. The updated EFLH resulted in savings that had a positive contribution of 11% on the program realization rate.

The other savings discrepancies in the analysis were due to differences in AHRI-rated efficiencies of the installed equipment, as opposed to the nameplate efficiencies utilized in the reported calculations. In some cases, this difference in efficiency rating warranted a shift in the baseline efficiencies based on values taken from the AR TRM. The utilization of AHRI-rated efficiencies resulted in a net negative effect of -3% on the program realization rate.

3.2.5.4.4 Midstream Non-Lighting NTG

In September and October 2023, ADM attempted to reach the four end use customers that had purchased HVAC equipment through the PSO Midstream offering. We interviewed three customers after contacting all four customers up to seven times (three phone calls, four emails). Interviewees included an operations manager, a general contractor, and an executive director. The operations manager and general contractor were involved with new construction projects; the executive director was involved with the purchase and installation of high-efficiency equipment at multiple school facilities over several years.

For Midstream HVAC, ADM will use a 3-year weighted average end-use decisionmaker score of 0.98. The primary reason for assigning a 3-year weighted average is the limited number of interviewees with verified, informed end-use HVAC decisionmakers in 2023. ADM attempted to reach the four end use customers who had purchased HVAC equipment through the PSO Midstream offering. Two 2023 interview respondents were not directly involved in the specification of equipment. The other interviewee was able to answer ADM's interview questions as they had been involved in the initial decision-making process and was aware of the specification of equipment. Based on these results, ADM determined that the assignment of a free ridership score using 2023 end use customer interview results alone was imprudent. A 3-year weighted average score for Midstream HVAC was calculated using end use decisionmaker interviews from 2021, 2022, and 2023 to assign a NTG score of 0.97 for 2023.

Table 3-136 and Table 3-137 for details the summary of net savings impacts for the Midstream Non-Lighting Program.

Table 3-136: Summary of Net Annual Energy Savings - Midstream Non-Lighting

Program Year	Reported Savings kWh	Gross Verified Savings kWh	Gross Realization Rate	Gross Lifetime Savings kWh	kWh NTG Ratio	Net Verified Savings kWh	Net Lifetime Savings kWh
2023	1,302,869	1,408,262	108%	19,419,124	98.51%	1,387,278	19,129,761

Table 3-137: Summary of Net Peak Demand Reduction – Midstream Non-Lighting

Program Year	Reported kW Savings	Gross Verified Savings kW	Gross Realization Rate	kW NTG Ratio	Net Verified Savings kW
2023	190.50	170.72	90%	100%	170.72

3.2.5.4.5 Midstream Total Lifetime Energy Savings

Lifetime energy savings were determined for each equipment type or line item incentivized within each project. Lifetime energy savings are determined by multiplying verified annual energy savings with the effective useful life (EUL) from the associated TRM for the installed equipment type. Gross and net lifetime energy savings are provided in Table 3-138. Average EUL by measure classification is provided for reference.

Table 3-138: Midstream EUL's and Lifetime Energy Savings

Measure Classification	Average EUL	Gross Program Lifetime Energy Savings (kWh)	Net Program Lifetime Energy Savings (kWh)
Lighting	9	17,129,665	14,506,014
Non-Lighting	14	19,419,124	19,129,761
Total	**N/A**	**36,548,789**	**33,635,775**

3.2.5.5 Process Evaluation Findings

The process evaluation consisted of a participant survey, distributor and service provider interviews, and program staff interviews. A detailed process evaluation memo was provided to PSO after the completion of the 2023 program year.

3.2.5.5.1 Program Operations Perspective

Program staff indicated that the mix of measures and participation levels have aligned with expectations for the year. They expect a greater mix of business types in the program moving forward and supply chain improvements to support growth of the program in future years. There remain challenges with rural participation which are being addressed.

3.2.5.5.2 Lighting End User Survey

ADM administered a mixed-mode (web/phone) survey through its in-house survey team in August and September 2023 to customers who purchased lighting through the PSO Midstream offering. The survey gathered information regarding awareness of the offering, decision-making, satisfaction, and the participation process. ADM invited 38 customers to take the survey and 17 replied (response rate of 45%). Six survey responses were collected via email invitation, and 11 were collected via follow-up phone calls. Customers who responded to the survey confirmed purchasing LED linear lamps, A-Line lamps, MR lamps, Globe, Candelabras, and/or PAR lamps. Findings from the end-user survey are:

- Customers are aware of the PSO Midstream program discount. Ninety percent of respondents said that they knew that all the energy-efficient lighting they purchased through the PSO Midstream Program had been discounted. All these respondents said they knew that the discount was sponsored by PSO.
- The lighting distributor staff play a significant role in customer awareness of the offering and understanding of efficient products. Eighty-six percent of respondents said that they learned about the discounted lighting from a distributor employee (81%) or materials at the store (5%).
- Most Midstream Lighting end use customers had not participated in PSO's other energy efficiency programs. Fifty-six percent of survey respondents reported that their business had not completed any projects for which they applied for a PSO

efficiency program rebate (50%), or they were not aware of their business applying for any PSO efficiency rebates in the past (6%).43

- Most Midstream-incented lamps are installed. Most of the survey respondents said that all the discounted lamps they purchased had been installed, though some respondents mentioned they had not had an opportunity to install all the lamps yet. Table 3-139 displays the percent of the program discounted lamps respondents reported having installed currently. The sample size was not statistically significant to use as a gross savings adjustment.

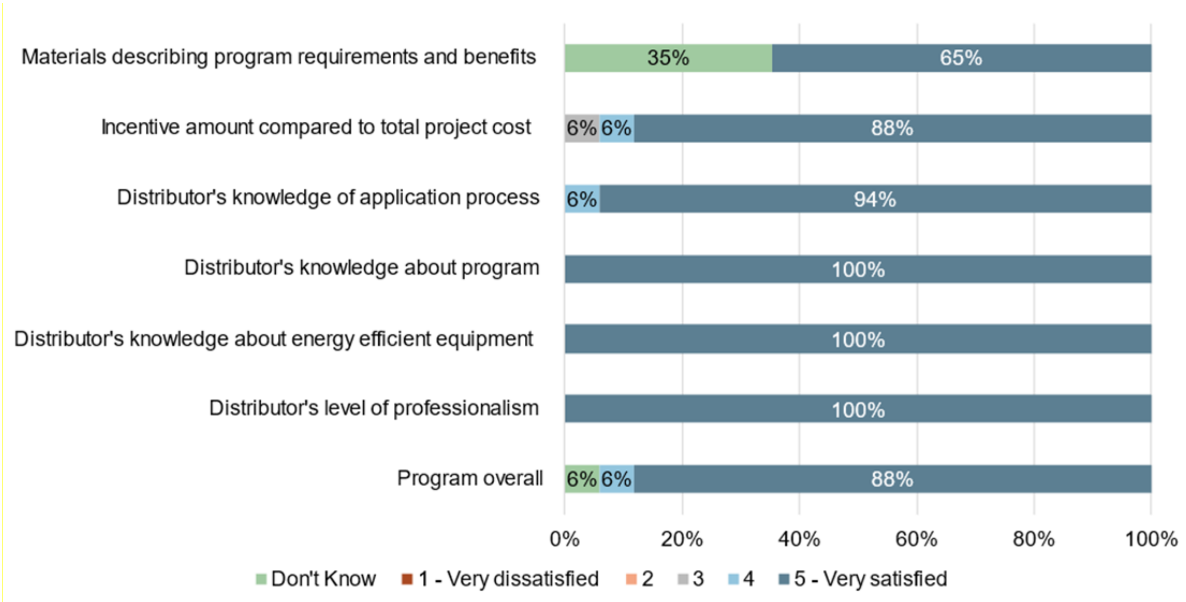
Table 3-139: Commercial Midstream Lighting In-Service Rates

Product Type	Percent of Lamps Installed	Sample Size (n)
LED Linear Lamp(s)	85%	13
Candelabra(s)	100%	2
PAR Lamp(s)	100%	1
MR Type Lamp(s)	100%	1
Globe Lamp(s)	100%	1
A-Line Lamp(s)	50%	2

- Forty-one percent of respondents wrote in comments suggesting additional lamp or fixture types that should be incentivized by PSO. Twenty-four percent of these respondents noted interest in lamps other than screw-in bulbs, such as exterior lighting. Further, 65% of respondents said they had recommended this PSO offering to someone else. Sixty-seven percent of customers who had not recommended the offering said they would recommend it.[44] Seventy-six percent of respondents said they were satisfied with PSO as their electric utility.[45]
- Satisfaction was high among respondents. See Figure 3-41.

[43] n=16
[44] n=6
[45] n=21. The remaining respondent did not know how to rate their satisfaction with PSO as their utility.

Figure 3-41: Midstream Lighting Customer Satisfaction



3.2.5.5.3 Lighting Distributor Interviews

In August and September 2023, ADM interviewed the two participating Midstream lighting distributors. These interviews addressed distributors' reasons for participating, the training they received, the types of customers they serve and how they reach them, their program experience, and the impact of Midstream participation on their sales and promotion practices. ADM also sought to investigate distributors' perspectives regarding the Midstream design and implementation and any perceived opportunities for improvement.

- Both lighting distributors were satisfied with the Midstream offering overall.
- The distributors observed that the PSO Midstream offering had influenced their companies to promote efficient lighting and noted using various methods to promote the Midstream-qualified products.
- One distributor observed their sales through the Midstream offering to be less than expected and cited the removal of LED screw-ins from the eligible measure list as the primary reason.
- The removal of screw-in bulbs in the summer of 2023 may have increased hotel and property management companies' motivation to take advantage of the Midstream offering. The more active distributor observed that property management companies had taken advantage of the Midstream offering at a higher rate than other types of companies in 2023.

- Distributor responses suggested that a portion of the lighting sold through Midstream would have been sold regardless of the PSO discounts, though estimates varied by lamp type.

3.2.5.5.4 Non-Lighting End User Survey

Three customers were interviewed after contacting all four customers up to seven times (three phone calls, four emails). Interviewees included an operations manager, a general contractor, and an executive director. Findings are as follows.

- The Midstream incentive acted as an influential factor in pushing a large organization to implement high-efficiency equipment for a multi-year, multi-facility improvement project.
- Findings from interviews with contacts representing new construction projects suggest the Midstream incentive was not a significant factor in the decision to purchase the high-efficiency equipment.
- The two interviewees who were aware of participation details were satisfied with their experience. All three interviewees were very satisfied with PSO as their electric utility.

3.2.5.5.5 HVAC Distributor Interviews

In August and September 2023, ADM interviewed two HVAC distributor contacts who participated in the PSO Midstream offering. Findings are as follows.

- Supply chain issues continued to impact PSO's Midstream HVAC offering in 2023. The distributor representative commented that stocking is dependent on factory production. Their company struggled to stock every type of equipment, though the availability of different equipment shifts over time.
- Both interviewees were satisfied with the Midstream HVAC offering overall, though they offered suggestions to improve their experience. The distributor contacts indicated that they had received sufficient support from implementation staff and were satisfied with the enrollment process, sales and incentive processing, and the overall experience. Nonetheless, both contacts offered suggestions to improve their participation experience:
- Interview findings suggest that the Midstream HVAC offering has not influenced the stocking of qualified equipment as expected. The distributor representative said their stocking of qualified units had not changed since enrolling in the Midstream HVAC offering, while the consultant stated that they do not stock equipment.
- The interviewees observed that the Midstream incentive is an influential factor in building owners' decision to install high-efficiency equipment. The distributor's

representative indicated that participation had increased their number of customers and expanded sales.

3.2.5.6 Commercial Midstream Conclusions and Recommendations

This section presents findings from the process and impact evaluation and recommendations based on these findings.

Conclusions

- Both lighting and HVAC distributors were satisfied with the Midstream offering overall.
- Midstream lighting customers were satisfied with the participation process, their lighting distributor, the equipment, and program offering overall.
- Midstream HVAC distributor and service provider interview findings suggest distributors and rebate processing companies take differing rebate processing fees. PSO's Midstream HVAC offering motivated a consultant to start a business that primarily generates revenue through recouping a percentage of rebate fees. The HVAC service provider observed that participating distributors individually determine processing fees and how much of the PSO incentive will be held back. For example, he indicated one distributor may pay half of the incentive to the service provider or end use customer compared to another which pays 75% of the incentive.
- A single consulting company drove Midstream HVAC sales in 2022 and 2023. Program tracking data indicates a single HVAC consulting company acting as a distributor was responsible for most HVAC incentive dollars paid in 2022 and 2023, as well as nearly half of the incentive dollars paid in 2021. Though all distributor contacts communicated challenges in obtaining high-efficiency equipment, this consulting company was able to obtain high-efficiency equipment to complete a large multi-year project through the program.

Recommendations

- Ensure the participation process does not dissuade lighting distributor participation. Continue to conduct outreach and support lighting distributors to ensure the participation process is well understood and not perceived as overly time-consuming or onerous.
- Investigate rebate fees recouped by HVAC distributors. Understanding the distribution of rebates between distributors, service providers, and end use customers is crucial to ensuring the fidelity of the program and its alignment with its design and intentions of influencing distributor and service provider recommendations, distributor stocking practices, and customer decision-making.

- Seek to reduce HVAC distributor rebate processing times and ensure timely payment of service providers. Working with distributors to establish payment systems that quickly process credits before projects are submitted could help lessen potential frustration with program participation for service providers.
- Continue to work with distributors to support participation. Interview findings suggest opportunities for additional or more frequent support. A lighting distributor noted interest in more timely support/email responses from program staff and an HVAC distributor said they were interested in being provided weekly reports that summarized paid project rebates (“Midstream Distributor Distribution Report”).

3.3 Home Weatherization Program

This chapter presents evaluation findings from the impact and process evaluation of the Home Weatherization's 2023 program year.

3.3.1 Program Overview

PSO's Home Weatherization Program objective is to generate energy savings and peak demand reduction for income-qualified residential customers through the direct installation of weatherization measures in eligible dwellings. The weatherization program provides no-cost energy efficiency improvements to PSO customers living in homes that are less than 2,200 square feet, built before 2010, with household incomes of $55,000 or less. 2023 performance metrics are summarized in Table 3-140.

Table 3-140: Performance Metrics – Weatherization

Metric	2023
Number of Customers	1,909
Budgeted Expenditures	$3,431,415
Actual Expenditures	$3,474,717
Energy Impacts (kWh)	
Projected Energy Savings	2,526,832
Reported Energy Savings	4,535,302
Gross Verified Energy Savings	4,535,250
Net Verified Energy Savings	4,535,250
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	908.65
Reported Peak Demand Savings	2,401.17
Gross Verified Peak Demand Savings	2,401.17
Net Verified Peak Demand Savings	2,401.17
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	2.96
Utility Cost Test Ratio	1.75

In 2023, PSO partnered with Titan ES and Revitalize T-Town (RTT) to deliver weatherization efficiency improvements:

- Titan ES is a home weatherization contractor that provides diagnostic energy assessments, customer education, and installation of weatherization measures to improve energy efficiency.

- RTT is a Tulsa-based non-profit organization that provides a variety of home improvement services for limited-income homeowners. The services provided by RTT include program-sponsored energy efficiency improvements, as well as other repairs such as roof repairs.

Through the Home Weatherization Program, participants received diagnostic energy assessments, which identify a list of cost-effective improvements such as air sealing, attic insulation, duct sealing, and water heater tank/pipe insulation. Table 3-141 shows measures installed through the program in 2023. Duct sealing made up the largest share of reported kWh savings and was the most common measure type installed. In conjunction with attic insulation and air sealing, this made up more than 99% of the program savings. In 2020 the program expanded and added several measures intended for mobile homes (low flow showerheads, faucet aerators, advanced power strips, LED lightbulbs, and mobile home air infiltration). In 2023, the program provided mobile home air infiltration, faucet aerators and LEDs to a limited number of participants. These measures made up less than one percent of program savings.

Table 3-141: Summary of Weatherization Measures Implemented

Measure	Number of Projects	% Share of Reported kWh Savings
Duct Sealing	1,569	56%
Attic Insulation	1,400	24%
Air Infiltration	1,640	20%
Water Heater Pipe Insulation	580	0.1%
Water Heater Jacket	44	0.1%
Air Infiltration (Mobile home)	4	<0.1%
Faucet Aerators (Mobile home)	3	<0.1%
LED (Mobile home)	1	<0.1%

PSO's Home Weatherization Program serviced 1,909 households during the 2023 program year. Participants saved an average of 2,376 kWh. This compares to an average of 1,828 kWh in 2019, 1,959 kWh in 2020, 1,911 kWh in 2021, and 2,158 in 2022. Titan ES was responsible for the installation of these energy efficiency measures at most of these homes (see Table 3-142).

Table 3-142: Weatherization Homes by Agency

Agency	Number of Homes
Titan ES	1,874
RTT	35
Total	**1,909**

3.3.2 EM&V Activities

This section provides an overview of evaluation methods employed for the verification of energy impacts and reporting on program feedback. Impact evaluation methodologies included a review of program data and materials, data collection activities, and gross and net impact calculation methodologies. Additional impact methodology information can be found in a supplemental document. Process evaluation activities included a participant survey, site visits with the program's contractor and third-party verifier, and a facilitated discussion with staff to gather and synthesize staff perspectives regarding the implementation and status of the program.

3.3.2.1 Data Collection

Several primary and secondary data sources were used for the evaluation. Tracking data was used as the basis for quantifying participation and assessing program impacts. Additional data was collected through surveys, on-site verifications with the primary program contractor and third-party verifier, and staff interviews. Table 3-143 summarizes the data collection activities and evaluation purposes.

Table 3-143: Weatherization Data Collection Efforts

Data Collection Activity	Achieved Size	Evaluation Purpose
Joint verification visits with Installation Contractor	3	Measure and installation process verification
Joint verifications with Third-Party Verification Contractor	3	Observation of verification process, verification of and measure installation
Customer Surveys	100	Measure verification, In-Service Rate, customer satisfaction
In-Depth Interviews with Program Staff	1	Gather and synthesize staff perspectives regarding the implementation of ADM's PY2022 recommendations and the status of the program, including any actions taken to update the design or implementation of the program.

3.3.2.1.1 Participant Survey Sampling Plan

ADM conducted a mixed mode (phone/email) survey of 2023 Home Weatherization Program participants. The survey sample was designed to be statistically representative of the program population and ensure accurate program insights. The sampling approach was designed to achieve a minimum ±10% precision at a 90% confidence level (90/10). As this is considered a large population, a sample size of 68 is desired.

Both respondent types (phone/email) were offered a $10 incentive (either digital or physical gift card) for completing the survey. Additional survey completes were obtained to increase the chance of survey participation in all areas the program impacted and to increase the chance of receiving feedback regarding all program measures.

3.3.2.1.2 Participant Survey Procedure

The participant survey informs the gross impact analysis by verifying the presence of reported tracking data measures. Respondents were asked to confirm whether they had received the reported measures. These responses were used to develop In-Service Rates (ISRs) that represent the portion of energy efficiency measures that were installed and are operational. Survey questions also sought to evaluate customer satisfaction with individual measures, program stakeholders, and the program overall.

Program participants that receive direct installation measures including faucet aerators, low flow showerheads, or water heater pipe insulation or jackets were asked if they were willing to send an email with photographic evidence of measure installation to further verify the installation of program measures.

3.3.2.2 Verified Gross Savings Methodologies

The methodology used to calculate annual energy savings (kWh) and peak demand impacts (kW) consisted of:

- Verifying measure installation: Calculation of installation rates (ISR) by measure for a sample of program participants utilizing data from a participant survey.
- Reviewing reported savings estimates for each measure: Review program tracking data and reported savings calculations for all measures to verify the accuracy of reported savings and provide an explanation of any savings discrepancies.
- Verified savings are calculated through an engineering desk review utilizing:
  - Oklahoma Deemed Savings Document (OKDSD)
  - Arkansas Technical Reference Manual v8.1 (AR TRM)

A brief description of each measure's calculation methodology is identified in this section. Detailed measure level algorithms and deemed savings values utilized for the verified annual energy savings (kWh) and peak demand (kW) reduction are explained in greater detail in a supplemental document. Table 3-144 displays the references or sources for savings methodologies for the measures offered through the home weatherization program in 2023.

Table 3-144: Home Weatherization Savings Methodologies

Methodology Source	Measure
AR TRM v8.1	Air Infiltration
	Attic Insulation
	Faucet Aerators
	ENERGY STAR Omni-Directional LEDs
	Advanced Power Strip(s)
Oklahoma Deemed Savings Document (OKDSD)	Duct Sealing
	Pipe Insulation and Water Heater Jackets
Prescriptive-like Savings	Mobile Home Air Infiltration

3.3.2.2.1 Site Verifications with Contractor

ADM staff shadowed the program's implementation contractor and Third-Party Verification (TPV) contractor during installation and post-installation verification visits. During the visits ADM verified contractor procedures and visually verified the installation of major program measures (attic insulation, duct sealing, and air sealing). ADM attended TPV visits to observe verification procedures and to visually corroborate program tracking records.

3.3.3 Impact Evaluation Findings

This section provides information on the impact evaluation findings for 2023.

3.3.3.1 Site Verifications

ADM conducted twelve on-site ride-along visits: six visits with Titan ES and six with the program's TPV. Upon arrival at each home, the ADM field technician observed areas where Titan ES staff intended to conduct air sealing or duct sealing, the pre-condition of the ride-along homes' attics, as well as initial blower door test and duct leakage test results.

ADM's field technician observed Titan ES staff perform work needed to improve each of the six homes' energy efficiency. Once work was completed, Titan ES staff performed final blower door and duct sealing tests. For each of the site verifications with Titan ES, ADM noted the following pre- and post-conditions for each program measure:

- Air Sealing: ADM observed homes with gaps around doors, under sinks, and around pipes and windows before Titan ES performed improvements. After Titan ES staff completed their work, ADM observed weatherstripping around doors, foam sealant under sinks around pipes, and caulking around windows and doors.
- Duct Sealing: ADM noted gaps around registers and plenum holes prior to Titan ES conducting weatherization improvements. After weatherization was complete signs of mastic and tape on ducts, plenums, HVAC registers and returns were noted.
- Attic Insulation: ADM observed that the six homes had unevenly spread insulation at depths ranging from 3-6 inches. After Titan ES staff completed weatherization, ADM's field technician verified insulation evenly spread at depths from 14-16 inches.

During the Titan ES verifications the ADM technician observed test-in and test-out values for both blower door and duct blaster tests and took pre- and post-pictures of the measures performed. The results were as expected for all six home verifications.

The ADM field technician met the TPV contractor at six homes that had participated in the program. The TPV contractor showed ADM's field technician the areas they observed as having signs of the claimed work done by Titan ES. Once all claimed work was observed and annotated as verified, the contractor performed blower door and duct leakage tests, if applicable. The contractor compared his results with Titan ES' results.

- Air Sealing: ADM observed weatherstripping around doors, foam sealant and caulking under sinks around pipes, and caulking around windows and doors at all four homes visited with the TPV that received this measure.

- Duct Sealing: ADM noted signs of mastic and tape on ducts, plenums, registers, and returns at all five homes visited with the TPV that received this measure.
- Attic Insulation: ADM verified insulation evenly spread at depths from 14-16 inches for hour homes visited with the TPV that received this measure.

During the TPV verifications the ADM technician observed test out values for both blower door and duct blaster tests and took post-pictures of the measures performed. The results were as expected with all six homes ADM visited with the TPV.

3.3.3.2 Verified Gross Annual Energy Savings

ADM conducted a mixed-mode (phone/email) survey of customers who participated in the Home Weatherization program. Before reviewing program data for the presence of valid contact information, we randomly assigned 1,273 program participants to either a phone (640) or a web group (633). A sample from each group was invited to take the survey in April, July, and October. There was a combined response rate of 17% for the phone and email surveys. Survey responses represented 10 counties and 36 zip codes.

3.3.3.2.1 Air Infiltration

A total of 28 customers were asked to confirm air infiltration improvements made through the program. One customer did not recall receiving air infiltration improvements and was removed from ADM's ISR calculation. Visually identifying caulking and/or sealing is not always apparent and as these respondents could not determine, their responses were considered inconclusive. Based on these findings, an ISR of 100% was applied.

The energy savings methodology for this measure is defined in the AR TRM. The required inputs are the results of the blower door test (CFM50 between pre-installation and post-installation) and an energy savings factor dependent on climate zone and HVAC system type. Algorithm inputs were confirmed through a review of program tracking data and survey efforts. These inputs were found to be consistent with reported estimates. The program level realization rates for air infiltration were 100% for kWh savings and kW peak demand reduction.

3.3.3.2.2 Attic Insulation

A total of 74 survey respondents were asked to confirm whether they had attic insulation installed; all of them confirmed having insulation installed through the program. An ISR of 100% was applied for attic insulation.

ADM found proper use of the algorithms in the AR TRM for reported energy savings. The program level realization rate for attic insulation was 100% for kWh savings and kW peak demand reduction.

3.3.3.2.3 Duct Sealing

A total of 89 customers were asked to confirm duct sealing improvements made through the program. Three respondents did not recall receiving duct sealing. Three stated they did not receive this measure. Titan ES staff followed up with these customers and were able to verify installation of duct sealing at their homes. Based on these results an ISR of 100% was applied.

ADM found proper use of the Oklahoma Deemed Savings Document (OKDSD) for reported savings in conjunction with the duct leakage reduction results to calculate measure savings. ADM calculated the prescriptive savings values for each home and determined the program-level realization rates for duct sealing were 100%.

3.3.3.2.4 LED Light Bulbs

ADM applied an ISR of 94% to the verified energy-saving calculation for LED lightbulbs. This ISR was determined using responses from ADM's 2020 and 2021 surveys because of limited participation with the measure in 2023. Reported savings calculations were consistent with the methodology specified in AR TRM v8.1. An updated baseline was applied per the AR TRM; this updated baseline and the ISR of 94% led to a less than 100% realization rate. LED savings made up a small portion of total program savings (<0.1%).

3.3.3.2.5 Water Heater Jackets and Pipe Insulation

ADM completed 11 verification surveys with customers that had water heater insulation or jackets installed in their homes through the program. Ten respondents were able to confirm installation of water heater jackets or pipe insulation and the eleventh was inconclusive. Based on these findings, an ISR of 100% was applied.

The deemed savings for water heater jackets installed on electric water heaters are sourced from the OKDSD. The deemed savings for this measure depend on 1) insulation thickness and 2) water heater tank size. The algorithm inputs were found to be properly used in reported savings calculations. The program-level realization rates for water heater jackets and pipe insulation were 100%.

3.3.3.2.6 Faucet Aerator(s)

Due to the limited installation of this measure through the program in 2023, ADM utilized survey responses from 2020 and 2021 to calculate the ISR for this measure. An ISR of 80% was applied to the verified energy saving calculation.

Combined with the ISR, realization rates of 83% for peak demand reduction and 85% for annual energy savings were determined. The main driver of the less than 100% realization rate for faucet aerator(s) was the application of the ISR. A minor factor that impacted the realization rate was that verified savings calculations relied on ARM TRM v8.1 whereas reported values were determined from AR TRM v7.0. Mixed water temperature assumptions for each weather zone were revised in AR TRM v8.1.

3.3.3.3 Verified Savings Summary

Prescriptive methodologies were used to determine annual energy savings and peak demand reduction. These gross energy savings were adjusted to account for in-service rates based on participant survey responses. ADM found consistent application of prescriptive methodologies with minor discrepancies with algorithm inputs. The methodologies were consistent with past evaluation years. Realization rate risk was apparent for direct installation measures in the application of in-service rates to gross savings. Table 3-145 displays the results.

Table 3-145: Home Weatherization In-Service Rates[46]

Measure	Verified/Claimed	Number of Measures	ISR	Other Realization Rate Factors
Attic Insulation	Verified	74	100%	N/A
	Claimed	74		
Duct Sealing	Verified	89	100%	N/A
	Claimed	89		
Infiltration	Verified	27	100%	N/A
	Claimed	27		
WH Pipe Wrap/Insulation	Verified	11	100%	N/A
	Claimed	11		
LED Bulbs	Verified	93	94%	N/A
	Claimed	99		
Faucet Aerators	Verified	12	80%	Savings Algorithm
	Claimed	15		

As Home Weatherization measures are offered free of charge to income qualified residential customers, the net-to-gross ratio is set at 100%.Verified and reported annual energy savings and peak demand reduction by measure are shown in Table 3-146. As shown, the measures with the largest impact were air infiltration, attic insulation, and duct sealing. This is consistent with past years as the program attributed most of its savings to air infiltration, attic insulation, and duct sealing from 2018 to 2023.

[46] No survey responses were collected in 2023 for faucet aerators or LED light bulbs; claimed and verified values and calculated ISRs for these measures are based on 2020 and 2021 survey responses.

Table 3-146: Home Weatherization Reported and Verified Energy Savings (kWh and Peak kW)

Measure	Reported Energy Savings (kWh)	Reported Peak Demand Savings (kW)	Verified Net Energy Savings (kWh)	Verified Net Peak Demand Savings (kW)	kWh Realization Rate	kW Realization Rate
Duct Sealing	2,539,887	1,112.00	2,539,887	1,112.00	100%	100%
Attic Insulation	1,067,960	974.00	1,067,960	974.00	100%	100%
Air Infiltration	915,436	312.10	915,436	312.10	100%	100%
Air Infiltration (Mobile home)	2,130	0.72	2,130	0.72	100%	100%
Water Heater Pipe Insulation	6,644	2.11	6,644	2.11	100%	100%
Water Heater Jacket	2,992	0.22	2,992	0.22	100%	100%
LED (Mobile home)	26	0.004	8	0.001	29%	29%
Faucet Aerators (Mobile home)	228	0.025	194	0.020	85%	83%
Total	**4,535,302**	**2,401.17**	**4,535,250**	**2,401.17**	**100%**	**100%**

3.3.4 Process Evaluation Findings

ADM's process evaluation activities included a participant survey and a facilitated discussion with program staff. The process evaluation memo ADM provided to PSO in December of 2023 contained more detailed information on the facilitated discussion and participant survey.

3.3.4.1 Program Operations Perspective

ADM led two facilitated discussions with the purpose of investigating the status of the program's implementation and design. The first discussion was held in June 2023 with PSO's program coordinator. The second call occurred in October 2023 with the Vice President of Titan ES and the PSO's program coordinator.

