Smart $aver 2020-2022 Evaluation Report

Duke Energy Carolinas and Progress

Submitted to Duke Energy

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1. Executive Summary

1.1. Program Summary

The Smart $aver program offers incentives to Duke Energy Carolinas and Progress (DEC/DEP) existing and new construction residential customers for improving their home's energy efficiency through the installation of energy-efficient heating, ventilating, and air conditioning (HVAC) units, smart thermostats, heat pump water heating, variable-speed pool pumps, duct sealing, and attic insulation with air sealing.

A tiered incentive structure for eligible HVAC equipment, along with optional smart thermostats, offers larger rebates for higher-efficiency units. As smart thermostats are not offered as a standalone incentive (though they are available through Duke Energy's online marketplace), customers must receive a rebate for a new HVAC system to be eligible for this additional $50 incentive.

Independent, prequalified contractors install eligible energy-efficiency measures, consistent with the program standards and guidelines, and they submit rebate application documentation on the customer's behalf.

1.2. Evaluation Objectives and Results

This report presents evaluation activities results and findings for the Smart $aver program, conducted by the evaluation team in the evaluation period of July 1, 2020–March 31, 2022.

1.2.1. Impact Evaluation

The evaluation team divided the impact evaluation into two tasks: first, determine gross savings; and second, determine net savings. The team reviewed the program database to inform the evaluation effort's design and sampling approach. Activities included an *in situ* metering study (n=70) to estimate operational loads for air-source heat pumps and central air conditioners as well as consumption based analyses and engineering analyses to estimate gross savings for all program measures during the evaluation period.

Net savings reflect the degree to which gross impacts resulted from program-specific efforts and incentives. The team administered attribution surveys with program participants and contractors to estimate free-ridership and spillover rates. Table 1-1 provides program-level results for the DEC Smart $aver program.

Table 1-1: DEC Program Impact Results

Measurement	Reported	Realization Rate	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	21,331,833	174%	37,092,413	84.12%	31,200,786
Summer Demand (kW)	5,835	136%	7,960	82.99%	6,606
Winter Demand (kW)	6,352	50%	3,156	88.42%	2,791

During the July 1, 2020–March 31, 2022, evaluation period, the DEC program provided rebates for 47,487 measures installed in single-family homes, resulting in 37,092 MWh in gross verified energy savings and 31,222 MWh in net verified energy savings. As shown in Figure 1-1 and Figure 1-2, the program primarily incentivized HVAC equipment and add-on smart thermostats, accounting for approximately 65% of verified energy savings.

Figure 1-1. Count of DEC Smart $aver Rebated Measures

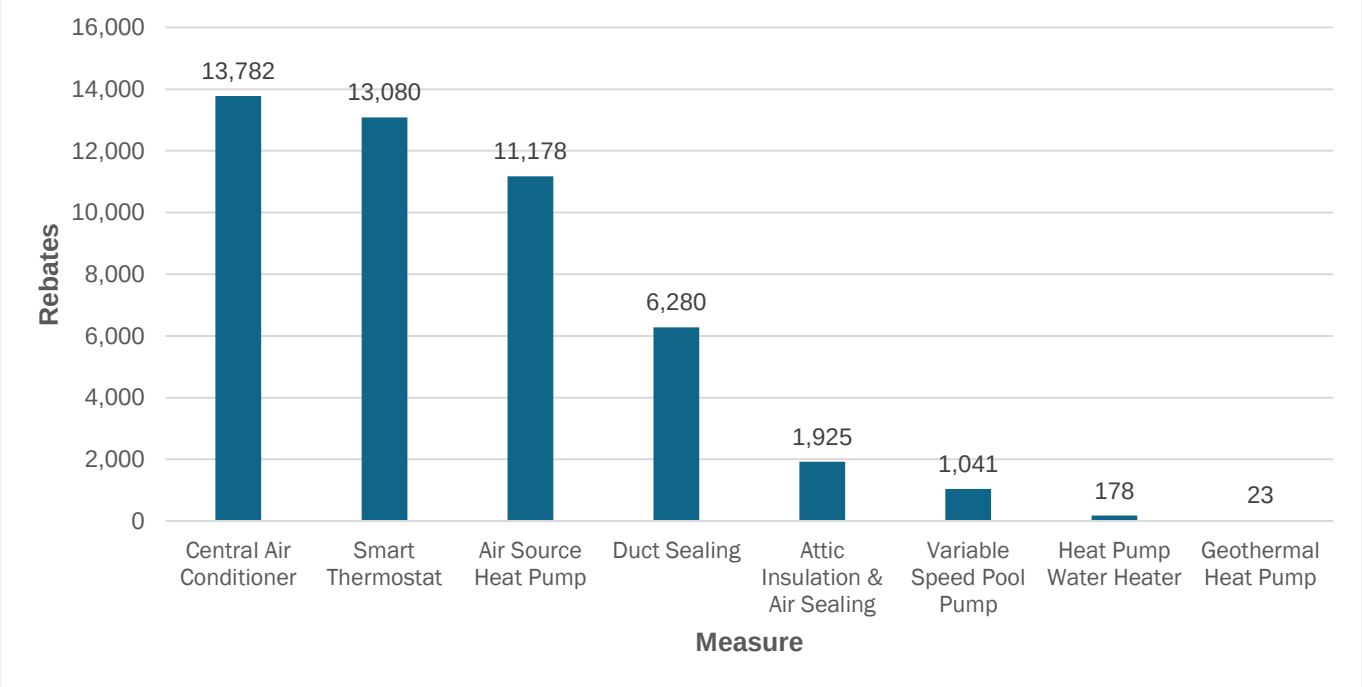


Figure 1-2. DEC Smart $aver Verified Energy Savings Portion by Measure