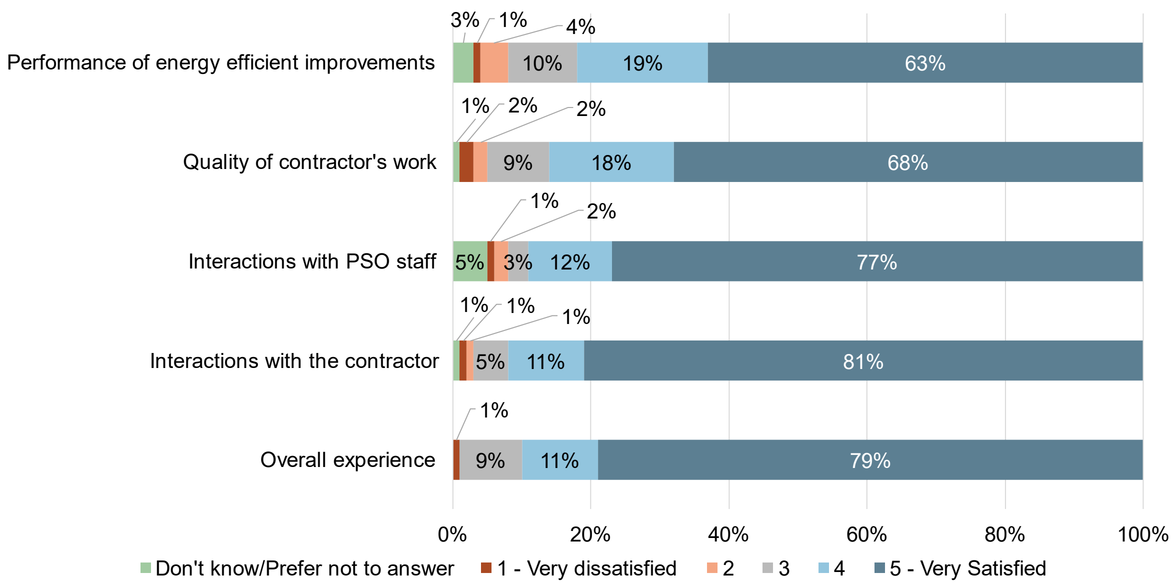
The program remained consistent in 2023 in energy efficiency measures offered except for additional budget available to implementation staff for "home readiness". This allows for minor home modifications to make homes eligible for energy efficiency improvements. In the past, homes that required modification could not participate in the program. Additionally, the implementation team started using text messaging as a tool to remind customers of their appointments if they are unresponsive to phone calls.

3.3.4.2 Participant Survey Results

The participant survey was completed by 47 participants through email and 55 participants through phone calls.

Most survey respondents stated they were satisfied with the performance of the improvements, the quality of the contractor's work, interactions with the contractor, and PSO staff (see Figure 3-42). Furthermore, nearly all survey respondents indicated satisfaction with their overall experience.[47]

Figure 3-42: Home Weatherization Customer Satisfaction

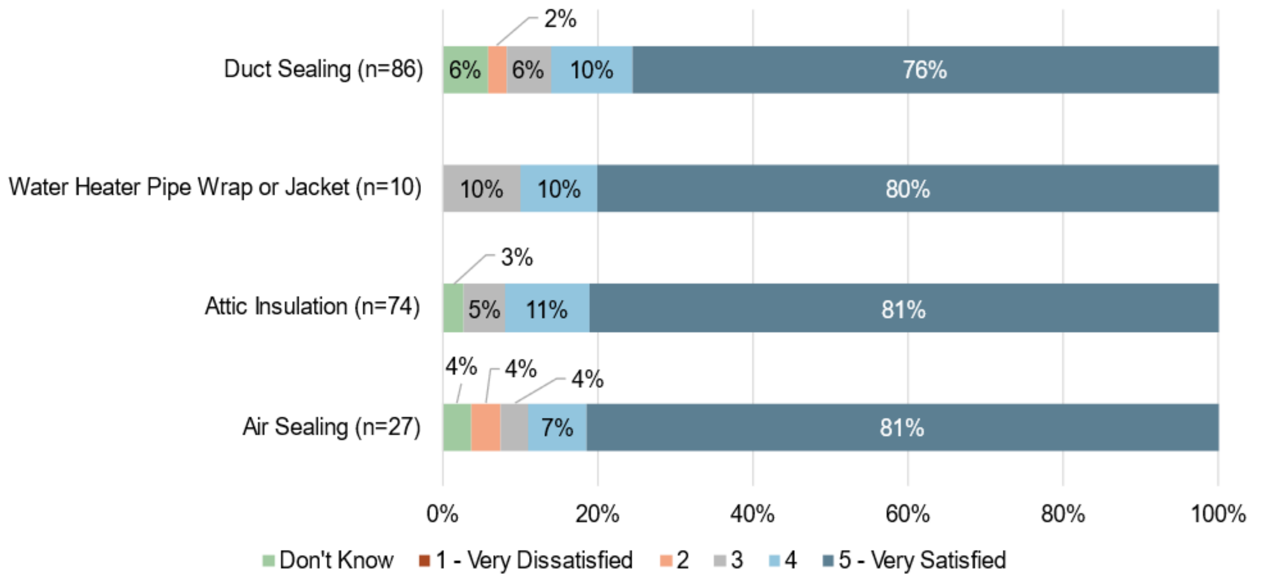


Ninety percent of survey respondents were satisfied with their experience overall. Further, 78% of respondents said they had recommended the program to someone else. And of those who had not recommended the program, 77% said they would be likely to recommend it (n=23).[48] Most survey respondents were satisfied with the measures they received through the program (see Figure 3-43).

[47] Eighty-seven percent of respondents rated their overall satisfaction with the home weatherization service a 4 (11%) or 5 (79%).

[48] Rated their likelihood of recommending the program a 7 or higher on a scale from 0 (not at all likely) to 10 (extremely likely).

Figure 3-43: Satisfaction with Weatherization Measures



3.3.5 Conclusions and Recommendations

The following summarizes the key findings from the evaluation of the Home Weatherization Program.

- Participant satisfaction remains high. Most participant survey respondents were satisfied with the program overall, the measures they received, and with PSO as their electric utility.
- The program offers an easy, straightforward enrollment and participation process for qualifying customers in PSO's territory. Overall, customers were satisfied with the sign-up and scheduling process. Survey findings also show that most customers were satisfied with the quality of the weatherization improvements and their experience with the program implementation contractor.
- The program is reaching customers throughout PSO territory. Tulsa County had the highest portion of homes that were weatherized through the program. However, Okmulgee and Comanche counties had higher relative participation rates when considering the total number of homes per county.
- A small amount of funding provided for "home readiness" has increased the number of homes that will be eligible to participate by making minor repairs prior to energy efficiency upgrades.

The following recommendations are offered for continued improvement of the Home Weatherization Program:

- Continue to support customers with home readiness measures. The addition of a home readiness measure to the program could provide a good opportunity to support those in need while advancing toward energy efficiency goals.
- Consider increased marketing for the program through stand-alone or on-bill email messages. Customers who pay bills online may be more inclined to interact with PSO when prompted by digital communication rather than through physical mail outreach. The high response rate to ADM's email survey indicates email and other forms of digital communication may be effective ways to recruit customers to the program.
- Maintain feedback and quality control mechanisms; continue to review customer requests and opportunities for follow-up. ADM plans to continue administering its customer survey quarterly and to provide PSO staff with any potentially actionable customer feedback and measure verification notes. The shift from annual to quarterly surveys has enabled more real-time follow-up and better recollection of program participation for sampled customers.

3.4 Conservation Voltage Reduction (CVR) Program

This chapter presents findings from the impact evaluation of the 2023 Conservation Voltage Reduction (CVR) program.

3.4.1 Program Overview

PSO's Conservation Voltage Reduction (CVR) program uses a system of devices, controls, software, and communications equipment to lower voltage levels for implemented distribution circuits. PSO implemented the program using Eaton's Yukon Integrated Volt/VAR Control (IVVC) automation software.[49] Voltage levels were controlled independently for each of the three phases for all evaluated circuits.

The 2023 CVR program evaluation consisted of 8 substations and 46 circuits (See Table 3-147). PSO's CVR deployment included upgrades inside the substation, as well as on the distribution system. Inside the substation included installing a new RTU, as well as new relaying or metering equipment to provide all the necessary information for the CVR system to function properly. The distribution system required the installation of voltage regulators, capacitor banks, end of line monitors, and repeaters. Once the construction was complete, all devices underwent a commissioning period of field testing. After field testing was completed and Yukon was programmed, CVR was put into service.

Table 3-147: CVR Deployment Timeline

Substation	In Service Date
Bartlesville Comanche	12/2/2022
Alex Bradley	2/9/2022
Chickasha North	3/1/2023
Cornville	8/1/2023
Tulsa SE	12/30/2022
East 61st	12/30/2022
53 and Garnett	12/30/2022
South Hudson	12/30/2022

Circuits associated with the eight substations serve a range of residential, commercial, industrial, municipal, and other/unknown customers. A breakdown of customer counts by sector (from historical data) is shown in Table 3-148.

[49] Eaton Integrated Volt/VAR Control
https://www.eaton.com/content/dam/eaton/products/utility-and-grid-solutions/grid-automation-systems/volt-var-management/volt-var-management-software/integrated-volt-var-control-br910005en.pdf
https://www.eaton.com/FTC/buildings/KnowledgeCenter/WhitePaper2/index.htm

Table 3-148: CVR Circuit Customer Count

Substation	Customer Count	Residential	Commercial	Industrial	Other/ Unknown	Municipal
Bartlesville Comanche	6,539	5,166	858	51	393	71
Alex Bradley	588	368	81	17	93	29
Chickasha North	2,578	1,901	284	54	256	83
Cornville	3,570	2,204	765	116	397	88
Tulsa SE	6,860	4,921	1,306	151	452	30
East 61st	9,815	7,482	1,469	91	740	33
53 and Garnett	6,972	5,805	827	24	283	33
South Hudson	3,793	2,088	1,275	234	165	31

Table 3-149 provides reported and verified program performance metrics.

Table 3-149: Performance Metrics - CVR

Metric	2023
Number of Customers	40,715
Budgeted Expenditures	$1,923,428
Actual Expenditures	$2,008,740
Energy Impacts (kWh)	
Projected Gross Energy Savings	35,725,719
Reported Energy Savings	29,756,919
Gross Verified Energy Savings	35,108,120
Net Verified Energy Savings	35,108,120
Peak Demand Impacts (kW)	
Projected Gross Peak Demand Savings	9,254.18
Reported Gross Peak Demand Savings	7,418.56
Gross Verified Peak Demand Savings	10,824.00
Net Verified Peak Demand Savings	10,824.00
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	1.96
Utility Cost Test Ratio	1.80

3.4.2 Evaluation Activities

For the 2023 CVR Program, ADM estimated typical year annual energy savings (kWh) resulting from the implementation and evaluation testing of CVR for the first year of each circuit. This section provides a description of the data collection, data cleaning, and regression analysis methodologies that ADM employed in the evaluation of the Conservation Voltage Reduction program.

ADM provided a schedule of events to deactivate CVR for an energy savings baseline. The schedule was balanced in terms of days where CVR was either on or off, such that ADM would be able to maximize operational time but still have enough “off” data to achieve a statistically significant counterfactual baseline for the evaluation methodologies employed in this analysis. Beginning 2022, PSO provided ADM with monthly data showing when each bus was enabled or disabled. In addition, time series voltage and power consumption data at minute intervals was provided to ADM by PSO every month for the evaluated circuits reflecting the substation operating schedule recommended by ADM. Upon delivery of this data, ADM conducted a review to verify that the “off” events and transition tests were responding as expected such that it could be incorporated into the final analysis of savings. ADM alerted PSO to any abnormalities or departures from steady state operation that would interfere with the accurate evaluation of savings.

3.4.2.1 Regression Analysis

The on/off regression analysis for CVR is the accepted industry standard for evaluation of voltage control technologies.[50] The regression model configuration used for this analysis is described in Equation 3-1.

Equation 3-1: CVR Regression Model Configuration

$$kWh_t = \beta_o + \beta_1 * Mode_t + \beta_2 * CDD_t + \beta_3 * WeatherVar2_t + \beta_4 * DayType_t + \beta_\theta * Hour_t + e_t$$

Where:

t	= the hourly interval the model is predicting usage for
$Mode_t$	= 1 if CVR is on during time t; 0 otherwise
CDD_t	= cooling degree days at time t
$WeatherVar2_t$	= if modeling the heating season months then it is heating degree days at time t; otherwise, it is cooling degree days at time t-1
$DayType_t$	= if the day was a weekday or a weekend/holiday
$Hour_t$	= An adjustment factor for varying consumption during different hours of the day.

[50] Conservation Voltage Reduction/Volt VAR Optimization EM&V Practices https://www.energystar.gov/sites/default/files/asset/document/Volt%20Var%20and%20CVR%20EMV%20Best%20Practice%2006-01-17clean%20-%20508%20PASSED.PDF

The coefficient 1 gives the estimated hourly savings the occur due to a substation circuit operating in CVR mode. All other coefficients are meant to control for other known variables that impact energy consumption, such as weather, time-of-day, and time-of-week. Separate regressions are run for the cooling season dataset (May through September) and the heating season dataset (October through April). In the event circuit level consumption is not dependent on weather (such as high industrial loads), or day of the week, the regression parameters are adjusted as needed.

3.4.2.2 CVR Factor Calculation

The result of the regression analysis is an estimated hourly savings value that results from CVR being operational on the given circuit during a given season. This value is then extrapolated to a percent reduction value to calculate the "CVR factor." The CVR factor represents the ratio between the percentage change in energy and the associated percentage change in voltage. CVR factor is calculated as the percent change in energy consumption divided by the percent change in voltage. Exceptions to the use of this framework are detailed in a supplemental document with detailed information on the evaluation methodologies.

3.4.2.3 Voltage Profile Determination

The final estimate of savings for each circuit and phase in the evaluation pool was calculated by taking the CVR factor for each circuit and phase from the analysis and multiplying it by the percent change in voltage of the voltage profile that best reflects both the average baseline and average operational voltages for that circuit. For more information on the process used for determining the most accurate voltage profile for each circuit are described in a supplemental document.

3.4.2.4 Final Savings Calculation

With CVR factors calculated and baseline voltage profiles determined, final savings can be calculated. Note that this is done separately for each circuit, phase, and season combination. Equation 3-2 shows how average daily percent usage reductions are calculated using the CVR factors estimated in previous steps.

Equation 3-2: Daily Percent Savings Calculation

$$DailySavingsPercent = CVR_{Factor} * \%\Delta Voltage$$

Where:

CVR_{Factor} = %ΔEnergy Consumption / %ΔVoltage

%ΔVoltage = The average percent reduction in voltage when CVR is operational vs. not operational

Daily kWh savings are then calculated by multiplying the average daily percent savings value with the average daily baseline energy consumption value. Final seasonal savings values are then calculated by multiplying the actual daily kWh savings by the number of days in the season. Equation 3-3 shows this calculation.

Equation 3-3: Season Savings Calculation

*Season Savings = (DailySavingsPercent * DailyBaselineEnergyUsage) *sdays*

Where:

DailySavingsPercent	=Average daily percent reduction in energy consumption
DailyBaselineEnegyUsage	=Average daily usage when CVR is not operational
Sdays	=Number of days in the evaluated season

Note that these are “typical year annual energy savings.” This means that final savings values represent the amount of savings that would have occurred had CVR been operational during every hour of the year.

3.4.2.5 Coincident Peak Demand Reduction (kW) Methodology

The gross verified peak demand reduction (kW) is calculated by multiplying the identified percent energy consumption reduction for each circuit and phase by the total consumption during the system-wide peak consumption hour. In 2023, the system peak consumption time was 3 PM to 4 PM on August 21, 2023.

3.4.2.6 Net-to-Gross Methodology

A net-to-gross ratio of 100% is assumed for this program, as it is impossible for a premise to receive reduced voltage due to CVR in the absence of the program.

3.4.3 Impact Evaluation Results

The evaluation of CVR includes an impact evaluation to determine the gross verified typical year annual energy savings (kWh) and gross verified typical year coincident peak demand reduction (kW). These results are presented from the industry standard evaluation method utilizing CVR system “OFF” days to develop CVR Factors. As additional improvements were made to each electrical circuit, baseline voltage condition was derived from the full year before CVR installation. Net impacts are equivalent to gross impacts for the CVR program due to the nature of implementation at the distribution level with no incentives provided.

3.4.3.1 Verified Annual Energy Savings (kWh)

The gross verified annual energy savings (kWh) represents an overall annual percent energy savings of 3.11% relative to the evaluated circuit demand. Table 3-150 and Table

3-151 below show the summary of a typical year's gross verified annual energy savings separated by season (Cooling versus Heating) due to operation of CVR on each circuit.

Table 3-150: CVR Cooling Season Verified Energy Savings (kWh)

Substation	Circuit	% Savings	Cooling Season Savings (kWh)	Cooling Season Annual Baseline Consumption (kWh)
Bartlesville Comanche	31	2.81%	186,382	6,631,408
	32	2.44%	438,117	17,956,719
	33	2.42%	412,088	17,002,806
	34	2.43%	159,698	6,578,237
	35	1.30%	206,757	15,930,627
	36	1.51%	326,551	21,696,432
	37	2.44%	238,834	9,797,649
	38	1.87%	119,797	6,392,137
Alex Bradley	AX11	3.12%	193,571	6,194,680
Chickasha North	CN11	2.65%	46,373	1,751,778
	CN14	2.68%	13,079	488,510
	CN17	2.61%	16,198	619,856
Cornville	CV11	3.78%	591,227	15,629,888
	CV113	3.50%	385,410	11,007,647
	CV15	6.07%	582,180	9,597,994
	CV19	5.10%	732,530	14,368,877
Tulsa SE	D1	3.96%	316,646	7,988,805
	D2	2.39%	206,200	8,625,645
	D3	4.82%	636,502	13,207,251
	D4	2.43%	292,592	12,021,499
	D5	2.42%	412,849	17,026,339
	D6	6.32%	1,156,259	18,294,087
	D7	4.25%	826,654	19,461,018
	D8	3.30%	537,740	16,272,695
	D9	4.13%	137,898	3,339,761

Substation	Circuit	% Savings	Cooling Season Savings (kWh)	Cooling Season Annual Baseline Consumption (kWh)
	D10	2.88%	347,015	12,068,435
East 61st	W1	3.51%	227,686	6,487,461
	W2	3.77%	153,938	4,082,784
	W3	2.82%	336,079	11,909,688
	W4	3.35%	614,322	18,319,357
	W5	3.29%	533,446	16,231,640
	W6	3.39%	533,457	15,730,969
	W7	3.19%	774,152	24,262,192
	W8	3.04%	669,638	21,992,331
53 and Garnett	XD1	3.34%	746,905	22,371,988
	XD2	3.34%	358,010	10,708,572
	XD3	1.50%	239,143	15,969,397
	XD5	7.30%	1,157,707	15,865,221
	XD6	7.32%	1,052,746	14,372,802
	XD7	7.32%	1,366,296	18,653,630
South Hudson	Y1	2.95%	411,918	13,972,932
	Y2	3.38%	457,551	13,541,719
	Y3	2.78%	213,719	7,687,795
	Y4	3.20%	488,049	15,261,814
	Y5	2.95%	500,199	16,941,014
	Y6	1.87%	263,293	14,083,040
Total		**3.51%**	**20,617,403**	**588,397,124**

Table 3-151: CVR Heating Season Verified Energy Savings (kWh)

Substation	Circuit	% Savings	Heating Season Savings (kWh)	Heating Season Annual Baseline Consumption (kWh)
Bartlesville Comanche	31	1.44%	127,727	8,864,934
	32	3.55%	437,023	12,308,921
	33	3.25%	472,632	14,539,563
	34	1.62%	177,268	10,944,596
	35	1.29%	157,561	12,256,777
	36	2.24%	430,897	19,271,677
	37	2.07%	257,791	12,442,687
	38	1.98%	125,842	6,357,106
Alex Bradley	AX11	2.10%	146,392	6,971,302
Chickasha North	CN11	0.14%	31,979	3,194,585
	CN14	1.32%	10,761	813,312
	CN17	2.88%	14,989	521,274
Cornville	CV11	2.56%	476,071	19,006,015
	CV113	0.00%	0	15,468,644
	CV15	0.00%	0	10,215,642
	CV19	0.00%	0	14,967,933
Tulsa SE	D1	2.85%	118,383	4,150,449
	D2	2.04%	222,864	10,935,553
	D3	1.59%	133,496	8,406,788
	D4	1.81%	186,230	10,295,521
	D5	2.75%	459,426	16,678,755
	D6	4.18%	557,571	13,352,289
	D7	5.22%	870,085	16,666,156
	D8	4.98%	964,457	19,370,736
	D9	1.36%	119,281	8,778,292
	D10	6.04%	715,230	11,835,282

Substation	Circuit	% Savings	Heating Season Savings (kWh)	Heating Season Annual Baseline Consumption (kWh)
East 61st	W1	3.02%	111,386	3,683,951
	W2	4.42%	154,115	3,484,513
	W3	2.99%	265,821	8,878,893
	W4	4.31%	781,407	18,139,256
	W5	1.95%	326,718	16,769,516
	W6	3.72%	546,503	14,690,474
	W7	2.08%	456,809	22,002,069
	W8	3.00%	581,245	19,361,043
53 and Garnett	XD1	1.80%	395,731	22,001,719
	XD2	1.05%	166,912	15,940,386
	XD3	2.00%	278,480	13,919,796
	XD5	2.13%	304,894	14,342,515
	XD6	1.96%	341,159	17,442,496
	XD7	2.02%	358,577	17,753,998
South Hudson	Y1	1.66%	256,076	15,383,812
	Y2	3.52%	618,846	17,594,681
	Y3	1.24%	140,009	11,282,567
	Y4	4.58%	587,844	12,832,786
	Y5	2.14%	285,612	13,349,966
	Y6	2.48%	318,616	12,859,120
Total		**2.68%**	**14,490,717**	**539,897,387**

3.4.3.2 Verified Coincident Peak Demand Reduction (kW)

The gross verified coincident peak demand reduction (kW) results per circuit are shown in Table 3-152.

Table 3-152: Verified Peak Demand Reduction

Substation	Circuit	Peak Demand Reduction (kW)
Bartlesville Comanche	31	60.73
	32	152.59
	33	172.27
	34	62.55
	35	87.86
	36	136.64
	37	186.08
	38	91.40
Alex Bradley	AX11	93.85
Chickasha North	CN11	19.26
	CN14	5.32
	CN17	9.06
Cornville	CV11	317.22
	CV113	195.14
	CV15	236.32
	CV19	363.61
Tulsa SE	D1	163.64
	D2	95.54
	D3	444.72
	D4	127.08
	D5	178.99
	D6	629.76
	D7	692.52
	D8	451.46
	D9	181.23
	D10	164.56
East 61st	W1	155.00

Substation	Circuit	Peak Demand Reduction (kW)
	W2	89.77
	W3	246.58
	W4	319.24
	W5	313.52
	W6	247.84
	W7	272.80
	W8	285.07
53 and Garnett	XD1	583.52
	XD2	234.30
	XD3	173.64
	XD5	350.44
	XD6	695.69
	XD7	457.68
South Hudson	Y1	137.31
	Y2	141.96
	Y3	56.40
	Y4	235.12
	Y5	336.93
	Y6	171.78
Total		**10,824.00**

3.4.4 Conclusions and Recommendations

The following summarizes the key findings of the evaluation of the CVR Program.

- The overall average reduction in distributed energy due to CVR across the evaluated circuits is 3.11%. Table 3-153 shows a comparison of how overall percent reduction compared to previous years' evaluations.

Table 3-153: CVR On/Off Overall Percent Reduction; Year-to-Year Comparison

Season	2019	2020	2021	2022	2023
Cooling	2.69%	3.16%	2.13%	2.08%	3.51%
Heating	2.66%	2.54%	3.29%	2.47%	2.68%

- The average CVR factor is 1.00 (1.07 during the cooling season, and 0.91 during the heating season). Table 3-154 shows a comparison of how the average CVR factors from this year compared to previous years' evaluations. CVR factors are known to range from zero to above one if the load is mostly unconverted (in-phase) electrical consumption (such as electric resistance heating and incandescent light bulbs).

Table 3-154: On/Off CVR Factors; Year-to-Year Comparison

Season	2019	2020	2021	2022	2023
Cooling	0.63	0.73	0.71	0.63	1.07
Heating	0.62	0.54	0.92	0.76	0.91

Recommendations

The following recommendations are offered for improvement of the CVR Program.

- Regression model fit improves when sufficient data is collected; ideally, evaluation testing should be performed for all circuits and all seasons.

4 Demand Response Programs

PSO's demand response (DR) portfolio in the program year consisted of two programs, one that targeted residential customers and one that targeted commercial and industrial customers. Program-level annual savings are summarized in Table 4-1.

Table 4-1: Annual Energy Savings – Demand Response Programs

Program	Gross Annual Energy Savings (kWh)					Net Impacts	
	Projected	Reported	Verified	Gross Realization Rate	Verified Lifetime Savings	NTG Ratio	Net Annual Energy Savings (MWh)
Power Hours	0	0	214,428	NA	214,428	100%	214,428
Peak Performers	63,000	0	1,091,528	1733%	1,091,528	100%	1,091,528
Demand Response Totals	**63,000**	**0**	**1,305,956**	**NA**	**1,305,956**	**100%**	**1,305,956**

Program-level peak demand reduction is summarized in Table 4-2.

Table 4-2: Peak Demand Reduction – Demand Response Programs

Program	Gross Peak Demand Reduction (kW)				Net Impacts	
	Projected	Reported	Verified	Gross Realization Rate	NTG Ratio	Net Peak Demand Reduction (MW)
Power Hours	19,722.71	20,761.00	22,028.00	106%	1.00	22,028.00
Peak Performers	63,000.00	91,087.00	58,748.00	64%	1.00	58,748.00
Demand Response Totals	**82,722.71**	**111,848.00**	**80,776.00**	**72%**	**1.00**	**80,776.00**

4.1 Power Hours Program

This chapter presents findings from the 2023 impact and process evaluation of the Power Hours program.

4.1.1 Program Overview

The Power Hours program provided ways to reduce energy usage of residential customers during peak demand periods by offering customers the option of participating in direct load control (DLC) events. DLC events reduce energy usage when demand is highest by communicating with registered Wi-Fi enabled thermostats installed in the homes of participants. Table 4-3 shows the performance metrics achieved by the program. The program resulted in over 214 megawatt-hours (MWh) of energy savings and over 22 megawatts (MW) of peak demand reduction.

Table 4-3: Performance Metrics – Power Hours Program

Metric	2023
Number of Customers	12,953[a]
Number of Devices	16,513[a]
Budgeted Expenditures	$2,170,722
Actual Expenditures	$1,588,064
Energy Impacts (kWh)	
Projected Energy Savings	-
Reported Energy Savings	-
Gross Verified Energy Savings	214,428
Net Verified Energy Savings	214,428
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	19,723
Reported Peak Demand Savings	20,761
Gross Verified Peak Demand Savings	22,028
Net Verified Peak Demand Savings	22,028
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	3.57
Utility Cost Test Ratio	2.02

[a]Represents participants active from July 26 to August 24, 2023

Peak demand reduction (kW) and annual energy savings (kWh) for each DLC event were calculated for customers in the DLC program. All PSO residential customers with an Advanced Metering Infrastructure (AMI) installed are eligible to participate in the program. Households participating in DLC events are required to have central air conditioning, active Wi-Fi service, and at least one program-eligible Wi-Fi-enabled thermostat installed. 2023 was the eighth year PSO administered the program. During the event season, which spanned from July 26, 2023, to August 24, 2023, there was a total of 16,513 active devices for at least one day. For each event, the available devices ranged from 15,459 to 15,753 with an average of 12,195 responsive devices.

The thermostats allow participants to receive a load curtailment signal performing a temperature offset. The temperature offset changes participants’ thermostat setpoint at the beginning of the event period. Setpoints can be increased by up to four degrees. A subset of participants in 2023 received a pre-cooling event. Participants' thermostats received a signal to lower the thermostat setpoint by two degrees either 60 minutes or 30 minutes before the DLC event. Once the DLC event period is over, the thermostat setpoints are returned to the setpoint before the event occurs.

Six DLC events occurred in 2023. All events used a temperature offset curtailment strategy, with an offset of three degrees. In three instances, precooling was utilized for a subset of customers to lower the temperature of their homes one hour (or 30 minutes) prior to the event, enhancing overall comfort during the event.

Participants can override the DLC curtailment if they do not wish to participate in an event or the precooling period. Participants can override (or opt out of) the curtailment or precooling adjustment either by using a mobile application or by manually changing the setpoint on the thermostat.

4.1.2 Evaluation Activities

The savings impact of the Power Hours program is measured in peak reduction (kW) and annual energy savings (kWh) during DLC events. Savings during peak event periods are the difference between a calculated counterfactual baseline and actual consumption for each residence. Counterfactual baselines are calculated for each residence using a regression analysis based on non-event, non-holiday weekdays with similar weather. The following section defines how these savings are calculated.

4.1.2.1 Verified Savings Methodology

The impact of DLC events is analyzed using 15-minute interval AMI billing consumption data provided by PSO. Software written in the statistical programming language R is used to process and analyze the data. Various data processing steps are applied to the data before analyzed. These steps include:

- Validating that the files are not corrupt and of a consistent size.
- Extracting and transferring data from these files.
- Updating PSO with remaining data needs (i.e., if files were missing or corrupted).

After the necessary files are validated, the data is cleaned and prepared for analysis. This includes:

- Performing data completeness checks on all data.
- Aggregating 15-minute consumption data to 30-minute consumption data by summing the two 15-minute kWh data within the 30-minute period. This is done for a better match with weather data and to improve statistical model effectiveness.

Local temperature data was retrieved from the National Oceanic and Atmospheric Administration (NOAA). Temperature values were converted to cooling degree days (CDD). This was done because CDD values can quantify how power consumption relates to the weather more effectively than temperature values. Equation 4-1 shows how temperature is converted to CDD.

Equation 4-1: Temperature to CDD Conversion

$$CDD_t = \begin{cases} 0 & if\ temp_t < cddbase \\ (temp_t - cddbase)\ /\ 48 & if\ temp_t \geq cddbase \end{cases}$$

Where:

$temp_t$ = temperature at time t

cddbase = determined CDD base temperature

To calculate the most accurate CDD values, the optimal CDD base temperature for the evaluated population was determined. A detailed description of how optimal CDD base temperatures is determined can be found in a supplemental document on evaluation methodologies.

Once the necessary data is processed, the devices that participate in the DLC events are identified. Because customers can manually override the DLC curtailment signal or various technical failures may occur, not every available device participates in the events. Thus, devices that are non-responsive to the called events need to be identified so that the calculation of energy savings included only devices that participate in the event.

A device is considered a non-responsive device (NRD) if it does not respond to the curtailment signal sent by PSO. This information is available for all devices at every 15-min interval during the DLC events except for one manufacturer of thermostats, which does not release account numbers due to an enhanced security strategy. These devices will be referred to as unidentified devices. For these devices, NRDs are identified using a combination of three tests, each of which is a different method of identifying if a drop in energy usage occurred at the start of a DLC event. A device is considered non-responding for an event day only if all three tests identify the device as non-responding. See the evaluation methodologies supplemental document for a more detailed description of each of these tests and how they are applied. Nevertheless, it is challenging to pinpoint NRD during the precooling period due to the brief duration of the adjustment (30 or 60 minutes) and the minor shift in energy consumption when contrasted with the inherent variability in energy consumption patterns.

Next, baseline energy usage curves are developed. These are used to estimate what energy usage would have been during an event day had the event not occurred. For each event, this counterfactual baseline is developed using AMI data from all responding devices during non-event, non-holiday weekdays that had similar weather to that of the event day being analyzed.

The k-means clustering algorithm is used to identify similar weather days to each event day. Average daily temperature and humidity is calculated for every non-holiday weekday for every month in which a DLC event was called (in 2023, this was June through August, with the inclusion of June to expand the pool of available non-event days). Then the k-means clustering algorithm is applied to the daily weather data. This method splits every day into one of the clusters (or similar groups) of dates. Any non-event day that was placed into the same cluster as the event day is used to calculate that event's baseline.

When appropriate data has been determined to calculate each event's baseline curve, a linear regression model is calculated using that data (Equation 4-2).

Equation 4-2: Baseline Energy Usage Curve Regression Model

$$kW_t = CDD_t + CDD_{t-2} + t$$

Where:

t = the 30-minute interval for which kW usage is being predicted

CDD_t = cooling degree days at time t

CDD_{t-2} = cooling degree days one hour before t

To ensure the baseline curves are as accurate as possible, a normalizing factor is calculated and applied to the baseline curve of each event day (Equation 4-3).

Equation 4-3: Normalization Factor Calculation

$$nf = kW_{actual.hour=es-2} \,/\, kW_{baseline.hour=es-2}$$

Where:

$kW_{actual.hour=es-2}$ = kW measured two hours before the event

$kW_{baseline.hour=es-2}$ = kW predicted by the baseline two hours before the event

With the baseline curve determined, demand reduction can be calculated. Demand reduction represents the average decrease in energy usage that occurs for the average event participant during a given time interval. Demand reduction is calculated for the precooling period, event period, and the snapback period. The event period is the time from when the event starts to when the event ends. The precooling period spans the 30 or 60 minutes leading up to the events' start. The snapback period is the time from when the event ends to two hours after the event ends. The snapback period represents the time when all devices are resuming normal function and, as a result, typically have a small spike in energy usage before returning to normal. Equation 4-4 shows the formula for calculating demand reduction.

Equation 4-4: Demand Reduction Calculation

$$kW_t^{reduction} = kW_t^{baseline} - kW_t^{actual}$$

Where:

t	= the 30-minute interval for which demand reduction is being calculated
$kW_t^{baseline}$	= kW demand predicted by the baseline at time t
kW_t^{actual}	= kW demand measured at time t

Demand reduction is then used to calculate average hourly energy savings for each event. The equation is shown in Equation 4-5. Program level saving was calculated by taking the sum of all the events in the season.

Equation 4-5: DLC Event Energy Savings (kWh) Calculation

$$kWh_{saved} = \sum_{t \in EventPeriod} \left(\frac{kW_t^{reduction}}{2}\right)$$

Where:

t	= the 30-minute interval for which energy savings is being calculated
EventPeriod	= all time intervals including the precooling period (30 or 60 minutes before event start, if applicable), the event itself, and the snapback period (the period extending from the event's conclusion to two hours thereafter)
$kW_t^{reduction}$	= demand reduction calculated at time t

Peak reduction is calculated for each event, representing the maximum drop in energy usage that occurred for the average event participant. The equation is shown in Equation 4-6. Program level peak reduction was calculated by taking the average peak reduction across all events.

Equation 4-6: Verified Peak Reduction (kW) Calculation

$$kW_{reduced} = mean_{t \in EventPeriod} \left(kW_t^{reduction}\right)$$

Where:

t	= the 30-minute interval for which energy savings is being calculated
EventPeriod	= all time intervals from event start hour to the event end hour
$kW_t^{reduction}$	= demand reduction calculated at time t

4.1.2.2 Net-to-Gross Estimation

A net-to-gross ratio is calculated to take into consideration the effect of free ridership on energy savings. Free ridership is the estimated proportion of participants that would have participated in the energy saving behavior incentivized by the program regardless of whether the program existed. Demand response programs are not likely to have net-to-gross effects because customers are unlikely to curtail load in absence of the program. For this reason, a net-to-gross ratio of 100% was assumed for all savings resulting from DLC events. This program was not expected to generate significant spillover effects; therefore, the evaluators did not assess spillover.

4.1.2.3 Process Evaluation Methodology

A process evaluation was completed to assess the Power Hours program. The program provides PSO residential customers with a way to reduce energy usage during peak demand periods by participating in DLC events. The evaluators assessed program design, operations, and delivery through a logic model facilitated discussion and a participant survey.

The evaluation addressed the following research questions to understand the program's effectiveness and efficiency better:

- What changes, if any, have been made to the program design or implementation procedures?
- Did the program implementation reflect its design? Are there ways to improve the design or implementation process?
- How do PSO customers learn about this program? What factors motivated participants decision to participate? Were there any trends in enrollment?
- How does PSO market this program? Which marketing methods are most effective? Which marketing methods are more effective?
- Were participants satisfied with their experience? What was the level of satisfaction with the incentives, the application process, and other aspects of program participation?
- How and when were participants notified about an event?
- What were the key successes and challenges during each program year?
- Looking forward, what are the key barriers and drivers to program success within PSO’s market?

Table 4-4 summarizes the data collection activities and corresponding process evaluation research objectives used to complete the process evaluation.

Table 4-4: Power Hours Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Program Materials Review	Review reports and support materials for clarity and consistency with program objectives.
Participant Survey	Assess participant's reasons for participating and experience with the program, including satisfaction.
Logic Model Develop and/or Review	Develop program logic models or review already-developed logic models by program staff.

4.1.3 Impact Evaluation Findings

The methods described in the EM&V Methodologies section were used to determine the impacts on customer energy use for the Power Hours program. The goal of the impact evaluation is to determine verified annual energy savings (kWh) and peak demand reduction (kW). Findings are presented and discussed in this section.

In 2023, six Direct Load Control (DLC) event were called. The schedule of these events is summarized in Table 4-5.

Table 4-5: Power Hours Summary of Events

Date	Event Start Hour	Event End Hour	Duration (Hours)	Curtailment Strategy
7/26	15	17	2	Temperature Offset
7/27	15	17	2	Temperature Offset
8/02	15	17	2	Temperature Offset
8/03	15	17	2	Temperature Offset
8/21	15	17	2	Temperature Offset
8/24	15	17	2	Temperature Offset

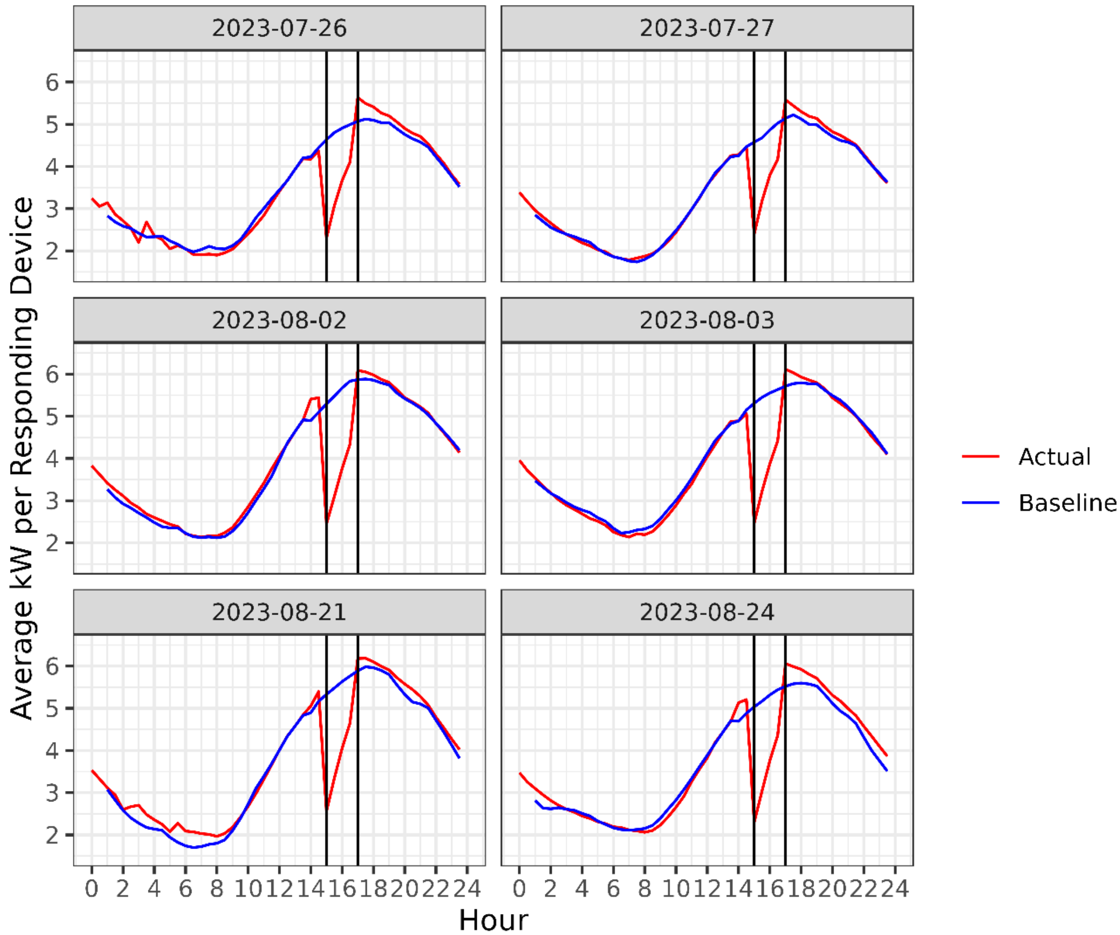
During the event season, which spanned from July 26, 2023, to August 24, 2023, there was a total of 16,513 active devices for at least one day. For each event, the available devices ranged from 15,459 to 15,753 with an average of 12,195 responsive devices. Out of the total events, three of them had precooling groups. The standard precooling period for these events was set at 60 minutes, except for the event on August 21, 2023, which had two subgroups with precooling periods of 60 minutes and 30 minutes, respectively. The distribution of devices between the precooling and non-precooling groups is detailed in Table 4-6.

Table 4-6: Summary of Participants

Date	Total Available Devices	Precool Devices	Precool Duration
7/26	15,459	0	
7/27	15,473	0	
8/02	15,556	7,133	60 minutes
8/03	15,564	0	
8/21	15,715	3,489	60 minutes
		3,608	30 minutes
8/24	15,753	7,091	60 minutes

Using the methodology described previously in this chapter, a baseline consumption curve was developed for each event day to represent a typical residence's performance. This was used to estimate what energy usage would have been during the event day had the event not occurred. The baseline consumption curve used for the demand reduction calculations are shown in Figure 4-1. Vertical lines represent the start and end time of the event.

Figure 4-1: Power Hours Actual vs. Baseline Energy Usage per Responding Device



Non-responsive device (NRD) identification was performed on all available devices using the methods discussed in the EM&V Methodologies section. Any device that was identified as an NRD for the event was removed from the analysis. The response rate is defined as the percentage of available devices that were not identified as an NRD. Table 4-7 shows the response rates for each event. The average response rates ranged from 71% to 81% with a higher rate for unidentified devices (~97%) than other models of devices (60% to 74%).

Table 4-7: Active and Responsive Device Counts per Event

Date	Device Provider	Available Devices	Responsive Devices	Response Rate
7/26	Unidentified Devices	4,181	4,067	97.27%
	Others	11,278	8,380	74.30%
	Total	15,459	12,447	80.52%
7/27	Unidentified Devices	4,189	4,079	97.37%
	Others	11,284	8,393	74.38%
	Total	15,473	12,472	80.60%
8/02	Unidentified Devices	4,240	4,149	97.85%
	Others	11,316	6,897	60.95%
	Total	15,556	11,046	71.01%
8/03	Unidentified Devices	4,255	4,140	97.30%
	Others	11,309	8,309	73.47%
	Total	15,564	12,449	79.99%
8/21	Unidentified Devices	4,370	4,254	97.35%
	Others	11,345	8,140	71.75%
	Total	15,715	12,394	78.87%
8/24	Unidentified Devices	4,400	4,283	97.34%
	Others	11,353	8,080	71.17%
	Total	15,740	12,363	78.55%

Demand reduction was calculated by comparing the hourly consumption predicted by the baseline consumption curve to the actual hourly consumption during the event. Results include demand reduction from the precooling period, event period, and the snapback period.

Demand reduction was calculated in 30-minute increments as shown in Table 4-8. Each column represents the average kW reduction per responding device during the specified time interval. Time intervals during the precooling and snapback periods are identified with grey cells.

Table 4-8: Power Hours Demand Reduction (kW) per 30-Minute Interval

Date	14:00 - 14:30	14:30 - 15:00	15:00 - 15:30	15:30 - 16:00	16:00 - 16:30	16:30 - 17:00	17:00 - 17:30	17:30 - 18:00	18:00 - 18:30	18:30 - 19:00	19:00 - 19:30
7/26	--	--	2.33	1.73	1.24	0.89	-0.56	-0.37	-0.32	-0.23	--
7/27	--	--	2.17	1.48	1.07	0.86	-0.44	-0.22	-0.18	-0.20	--
8/02	-0.50	-0.34	2.84	2.38	1.91	1.50	-0.22	-0.17	-0.12	-0.08	--
8/03	--	--	2.83	2.22	1.67	1.21	-0.40	-0.26	-0.14	-0.09	--
8/21	-0.16	-0.23	2.77	2.14	1.58	1.12	-0.29	-0.20	-0.14	-0.10	--
8/24	-0.44	-0.32	2.72	2.12	1.55	1.08	-0.54	-0.41	-0.33	-0.24	--

4.1.3.1 Verified Savings

Average annual energy savings per responding device was calculated for each event, using the demand reduction results above. Total energy savings for each event were calculated by multiplying the average energy savings per responding device by the number of responding devices for that event. Table 4-9 shows average annual energy savings per device and total savings for the duration of each event.

Table 4-9: Power Hours Energy Savings (kWh) per Event

Date	Responsive Devices	Savings During Event Hours, per Device (kWh)	Savings During Snapback Hours, per Device (kWh)	Savings During Precool Hours, per Device (kWh)	Energy Savings per Device (kWh)	Total Energy Savings (kWh)
7/26	12,447	3.10	-0.74		2.36	29,423
7/27	12,472	2.80	-0.51		2.29	28,559
8/02	11,046	4.32	-0.30	-0.42	3.60	39,760
8/03	12,449	3.98	-0.44		3.54	44,068
8/21	12,394	3.81	-0.36	-0.20	3.25	40,266
8/24	12,363	3.75	-0.75	-0.38	2.62	32,353
Total						**214,428**

Peak reduction per device was calculated by finding the largest difference between the baseline curve and the actual usage curve that occurred during event hours (see Equation 4-6). The peak reduction per event was then calculated by multiplying the peak reduction per device by the number of responsive devices for that event. Table 4-10 shows peak reduction per device and total reduction for the duration of each event.

Table 4-10: Power Hours Program-Level Peak Reduction (kW) per Event

Date	Responsive Devices	Peak Reduction per Device (kW)	Peak Reduction per Event (kW)
7/26	12,447	1.55	19,307
7/27	12,472	1.40	17,461
8/02	11,046	2.16	23,854
8/03	12,449	1.99	24,769
8/21	12,394	1.90	23,604
8/24	12,363	1.87	23,174
Average			**22,028**

Program level peak reduction was calculated by taking the average peak reduction across all events. Max peak reduction was calculated by finding the maximum peak reduction across the six events. These results are shown in Table 4-11.

Table 4-11: Power Hours Total Peak Reduction

Verified Peak Reduction (kW)	Max Peak Reduction (kW)
22,028	24,769

Total net energy savings were calculated by adding up the total energy savings of each DLC event. The results are shown in Table 4-12.

Table 4-12: Power Hours Total Net Energy Savings

Source	Total Energy Savings (kWh)
DLC Events	214,428

4.1.3.2 Precooling Findings

The events that occurred on August 2, 2023, August 21, 2023, and August 24, 2023, had precooling groups, as indicated in Table 4-6. Specifically, for the events on August 2, 2023, and August 24, 2023, the precooling period was set at 60 minutes. However, the event that took place on August 21, 2023, had two subgroups with different precooling periods: one with a 60-minute precooling period and another with a 30-minute precooling period. The energy usage curves for these events (as shown in Figure 4-1) reveal a small peak in energy consumption. Figure 4-2 provides a comparison of consumption patterns between users who had precooling and those who did not.

Figure 4-2: Power Hours Pre-Cooling Event Impact

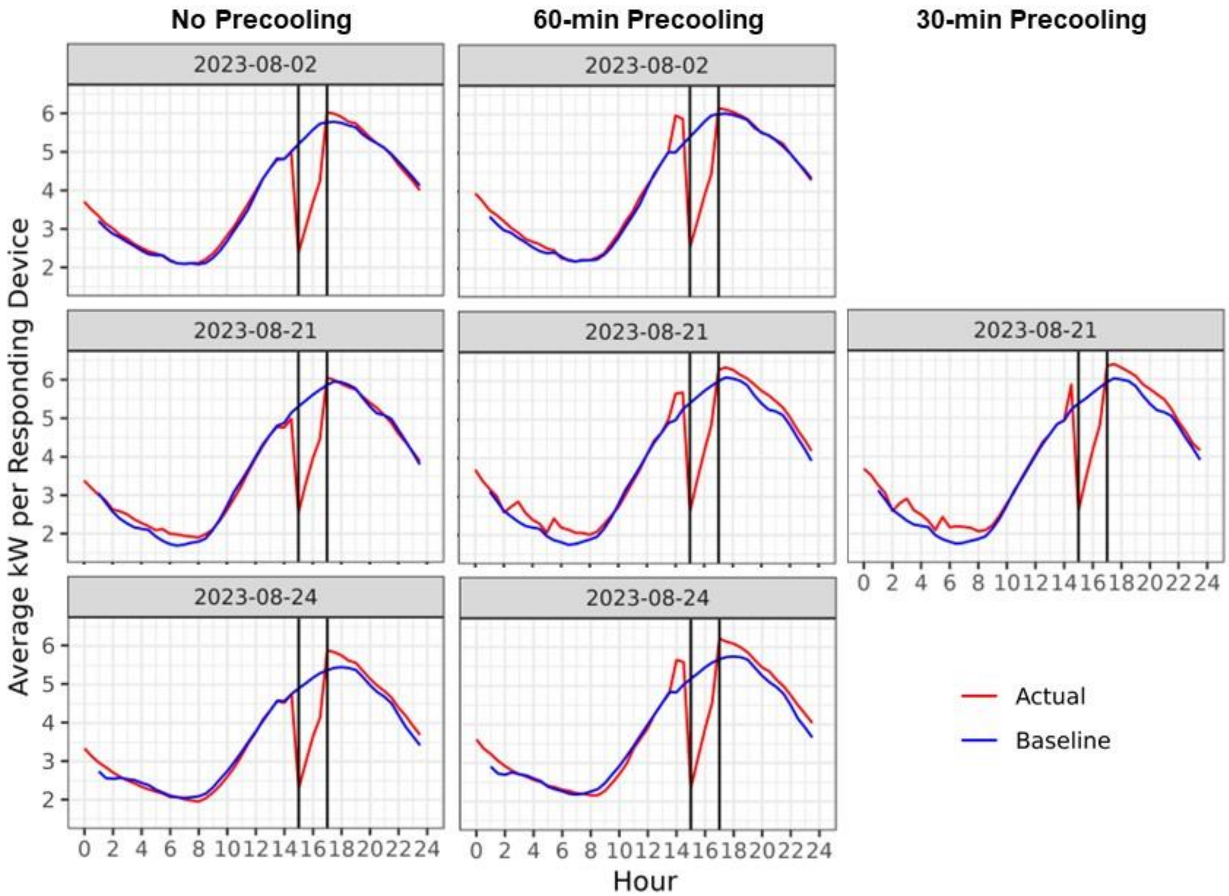


Table 4-13, Table 4-14, and Table 4-15 show the demand reduction in 30-minute increments for devices in different precool modes.

Table 4-13: Power Hours Demand Reduction (kW) per 30-Minute Interval for Devices without Pre-cooling

Date	14:00 - 14:30	14:30 - 15:00	15:00 - 15:30	15:30 - 16:00	16:00 - 16:30	16:30 - 17:00	17:00 - 17:30	17:30 - 18:00	18:00 - 18:30	18:30 - 19:00	19:00 - 19:30
7/26	--	--	2.33	1.73	1.24	0.89	-0.56	-0.37	-0.32	-0.23	--
7/27	--	--	2.17	1.48	1.07	0.86	-0.44	-0.22	-0.18	-0.20	--
8/02	--	--	2.83	2.36	1.90	1.50	-0.26	-0.21	-0.16	-0.09	--
8/03	--	--	2.83	2.22	1.67	1.21	-0.40	-0.26	-0.14	-0.09	--
8/21	--	--	2.77	2.17	1.66	1.29	-0.19	-0.04	0.04	0.06	--
8/24	--	--	2.61	2.05	1.53	1.15	-0.52	-0.41	-0.31	-0.19	--

Table 4-14: Power Hours Demand Reduction (kW) per 30-Minute Interval for Devices with 60 Minutes Pre-cooling Period

Date	14:00 - 14:30	14:30 - 15:00	15:00 - 15:30	15:30 - 16:00	16:00 - 16:30	16:30 - 17:00	17:00 - 17:30	17:30 - 18:00	18:00 - 18:30	18:30 - 19:00	19:00 - 19:30
8/02	-0.95	-0.66	2.87	2.42	1.94	1.52	-0.15	-0.10	-0.08	-0.05	--
8/21	-0.69	-0.44	2.82	2.17	1.57	1.02	-0.29	-0.26	-0.23	-0.15	--
8/24	-0.84	-0.58	2.84	2.20	1.59	1.04	-0.54	-0.39	-0.34	-0.25	--

Table 4-15: Power Hours Demand Reduction (kW) per 30-Minute Interval for Devices with 30 Minutes Pre-cooling Period

Date	14:00 - 14:30	14:30 - 15:00	15:00 - 15:30	15:30 - 16:00	16:00 - 16:30	16:30 - 17:00	17:00 - 17:30	17:30 - 18:00	18:00 - 18:30	18:30 - 19:00	19:00 - 19:30
8/21	--	-0.64	2.78	2.09	1.48	0.97	-0.42	-0.37	-0.31	-0.25	--

Table 4-16 contrasts the peak and average reduction per device among subgroups with and without precooling (and duration of precooling period) during the August 2, 21, and 24 events. It indicates that precooling increased the maximum peak reductions per device during all three events, occurring at the onset of each event. The average reductions across the event period were increased for the August 2 and 24 events but not the August 21 event. This is caused by the longer average opted-out time for customers with precooling than those without.

Table 4-16: Contrast of Demand Reduction (kW) per 30-Minute Interval Devices with Different Pre-cooling Modes for Power Hours

Date	Precool Duration (Min)	Number of Available Devices	Number of Responsive Devices during Events	Average Opted-out Length per Device (Min)	Number of Responsive Devices during Precooling	Maximum Peak Reduction per Device (kW)[a]	Average Peak Reduction per Device (kW)
8/02	60	7,133	5,108	12.7	4,430	2.87	2.19
	0	8,423	5,938	7.3	--	2.83	2.15
8/21	60	3,489	2,998	14.0	2,673	2.82	1.89
	30	3,608	3,114	13.0	2,771	2.78	1.83
	0	8,618	6,282	8.5	--	2.77	1.97
8/24	60	7,091	6,277	12.7	5,418	2.84	1.92
	0	8,662	6,086	8.2	--	2.61	1.83

[a]The maximum 30-min demand reduction during the events typically occurred in the first 30-min.

Table 4-17 contrasts the energy savings per device among subgroups with and without precooling (and duration of precooling period) during the August 2, 21, and 24 events. It indicates that precooling had decreased savings per device during all three events. This is caused by the energy consumption during the precooling events.

Table 4-17: Contrast of Energy Savings (kWh) for Devices with Different Pre-cooling Modes for Power Hours

Date	Precool Duration (Min)	Number of Available Devices	Number of Responsive Devices during Events	Average Opted-out Length per Device (Min)	Number of Responsive Devices during Precooling	Savings per Device (kWh)			
						Event Hours	Snapback Hours	Precool Hours	Total
8/02	60	7,133	5,108	12.7	4,430	4.37	-0.19	-0.81	3.38
	0	8,423	5,938	7.3	--	4.29	-0.36	--	3.93
8/21	60	3,489	2,998	14.0	2,673	3.79	-0.47	-0.56	2.76
	30	3,608	3,114	13.0	2,771	3.66	-0.67	-0.32	2.67
	0	8,618	6,282	8.5	--	3.94	-0.06	--	3.88
8/24	60	7,091	6,277	12.7	5,418	3.83	-0.76	-0.71	2.36
	0	8,662	6,086	8.2	--	3.67	-0.71	--	2.96

4.1.4 Process Evaluation Findings

ADM's process evaluation activities included a review of program materials, a participant survey, and program staff interviews. A process evaluation memo was delivered to PSO after the completion of the 2023 program year which includes details of the methodologies and findings. This section summarizes findings from the process evaluation.

4.1.4.1 Program Activity

The Power Hours Program had 12,953 active participants with 16,513 devices in 2023. ADM reviewed the distribution of thermostats by participants. Ten thermostat models were available for participation.

4.1.4.2 Program Operations Perspective

ADM conducted a discussion with program staff during 2023. The discussion aimed to provide valuable insights into the program's operations. A precooling option was added to the program in 2023 to support a consistent demand reduction across the event period. According to program staff, the introduction of precooling also addresses comfort concerns during events.

Precooling was implemented for customers not enrolled in time-of-day and/or recently enrolled Power Hours participants. Precooling is set at either 60 minutes or 30 minutes with a thermostat adjustment of two degrees. The purpose is to improve customer satisfaction by addressing comfort concerns.

The program's platform was highly regarded for its ease of use. Dispatching events were described as a straightforward and efficient process. This user-friendly interface contributes to a smoother program experience for both administrators and participants.

Another strength noted was the name recognition and popularity of Power Hours among customers. Despite potential differences in understanding due to program evolution, customers still associate the name with the program. This recognition helps maintain familiarity and engagement with the program.

A low smart thermostat penetration rate in the service territory presented a barrier to achieving program enrollment goals. PSO has included several program delivery methods for smart thermostats which should assist with the program’s enrollment goals in the future. The delivery mechanisms within other programs provide guidance and encouragement to enroll in Power Hours. Additionally, the program utilizes a connectivity optimization process to encourage customers to reconnect their devices if they go offline. Notifications are sent, and devices that remain offline for a specified period and have received multiple notifications may be removed from the program.

4.1.4.3 Participant Survey Results

ADM administered an online survey to collect information about participants’ experiences and satisfaction with the Power Hours program for 2023. Evaluators developed the survey to address general questions that all participants could answer (program awareness, program satisfaction, and demographics). The following section summarizes the feedback received from 279 participants who completed the 2023 survey (Table 4-18 summarizes the results from the email campaign).

Table 4-18: Power Hours Summary of Email Campaign

Survey Statistics	Count
Number of participants initially contacted by email	3,479
Number of undelivered emails	121
Completed surveys	279
Response rate	8%

New enrollees provided feedback about the most influential factors in their decision to enroll in the program, with 59% primarily driven to save money on their energy bills, followed by 23% who mentioned that the enrollment incentive played a significant role in their decision (see Table 4-19). Additionally, 14% indicated their enrollment was motivated by a commitment to reducing energy consumption to address climate change and 4% cited the program's recommendation by PSO. Participants cited a range of other reasons for enrolling in Power Hours (e.g., saving electricity, money, and energy). Some highlighted the program's incentives and financial benefits as motivating factors. Additionally, the convenience of automatic temperature adjustments, the potential to help the grid, and a focus on energy conservation were among the other reasons for enrollment.

Table 4-19: Reasons to Enroll in the Power Hours Program

Response	Percentage of Respondents (n = 70)
Save money overall on energy bills	59%
The enrollment incentive	23%
Program was recommended by PSO	4%
To reduce energy to address climate change	14%

4.1.4.3.1 Precooling

Forty-one percent of survey respondents who had participated in precooling events were familiar with the idea or had heard of it before, while 59% had not. Among the 34 respondents who were familiar with precooling, 38% noticed that the temperature of their home was cooled before the peak event occurred compared to 62% who had not noticed the precooling. Among the 13 participants who noticed the precooling events, 92% did not make any adjustments to their thermostat settings, while 8% indicated that they increased the temperature.

The 13 participants who were aware of the precooling events shared mixed experiences and impressions of the feature. Some respondents reported positive outcomes, such as a cooler home that remained comfortable. Others found it helpful to some extent but noted that the extreme Oklahoma summer made it challenging for older homes to maintain a cool temperature. A few participants expressed that their homes stayed cool, despite living in older houses, and appreciated the precooling feature. However, some mentioned their homes became very warm or experienced limitations due to the structure of their houses. Overall, there was a range of experiences and perceptions, with some participants finding the feature beneficial and others facing challenges.

4.1.4.3.2 Peak Events

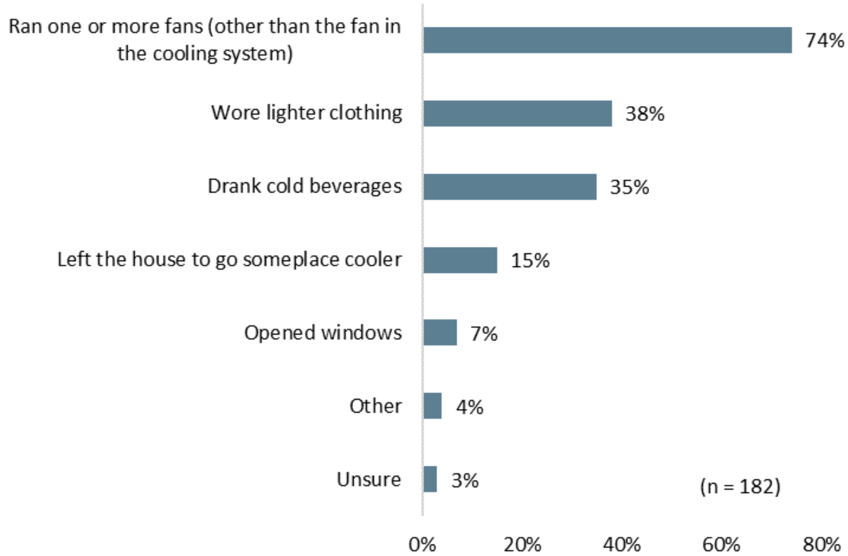
Participants provided feedback on their experiences with peak events. Twenty-eight percent of survey respondents first became aware of a peak event by seeing the notice on an app on their phone (see Table 4-20). Participants provided other ways they became aware of the peak event. Some mentioned that the changes were not very noticeable because they already maintained a warm thermostat setting in the summer for energy conservation. A few participants relied on the program's schedule and email notifications to be aware of these adjustments. Others mentioned that they only became aware of thermostat adjustments through PSO emails displaying their energy consumption. Additionally, some participants noted that they noticed the temperature difference, but a notification system would be preferred for enhanced convenience, as it occasionally caused them to question their air conditioning performance.

Table 4-20: How Participants First Became Aware of a Peak Event

Response	Percentage of Responses (n = 271)
Saw the notice on the app on phone	28%
Noticed the difference in how the home felt	27%
Saw the notice on thermostat	23%
Was not aware of peak events	16%
Other	2%
Unsure	3%

More than half (66%) of survey respondents reported that they were less comfortable during an event, 19% were at least as comfortable compared to other times, 14% reported that they were much less comfortable, and 1% were unsure. Many participants ran fans during events to remain comfortable, followed by wearing lighter clothing, or drinking cold beverages (see Figure 4-3). Among those who took other actions, some opted out of the event if they felt uncomfortable. One participant reported that their home was under construction, with the thermostat either turned off or set to the minimum, leading to minimal savings. Another individual mentioned that their spouse occasionally overrode the system to lower the temperature. Others resorted to opening windows, turning on ceiling fans to circulate air, or adjusting the thermostat, albeit not always to the lowest setting.

*Figure 4-3 Actions Taken During Peak Events to Remain Comfortable**



**Survey respondents who indicated they did nothing or were not home for any events were removed from the figure.*

Among those who took actions to remain comfortable, 61% reported that they remained comfortable in their home most of the time, followed by 31% who reported some of the time, and 7% who indicated the actions did not help.

Ninety-two participants stated they or someone in their household overrode the temperature adjustment during a peak event. The most common reason for overriding the event was that the home felt too uncomfortable (74%), followed by 11% who indicated another person in the home did not know about the event, 3% did not like PSO adjusting their thermostat, and 1% who were not aware they were enrolled in the program. About 10% indicated that there were other reasons they overrode the temperature adjustment. These respondents were influenced by factors such as house-related activities and personal comfort preferences. Some participants modified the temperature settings, while others experienced changes due to family members' preferences or external factors, like the presence of guests.

More than half of survey respondents (58%) indicated the number of peak events that occurred over the summer was about what was expected, followed by 15% who indicated it was fewer than expected (see Table 4-21). Those who anticipated fewer events indicated they expected approximately 14 peak events. About five peak events are what was expected among those who indicated there were more events than they had anticipated.

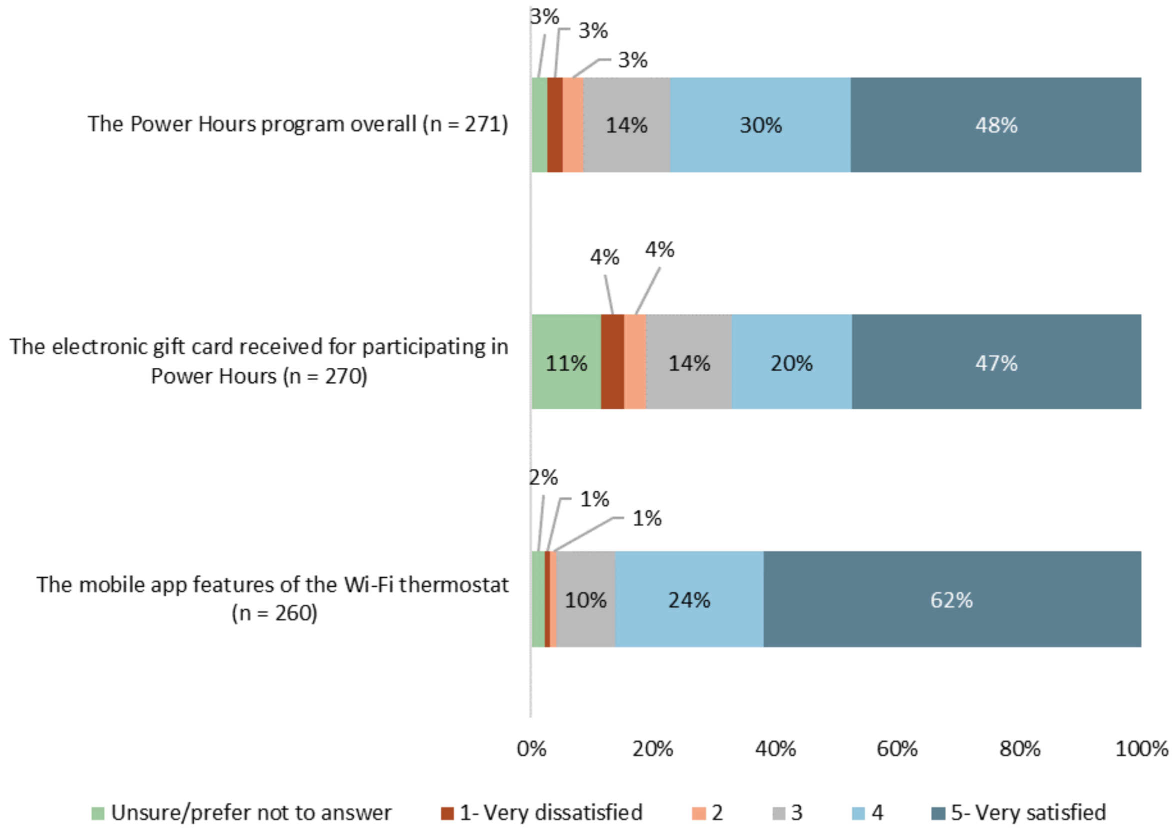
Table 4-21: Expected Number of Peak Events

Response	Percentage of Responses (n = 93)	Average Number of Anticipated Peak Events
More than expected	8%	5
About what was expected	58%	n/a
Fewer than expected	15%	14
Unsure	19%	n/a

4.1.4.3.3 Participant Satisfaction

Many survey respondents (77%) were very or somewhat satisfied with the program overall (see Figure 4-4). Participants expressed various reasons for their dissatisfaction with the program. Many mentioned issues related to the electronic gift card, including its limited usability as it can only be used online and the fact that it expires. Some found the process of redeeming the electronic gift card too complicated and preferred a tangible gift card of greater value. Others were dissatisfied because they felt the program didn't result in significant savings or because the higher temperature periods were too long, causing discomfort. Several participants also expressed frustration with the program's impact on their electric bills.

Figure 4-4: Participant Satisfaction



4.1.5 Conclusions and Recommendations

The following summarizes the key findings from the evaluation of the Power Hours program:

- Six DLC events were called in 2023 compared to eight in 2022 and six in 2021. Events in 2023 were all two hours compared to years past where some were three hours.
- Enrollment increased from 11,029 customers and 13,497 devices in 2022 to 12,953 customers and 16,513 devices in 2023. Increased thermostat offerings in residential programs are generating additional opportunities for demand response.
- Average event peak demand reduction per device ranged from 1.40 kW to 2.16 kW with a mean of 1.86±0.28 kW. This is higher than 2022, which ranged from 0.86 kW to 1.86 kW per device with a mean of 1.55±0.37 kW. Two events in 2022 were called during periods of lower temperatures, resulting in lower demand reduction. Excluding those 2022 events results in a 2022 mean peak reduction of 1.71±0.25 kW. The difference between this 2022 average of 1.71 kW and the 2023 average of 1.86 kW is likely associated with higher relative humidity during event

hours in 2023 (35.2%) than in 2022 (30.7%), although the average temperature for the event hours in these two years was similar: 101.9 °F in 2022 vs. 101.2 °F in 2023. It is expected that air conditioning cycles at a higher frequency as humidity increases[51].

- Pre-cooling slightly increased the maximum peak demand reduction for all three events this measure was implemented, especially during the beginning of events when the reduction is the highest. Pre-cooling also increased the average demand for 2 out of the 3 events except the August 21 one when the pre-cooling group was further split into different pre-cooling times (30 and 60 min). Participants' awareness of precooling events varied, with many being unfamiliar with the concept. Among those aware of precooling, mixed experiences were reported, ranging from positive outcomes of cooler and more comfortable homes to challenges in maintaining a cool temperature, particularly for older houses in extreme summer conditions. While some participants appreciated the precooling feature, others encountered limitations based on their home characteristics. Customers with pre-cooling had a slightly longer opt-out time than those without.
- ADM noticed that the effect of pre-cooling on increasing the average peak demand reduction was not always consistent and was small in magnitude, typically ~0.1 kW per device. Nevertheless, pre-cooling users consumed more energy on event days than users without pre-cooling, typically 0.6-0.8 kWh per device for a 60-minute pre-cooling period.
- ADM found the effect of pre-cooling was enhanced by a longer pre-cooling period (60 min vs. 30 min). The increase in maximum peak demand reduction for users with a 30-minute pre-cooling period was marginal (~0.01 kW per user) compared to those without pre-cooling at all. However, there was uncertainty associated with this conclusion as there was only one event testing such a case.
- Participants were satisfied with Power Hours. Satisfaction with the program varied among promoters, detractors, and passive respondents. Promoters of the Power Hours program commended it for its cost savings, ease of use, and positive impact on energy conservation, expressing a willingness to recommend it.

The following recommendations are offered for continued improvement of the Power Hours program:

- Address challenges with incentives and gift cards by exploring alternative reward options or simplifying the redemption process. Exploring alternative reward options involves considering a range of incentives that resonate with participants. Introducing a tiered reward system based on participation levels or loyalty could

[51] https://ma-eeac.org/wp-content/uploads/BEH2-Revised-Final-Report_02Oct2018.pdf

enhance motivation. Simplifying the redemption process is crucial to improving participant satisfaction. Ensure there are clear and concise instructions, accompanied by visual guides, to guide participants through the redemption process seamlessly. Regularly updating participants on the expiration dates and terms of use for electronic gift cards may prevent frustration and encourage timely utilization.

- Continue exploring practices focused on increasing each device's event peak reduction and savings. The shorter event period may benefit both demand reduction and savings. Pre-cooling resulted in additional peak reduction but was offset in savings over the event. ADM suggests more testing to confirm the effect of pre-cooling in the next program year, and at least a 60-minute pre-cooling period for more significant results. Field load dispatch was discussed but did not appear to be implemented.

4.2 Peak Performers Program

This chapter presents findings from the impact and process evaluation of the 2023 Peak Performers Program.

4.2.1 Program Overview

The Peak Performers program is a demand response (DR) program that provides incentives to commercial and industrial (C&I) customers that can, on short notice, reduce their electric usage to provide extra capacity during hours of peak demand.

The Peak Performers program is run between June 1 and September 30, which is the height of the cooling season. Participation among businesses is completely voluntary. Businesses who choose to participate are typically given at least two hours of advanced notice via email or text message and are requested to reduce electric consumption over a requested period, known as a “Peak Event.” A Peak Event may be called for a duration of two to four hours on any weekday from 1 p.m. to 7 p.m., excluding holidays. Businesses can opt out of any event and will not be penalized. Program agreements specify that there will be no more than three events during any one calendar week and no more than 16 events in each season. At the end of the season, participants are reimbursed based on verified demand savings at a rate of $32 per average kW reduction. A bonus equivalent to 5% of the total payout will be paid to customers who participate in all Peak Events.

A total of 238 customers and 1,911 premises participated in the program during 2023 with 1,791 participating in at least one event. Table 4-22 shows the performance metrics achieved by the program.

Table 4-22: Performance Metrics – Peak Performers

Metric	2023
Number of Customers	238
Number of Premises	1,911
Budgeted Expenditures	$3,884,753
Actual Expenditures	$3,344,719
Energy Impacts (kWh)	
Projected Energy Savings	63,000
Reported Energy Savings	-
Gross Verified Energy Savings	1,091,528
Net Verified Energy Savings	1,091,528
Peak Demand Impacts (kW)	
Projected Peak Demand Savings	19,723
Reported Peak Demand Savings	91,087
Gross Verified Peak Demand Savings	58,748
Net Verified Peak Demand Savings	58,748
Benefit / Cost Ratios	
Total Resource Cost Test Ratio	11.40
Utility Cost Test Ratio	2.85

4.2.2 EM&V Activities

The section below presents the impact and process evaluation methodologies to assess the 2023 Peak Performers program. The purpose of the impact evaluation is to determine gross verified peak demand savings (kW) as well as gross verified annual energy savings (kWh). Savings are verified by developing a counterfactual baseline consumption curve and calculating the difference between the baseline curve and actual consumption over the period of the Peak Event. The purpose of the process evaluation is to assess program design, operations, and delivery through a facilitated discussion about the program logic model and participant surveys.

4.2.2.1 Data Retrieval and Review

The impact of peak events is analyzed using program tracking data and interval meter data for all program participants. Software written in the statistical programming language R was used to process and analyze the data. Various data processing steps are applied to the data before analyzed. These steps include:

- Validating that the files are not corrupt and of a consistent size.

- Extracting and transferring data from these files.
- Identifying any periods of missing interval meter data for any of the program participants.
- Updating PSO with remaining data needs (i.e., if files were missing or corrupted).

After the above steps are performed, the data is ready for analysis.

4.2.2.2 Calculating Baseline Demand Curves

Baseline demand curves are developed for each customer with the provided data. These are used to estimate what the demand would have been during an event day had the event not occurred. In 2023, ADM employed multiple baseline methodologies and selected the best fitting models for each premise number. A comprehensive explanation of each baseline methodology and how they are used to create the final counterfactual baseline demand curves is available in a supplemental document.

To choose the most accurate baseline model for each premise, ADM evaluated each model's performance on the 30 weekdays over the program year where demand is highest (07/03/2023, 07/10/2023, 07/11/2023, 07/12/2023, 07/13/2023, 07/17/2023, 07/18/2023, 07/19/2023, 07/20/2023, 07/24/2023, 07/25/2023, 07/26/2023, 07/28/2023, 07/31/2023, 08/01/2023, 08/04/2023, 08/08/2023, 08/09/2023, 08/10/2023, 08/11/2023, 08/14/2023, 08/16/2023, 08/17/2023, 08/18/2023, 08/22/2023, 08/23/2023, 08/25/2023, 08/29/2023, 08/30/2023, 08/31/2023) during typical demand response hours for each premise number. These days were chosen from all non-event, non-holiday[52] weekdays during the months of July to August. These will be referred to throughout the report as "proxy event days". Performance was measured by fitting every type of baseline model to each proxy event day and calculating the residual root mean squared error (RRMSE) scores of each model's predictions.

It has been ADM's experience that baseline estimation methodologies often produce consistent results, but in some cases, these estimations can produce divergent results. To minimize calculation bias, we combined results as a weighted average of the best four models for each premise number. The weights were the inverse squares of the model RRMSEs. For example, if the four best-fitting models have RRMSEs of 5%, 11%, 25%, and 52% respectively, their relative weights will be 80%, 16%, 3%, and 1% respectively.

4.2.2.3 Savings Calculations

With baseline demand curves determined for each participant, demand reduction can be calculated by comparing it to the site-specific actual consumption on the day of a Peak

[52] ADM defined a "holiday" as any date that falls on a U.S. federal holiday or observed U.S. federal holiday. See https://www.opm.gov/policy-data-oversight/pay-leave/federal-holidays/#url=Historical-Data for a complete list.

Event. Demand reduction represents the average decrease in demand that occurs for an event participant during an hourly period. Demand reductions during peak events are estimated on a premise-by-premise basis. Equation 4-7 shows the formula for calculating demand reduction.

Equation 4-7: Hourly Demand Reduction Calculation

$$kW_t^{reduction} = kW_t^{baseline} - kW_t^{actual}$$

Where:

t	= the hourly interval for which demand reduction is being calculated
$kW_t^{baseline}$	= kW demand predicted by the baseline at time t
kW_t^{actual}	= kW demand measured at time t

Peak demand reduction is calculated by taking the average of every hourly demand reduction that occurred during the event period; the event period being the time from when the event starts to when the event ends. The equation is shown in Equation 4-8. The seasonal peak demand reduction was then calculated as the mean reduction of all the event hours.

Equation 4-8: DR Event Peak Demand Reduction (kW) Calculation

$$kW_{reduced} = \frac{1}{|EventPeriod|} \sum_{t \in EventPeriod} kW_t^{reduction}$$

Where:

t	= an hourly interval
EventPeriod	= all time intervals from event start hour to the event ending hour
$kW_t^{reduction}$	= hourly demand reduction calculated at time t

Hourly demand reduction is also used to calculate the energy savings for a given premise/event. The total DR event energy savings for a premise/event is calculated by summing together the hourly demand reduction that occurred at every hour during a DR event day[53]. The equation is shown in Equation 4-9. The seasonal energy savings was then calculated as the sum of the savings of all the events.

[53] Note that the entire day is used for calculating energy savings because previous years have indicated that some load shifting was occurring during the event day. Therefore, the entire day must be used as the evaluation period to accurately capture energy savings.

Equation 4-9: DR Event Energy Savings (kWh) Calculation

$$kWh_{saved} = \sum_{t \in EventDay} kW_t^{reduction}$$

Where:

t = an hourly interval

EventDay = all hourly time intervals that occur during a DR event day

$kW_t^{reduction}$ = hourly demand reduction calculated at time t

4.2.2.4 Process Evaluation Methodology

ADM evaluators completed a process evaluation to assess the Business Demand Response program, also referred to as Peak Performers. During 2023, the evaluators assessed program design, operations, and delivery through a program staff interview and participant surveys.

The evaluation addressed the following research questions to better understand the program's effectiveness and efficiency.

- What changes, if any, have been made to the program design or implementation procedures since previous years?
- Did the program implementation reflect its design? Are there ways to improve the design or implementation process?
- How do PSO customers learn about this program? What factors motivated participants decision to participate? Were there any trends in enrollment?
- How does PSO market this program? What type of participants will be targeted (e.g., types of sectors, business sizes, areas within the service territory? Which marketing methods are most effective?
- Were participants satisfied with their experience? What was the level of satisfaction with the reimbursement amount, the enrollment process, and other aspects of program participation?
- Has participating in the program led to participation in other PSO programs or other energy efficiency actions not recommended by the program?
- What types of businesses participate in the program?
- How and when were participants notified about an event?
- What were the key successes and challenges during each program year?

- Looking forward, what are the key barriers and drivers to program success within PSO's market?

Table 4-23 below summarizes the data collection activities and corresponding process evaluation research objectives used to complete the process evaluation.

Table 4-23: Peak Performers Process Evaluation Data Collection Activities Summary

Data Collection Activity	Process Evaluation Research Objectives
Program Materials Review	Review reports and support materials for clarity and consistency with program objectives.
Participant Survey	Assess the participant's reasons for participating and experience with the program, including satisfaction.
Program Staff Interview	Evaluate the viewpoints of program staff concerning program operations, its strengths, weaknesses, obstacles to success, and areas for enhancement.

A detailed report on the methodologies and findings of the process evaluation was delivered to PSO in December 2023.

4.2.2.5 Net-to-Gross Methodology

A net-to-gross ratio is calculated to take into consideration the effect of free ridership on energy savings. Free ridership is the estimated proportion of participants that would have participated in the energy saving behavior incentivized by the program regardless of whether the program existed. Demand response programs are not likely to have net-to-gross effects because customers are unlikely to curtail load in absence of the program. For this reason, a net-to-gross ratio of 100% was assumed for all savings resulting from DLC events. This program was not expected to generate significant spillover effects; therefore, the evaluators did not assess spillover.

4.2.3 Impact Evaluation Results

The methods described in this section were used to determine the impacts on customer energy use for each participant. Aggregated participant results determine program level impact for the peak demand reduction (kW) and energy savings (kWh). Findings are presented and discussed in this section.

4.2.3.1 Verified Savings

In 2023, five Peak Performers Demand Response events were called. The schedule of these events is summarized in Table 4-24.

Table 4-24: Summary of Peak Performers Demand Response Events

Date	Event Start Hour	Event End Hour	Duration (Hours)
07/27/2023	15	17	2
08/02/2023	15	17	2
08/03/2023	15	17	2
08/21/2023	15	17	2
08/24/2023	15	17	2

A baseline demand curve was developed for each premise for each event day, used to estimate what the demand would have been during the event day had the event not occurred.

ADM chose 30 proxy event days based on which non-event; non-holiday weekdays had the highest overall energy demand within the participant population. Proxy event days are meant to closely represent the conditions of a regular event day. Therefore, an accurate baseline methodology should be able to closely predict actual demand during each of the proxy event days. Figure 4-5 shows the sum of actual demand (all premises) as well as the sum of predicted baseline demand during each proxy event day, for the entire participant population.

Figure 4-5: Peak Performers Actual vs. Baseline Energy Demand -- Proxy Event Days

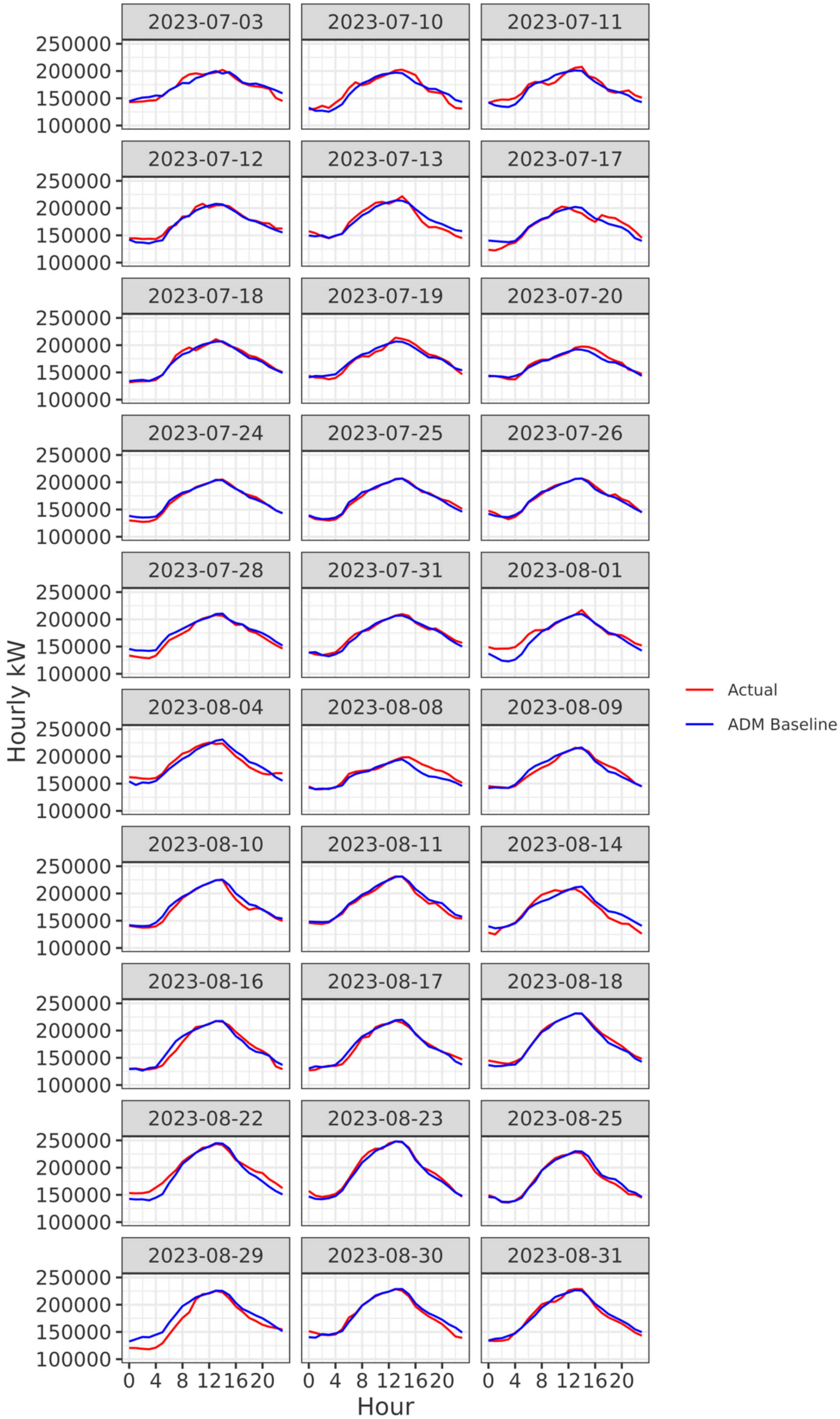
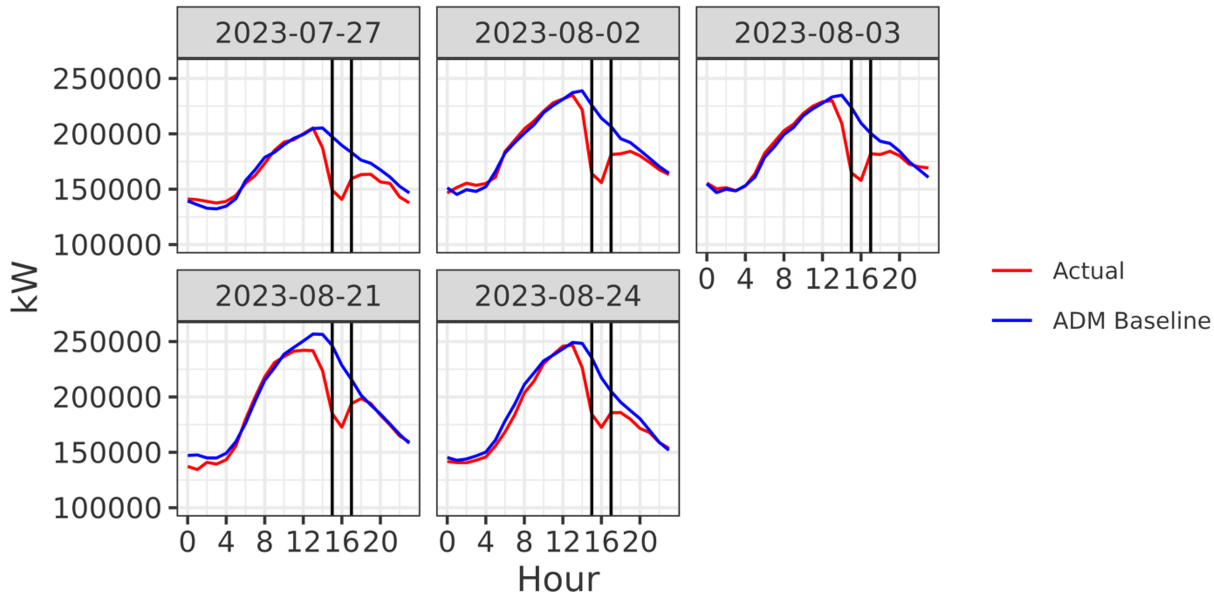


Figure 4-6 shows the sum of actual energy demand as well as the sum of predicted baseline demand during each peak event day, for the entire participant population. The grey area represents the event period.

Figure 4-6: Peak Performers Actual vs. Baseline Energy Demand – Peak Event Days



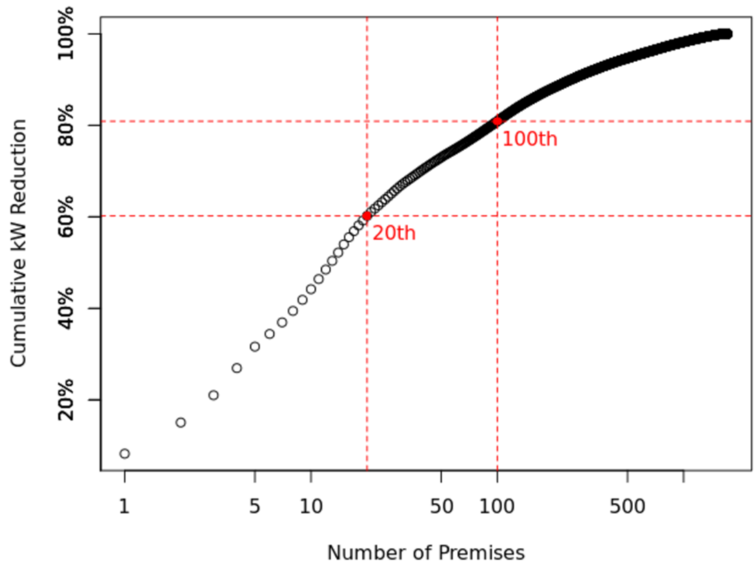
The difference between the modeled baseline and actual demand for each hour of each event was calculated for each premise. Consistent with industry standards for calculating peak demand reduction, such as the Uniform Methods Project (UMP), the peak demand reduction for each event was determined as the average reduction across event hours for each premise. Therefore, the total peak demand reduction per event is the summation of each premises hourly average reduction during the event. The total peak demand reduction for the program is the average reduction across all events. Table 4-25 shows the peak demand reduction for each event as well as how many participants curtailed.

Table 4-25: Peak Performers Program-Level Peak Demand Reduction (kW) per Event

Date	Participants	Non-Participants	Percent kW Reduction (%)	Peak Reduction per Event (kW)
07/27/2023	1,596	315	37.2	51,609
08/02/2023	1,436	475	38.0	63,438
08/03/2023	1,447	464	38.7	60,240
08/21/2023	1,394	517	32.8	60,314
08/24/2023	1,520	391	29.9	50,999
2023 Verified Peak Demand Reduction (kW)				**58,748**

The program's total kW peak reduction is largely contributed by the top premises. The cumulative fraction of peak reduction is shown in Figure 4-7. The top 20 premises with the highest kW peak reduction contributed to 60% of the program's total peak demand reduction.

Figure 4-7: Peak Performers Cumulative kW Reduction for Largest Contributors



Participant incentives are determined based on reported (reported) estimates of peak demand reduction. A comparison of reported estimates to verified results are shown in Table 4-26.

Table 4-26: Peak Demand Reduction Results

Reported Peak kW	Verified Peak kW	Peak kW Realization Rate
91,087	58,748	64%

Energy savings were calculated for each event. Total energy savings for each event were calculated by summing the hourly demand reduction values for each premise during every hourly period on a peak event day. Table 4-27 shows the total energy savings for each event and the total across all events.

Table 4-27: Energy Savings (kWh) per Event

Date	Total Energy Savings (kWh)
07/27/2023	196,022
08/02/2023	207,482
08/03/2023	201,440
08/21/2023	222,734
08/24/2023	263,850
Verified Energy Savings (kWh)	**1,091,528**

4.2.3.2 Lifetime Energy Savings

Energy impacts are determined each year and therefore an effective useful life of one year is applied to quantify the lifetime savings of participants for any given program year.

4.2.4 Process Evaluation Findings

The process evaluation included a review of program tracking data, a participant survey, and the development of a logic model through a facilitated discussion with program staff. A process evaluation memo was delivered to PSO after the completion of the 2023 program year which includes details of the methodologies and findings. This section summarizes findings from the process evaluation.

4.2.4.1 Program Operations Perspectives

ADM conducted a facilitated discussion with the program manager for the Peak Performers program to discuss operations and any changes for 2023. Some improvements administered in 2023 included additional messaging to participants, an updated process for account verification, and an updated process for payment processing. Additionally, a contact master account system was developed, where customers with multiple accounts have one account designated as the contact master. This account holds all the current information, including addresses, contact details, and event notifications for all their business locations.

Overall, the program's strengths lie in its customer-centric approach, providing autonomy, ease, and financial incentives for participating facilities. Peak Performers allows customers to decide how to curtail their energy usage, giving them a sense of control and allowing them to have an impact on the program's outcomes. According to PSO, customers appreciate the simplicity and ease of participating in the program. There is no penalty if unable to participate, making the decision to participate less burdensome. Lastly, Peak Performer participants receive monetary compensation for their facilities' curtailment efforts. This aspect can be advantageous for public schools, as it provides an opportunity to earn additional funds.

4.2.4.2 Participant Survey Results

ADM administered an online survey to program participants between November 2023 and December 2023. The survey was conducted to collect data on how participants learned of the program, satisfaction with the events, and overall program satisfaction. ADM administered the survey to 212 program contacts. Twenty-nine participants completed the survey.

Peak Performers survey participants represented various industry sectors. Thirty-one percent were from the K-12 schools, followed by industrial/manufacturing at 14%, and office settings at 10%. Other sectors, each comprising 3% of the participants, include religious worship, institution/government, healthcare, data center, yoga studio, library, vocational-technical school, private golf club/restaurant, pipeline, and childcare.

4.2.4.2.1 Event Participation

The Peak Performers program description states there could be up to 16 events conducted in a program year and there were five events in 2023. All survey respondents recalled the number of events their organization participated in. Most survey respondents (76%) indicated they did not opt out of any events. Opting out of events was driven by availability during the event but also influenced by production scheduling.

In 2023, most respondents, 69%, found that the number of peak events aligned with their expectations. Meanwhile, 21% experienced fewer peak events than anticipated, and just 3% reported more peak events than expected. Additionally, 7% expressed uncertainty regarding their expectations about the peak events in 2023 (see Table 4-28).

Table 4-28: Expected Number of Events per Year for Peak Performers

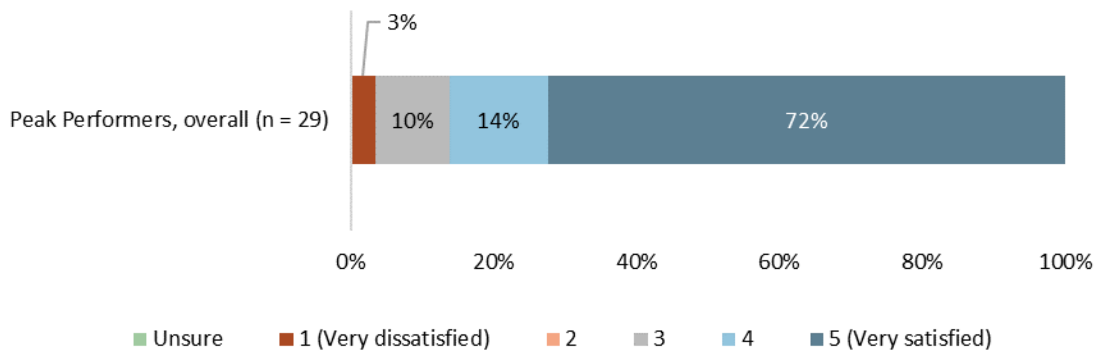
Response	Percentage per Response (n = 45)
Less than expected	21%
About what was expected	69%
More than expected	3%
Unsure	7%

Regarding the preferred number of events each program year, respondents presented diverse preferences with an average of 4.2 per year. While no participants favored 1 or less per year, 31% indicated a preference for 2 to 4 per year, and 24% opted for 5 to 7 per year. Interestingly, 31% favored participating in as many events as needed.

4.2.4.2.2 Participant Satisfaction

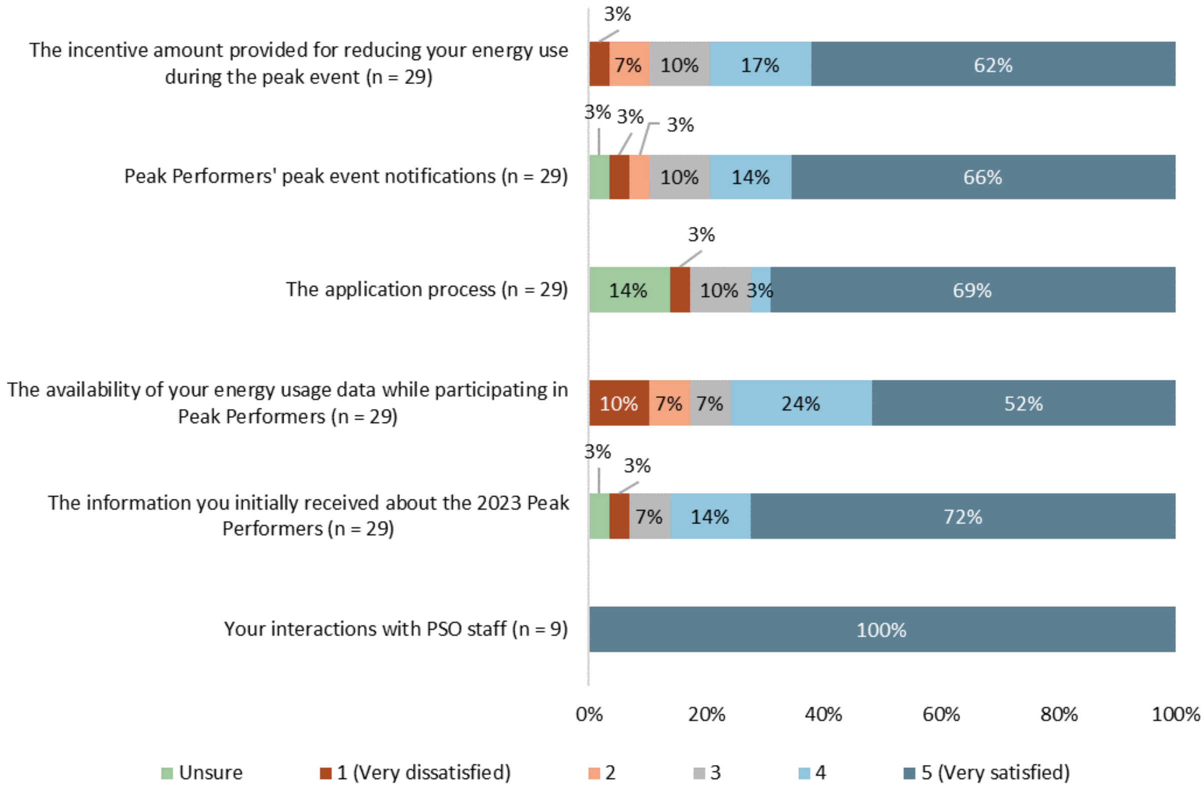
As illustrated in Figure 4-8, 86% of participants are somewhat or very satisfied with the program overall.

Figure 4-8: Overall Satisfaction with Peak Performers



Participant satisfaction with various aspects of the Peak Performers program varied. Regarding the information initially received about Peak Performers, 72% reported being very satisfied, while a small percentage expressed dissatisfaction. The availability of energy usage data during participation was considered satisfactory by 52% of participants, with varying levels of satisfaction. The application process received a high satisfaction rate of 69%, and peak event notifications were generally satisfactory, with 66% expressing high satisfaction. For the incentive amount provided for reducing energy use during peak events, 62% reported being very satisfied, although a minority indicated dissatisfaction. These findings suggest an overall positive experience with the program (see Figure 4-9).

Figure 4-9: Participant Satisfaction of Peak Performers



4.2.5 Conclusions and Recommendations

The following summarizes the key findings of the evaluation of the Peak Performers Program:

- The percentage of load reduction ranged from 29.9% to 38.7% across five events. The program called five two-hour events, one less than last year and shorter (the program in 2022 called four two-hour events and two three-hour events).
- Enhancements in their QA/QC procedures are improving implementation processes.
  - A formal process was introduced to verify accounts before and after the season, ensuring ownership of participating properties.
  - Integration of CIS data has notably improved the verification process, enabling the identification of active accounts and accurate payment calculations.
  - The check processing practice has been refined for a smoother experience.
  - A verification process for mailing addresses has been implemented to ensure precise payments.

    - The development of a contact master account system streamlines information for customers with multiple accounts.
- Survey participants had positive and effective communication experiences. Thirty-one percent of survey participants communicated with PSO staff upon program participation. All nine respondents who interacted with PSO staff reported being very satisfied with these interactions.
- Most participants (76%) did not opt out of any event, while 14% opted out of one event. Sixty-nine percent of respondents found the number of peak events aligned with their anticipations, while 21% experienced fewer and 3% reported more than expected.
- Peak Performers experienced strong overall positive experiences, underscoring the success of the program in meeting participant expectations. A substantial majority of participants expressed satisfaction with the Peak Performers program overall.

The following recommendations are offered for continued improvement of the Peak Performers program.

- Continue the proactive approach in addressing administrative complexities to ensure a seamless experience for participants.
- Consider tailoring program communications to participating organizations for more active engagement. Survey findings highlight a mix of roles, with 69% designated as points of contact and significant percentages actively involved in communication and sign-ups. Recognizing this diversity, tailored communications can address specific needs, ensuring relevance and resonance.
- Continue focusing on communication strategies and engagement practices with participants. Regular communication channels to keep participants informed about upcoming events may help increase levels of participation. While challenging to provide real-time consumption data to participants, providing near real-time data after events may help participants understand the effectiveness of their event operating strategies and how to best prepare for the next event.

5 Research & Development Pilot Programs

The 2022-2024 Demand Side Management (DSM) filing for Public Service Company of Oklahoma (PSO) provided a provision to conduct research and development projects to discover new ideas to improve energy efficiency processes, products, and services. Studies are underway to assess the potential for new energy efficiency and demand response opportunities for PSO customers. The studies include Demand Management Integrated Resources, Efficient Homes and Communities, Non-Wires Alternative Pilot, and a Virtual Diagnostics Tool.

5.1 Virtual Diagnostics Tool (VDT)

PSO implemented a Virtual Diagnostics Tool (VDT) to help PSO identify residential customers with above average energy intensity and to diagnose the cause (heating, cooling, lighting, etc.). The tool is accessed through a unique dashboard created for PSO that is integrated with cloud-based AMI database. The dashboard and database can be updated to support other objectives such as potential analysis, program design, evaluation of savings for any technology.

The tool is designed to provide PSO with the following benefits:

- Engage with customers in a more meaningful manner once PSO understands their energy consumption patterns and persona.
- Target specific measures (energy efficiency, demand response, DER) to the right customer (or groups of customers) at the right time and location on the grid.
- Identify the customers with the greatest potential to save kWh and kW.
- Can be used to evaluate realized meter-based outcomes and to quantify delivered GHG emission reductions.
- Can be used to develop forecasted load on a substation basis.

Project deliverables for the 2023 program year included:

- Establish AMI and CIS data pipelines for ongoing data feeds. This step included building out QA and data processing automation to reduce time requirements going forward.
- Analyze program participation data to identify trends by different categorical variables to determine who is participating in different programs and find gaps in participation.
- Perform AMI based EM&V on all programs to identify program performance expectations at the individual household level and aggregated up through any

relevant categorical variable to measure how different programs are performing for different groups of customers.

- Provide recommended measure lists for different customer groupings.
- Create a digital twin of every residential premise to simulate savings from different measures at the individual household level.
- Recommendation list for every premise of the measures that will have a positive impact for the customer, with ability to sort by available KPI's.
- Interactive Dashboard will allow PSO to select their top areas of impact which identifies customers in most-need of a customer program, and then show the simulated impact for various measures for that customer.
- Data Visualizations in multiple formats including aggregated and available in charts, mapped in a geospatial view, and in tabular formats at the individual customer level. All data can be exported for easy use.
- Prepare for full historical AMI transfer.

The tool is expected to be fully operational in June 2024.

5.2 Efficiency Homes and Communities

The Efficiency Homes and Community (EHC) is to conduct an Efficiency Community Demonstration project. The goal of the community demonstration project is to develop a residential new construction plan that:

- Goes beyond normal baseline code standards for energy efficiency and resilience.
- Will have very low utility bills now and in the future, plus have a low cost to maintain.
- Is built to a higher standard than conventional homes.
- Is more durable, comfortable (year-round), and has better indoor air quality.
- Reduces outside noise.
- Overall, it is better for the environment and sets a new high standard for future homes.

5.2.1 Methodology for ECH

Both Ekotrope and Cove.Tool software were used to determine estimated energy savings and incremental cost information. Both software programs are approved by the Residential Energy Services Network (RESNET) and EPA for rating and verifying ENERGY STAR® homes. Each allows detailed modeling and configuration of inputs in the following categories:

- Construction materials
- Internal loads
- Shading and overshadowing
- HVAC + water heating equipment
- Duct location + infiltration.

Results of more than 50 modeling computations were compared in both software tools to gauge realistic kWh savings estimates as compared to the baseline home. The Tulsa weather station was selected to represent the climate zone for this analysis.

An estimate of incremental cost difference between the ECM upgrades and baseline cost compared to the kWh savings was considered. These estimates should be used to guide decision makers toward upgrades that have the greatest potential impact on energy use. Availability of product, labor to install, and occupant preferences are other key factors to cost differences and return on investment that fall outside the scope of this report. The energy rate assumed for the energy savings are based on the normalized residential energy tariffs for PSO at $0.11 per kWh (kilowatt per hour).

A baseline energy model was developed using a 1,700 square foot home with a two-ton HVAC system. The baseline home uses typical design practices found in PSO territory using current Oklahoma residential building code standards.

5.2.2 Model Results

The three selected designs result in energy savings of 22%, 40%, and 47% (in terms of meeting the requirements of a DOE Zero Energy Ready Home[54]). Home designs were rated as bronze through gold.

The bronze level home is like PSO certified homes constructed in the Tulsa market during the 2023 rebate year. These homes include R-15 blown insulation in the exterior walls, an entry level HVAC system with ducts in a traditional vented attic. Most of the savings are achieved through improvement in windows, a tight building envelope through additional air sealing strategies, and reduced air leakage in the duct system.

The silver level home provides efficiency gains with wall insulation and duct location. By adding a 1-inch extruded polystyrene (XPS foam) foam board to the exterior of the wall sheathing, you gain both insulation R-value and envelope sealing with very little costs (approximately $500 per home). Similarly, moving the ducts into conditioned space increases energy savings by approximately 15% and can be achieved through minimal increased costs depending on the design strategy. Due to the reduction in air changes

[54] https://www.energy.gov/eere/buildings/zero-energy-ready-home-program

inside the home, an air cycler system is required to deliver and mix outdoor air into the HVAC system supply.

Upgraded components of the gold home include all the same as Silver plus a geothermal system with desuperheat water. As noted in the graph, there is an estimated 7% reduction in energy use for these components. Although this reduction seems small, the overall consumption of the home is under 10,000 kWh per year which makes each incremental savings advancement harder to achieve. In a standard code-built home with little to no energy upgrades, a geothermal system with desuperheat water would result in 34% reduction in energy use. A summary of results for the four designs is shown in Table 5-1.

Table 5-1: Community Demonstration Home Design Summary

Building Components	Baseline	Bronze	Silver	Gold
Certification	None	PSO Rebates	EnergyStar v3.1	DOE NZE Home EnergyStar v3.2
Annual Usage (kWh)	17,030	13,251	10,137	9,031
Annual Energy Savings	0%	22%	40%	47%
Potential Bill Savings	None	$415	$758	$880
HERS Score	**85**	**60**	**60**	**48**

The gold level design presents the DOE's net zero ready design. A Zero Energy Ready Home is a high performing energy efficient home that requires first and foremost construction practices that are the most energy efficient to minimize the overall electric load.

5.2.2.1 Non-Energy Benefits

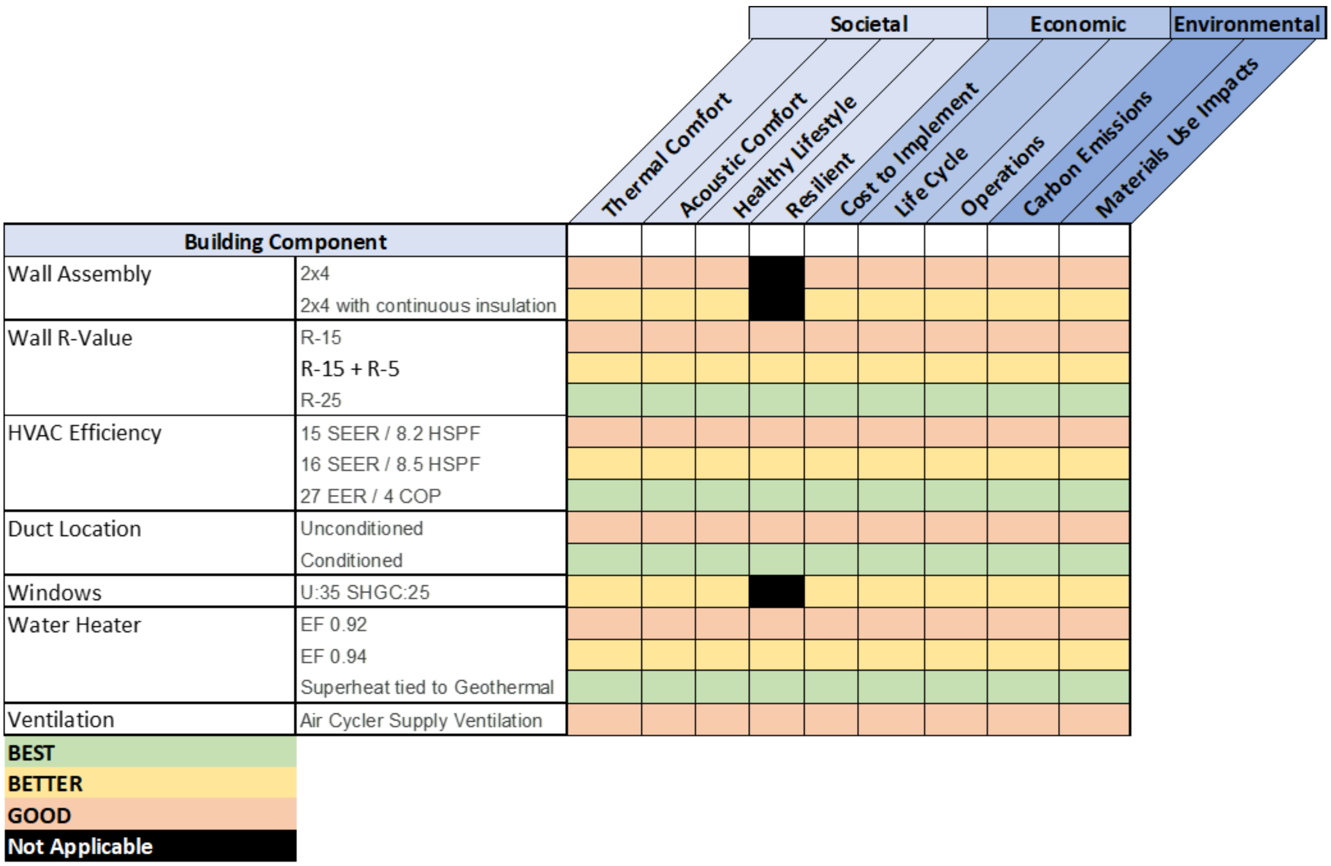
The following diagram provides a high-level review of the societal, economic, and environmental non-energy benefits for the recommend energy conservation measures for the energy models presented in Table 5-1. The information is provided to show the impacts of measures beyond energy savings to allow for consideration of these factors in the decision-making process.

The extra investment in the Bronze through Gold home types provides the homeowner with benefits beyond energy savings. PSO customers have also reported on non- energy benefits. PSO homebuyer surveys show additional benefits when purchasing an energy efficient new home. These responses include:

- Lower long-term ownership costs

- Reduction in health issues such as asthma and COPD triggers
- Higher market value
- Increased comfort and sense of safety
- Reduced carbon emissions
- Safeguard against future energy price fluctuations.

Figure 5-1: Non-Energy Benefits of Each Building Component



5.2.2.2 Workforce Development

Builders will reach significant milestones in the pursuit of building toward net zero including achieving ENERGY STAR v3.1 and Indoor Air Plus certification. As part of this process, construction trades will need additional training to successfully execute technical strategies embedded in these certifications. This training will help sustain and retain a viable workforce that can support the needs of current and future building projects. One example of this training is the installation of rigid insulation around the exterior walls. This building strategy is becoming more prevalent in states with stringent energy codes and may potentially become code in Oklahoma.

5.2.2.3 Net Zero Energy Ready

Net zero energy is defined as a system that produces at least as much energy as it consumes on an annual basis. A Zero Energy Ready Home is a high performing energy efficient home that can achieve net zero with the addition of a renewable energy system like roof top solar. To build a new construction Zero Energy Ready Home requires first and foremost construction practices that are the most energy efficient to minimize the overall electric load. In addition, a true net zero home must be all electric. The initial investment to reach a net zero status is often too much for a homebuilder to provide, therefore PSO is encouraging the adoption of design strategies that prepare the home for future net zero status. Silver and Gold tiers are the recommended building strategies for a Zero Ready Home. In addition to the building components found in Table 1, the home must meet the following conditions for future zero energy ready use as recommended by the Department of Energy*:

- Available free roof area within +/- 45° of true south.
- Roof allowable dead load rating can support an additional 6 lbs/sq.ft. for future solar system.
- Install a 1" metal conduit for the DC wire run from the designated array location to the designated inverter location, and from the inverter location to the electrical service panel (cap and label both ends).
- Install and label a 4x4 plywood panel area for mounting an inverter and balance of system components.
- Provide a labeled slot for a double-pole breaker in the electrical service.

Table 5-2: Estimated Performance

Building Component	Annual kWh Usage	kW Capacity DC	Estimated Qty of Panels	Estimated Solar Output (kWh/year)	Estimated System Cost	Estimated ROI of Solar Panes
Baseline Home	17,030	10	5	2,878	$ 5,215	5.92 years
Bronze Home	13,251	10	5	2,878	$ 5,215	4.60 years
Silver - Energy Star	10,137	10	5	2,878	$ 5,215	3.52 years
Gold - Net Zero Ready	9,031	10	5	2,878	$ 5,215	3.14 years

While achieving net zero is a long-term goal, there are obstacles to overcome in the short term. Current home designs for an average 1,700 square foot home allow for only 705 square feet of roof area for solar panel placement. Additionally, home orientation is a huge requirement when considering solar panel output.

5.2.3 Conclusion of Modeling

Evolving technology in energy efficiency provides home builders with thousands of possibilities for reducing the energy burden for new construction projects. The three options provided in this report represent the most attainable building practices based on the Oklahoma market today.

The three tiers (Bronze – Gold) are the best options based on the availability of materials, incremental cost increases, and potential energy savings. Of these three tiers PSO believes the top two for implementation are the silver or gold levels. This will allow the home builder to achieve ENERGY STAR v3.1 certification and zero ready.

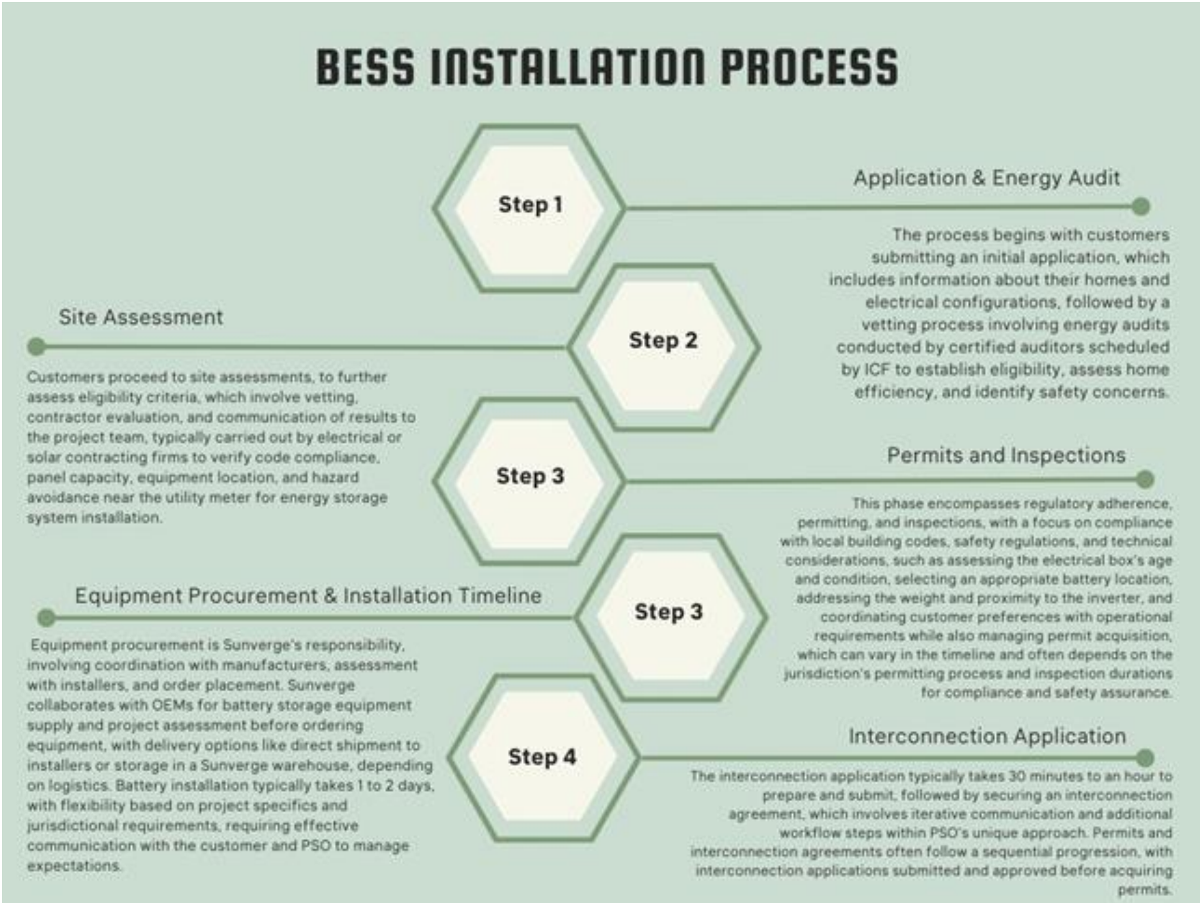
5.3 Demand Management Integrated Resources - Behind the Meter Battery Energy Storage System (BTM BESS)

The objective of the pilot program is to study and test the properties of behind the meter (BTM) residential and small commercial Battery Energy Storage Systems (BESS) to explore the potential for peak demand reduction, load shifting, solar integration, and backup power resources. ADM has been contracted to assess the energy impacts and assess the pilot program through a process evaluation. The process evaluation consists of participant surveys (to assess the installation process, system performance, and the participation process overall) and stakeholder interviews.

5.3.1 Overview of the Installation Process

The battery installation process includes several essential steps: application, energy audits, site assessments, permits and inspections, equipment procurement, and interconnection application. Initially, customers submit applications with required information. Energy audits follow, evaluating energy consumption patterns and providing sizing recommendations. Site assessments determine suitability and modification needs. Upon approval, the installer acquires permits, a process varying by location. Equipment procurement ensures components readiness. The installation team then installs the system per design specs. Post-installation, inspections verify compliance with local codes. Finally, the interconnection application facilitates grid connection. This process ensures a safe, compliant, and operational BESS, enhancing energy resilience and efficiency. Refer to Figure 5-2 for a graphical overview.

Figure 5-2: Graphical Overview of BESS Installation Process



5.3.1.1 Installation Timeline

Creating a comprehensive installation plan for each project or customer is a process involving various sequential components. The initiation typically revolves around the interconnection application, whose duration varies based on jurisdictional specifics. For instance, for a battery-only system, the approval of this application by PSO may span approximately two weeks.

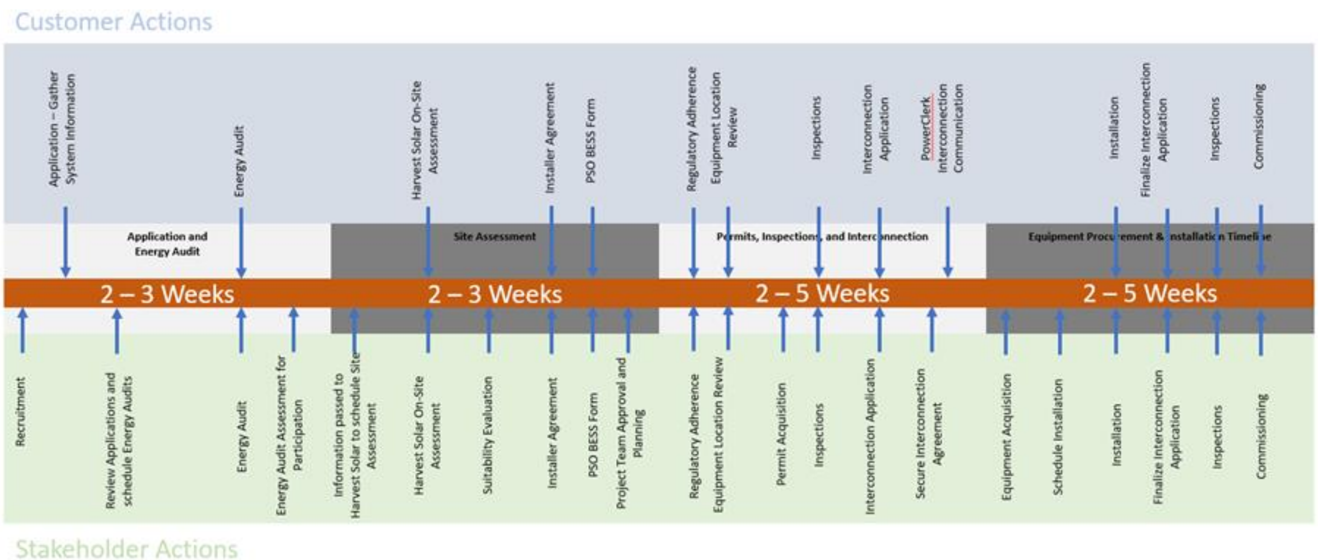
The coordination of site audit scheduling and the completion of essential paperwork commence post-approval. This phase necessitates homeowner availability, typically spanning two consecutive days for installation. Following this, the permitting process unfolds, taking a week after the finalization of the site audit and paperwork.

The subsequent phase involves the finalization of the interconnection application, which demands the submission of requisite documentation, including permit details and photographs. The duration of this step can be variable, often encompassing a few weeks. The requirement for a revenue meter on the battery may extend the timeline by a couple of weeks, encompassing utility personnel installing the meter. Inspections, executed prior to meter installation, introduce further variability in terms of timing.

Crucially, it's noteworthy that several of these steps can occur concurrently. While the interconnection application undergoes finalization, other parallel activities such as permitting, scheduling, and inspections might also be underway.

The anticipated timeline for the installation falls within the range of 1 to 2 months, starting from interconnection application submission and concluding with the final inspection and approval. Nevertheless, this timeframe's flexibility is dependent on specific project attributes, jurisdictional requirements, and other variables. Effective communication with the customer and PSO concerning the estimated timeline is important for managing expectations and facilitating timely project completion. See Figure 5-3 for a graphical illustration of the installation timeline.

Figure 5-3: BESS Installation Timeline



5.3.2 Customer Installation Survey

ADM administered an online survey to PSO residential customers who own solar systems and have installed BESS. The purpose of the survey was to gather participants' insights into participant knowledge, awareness, and satisfaction with the program, as well as their motivations for participation. The survey was sent to 19 customers and 12 surveys were completed online. The following section summarizes the key findings from the survey.

5.3.2.1 Participant Experience with the Pilot Study

Participants' awareness of the BESS pilot study came from various sources. Most respondents (50%) reported learning about the program through emails from PSO. PSO representatives played a significant role, with 17% of respondents citing them as the channel through which they first became aware of the program. Other sources included friends, family members, or colleagues, social media, and an ICF representative.

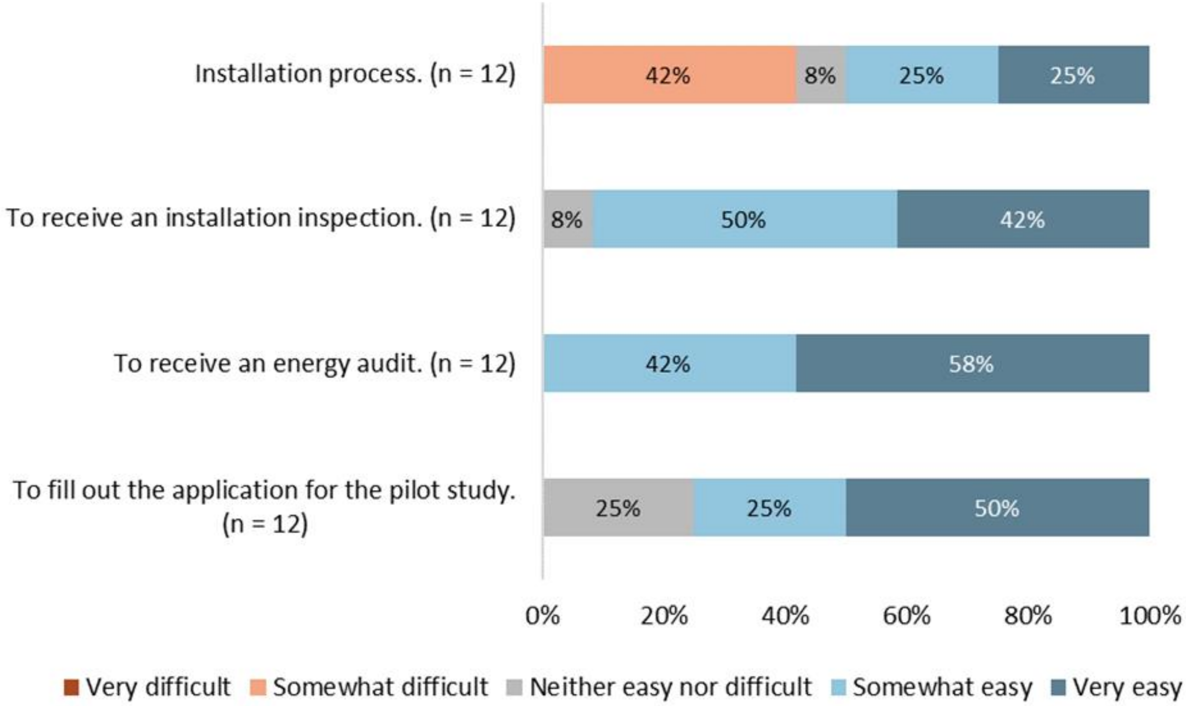
Table 5-3: Source of Awareness

Response	Percentage of Survey Responses (n = 12)
Email from PSO	50%
Friend, family member, or colleague	8%
PSO representative	17%
Social media (Facebook)	8%
ICF Representative	8%
Unsure	8%

Survey participants found the application process for the pilot study to be straightforward, with 75% rating it as either very or somewhat easy. All found receiving an energy audit to be very or somewhat easy. Most (92%) found receiving an installation inspection to be either very or somewhat easy. Overall, the installation process received mixed feedback, with 42% finding it somewhat difficult, and 50% considering it somewhat or very easy. Refer to Figure 5-4 for additional information.

Participants provided feedback on what would have made the installation process easier. One respondent highlighted difficulty with wiring, resulting in frequent shutdowns and uncertainty about the system's proper functionality. Another mentioned significant change made by the city inspector throughout the installation process. Equipment compatibility issues were raised, with customers suggesting the need for PSO to establish a testing laboratory for different equipment combinations, particularly crucial for widespread implementation. The lack of standardization in solar equipment interoperability was emphasized, with a call for PSO to advocate for more uniformity in this area. Additionally, concerns were raised about incomplete work, disconnection of monitoring equipment, and the installer's lack of experience in battery storage, contributing to a perceived longer-than-anticipated duration of the installation process.

Figure 5-4: Participants Rating of Various Aspects of the Battery Installation Process

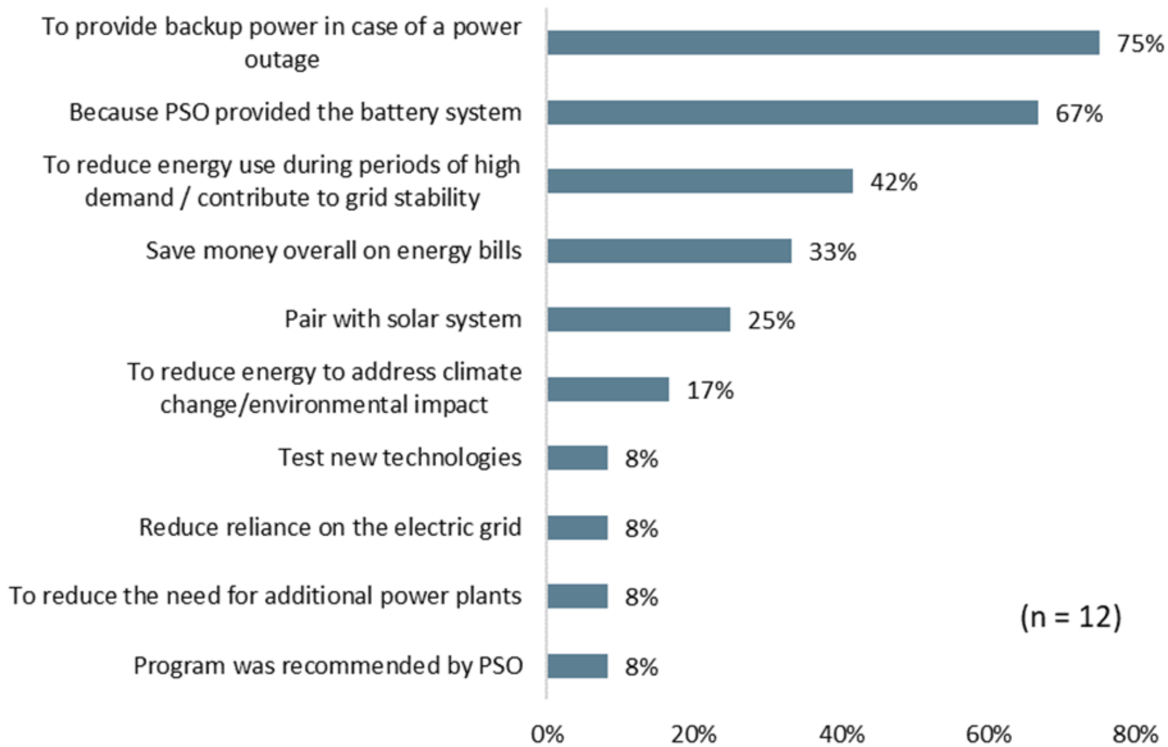


5.3.2.2 Factors Influencing Decision to Participate

Seven survey respondents indicated that they had concerns about participating in the BESS pilot before deciding to participate. One major worry was the lack of information about potential costs at the program's conclusion. There were uncertainties about the impact on existing systems, warranty validity, time commitment, and a general feeling of insufficient knowledge. Participants sought assurance that the battery backup would effectively store and utilize energy without financial loss in relation to their agreement with PSO. Concerns were raised about penalties, potential home sale within the pilot period, increased home insurance, and the risk of fire hazards. Some participants questioned PSO’s ability to swiftly adapt to changes in a rapidly evolving field, accompanied by concerns about overwhelming paperwork. However, many participants noted that these concerns did not materialize, although worries about PSO charging batteries during periods of low power generation and potentially causing higher bills persisted.

The survey participants identified the influential factors behind their decision to participate in the pilot study. Providing backup power in case of power outages was the top reason respondents chose to participate in the BESS pilot. PSO providing a battery system also ranked high on their list of motivations. Additionally, the desire to contribute to grid stability by reducing energy use during periods of high demand was also a significant consideration. See Figure 5-5 for more details.

Figure 5-5: Participants' Motivation to Participate in BESS Pilot Study



Seventy-five percent of survey participants indicated that they had explored websites and independently sought to learn more about battery storage programs or systems. This could have included watching videos or reading educational materials available on related websites. Seven survey respondents indicated that PSO could be more helpful in providing educational materials about battery or energy storage. One participant expressed frustration with the lack of access to an app for monitoring solar production after inverter changes, highlighting the need for improved communication and technical support. Others sought information on the impact of the battery on grid reliance and energy usage during peak times. Some respondents were unsure but desired an illustration of the overall set-up and a mutual understanding of the benefits for both PSO and ratepayers. Recommendations included providing an overview, detailed schematics, and explanations of how components work together, along with examples from energy monitoring software and references to technical literature from manufacturers. Some respondents suggested broader education initiatives on various battery storage types and costs beyond the pilot program.

Survey participants rated their understanding of reducing energy use during periods of high demand as very good (an average score of 4.6 on a 5-point scale). They also assessed their comprehension of the pilot study as less than moderately good, giving it an average score of 3.8 on a 5-point scale.

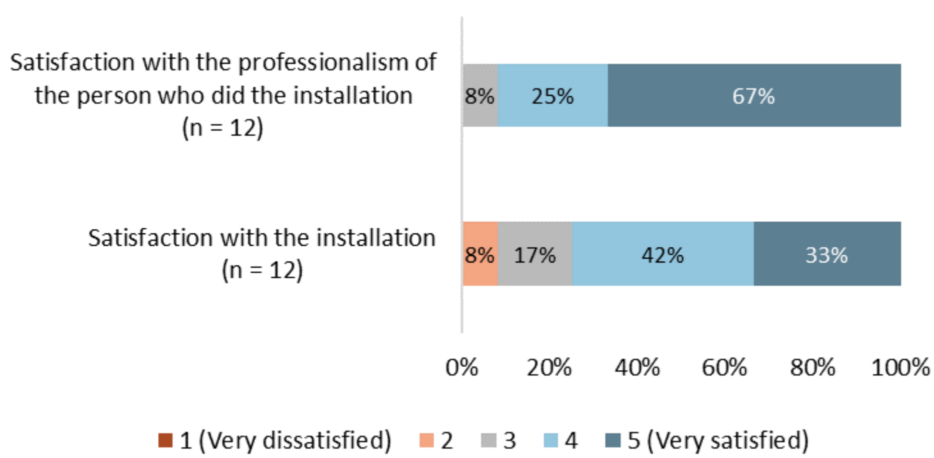
5.3.2.3 Installation and Support Evaluation

More than half (67%) indicated that installer was able to answer all the questions that participants may have had about the pilot study, while 33% of respondents indicated they were not able to. Those who did not get all their questions answered provided specifics on what was not answered. These included inquiries about the battery's persistent self-shutoff, whether periodic draining was necessary and how to execute it, and the absence of access to their production data. Concerns were raised about potential end-of-program payments, and some participants lacked information beyond the sign-up process, highlighting gaps in their understanding of the overall program. Additionally, participants struggled to explain the system's operation, including how the battery would be charged—whether by their solar system or the grid—and how PSO would utilize it.

Ninety-two percent of survey respondents indicated that the person who performed the installation did not try to sell any solar equipment or provide a quote for a PV system, while one person indicated that they attempted to sell them solar equipment.

The respondent provided feedback on their satisfaction with the installation and professionalism of the installer. Pilot study participants were satisfied with the installation and with the level of professionalism of the person who conducted the installation (see Figure 5-6). One participant expressed dissatisfaction with the equipment installation for several reasons. The battery pack failed to function during power outages, and the inverter was reported to be incorrectly utilizing solar power. Additionally, this person highlighted issues such as the lack of access to the inverter app for monitoring solar array operation and ongoing troubleshooting by the installer. Despite the battery pack indicating a 'green' status, the overall system was not operating correctly, contributing to the overall dissatisfaction with the installation.

Figure 5-6: Satisfaction with Installation and Installer



Most survey respondents indicated that the level of support they received during the installation process was somewhat or very supportive. Seven survey respondents indicated that they reached out to PSO to answer questions about the pilot study. Eighty-six percent stated that PSO thoroughly addressed their questions. One participant was unable to get an answer to their question regarding the decrease in production compared to the period before the battery installation.

5.3.3 Lessons Learned

The BESS pilot program has yielded valuable lessons for the implementation team. Early engagement with the interconnection team from PSO has emerged as a crucial lesson learned. Involving them during the program's development phase ensures alignment with utility policies and goals, preventing the need for later adjustments. Designating a specific decision-maker within the interconnection team has been highlighted as essential to avoid delays caused by hesitancy in decision-making. Another lesson learned was the careful selection of retrofitting candidates, particularly those with minimal modifications required, which have streamlined installations. One other lesson learned was shifting the home energy checkup earlier in the process enhances the customer experience by addressing potential issues promptly.

The installer highlighted efficiency and consistency in battery energy storage system installations which can be enhanced through a series of measures. They suggested implementing a standardized review process for battery applications that could help to streamline the approval process, particularly by assigning dedicated reviewers for specific inverter types. Clarity in industry spec sheets, especially regarding inverter capabilities, eliminates confusion during the selection process. Further enhancements involve streamlining the AEP/PSO's interconnection software system for a smoother customer experience, addressing issues like excessive automated emails. Creating a more organized and structured installation process, with clear communication channels for installers, reduces delays and confusion. Maintaining consistency in installer agreements and approvals minimizes changes post-approval, preventing customer dissatisfaction. Prioritizing quality control minimizes rework, promoting safer and more reliable installations. Educating customers about the installation process and managing their expectations regarding approval timelines is crucial. Exploring opportunities for installer participation in design discussions and maintaining open, responsive communication channels are key elements for ensuring successful battery energy storage system installations, as revealed during the interview.

Despite challenges, customer enthusiasm and satisfaction remain high, according to ICF. Staffing and workforce availability for installations pose challenges, suggesting a need to explore strategies for maintaining a stable workforce. Optimizing site identification practices, diversifying potential installation sites, and ensuring the presence of experienced resources are avenues for improvement. Comprehensive documentation, proactive problem-solving, and bolstering stakeholder communication and collaboration are key to addressing challenges and enhancing the efficiency of BESS installations. Additionally, there is a strong commitment to supporting PSO and enhancing processes among implementation contractors and subcontractors. Key areas for improvement include consistency in application requirements, streamlined documentation, and an organized installation process. These efforts aim to ensure efficient, high-quality battery energy storage system installations and program success.

5.4 Non-Wires Alternative Pilot Study

This pilot study seeks to implement site-specific energy efficiency measures to reduce the summer demand peak on Oklahoma circuits XG-1 and XG-3 in Owasso from station 691. Energy efficiency and demand response measures were implemented based on current program offerings for residential and commercial customers. Evaluation was conducted to determine verified consumption reduction during the circuit peak. The circuit peak occurs during the summer, consistent with PSO's system peak. The goal of the pilot is to reduce the summer peak load by 460 kW.

5.4.1 Methodology

To accurately assess the impact of demand response and energy efficiency on the peak load of a substation, the hour with the highest load must be determined. PSO provided load data for circuits in question from 2021 and 2022. This data indicates that the substation peak load coincides with the PSO's system peak load. For 2023 the PSO system peak load hour is 4 PM to 5 PM CDT on August 21st. Results for this study are based on load reduction during this hour in 2023. Energy impacts for this hour were calculated for each measure installed as an end-use on the substation.

5.4.1.1 Power Hours

The same methodology used for the Power Hours program was used to estimate the peak demand reduction for Owasso residents for the system peak hour. For more details, refer to the Power Hours Methodologies section. Load reduction differs from Power Hours results as for this study we are presenting the load reduction during the peak hour, not the average across the event.

The number of devices available and participating in the demand response event on August 21st are shown in Table 5-4.

Table 5-4: Power Hours Owasso Participants

Event Date	Total NWS Devices	Responsive NWS Devices	NWS-Level Response Rate	Program-Level Response Rate
8/21/2023	59	42	71.2%	78.9%

5.4.1.2 Peak Performers

Demand response for commercial sites was measured by the Peak Performers program. Because baseline loads and reductions are calculated for each site, the reductions for Owasso businesses during the system peak hour were pulled from the Peak Performers analysis results. For more details about the methodology, refer to the Peak Performers section. Seven businesses participated in the demand response event on August 21st.

5.4.1.3 Energy Efficiency Programs

The remaining sites were energy-efficiency program participants. Energy impacts could not be determined from a billing analysis for the system peak hour. Engineering algorithms, based on provided project documentation, were used to determine the savings impact over the summer peak period.

5.4.2 Results

The PSO system load peak occurred on August 21, 2023, from 4:00 PM to 5:00 PM CDT. It was assumed that the Owasso circuit peak occurred at the same date and time just as in previous years. Load reduction during this peak hour is shown by measure and program in Table 5-5. Peak reductions for demand response programs are averages across the hour. The total peak reduction was 450 kW.

Table 5-5: Non-Wires Solution Peak Load Reduction

Program	Measure	NWS-Level Peak Reduction (kW)
Power Hours	Demand Response	56.72
Peak Performers	Demand Response	362.63
C&I	LED Lighting	0.56
C&I	LED Lighting	0.92
C&I	Refrigeration gasket, strip curtain	0.17
C&I	Refrigeration gasket	0.02
C&I	HVAC	7.07
C&I	LED Lighting	22.19
	Total	**450.28**

The Owasso participants had slightly lower average savings compared to the program-wide average. Savings per device are compared in Table 5-6. The average savings for the event on August 21 was 115 kW.

Table 5-6: Power Hours Reductions

Program	NWS-Level Peak Reduction (kW)	NWS-Level Peak Reduction per Device (kW)	Program-Level Peak Reduction per Device (kW)
7/26/2023	83.17	2.03	2.33
7/27/2023	62.15	1.68	2.18
8/2/2023	103.81	2.53	2.85
8/3/2023	99.39	2.62	2.84
8/21/2023	115.26	2.74	2.78
8/24/2023	87.77	2.25	2.73

The subset of Peak Performers participant results for the Owasso circuit are listed in Table and are compared to the program-level results. The event-average demand savings on the peak day was 426 kW. The top contributor had a peak load reduction of 209 kW during the August 21, 2023, event.

Table 5-7: Peak Performers Reductions

Event Date	Participants	NWS-Level Total Reduction (kW)	NWS-Level Percent Reduction	Program-Level Percent Reduction
7/27/2023	9	212.17	20.5%	37.2%
8/2/2023	7	330.52	26.9%	38.0%
8/3/2023	5	460.59	50.9%	38.7%
8/21/2023	7	425.83	28.3%	32.8%
8/24/2023	7	362.16	26.2%	29.9%

The remaining savings from energy efficiency programs were calculated from engineering algorithms. The measures are summarized below (Table 5-8).

Table 5-8: Commercial Programs Reductions

Measure	Demand Savings (kW)
LED Lighting	0.56
LED Lighting	0.92
Refrigeration gasket, strip curtain	0.17
Refrigeration gasket	0.02
HVAC	7.07
LED Lighting	22.19
Total	**30.89**

5.4.3 Findings and Conclusions

The following summarizes the key findings of the NWS pilot.

- Most savings come from the Power Hours and Peak Performers programs.
- For Power Hours, the participation and event reductions were lower for the Owasso circuit than the program-wide results.
- For Peak Performers, the Owasso circuit had comparable percent reductions with the program-wide results.
- The gross summer peak demand reduction for all programs on the Owasso circuit was 450 kW.

Appendix A: Glossary

Cash Inducement Costs: Refers to customer and service provider rebate/incentive costs incurred by PSO in the implementation of a program.

Coincidence Factor (CF): For energy efficiency measures, the CF represents the fraction of connected load reduction that occurs during the peak demand period.

Deemed Savings: A savings estimate for homogeneous measures. An assumed average savings across many rebated units is applied to each individual unit installed.

Effective Useful Life (EUL): The number of years (or hours) that an energy-efficient technology is estimated to function. Also, referred to as "measure life."

EM&V Administrative Costs: EM&V administrative costs include all costs associated with evaluation, measurement and verification of reported energy and demand impacts resulting from the implementation of a program.

Reported: Refers to estimates of energy savings and peak demand reduction developed before program evaluation. Equivalent to "reported impacts" or also "reported."

Verified: Refers to estimates of energy savings and peak demand reductions developed from program evaluation. Equivalent to "verified impacts" or also "verified."

Free-ridership: Percentage of participants who would have implemented the same energy-efficiency measures in a similar timeframe even in the absence of the program.

Gross Impacts: Changes in energy consumption/demand that result directly from program-promoted actions regardless of the extent or nature of program influence on these actions.

In-Service Rate (ISR): The percentage of measures incented that are installed and operating.

Impact Evaluation: Impact evaluation is the verification and estimation of gross and net impacts resulting from the implementation of one or more energy-efficiency or demand response programs.

Measure: An energy-efficiency "measure" refers to any action taken to increase energy efficiency, whether through changes in equipment, control strategies, or behavior.

Net Savings: The portion of gross savings that is directly attributable to the actions of an energy-efficiency or demand response program.

Net-to-Gross Ratio (NTGR): A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program impacts. Generally calculated as 1 – (free-ridership %) + (Spillover %).

Non-Cash Inducement Costs: Non-cash inducement costs include third party implementation costs and advertising costs incurred by PSO in the implementation of a program. PSO earns no incentives for advertising costs.

Non-Energy Benefits: Non-energy benefits refer to any benefits PSO customers may experience due to their participation in PSO programs beyond energy savings. Examples include improved comfort, aesthetic enhancements, better indoor air quality, improved security, better employee productivity, etc.

Non-EM&V Administrative Costs: Non-EM&V administrative costs include PSO staff labor costs and overhead costs associated with implementing a program.

Oklahoma Deemed Savings Documents (OKDSD): Refers to the Oklahoma Deemed Savings, Installation & Efficiency Standards, and associated work papers for small commercial and residential energy efficiency measures. These documents were originally submitted to the OCC as part of Cause No. PUD 201800073. In 2013, the documents were updated to reflect more recent and applicable baseline conditions.

Participant Cost Test (PCT): The PCT examines the cost and benefits from the perspective of the customer installing the energy efficiency measure. Costs include incremental costs of purchasing and installing efficient equipment, above the cost of standard equipment. Benefits include customer bill savings, incentives received from the utility, and any applicable tax credits.

Peak Demand: For the purposes of this report peak demand refers to the average metered demand during the peak period, defined as 2PM to 9 PM during the summer months, June through September, excluding weekends and holidays. Note that for the Peak Performers program, peak demand reduction is calculated as the average reduction during event hours.

Process Evaluation: A systematic assessment of an energy-efficiency program for documenting program operations at the time of examination and identifying potential improvements that can be made to increase the program's efficacy or effectiveness.

Projected, Reported, and Verified Savings: Projected impacts refer to the energy savings and peak demand reduction forecasts submitted to the OCC as part of PSO's 2022 - 2024 portfolio filing on June 23, 2021.[55] Reported impacts refer to energy savings and peak demand reduction estimates based on actual program participation in 2023, before program evaluation activities. Finally, verified impacts refer to energy savings and demand reduction estimates for 2023 developed through independent program evaluation, measurement, and verification (EM&V).

Ratepayer Impact Measure (RIM): The RIM examines the impact of energy-efficiency programs on utility rates. Reduced energy sales can lower revenues and put upward

[55] Cause No. PUD 2021000041.

pressure on retail rates as the remaining fixed costs are spread over fewer kWh. Costs include overhead and incentive payments and the cost of lost revenue due to reduced sales. Benefits include cost savings associated with not delivering energy to customers. These “avoided costs” include generation, transmission, and distribution costs.

Realization Rate: The ratio of verified impacts to reported impacts.

Societal Cost Test (SCT): The SCT includes the same costs and benefits as the TRC but uses a lower discount rate to reflect the overall benefit to society over the long term.

Spillover: Energy and/or demand savings caused by a program, but for which the utility did not have to provide cash inducements.

Total Resource Cost Test (TRC): The TRC measures the net benefits of the energy-efficiency program for the region. Costs included in the TRC are incremental costs of purchasing and installing the efficient equipment, above the cost of standard equipment and overhead cost associated with implementing the program. Benefits include cost savings associated with not delivering energy to customers. These “avoided costs” include generation, transmission, and distribution costs.

Utility Cost Test (UCT): The UCT examines the costs and benefits of the energy-efficiency program from the perspective of the utility company. Costs include overhead (administration, marketing, EM&V) and incentive costs. Benefits include cost savings associated with not delivering energy to customers. These “avoided costs” include generation, transmission, and distribution costs. This test is also often referred to as the Program Administrator Cost Test (PACT).

Appendix B: Portfolio Cost-Effectiveness

This appendix provides an overview of each programs' participation, verified reduction in peak load, verified annual energy savings (kWh), annual admin costs, total program costs, as well as a summary of the cost effectiveness analysis.

B.1.1 Cost Effectiveness Summary

This appendix covers all verified electricity and peak demand savings, and associated program costs incurred in the implementation of PSO's 2023 energy efficiency and demand response portfolio from January 1, 2023, through December 31, 2023.

The cost-effectiveness of PSO's 2023 programs was calculated based on reported total spending, verified energy savings, and verified demand reduction for each of the energy efficiency and demand response programs. All spending estimates were provided by PSO. The methods used to calculate cost-effectiveness are informed by the California Standard Practice Manual. [56]

The demand reduction (kW) and energy savings (kWh) presented throughout this appendix represent net savings at the generator by applying program level net-to-gross (NTG) ratios and adjusting for line losses. Program level NTG ratios for the 2023 programs were estimated by ADM as part of the portfolio impact evaluation. Verified energy savings estimates at the meter were adjusted to account for line losses using a line loss adjustment factor of 1.0586 for energy savings and 1.0781 for peak reduction. For gas savings estimates, a 1.014 gas loss factor was included.

To calculate the cost-effectiveness of each program, measure lives were assigned on a measure-by-measure basis. Measure life values came from the Oklahoma Deemed Savings Documents (OKDSD) or the Arkansas TRM.[57] Additionally, assumptions regarding incremental/full measure costs were necessary. These costs were taken directly from the portfolio plan, California's Database for Energy Efficiency Resources (DEER) or project specific invoices. Avoided energy, capacity, transmission/distribution, and CO_2 costs used to calculate cost-effectiveness were provided by PSO and are found in Section B.4 of this appendix. Residential and commercial rates used to estimate certain cost-effectiveness tests were also provided by PSO.

Table B-1 lists each program included in this analysis, along with the projected savings estimates and projected budget. Impacts show in Table B-1 are net-at-generator, reflecting the NTG projections and line losses.

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[56] California Standard Practice Manuel: Economic Analysis of Demand Side Management Programs, October 2001. Available at: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf

57 http://www.apscservices.info/EEInfo/TRM6.pdf

Table B-2 lists each program included in this analysis, along with the final verified savings estimates, total expenditures, Utility Cost Test (UCT)[58] results, and Total Resource Cost Test (TRC) results. Impacts shown in Table B-2 presents values of net-at-generator, reflecting NTG assumptions and line losses as described above. Results from the UCT and TRC are focused on in this summary for the following reasons:

- The TRC and UCT results are a direct input to the shared savings component of the Demand Side Management Cost Recovery Rider (DSM Rider) as described in Oklahoma Administrative Code (OAC) 165:35-41-8(a).[59]
- Oklahoma Administrative Code (OAC) 165:35-41-2 lists the goals of energy efficiency and demand response programs as (1) minimize the long-term cost of utility service, and (2) avoid or delay the need for new generation, transmission, and distribution investment. The TRC test best reflects these goals, as it looks at benefits and costs from the perspective of all utility customers in the utility's service territory (participants and non-participants).

In addition to UCT and TRC results, results from the Ratepayer Impact Measure (RIM), Participant Cost Test (PCT) and Societal Cost Test (SCT) are included in the body of this appendix. Based on verified program impacts and spending during 2023, PSO's overall portfolio is cost-effective based on both the UCT and TRC.

Table B-1: Projected by Program, 2023 (Impacts are Net, at Generator)

Program	Projected Peak Demand Reduction (kW)	Projected Annual Energy Savings (kWh)	Annual Gas Savings (Therms)	Program Budget
Business Rebates	7,995	38,608,993	(162,626)	$11,828,414
Residential Energy Services	7,227	40,633,918	1,319,464	$10,009,474
Home Weatherization	983	2,670,356	155,169	$3,431,415
Conservation Voltage Reduction	10,007	37,754,940	-	$1,923,428
Total – EE Programs	**26,212**	**119,668,207**	**1,312,007**	**$27,192,731**
Power Hours	21,328	-	-	$2,170,722
Peak Performers	68,128	66,578	-	$3,884,753
Total – DR Programs	**89,456**	**66,578**	**-**	**$6,055,475**
Total – R&D Programs	**252**	**198,766**	**-**	**$892,902**
Total	**115,920**	**119,933,552**	**1,312,007**	**$34,141,108**

58 The UCT is also referred to as the Program Administrator Cost Test (PACT).
59 http://www.occeweb.com/rules/CH35finalrules111819.pdf.

Table B-2: Cost-Effectiveness by Program, 2023 (Impacts are Verified Net)

Program	Peak Demand Reduction (kW at Meter)	Peak Demand Reduction (kW at Generator)	Energy Savings (kWh at Meter)	Energy Savings (kWh at Generator)	Total Program Expenditures	TRC (b/c ratio)	UCT (b/c ratio)
Business Rebates	6,165	6,688	36,172,541	38,424,199	$10,596,028	1.62	1.96
Residential Energy Services	11,312	12,271	53,353,272	56,674,392	$11,345,093	1.98	1.75
Home Weatherization	2,401	2,605	4,535,250	4,817,559	$3,474,717	2.96	1.75
Conservation Voltage Reduction	10,824	11,741	35,108,120	37,293,520	$2,008,740	1.96	1.80
Total – EE Programs	**30,703**	**33,305**	**129,169,183**	**137,209,670**	**$27,424,579**	**1.95**	**1.82**
Power Hours	22,028	23,895	214,428	227,776	$1,588,064	3.57	2.02
Peak Performers	58,748	63,728	1,091,528	1,184,050	$3,344,719	11.40	2.85
Total – DR Programs	**80,776**	**87,623**	**1,305,956**	**1,411,825**	**$4,932,783**	**7.14**	**2.56**
Total – R&D Programs	**0**	**0**	**0**	**0**	**$909,831**	**NA**	**NA**
Total	**111,479**	**120,928**	**130,475,139**	**138,621,495**	**$33,267,193**	**2.11**	**1.87**

B.2 Energy-Efficiency Programs

PSO’s energy efficiency portfolio in 2023 consisted of four programs. Table B-3 provides a summary of program participation and verified net impacts for each of the energy-efficiency programs. Table B-4 provides reported costs per program.

Table B-3: Energy-Efficiency Programs – Verified Impacts (Net, at Generator)

Program	Number of Participants in 2023*	Verified Peak Demand Reduction (kW)	Verified Annual Energy Savings (kWh)	Verified Gas Savings (Therms)
Business Rebates	890	6,688	38,424,199	-146,468
Residential Energy Services	273,197	12,271	56,674,392	910,931
Home Weatherization	1,909	2,605	4,817,559	537,079
Conservation Voltage Reduction	40,715	11,741	37,293,520	0
Total – EE Programs	**316,711**	**33,305**	**137,209,670**	**1,301,542**

*Participants represent a residence or business who participated as opposed to the number of measures or projects. For Energy Saving Products, the actual number of customers is unknown and instead this count is of unique customers that received rebates for qualifying downstream measures. ESP in total rebated 268,122 products.

Table B-4: Energy-Efficiency Programs – Reported Costs

Program	Annual Non-EM&V Admin Costs ($)[60]	Annual EM&V Admin Costs ($)	Annual Cash Inducement Costs ($)[61]	Annual Non-Cash Inducement Costs ($)[62]
Business Rebates	$342,152	$361,250	$6,205,277	$3,687,350
Residential Energy Services	$289,015	$349,770	$7,268,486	$3,437,822
Home Weatherization	$91,712	$55,689	$3,153,862	$173,453
Conservation Voltage Reduction	$18,998	$45,258	$0	$1,944,485
Total – EE Programs	**$741,877**	**$811,967**	**$16,627,625**	**$9,243,110**

Table B-5 shows the measures with measure life and associated programs. The measure life for Business Rebates measures is calculated as a weighted average based on annual energy savings. The programs for Behavioral Modification, Peak Performers, and Conservation Voltage Reduction each have a Tier 1 EUL of one year.

60 Non-EM&V Admin Costs include PSO staff labor costs and overhead costs.
61 Cash inducement costs refer to customer rebate costs.
62 Non-cash inducement costs include third party implementation costs.

Table B-5: Measure Life

Measure	Measure Life	Business Rebates	Multifamily	Home Weatherization	Energy Saving Products	Homes Rebates	Education	Power Hours	CVR	Behavioral	Business Demand Response
Air Sealing	11		X	X		X					
Duct Replacement	20					X					
Duct Sealing	18		X	X		X					
Central AC	19					X					
Air Source Heat Pump	16		X			X					
Ground Source Heat Pump	25					X					
Insulation - Attic	20		X	X		X					
Insulation - Kneewalls/Vertical Attic Wall	20					X					
Insulation - Exterior Wall	20					X					
HVAC Tune-Up	10		X			X					
WiFi Thermostat	11				X	X					
New Construction Homes	20					X					
Home Energy Check-Up	10					X					
Lighting	12	X	X	X	X		X				
Custom	14	X									

Measure	Measure Life	Business Rebates	Multifamily	Home Weatherization	Energy Saving Products	Homes Rebates	Education	Power Hours	CVR	Behavioral	Business Demand Response
HVAC	12	X									
Kitchen & Appliances	13	X									
Commercial New Construction Lighting	10	X									
Oil & Gas	14	X									
Refrigeration	9	X									
HVAC	17	X	X								
Advanced Power Strip	10				X		X				
Furnace Filter Alarm	14						X				
Water Heater Temp. Setback	2						X				
Refrigerator temp setback	1						X				
Furnace Filter	0				X						
Bathroom Ventilation Fans	12				X						
Door Seals and Sweeps	15				X						
Room Air Conditioners	11				X						
Room Air Purifiers	9				X						
Spray Foam	10				X						

Measure	Measure Life	Business Rebates	Multifamily	Home Weatherization	Energy Saving Products	Homes Rebates	Education	Power Hours	CVR	Behavioral	Business Demand Response
Clothes Dryers	13				X						
Clothes Washers	14				X						
EV Chargers	10				X						
Heat Pump Water Heaters	10				X						
Water Heater Jacket	7			X							
Water Heater Pipe Insulation	13			X							
Faucet Aerators	10		X	X							
Refrigerator	17		X								
Low Flow Shower Head	10		X								
Windows	20		X								
Home Energy Report	1									X	
Conservation Voltage Reduction	25								X		
DLC Events	1							X			X

In the tables that follow, total costs and benefits, and cost-effectiveness test results are provided for each energy-efficiency program in the program year.

B.2.1 Business Rebates Program

Table B-6: Business Rebates Benefit/Cost Tests

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost Test	Participant Cost Test
Benefit/Cost Ratio	**1.96**	**1.62**	**0.48**	**1.91**	**3.77**
Net Benefits ($000s)	9,771.37	7,985.08	(21,485.15)	11,779.27	24,833.76
Total Benefits ($000s)	19,905.83	20,883.31	19,905.83	24,677.49	33,802.80
Total Costs ($000s)	10,134.46	12,898.22	41,390.98	12,898.22	8,969.04

B.2.2 Residential Energy Services Program

Table B-7: Residential Energy Services Benefit/Cost Tests

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost Test	Participant Cost Test
Benefit/Cost Ratio	**1.75**	**1.98**	**0.42**	**2.33**	**4.89**
Net Benefits ($000s)	8,086.49	13,456.58	(26,330.14)	18,183.92	39,437.06
Total Benefits ($000s)	18,915.94	27,158.09	18,915.94	31,885.42	49,577.60
Total Costs ($000s)	10,829.45	13,701.51	45,246.07	13,701.51	10,140.54

B.2.3 Residential Energy Services: Multifamily SubProgram

Table B-8: Multifamily Benefit/Cost Tests

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost Test	Participant Cost Test
Benefit/Cost Ratio	**2.53**	**2.89**	**0.47**	**3.37**	**5.20**
Net Benefits ($000s)	1,257.22	1,498.77	(2,377.99)	1,887.30	3,336.21
Total Benefits ($000s)	2,078.58	2,293.81	2,078.58	2,682.34	4,131.25
Total Costs ($000s)	821.36	795.04	4,456.57	795.04	795.04

B.2.4 Home Weatherization Program

Table B-9: Home Weatherization Benefit/Cost Tests

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**1.75**	**2.96**	**0.62**	**3.54**	**4.66**
Net Benefits ($000s)	2,598.43	6,810.23	(3,660.36)	8,824.39	11,536.41
Total Benefits ($000s)	6,073.15	10,284.95	6,073.15	12,299.10	14,690.27
Total Costs ($000s)	3,474.72	3,474.72	9,733.51	3,474.72	3,153.86

B.2.5 Residential Energy Services: Energy Saving Products SubProgram

Table B-10: Energy Saving Products Benefit/Cost Tests

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**4.40**	**3.92**	**0.32**	**4.47**	**10.37**
Net Benefits ($000s)	3,781.60	4,922.33	(10,177.23)	5,853.99	14,533.49
Total Benefits ($000s)	4,893.11	6,610.39	4,893.11	7,542.05	16,083.94
Total Costs ($000s)	1,111.52	1,688.06	15,070.34	1,688.06	1,550.46

B.2.6 Residential Energy Services: Home Rebates SubProgram

Table B-11: Home Rebates Benefit/Cost Test

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**1.29**	**1.62**	**0.50**	**1.96**	**3.24**
Net Benefits ($000s)	2,109.95	5,985.19	(9,412.80)	9,225.85	16,244.49
Total Benefits ($000s)	9,392.64	15,589.72	9,392.64	18,830.38	23,488.07
Total Costs ($000s)	7,282.69	9,604.53	18,805.43	9,604.53	7,243.58

B.2.7 Residential Energy Services: Education SubProgram

Table B-12: Education Benefit/Cost Test

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**1.74**	**1.91**	**0.37**	**2.15**	**5.35**
Net Benefits ($000s)	507.08	619.64	(2,038.81)	786.13	2,397.48
Total Benefits ($000s)	1,188.69	1,301.24	1,188.69	1,467.73	2,948.95
Total Costs ($000s)	681.60	681.60	3,227.50	681.60	551.47

B.2.8 Residential Energy Services: Behavioral Modification SubProgram

Table B-13: Behavioral Benefit/Cost Test

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**1.46**	**1.46**	**0.37**	**1.46**	**NA**
Net Benefits ($000s)	430.64	430.64	(2,323.31)	430.64	2,925.38
Total Benefits ($000s)	1,362.92	1,362.92	1,362.92	1,362.92	2,925.38
Total Costs ($000s)	932.27	932.27	3,686.23	932.27	NA

B.2.9 Conservation Voltage Reduction

Table B-14: CVR Benefit/Cost Test

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**1.80**	**1.96**	**0.57**	**2.45**	**NA**
Net Benefits ($000s)	17,808.31	21,604.50	(30,400.88)	32,529.45	40,242.34
Total Benefits ($000s)	40,200.84	43,997.04	40,200.84	54,921.98	40,242.34
Total Costs ($000s)	22,392.53	22,392.53	70,601.72	22,392.53	NA

B.3 Demand Response Programs

PSO's demand response portfolio in 2023 consisted of two demand response programs. Table B-15 provides a summary of program participation and verified net impacts for the 2023 demand response portfolio. Table B-16 provides a summary of 2023 program costs.

Table B-15: Demand Response Programs – Verified Impacts (Net, at Generator)

Program	Number of Participants in 2023	Verified Peak Demand Reduction (kW)	Verified Annual Energy Savings (kWh)	Gas Savings (Therms)
Power Hours	12,953	23,895	227,776	0
Peak Performers	1,911	63,728	1,184,050	0
Total – DR Programs	**14,864**	**87,623**	**1,411,825**	**0**

Table B-16: Demand Response Programs – Reported Costs

Program	Annual Non-EM&V Admin Costs ($)	Annual EM&V Admin Costs ($)	Annual Cash Inducement Costs ($)	Annual Non-Cash Inducement Costs ($)
Power Hours	$132,302	$124,288	$688,662	$642,812
Peak Performers	$95,083	$80,744	$3,013,232	$155,660
Total – DR Programs	**$227,385**	**$205,031**	**$3,701,894**	**$798,472**

B.3.1 Power Hours Program

Table B-17: Power Hours Benefit/Cost Test

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**2.02**	**3.57**	**2.00**	**3.57**	**NA**
Net Benefits ($000s)	1,623.04	2,311.71	1,605.25	2,311.71	707.57
Total Benefits ($000s)	3,211.11	3,211.11	3,211.11	3,211.11	707.57
Total Costs ($000s)	1,588.06	899.40	1,605.86	899.40	NA

B.3.2 Peak Performers Program

Table B-18: Peak Performers Benefit/Cost Test

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost test	Participant Cost Test
Benefit/Cost Ratio	**2.85**	**11.40**	**2.77**	**11.40**	**4.13**
Net Benefits ($000s)	5,576.81	7,836.73	5,486.22	7,836.73	2,356.15
Total Benefits ($000s)	8,590.04	8,590.04	8,590.04	8,590.04	3,109.46
Total Costs ($000s)	3,013.23	753.31	3,103.82	753.31	753.31

B.4 Research and Development

PSO's research and development portfolio in 2023 consisted of research and development programs with a verified net peak demand reduction of 0 kW and a verified net energy savings of 0 kWh as the studies will not claim any savings for 2023. The following tables provide a summary of activity and results.

Table B-19: Research and Development Programs - Verified Impacts (Net, at Generator)

Program	Number of Participants in 2023	Verified Peak Demand Reduction (kW)	Verified Annual Energy Savings (kWh)	Verified Gas Savings (Therms)
Non-Wires	57	450.28	205,351	0
BESS	20	0	0	0
Total – R&D Programs	**77**	**450.28***	**205,351***	**0**

*All savings from R&D were captured within programs. Savings listed in this table represent the portion of program savings attributed to R&D.

Table B-20: Research and Development Programs - Reported Costs

Program	Annual Non-EM&V Admin Costs	Annual EM&V Admin Costs	Annual Cash Inducement Costs	Annual Non-Cash Inducement Costs
Research and Development	$127,275	$46,364	$470,322	$265,869
Total – R&D Programs	**$127,275**	**$46,364**	**$470,322**	**$265,869**

Table B-21: Research and Development Programs Benefit/Cost Test

Metric	Utility Cost Test	Total Resource Cost Test	Ratepayer Impact Measure	Societal Cost Test	Participant Cost Test
Benefit/Cost Ratio	**0.00**	**NA**	**0.00**	**NA**	**NA**
Net Benefits ($000s)	(470.32)	0.00	(470.32)	0.00	470.32
Total Benefits ($000s)	0.00	0.00	0.00	0.00	470.32
Total Costs ($000s)	470.32	NA	470.32	NA	NA

B.5 Avoided Costs

The avoided costs in Table B-22 were developed for energy, capacity, transmission, and distribution (T&D), and CO_2 during the portfolio design process (PUD 2021000041) and utilized for the TRC, UCT SCT & PCT tests. The values used to calculate avoided costs for the RIM test values were scaled fuel cost factors + embedded cost rate (ECR).[63]

Table B-22: Avoided Costs from PSO Portfolio Plan

Year	SPP - Energy	SPP Capacity		T&D Costs	CO2	Natural Gas
	$/MWh	$/MW-day	$/kW-yr	$/kW-yr	($/metric tonne)	($/Mcf)
2022	$42.85	$263.35	$96.12	$33.66	$0.00	$5.37
2023	$46.06	$268.14	$97.87	$34.27	$0.00	$5.40
2024	$49.52	$273.03	$99.66	$34.90	$0.00	$5.43
2025	$50.56	$278.00	$101.47	$35.53	$0.00	$5.46
2026	$53.28	$283.07	$103.32	$36.18	$0.00	$5.49
2027	$56.46	$288.22	$105.20	$36.84	$0.00	$5.52
2028	$77.56	$293.47	$107.12	$37.51	$13.61	$5.69

[63]https://psoklahoma.com/global/utilities/lib/docs/ratesandtariffs/Oklahoma/PSO%20Riders%20Jan%2020 19.pdf

Year	SPP - Energy	SPP Capacity		T&D Costs	CO2	Natural Gas
	$/MWh	$/MW-day	$/kW-yr	$/kW-yr	($/metric tonne)	($/Mcf)
2029	$77.73	$298.82	$109.07	$38.19	$14.08	$5.86
2030	$78.89	$304.26	$111.06	$38.89	$14.58	$6.03
2031	$78.98	$309.80	$113.08	$39.60	$15.09	$6.20
2032	$79.91	$315.45	$115.14	$40.32	$15.62	$6.37
2033	$82.12	$321.19	$117.24	$41.05	$16.16	$6.54
2034	$83.72	$327.04	$119.37	$41.80	$16.73	$6.71
2035	$85.02	$333.00	$121.55	$42.56	$17.31	$6.88
2036	$86.71	$339.07	$123.76	$43.34	$17.92	$7.05
2037	$89.98	$345.24	$126.01	$44.13	$18.55	$7.22
2038	$92.75	$351.53	$128.31	$44.93	$19.20	$7.40
2039	$93.72	$357.93	$130.65	$45.75	$19.87	$7.57
2040	$97.16	$364.45	$133.03	$46.58	$20.56	$7.74
2041	$98.82	$371.09	$135.45	$47.43	$21.28	$7.91
2042	$100.30	$377.85	$137.92	$48.30	$22.03	$8.08
2043	$103.10	$384.74	$140.43	$49.18	$22.80	$8.25
2044	$105.94	$391.74	$142.99	$50.07	$23.60	$8.44
2045	$109.88	$398.88	$145.59	$50.98	$24.42	$8.62
2046	$113.78	$406.15	$148.24	$51.91	$25.28	$8.81
2047	$117.34	$413.54	$150.94	$52.86	$26.16	$9.00

Appendix C: Summary of the 2022-2024 Demand Portfolio Energy Efficiency & Demand Response Programs

C.1 Introduction

Public Service Company of Oklahoma (PSO) received approval of the 2022 - 2024 Demand Portfolio, by the Oklahoma Corporation Commission in 2021, in Cause No. PUD 2021000041. The following sections discuss the Demand Portfolio goals and actuals for energy savings (kWh), peak demand reduction (kW), program cost, cash inducements and cost effectiveness for each year.

C.1.1 Savings Summary

The savings summary of PSO's 2022-2024 Demand Portfolio is calculated based on verified energy savings and peak demand reduction for each of the energy efficiency and demand response programs. The cash inducements paid were reconciled and verified with the tracking and reporting system. All spending values were provided by PSO. All energy savings and demand reduction values were taken directly from the portfolio tracking data provided by PSO. The verified energy savings and demand reductions reflect Evaluation, Measurement and Verification (EM&V) findings determined by ADM for each program year. Reported costs, verified annual energy savings, and verified peak demand reduction by program are shown in this section. The peak demand reduction (kW) and annual energy savings (kWh) presented throughout this appendix represent net savings at the generator by applying program level net-to-gross (NTG) ratios and adjusting for line losses.

C.1.2 kWh Energy Savings

The annual energy savings (kWh) presented in Table C-1 represent verified net savings at the generator by applying program level net-to-gross (NTG) ratios and adjusting for line losses (a line loss adjustment factor of 5.86%).

Table C-1: Net kWh Savings by Program (Impacts are Net, at Generator)

Program	2022	2023	2024	2022-2024	3-Year Goal	% to Goal
Energy Efficiency Programs						
Business Rebates	44,612,699	38,424,199		83,036,897	116,096,391	72%
Residential Energy Services	55,335,876	56,674,392		112,010,268	122,333,178	92%
Home Weatherization	4,213,453	4,817,559		9,031,012	8,011,067	113%
Conservation Voltage Reduction	16,927,422	37,293,520		54,220,942	88,835,153	61%
Energy Efficiency Totals	**121,089,450**	**137,209,670**		**258,299,120**	**335,275,789**	**77%**
Demand Response Programs						
Power Hours	130,989	227,776		358,765	0	-
Peak Performers	822,519	1,184,050		2,006,568	206,076	974%
Demand Response Totals	**953,508**	**1,411,825**		**2,365,333**	**206,076**	**1148%**
Research and Development Programs						
Research and Development	-	-	-	-	548,717	0%
R&D Totals	**-**	**-**	**-**	**-**	**548,717**	**0%**
Total	**122,042,957**	**138,621,495**		**260,664,4524**	**336,030,581**	**78%**

C.1.3 kW Demand Savings

The annual demand reduction (kW) presented in Table C-2 represents net savings at the generator by applying program level net-to-gross (NTG) ratios and adjusting for line losses (a line loss adjustment factor of 7.81%).

Table C-2: Net kW Savings by Program (Impacts are Net, at Generator)

Program	2022	2023	2024	2022-2024	3-Year Goal	% to Goal
Energy Efficiency Programs						
Business Rebates	9,172	6,688		15,860	24,035	66%
Residential Energy Services	11,904	12,271		24,175	21,750	111%
Home Weatherization	2,417	2,605		5,022	2,948	170%
Conservation Voltage Reduction	3,882	11,741		15,623	23,547	66%
Energy Efficiency Totals	**27,375**	**33,305**		**60,680**	**72,280**	**84%**
Demand Response Programs						
Power Hours	16,390	23,895		40,285	64,008	63%
Peak Performers	59,870	63,728		123,598	210,873	59%
Demand Response Totals	**76,260**	**87,623**		**163,883**	**274,881**	**60%**
Research and Development Programs						
Research and Development	**-**	**-**		-	688	0%
Research and Development Totals	**-**	**-**		**-**	**688**	**0%**
Portfolio Total	**103,635**	**120,928**		**224,563**	**347,849**	**65%**

C.1.4 Program Costs

The program costs presented in Table C-3 represent total spending of the demand portfolio.

Table C-3: Total Program Cost by Program

Program	2022	2023	2024	2022-2024	3-Year Goal	% to Goal
Energy Efficiency Programs						
Business Rebates	$10,865,860	$10,596,028		$21,461,888	$35,545,622	60%
Residential Energy Services	$11,398,035	$11,345,093		$22,743,128	$30,549,377	74%
Home Weatherization	$3,361,071	$3,474,717		$6,835,789	$10,294,676	66%
Conservation Voltage Reduction	$357,203	$2,008,740		$2,365,943	$4,555,971	52%
Energy Efficiency Totals	**$25,982,169**	**$27,424,579**		**$53,406,747**	**$80,945,645**	**66%**
Demand Response Programs						
Power Hours	$1,723,832	$1,588,064		$3,311,896	$6,471,965	51%
Peak Performers	$3,234,711	$3,344,719		$6,579,429	$12,037,752	55%
Demand Response Totals	**4,958,543**	**4,932,783**		**9,891,325**	**18,509,717**	**53%**
Research and Development Programs						
Research and Development	371,944	909,831		1,281,775	2,587,706	50%
Research and Development Totals	**371,944**	**909,831**		**1,281,775**	**2,587,706**	**50%**
Total	**31,312,655**	**33,267,193**		**64,579,848**	**102,043,068**	**63%**

C.1.5 Cash Inducements

Cash inducements are presented in Table C-4. Cash inducements are direct payments to customers or trade allies on behalf of customers, namely rebates and incentives.

Table C-4: Total Cash Inducements by Program

Program	2022	2023	2024	2022-2024	3-Year Goal	% to Goal
Energy Efficiency Programs						
Business Rebates	$6,354,687	$6,205,277		$12,559,963	$20,319,592	62%
Residential Energy Services	$7,084,378	$7,268,486		$14,352,865	$18,089,672	79%
Home Weatherization	$3,077,531	$3,153,862		$6,231,393	$7,999,755	78%
Conservation Voltage Reduction	$0	$0		$0	$-	0%
Energy Efficiency Totals	**$16,516,596**	**$16,627,625**		**$33,144,221**	**$46,409,019**	**71%**
Demand Response Programs						
Power Hours	$523,111	$688,662		$1,211,773	1,561,500	78%
Peak Performers	$2,933,222	$3,013,232		$5,946,455	10,019,175	59%
Demand Response Totals	**$3,456,333**	**$3,701,894**		**$7,158,227**	**11,580,675**	**62%**
Research and Development Programs						
Research and Development Totals	**$-**	**$470,322**		**$470,322**	**712,152**	**66%**
Total	**$19,972,929**	**$20,799,842**		**40,772,771**	**58,701,846**	**69%**

C.1.6 Cost Effectiveness

Figure C-1 shows the Demand Portfolio's Total Resource Cost Test (TRC) results and Utility Cost Test (UCT)[64] results for each year. The reported impacts are net-at- generator, reflecting NTG assumptions and line losses as described in each year's Annual Report. These results adhere to the stipulations set forth by the Oklahoma Corporate Commission for the Demand Side Management Cost Recovery Rider. Oklahoma Administrative Code (OAC) 165:35-41-2 lists the goals of energy efficiency and demand response programs as (1) minimize the long-term cost of utility service, and (2) avoid or delay the need for new generation, transmission, and distribution investment. The TRC test best reflects these goals, as it looks at benefits and costs from the perspective of all utility customers in the utility's service territory (participants and non-participants).

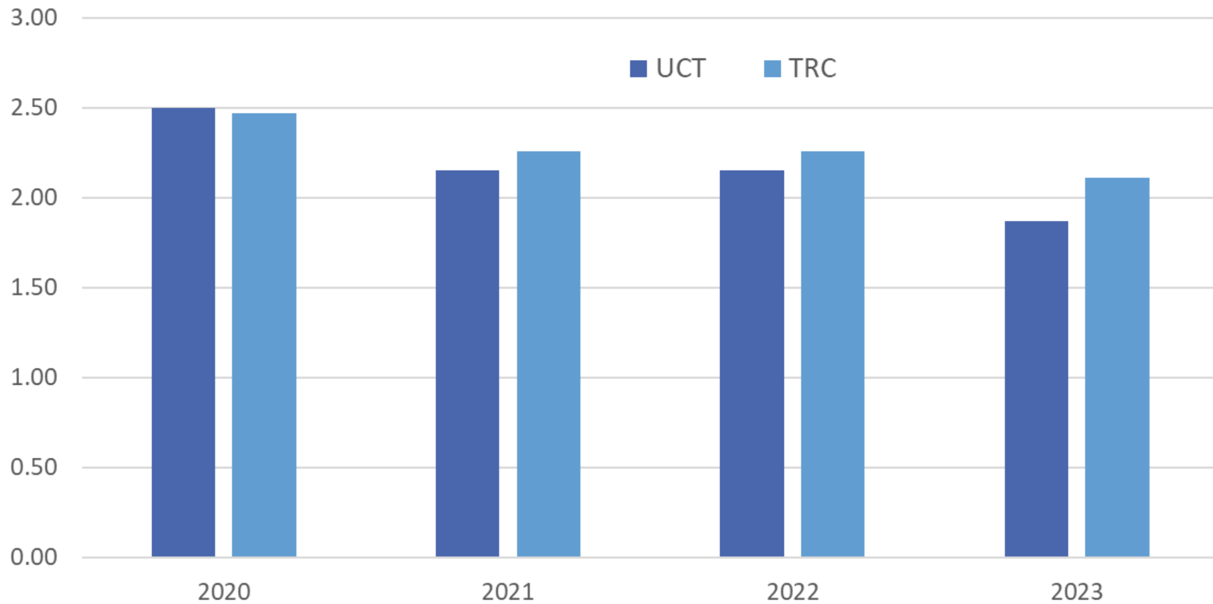
In addition to TRC and UCT results, results from the Ratepayer Impact Measure (RIM), Participant Cost Test (PCT) and Societal Cost Test (SCT) are included in each year's Annual Report. Based on reported program impacts and spending through December 31, 2023, PSO's overall portfolio is cost-effective based on both the TRC and UCT.

Figure C-1 shows the changes in cost effectiveness ratios over the portfolio period.

[64] The UCT is also referred to as the Program Administrator Cost Test (PACT)

The ratios greater than one emphasize the significant benefit provided customers over cost incurred.

Figure C-1: Demand Portfolio Cost Effectiveness by Year



C.2 Energy-Efficiency Programs

In 2023, PSO offered customers a suite of residential energy efficiency subprograms under Residential Energy Services, a suite of commercial and industrial energy efficiency subprograms under Business Rebates, and a Home Weatherization program for low-income customers. The Residential Energy Services program consists of the following subprograms: Multifamily and Manufactured Homes, Energy Saving Products, Home Rebates, Behavioral Modification, and Education. The Business Rebates program consists of the following subprograms: Custom and Prescriptive, Small Business Energy Solutions, and Commercial Midstream.

C.2.1 Business Rebates Program

PSO's Business Rebates Program seeks to generate energy and demand savings for large and small commercial and industrial customers through promotion of high efficiency electric end use products including (but not limited to) lighting, HVAC, Agricultural, and motors. The program provides PSO's commercial and industrial customers with flexibility in choosing how to participate, by either self-sponsoring or by working through a third-party service provider to leverage technical expertise. The program included targeted subprograms in Small Business Energy Solutions, Midstream retail discounts, and Custom and Prescriptive measures (including strategic energy management).

C.2.2 Residential Energy Services

PSO's Energy Saving Products Program seeks to generate energy and demand savings for residential customers through the promotion of energy saving LED light bulbs, air filters, weatherization measures, electric vehicle chargers, smart thermostats, and EnergyStar® appliances. The purpose of this program is to provide PSO residential customers inducements for purchasing products that meet high efficiency standards. The program included delivery mechanisms of upstream retail discounts for appliances, downstream rebates for appliances and EV Chargers, free-of-charge LEDs distributed through food banks, and a limited time-offering through the PSO website for lighting and appliances.

PSO's Home Rebates Program seeks to generate energy and demand savings for residential customers through the promotion of comprehensive efficiency upgrades to building envelope measures and HVAC equipment for both new homes and retrofits. The purpose of the Home Rebates Program is to provide PSO residential customers with inducements for increasing building envelope efficiencies and installing items such as high efficiency appliances and HVAC equipment.

PSO's Education Program seeks to generate energy and demand savings for residential customers by providing elementary school students with easy self-install energy efficiency measures, such as LEDs and Advanced Power Strips. The purpose of the Education Program is to provide PSO residential customers with an educational experience on how to make their homes more efficient. A lesson plan is provided to the classroom teacher, which engages the students in learning about energy efficiency while also practicing mathematics and science. The students are then provided with the take-home energy efficiency kit. Energy savings are achieved when these measures are installed in homes.

The Behavioral Modification program provides monthly energy usage reports to residential customers. The program was designed to generate greater awareness of energy use and ways to manage energy use through energy efficiency education in the form of an emailed energy report. The energy report provides customers with energy conservation tips. It is expected that through this education, customers will adopt energy conservation tips that will lead to more efficient energy use in their homes.

PSO's Multifamily and Manufactured Homes Program seeks to generate energy savings for owners, operators, and service providers of Multifamily facilities and manufactured homes through promotion of high efficiency electric end use products. The program seeks to combine provision of financial inducements with access to technical expertise to maximize program penetration across the range of potential Multifamily customers. Prescriptive rebate amounts are provided to participating customers for some measures including certain types of lighting, lighting controls, HVAC equipment, water-related equipment, and other equipment. Custom projects (i.e., chillers) that do not fall into prescriptive measure categories are rebated on a per kWh and kW impact basis. Energy efficiency measures for manufactured homes included direct install measures (LED screw-in light bulbs replacing incandescent, low-flow showerheads, and faucet aerators) as well as duct sealing and air sealing. Eligible manufactured homes must use electric heating.

C.2.3 Home Weatherization Program

PSO's Home Weatherization Program seeks to generate energy and demand savings for limited income residential customers through the installation of a wide range of cost-effective weatherization and other measures in eligible dwellings. The purpose of the Home Weatherization Program is to provide PSO's limited income residential customers with the financial assistance they need to make their homes more energy efficient, increase comfort levels, and reduce their utility bills.

C.2.4 Conservation Voltage Reduction

PSO's Conservation Voltage Reduction (CVR) Program seeks to generate energy and demand savings by using a system of devices, controls, software, and communications equipment to manage reactive power flow and lower voltage level for implemented distribution circuits at substations. The purpose of the CVR Program is to achieve energy efficiency savings by managing the voltage and power factor along the distribution circuit and lower the voltage profile within an acceptable bandwidth.

C.3 Demand Response Program

PSO's portfolio consisted of two demand response programs: Peak Performers for Non-Residential customers and Power Hours for residential customers.

C.3.1 Peak Performers Program

The Peak Performers program is designed to incentivize commercial and industrial facilities for curtailing their energy usage during periods of high electrical demand.

Nonresidential PSO customers enroll in the program and are notified when a load reduction event is initiated. Participants have the option of participating in each event individually and are paid incentives based on average reduction over the course of all events. There is no direct penalty for opting out of specific event days. The program is active during summer months when average demand typically approaches designated capacity thresholds.

C.3.2 Power Hours

The Power Hours Program provides ways to reduce energy usage of residential customers during peak demand periods by offering customers the option of participating in direct load control (DLC) events. DLC events reduce energy usage when demand is highest by communicating with registered Wi-Fi enabled thermostats installed in the homes of participants. Smart thermostats help lower electricity usage by providing customers with improved real-time information about HVAC usage and cost, improved user interfaces, and algorithm optimization (such as occupancy detection and prediction).

Appendix D: Identification of Program Implementers

Table D-1 identifies program implementation contractors and associated contact information by 2023 program.

Table D-1: Program Implementer Identification

Program(s)	Implementation Contractor	Contact	Contact Title	Contact Address	Contact Phone	Contact Email
Business Rebates	ICF International	Andrea Palmer	Portfolio Director	7136 S. Yale Ave. #330, Tulsa, OK	918-348-0503	Andrea.palmer@icf.com
Multifamily and Manufactured Homes	ICF International	Andrea Palmer	Portfolio Director	7136 S. Yale Ave. #330, Tulsa, OK	918-348-0503	Andrea.palmer@icf.com
Home Weatherization	Titan ES, LLC	Scott Carter	Vice-President	1327 N 105th E Ave, Tulsa OK 74116	405-632-1700	scarter@titanes.us
	Revitalize T-Town	Jennifer Barcus - Schafer	Chief Executive Officer	14 E 7th St, Tulsa, OK 74119	918-742-6241	jennifer@revitalizettown.org
	Ki Bois Community Action Foundation	Michael Knapp	Weatherization Director	200 SE A Street Stigler, Oklahoma 74462	918-967-3325	michael.knapp@kibois.org
Energy Saving Products, Home Rebates	ICF International	Andrea Palmer	Portfolio Director	7136 S. Yale Ave. #330, Tulsa, OK	918-348-0503	Andrea.palmer@icf.com
Education	AM Conservation Group	Josh Levig	Director of Program Management	976 United Circle, Sparks, NV 89431	775-813-7445	jlevig@amconservation.com
Power Hours	EnergyHub	Sanjay Pai	Associate Director	41 Flatbush Ave, Ste 400A Brooklyn, NY 11217	203-809-5214	pai@energyhub.net
Peak Performers	PSO	Mary Jackson	EE & Consumer Program Coordinator Sr	212 E. 6th St. Tulsa, OK 74119	918-700-2325	majackson@aep.com

Program(s)	Implementation Contractor	Contact	Contact Title	Contact Address	Contact Phone	Contact Email
CVR	PSO	Shane Ptomey	Smart Grid Systems Mgr	212 E. 6th St. Tulsa, OK 74119	918-599-2064	septomey@aep.com
Behavioral	Oracle	Sharon Giljum	Sr. Client Success Manager	2300 Oracle Way, Austin TX 78741	314-541-9869	Sharon.giljum@oracle.com

Appendix E: Training and Customer Outreach

During the program year, PSO conducted several service provider recruitment and training events. Additionally, PSO sponsored various customer outreach events and stakeholder presentations. Table E-1 summarizes service provider recruitment and training events, customer outreach events, and other non-lighting promotion events throughout the program year.

Table E-1: Service Provider Recruitment & Training Events, Customer Outreach Events, and Other Non-Lighting Promotional Events

Date	Event Name	Location	Training/Education Type	Number of Attendees
01/19/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	11-20
05/25/23	PowerForward Overview	Portfolio (All Programs)	Tulsa General Office	0-10
02/15/23	PowerForward Overview	Portfolio (All Programs)	Tulsa General Office	11-20
03/01/23	PowerForward Overview	Portfolio (All Programs)	Tulsa General Office	11-20
03/02/23	HPH Service Provider Training	Residential Programs	Virtual - Phone/Online	21-30
03/02/23	HPH Service Provider Training	Residential Programs	Virtual - Phone/Online	11-20
05/16/23	PowerForward Overview	Portfolio (All Programs)	Tulsa General Office	0-10
06/14/23	PowerForward Overview	Portfolio (All Programs)	Other	21-30
08/01/23	PowerForward Overview	Residential Programs	Tulsa General Office	0-10
10/04/23	HPH Service Provider Training	Portfolio (All Programs)	Other	11-20
10/18/23	HPH Service Provider Training	Portfolio (All Programs)	McAlester SC	21-30
10/25/23	HPH New Home Builder/Rater Recruitment	Residential Programs	Tulsa General Office	21-30
11/08/23	HPH Service Provider Training	Portfolio (All Programs)	Bartlesville SC	11-20
11/16/23	HPH Service Provider Training	Portfolio (All Programs)	Weatherford SC	11-20
10/19/23	PowerForward Overview	Portfolio (All Programs)	McAlester SC	11-20
06/14/23	PowerForward Overview	Portfolio (All Programs)	McAlester SC	21-30
03/02/23	HPH Service Provider Training	Residential Programs	Tulsa General Office	41-50
04/18/23	HPH Service Provider Training	Residential Programs	Tulsa General Office	31-40

Date	Event Name	Location	Training/Education Type	Number of Attendees
03/07/23	PowerForward Overview	Residential Programs	Tulsa General Office	11-20
08/30/23	PowerForward Overview	Residential Programs	Virtual - Phone/Online	11-20
02/09/23	PowerForward Overview	Portfolio (All Programs)	Other	21-30
04/04/23	PowerForward Overview	Portfolio (All Programs)	Other	31-40
12/01/23	PowerForward Overview	Business Programs	Virtual - Phone/Online	0-10
11/15/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
11/08/23	HPB Service Provider Training	Business Programs	Bartlesville SC	11-20
11/02/23	PowerForward Overview	Business Programs	Other	11-20
11/01/23	PowerForward Overview	Business Programs	Virtual - Phone/Online	0-10
10/18/23	HPB Service Provider Training	Business Programs	McAlester SC	11-20
10/12/23	PowerForward Overview	Business Programs	Virtual - Phone/Online	0-10
10/04/23	HPB Service Provider Training	Business Programs	Other	11-20
09/14/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
08/10/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
07/13/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
06/08/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
05/11/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
04/13/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
02/09/23	PowerForward Overview	Portfolio (All Programs)	Virtual - Phone/Online	0-10
02/07/23	HPB Service Provider Training	Business Programs	Other	71-80
02/15/23	HPB Service Provider Training	Business Programs	Other	21-30
05/18/23	HPB Lunch and Learn	Business Programs	Other	21-30
05/30/23	HPB Service Provider Training	Business Programs	Other	0-10
06/01/23	HPB Service Provider Training	Business Programs	Other	0-10
08/15/23	HPB Service Provider Training	Business Programs	Other	0-10
10/24/23	HPB Service Provider Training	Business Programs	Other	0-10
12/07/23	PowerForward Overview	Business Programs	Other	21-30

Appendix F: Marketing Synopsis – Customer Engagement

The following pages of this appendix provide examples of materials used to promote, engage, and educate customers on PSO's Demand Portfolio in the 2023 program year.

PSO's customer engagement strategies for Power Forward with PSO continue to evolve in attracting, engaging, and educating customers on energy efficiency. Multichannel customer engagement strategies are utilized to increase opportunities for customer awareness, engagement and education.

F.1 2023 Program Customer Engagement Goals

This section presents the methods used to meet PSO's portfolio engagement goals.

F.1.1 Strategies and Tactics

- Identify unknown audiences, reach underserved demographics, segment creative and messaging, with a focus on improving program parity.
- Utilize dynamic content to improve education with social media channels.
- Utilize paid media to deliver targeted messages to customers.
- A/B Message Testing
- Continue to identify opportunities for customer education.
- Collect feedback from customers, industry experts and partners to improve the clarity, effectiveness, and follow-up efforts of PSO's energy-efficiency program customer engagement.

F.1.2 PSO Website

The PSO Power Forward website showcases all the consumer programs that focus on energy efficiency and demand response. Home and business rebate information, participant applications, education material and more is available on the website. There is a service provider portal and learning center as well as home builder materials. Energy efficiency tips and tricks are also present on the website to help customers make the most efficient use of energy. Examples of the website are shown below.

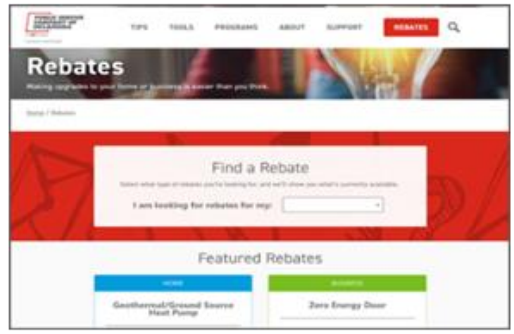
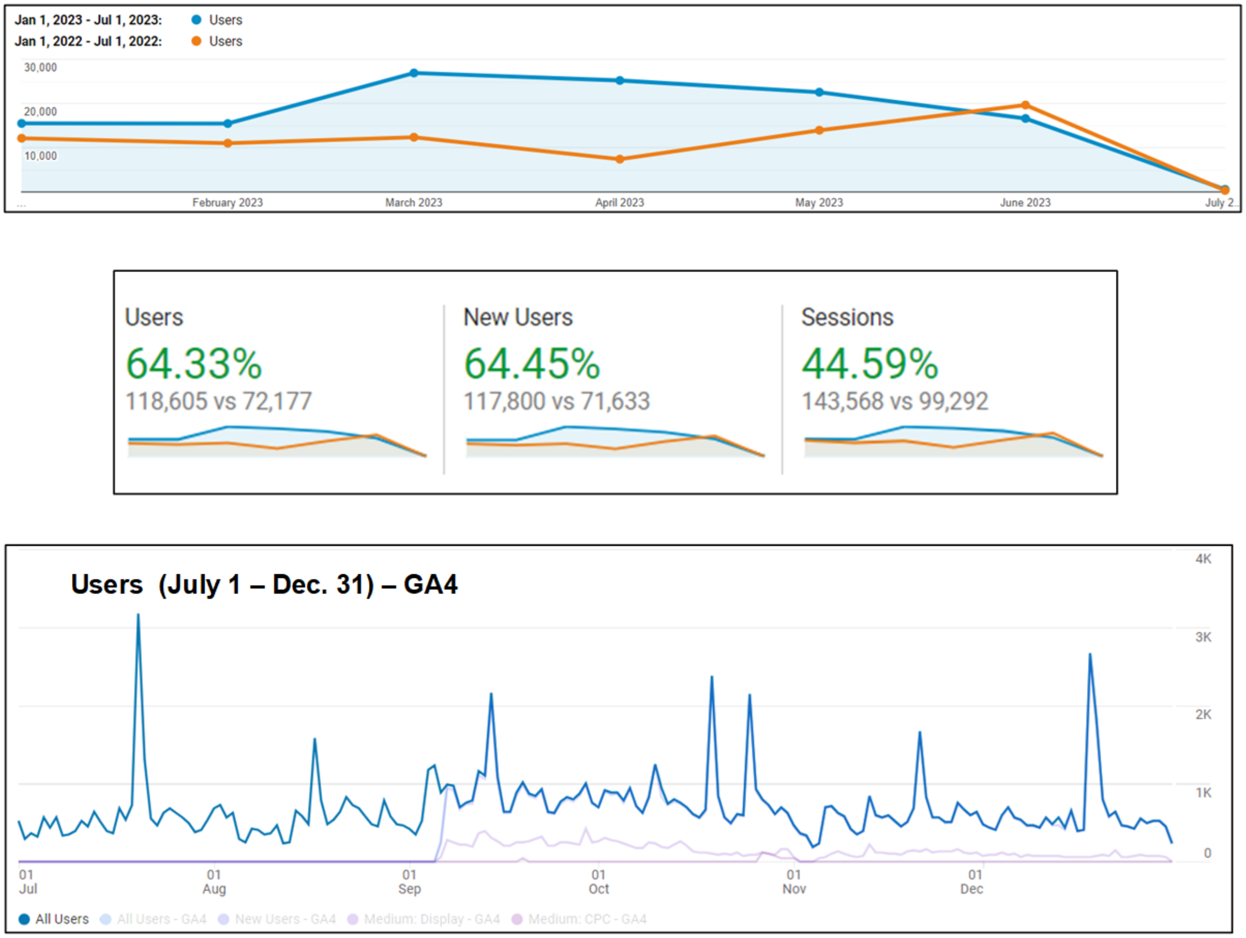


Figure F-1: Website Front Pages

F.2 Overall Website Performance

For 2023, there were 235,583 total users, 233,274 new users, 194,643 engaged sessions, and 492,271 pageviews on the Power Forward website. In comparison to 2022, total users and new users increased by nearly 80,000 in 2023. The figures below present website performance.

Figure F-2: Overall User Visits[65]

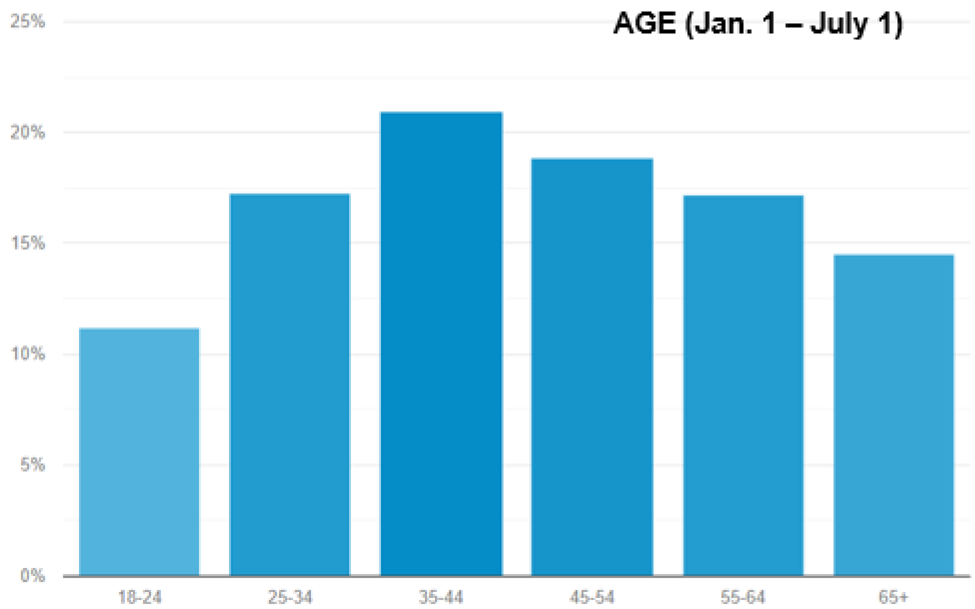


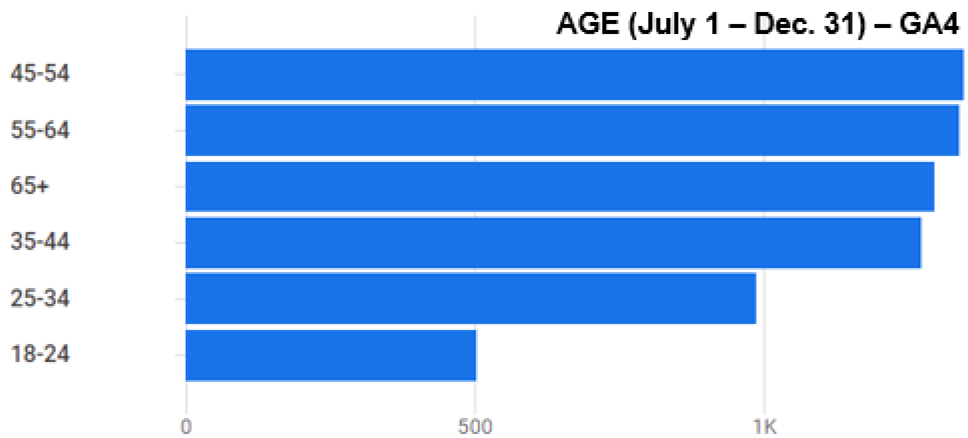
F.2.1 Site Visitors: By Age

Website visitors for 2023 fluctuated across all age groups, however the primary users fell within the 35-44- and 45–54-year-old age ranges. Website demographic is both male and female with the number of female users being slightly higher for 2023.

[65] Google Analytics upgraded their data analytics version to GA4 on July 1, 2023. Previous data was not able to be integrated into GA4, therefore reporting is split. Website data analytics are separated by January 1, 2023 – July 1, 2023, and July 1, 2023 – December 31, 2023, due to Google's upgrade mid-year.

Figure F-3: Age Group Comparison

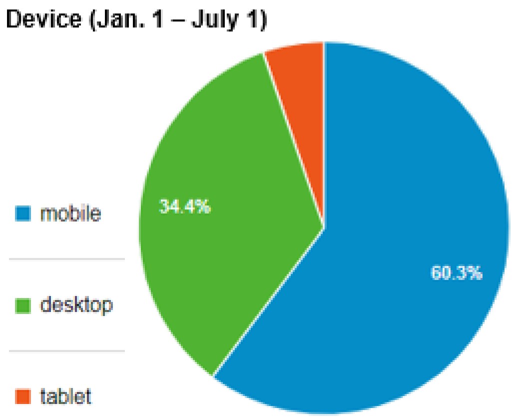


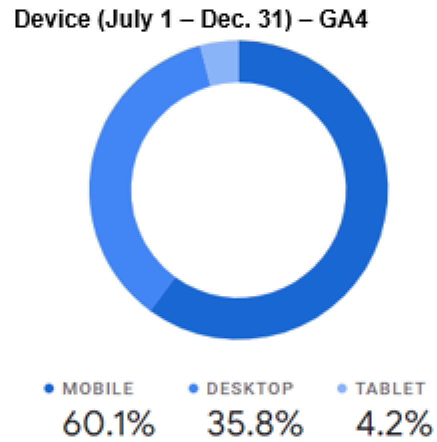


F.2.2 Site Visitors: By Device

Most website users in 2023 used mobile devices. Performance metrics continue to show that mobile is the primary device used. Desktop users made up the second largest device group while tablet users were significantly lower than mobile or desktop users.

Figure F-4: Site Visitors by Device

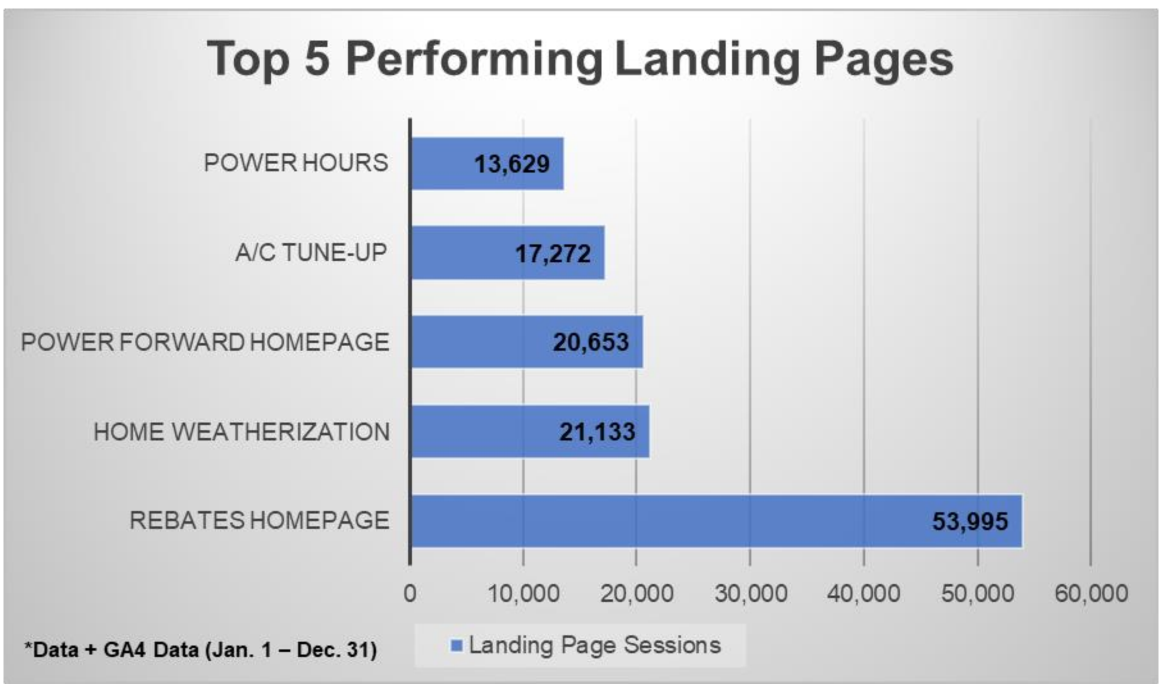




F.2.3 Website Engagement

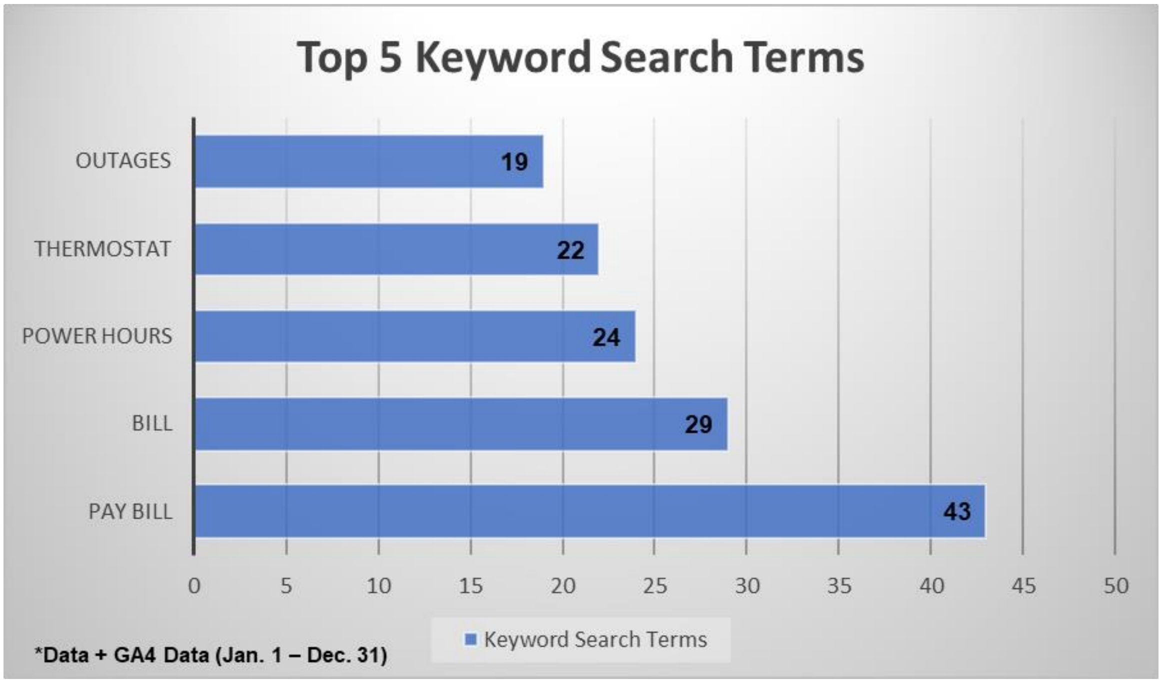
The following pages have the most engagement – determined by total page sessions by users. The general rebates landing page was the top performing landing page in 2023, which was followed by the Home Weatherization landing page.

Figure F-5: Website Engagement



The most searched terms on the Power Forward website for 2023 were “Pay bill”, “bill”, “power hours”, “Thermostat”, and “Outages”. Additional terms searched were “solar”, “time of day”, and “energy audit”.

Figure F-6: Website Keyword Search Terms



F.2.4 Paid Search Results

Paid search is being utilized to capture customers at the start of their energy efficiency journey. In 2023, we consistently refined search keywords to increase media effectiveness to support engagement tactics while making sure to have easily accessible information for customers looking for PSO's Consumer Programs and/or rebate options.

Top Search Terms for 2023

- **Residential:** "new appliance rebate", "weatherization assistance", "heating", "pso weatherization program", "central air conditioner", "reduce electric bill"
- **Commercial:** "business rebates", "small business rebates", "business energy rebates", "commercial rebates", "HVAC business rebatess"

F.2.5 Web Traffic

F.2.5.1 Social Media

Social media continues to be a strong driver of traffic to the PSO Power Forward website. In 2023, we continued placements on Facebook/Instagram, LinkedIn, and Pinterest for media to diversify and reach customers across a variety of platforms where content is highly consumed. Dynamic content was a new strategy introduced the second half of the year to better understand what customers preferences were when it came to specific images and/or verbiage.

F.2.5.2 Display

Programmatic display was another great driver to the PSO Power Forward website. The content was a mixture of energy efficiency and rebate information in both static and animated display banners. Data showed that both commercial and residential customers preferred animated display banners over static.

F.2.5.3 Videos

In 2023, the video customer engagement strategy leveraged multiple programmatic and connected television platforms (YouTube, Facebook/Instagram, LinkedIn, Hulu, etc.) to reach a wider customer base. Optimizations focused on fine tuning audience targeting on these platforms to maximize KPIs while reducing spend.

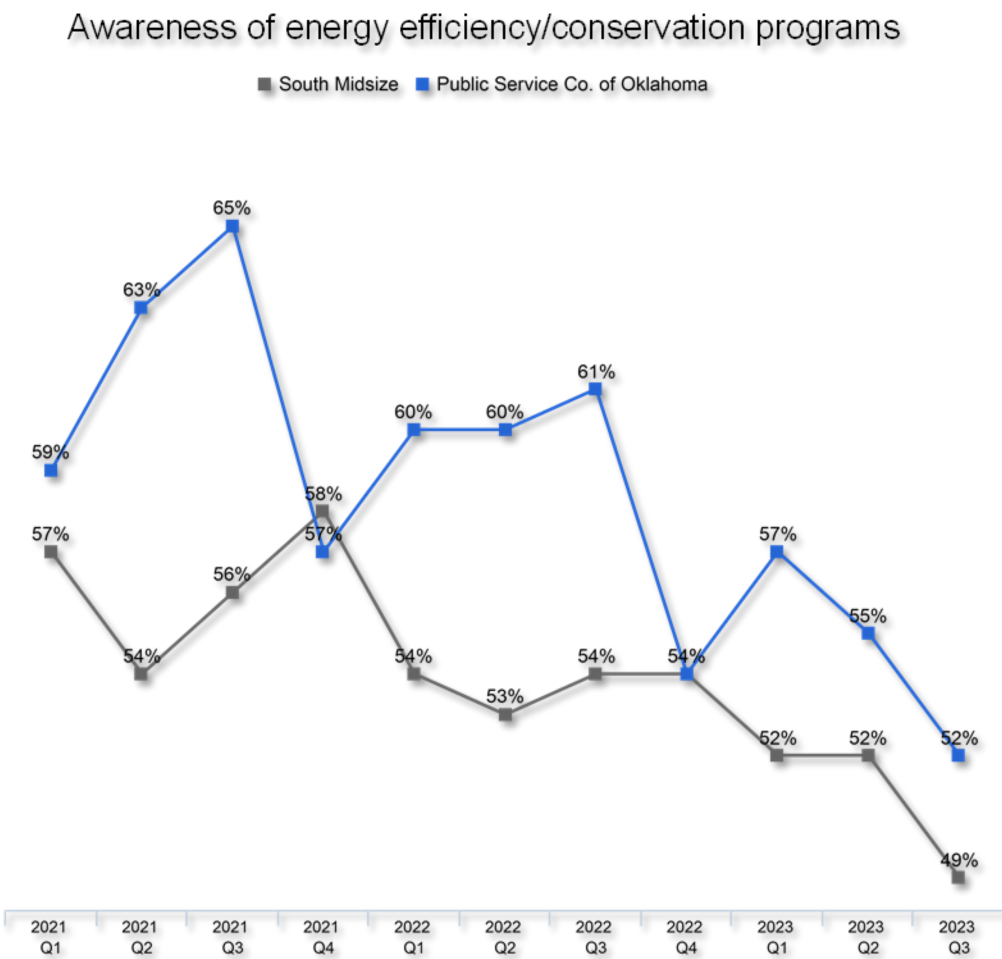
F.2.5.4 Email Customer Engagement

Email communications for 2023 were sent to not only residential PSO customers but commercial as well. Email content focused on home and business rebates available to customers plus energy efficiency program information for those who may be searching for ways to increase efficiency in their home or business. Program participation data was utilized to ensure the right customers were targeted with relevant messaging. Emails included clear call to action buttons to improve customer engagement and experience.

F.3 J.D. Power Scores

PSO's J.D. Power scores that focus on the awareness of energy efficiency programs continue to be higher than the average South Midsize segment. Multiple engagement strategies have helped PSO maintain awareness among customers along with clear messaging about eligibility and offerings with these programs. These strategies will continue to be the focus moving forward.

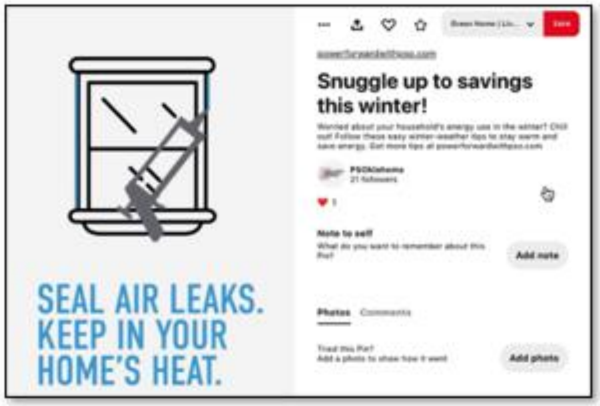
Figure F-7: PSO's J.D. Power Scores



F.4 Creative Examples

A residential newsletter was sent to approximately 375,000 customers monthly. Content highlights energy-saving blog content, tips and available rebates/limited time offer. Customers are encouraged to visit the Power Forward with PSO website for more information about these articles.

Figure F-8: Home Rebates & General Energy Efficiency



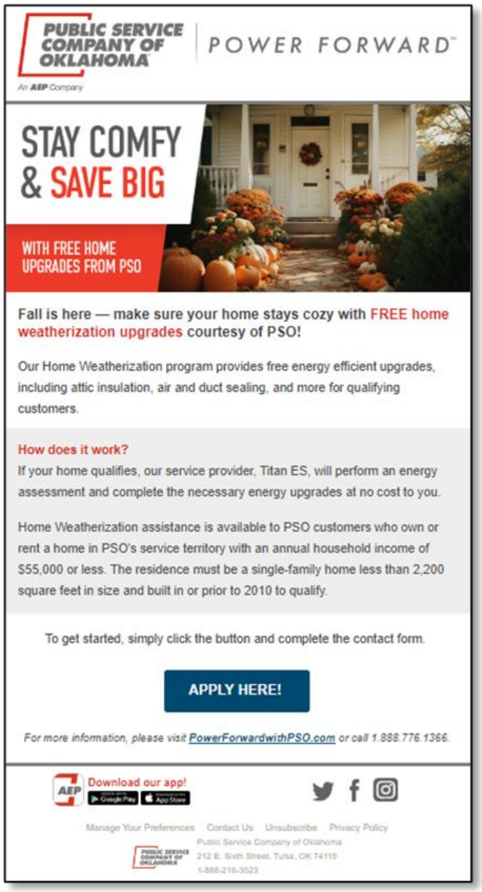
General Energy Efficiency Pinterest Ad

Home Rebates Email - Limited Time Offer

Home Rebates Bill Insert – EV Charger

Home Rebates Display Video – HVAC/Heat Pump

Figure F-9: Home Weatherization Creative Content



Home Weatherization Customer Email

Home Weatherization Organic Social

Home Weatherization Video Display Ad - Spanish

Figure F-10: Power Hours Creative Content

Power Hours Bill Insert

Power Hours Tri-Fold Brochure – New Layout

Figure F-11: Small Business Creative Content

Small Business Print Ad – Tulsa Chamber

Small Business Rebates
Paid Social Media Ad

Small Business Display Ad

Figure F-12: Commercial and Industrial Creative Content

Business Rebates Billboard

Business Rebates Print Ad – Tulsa People

Business Rebates CTV/OTT Video – Oil & Gas

Figure F-13: Peak Performers Creative Content

Peak Performers Display Ad

Peak Performers Digital Video

Peak Performers Flyer Handout

F.5 Community Engagement

PSO participated in a variety of community events, including tradeshows, lighting demonstrations, program presentations, seminars and more. Local community events are used to help educate customers and bring awareness to rebates plus energy efficiency program offerings.

- 52+ service provider training events, including programs overview.
- 40+ local community events throughout the state (Grove, Lawton, Tulsa, etc.)

BOK Center Outdoor Event

Tulsa Home & Garden Show

Tulsa Living Home Expo

Jenks Route 66 Festival

Service Provider Training

Appendix G: Overview of ADM Associates

ADM Associates is a professional services corporation providing research and consulting services in applied energy engineering and economics to utilities and other clients nationwide. The services ADM provides primarily relate to comprehensive energy research and energy-efficiency program implementation and evaluation. ADM's headquarters are in Sacramento, California with regional field offices in Nevada (Reno), Portland (Oregon), and the California Bay Area (Fremont). ADM has remote staff located throughout the country, including Oklahoma. From these offices, ADM conducts energy-related studies and projects throughout the United States and Canada for utility companies, government agencies and other clients.

ADM has been performing energy research and evaluation activities for over forty (40) years and has demonstrated its commitment to quality and customer service. ADM is currently conducting evaluations of residential, commercial, and industrial programs for utilities across the United States.

ADM is dedicated to creating a safe work environment and to provide training for our employees. All ADM employees undergo general safety training. Our field technicians and engineers undergo additional safety training related to fieldwork. We encourage all our employees to be responsible and alert to identify hazardous conditions wherever they may exist be it in transportation to the customer or at the customer’s facility. If hazardous conditions are found, they are to report them immediately to their supervisor or the ADM Safety Officer. Never are they to proceed to work in an identified hazardous situation. ADM follows Cal/OSHA rules and guidelines for safety in the workplace and these rules are as or more stringent than the federal OSHA rules.

Personal Protective Equipment (PPE) is provided and the procedures to use it as appropriate for the work expected. Our field staff is provided training to safely conduct activities they may encounter. Specifically, this includes the use of ladders and the rules associated with working at heights. Three points of contact on ladders are always required. Body harnesses are required when being lifted by a man lift or bucket, although we also train to avoid the use of lifts. If rooftops need to be accessed, our field staff is trained to identify if it is safe to be there and the requirements for perimeter protection. For those that will make electrical measurements, electrical safety training is given for new hires and periodically reviewed for all employees working in such conditions. Electrical safety training includes the use of PPE and the voltage the PPE is appropriate for use around. Arc flash training reinforces the reason for using PPE. ADM does not conduct any measurement activity on systems over 500 Volts. Other training includes exposure to asbestos, lead, and hydrogen sulfide. Employees are trained to follow safety procedures and there are consequences for not following proper procedures which can include termination of employment.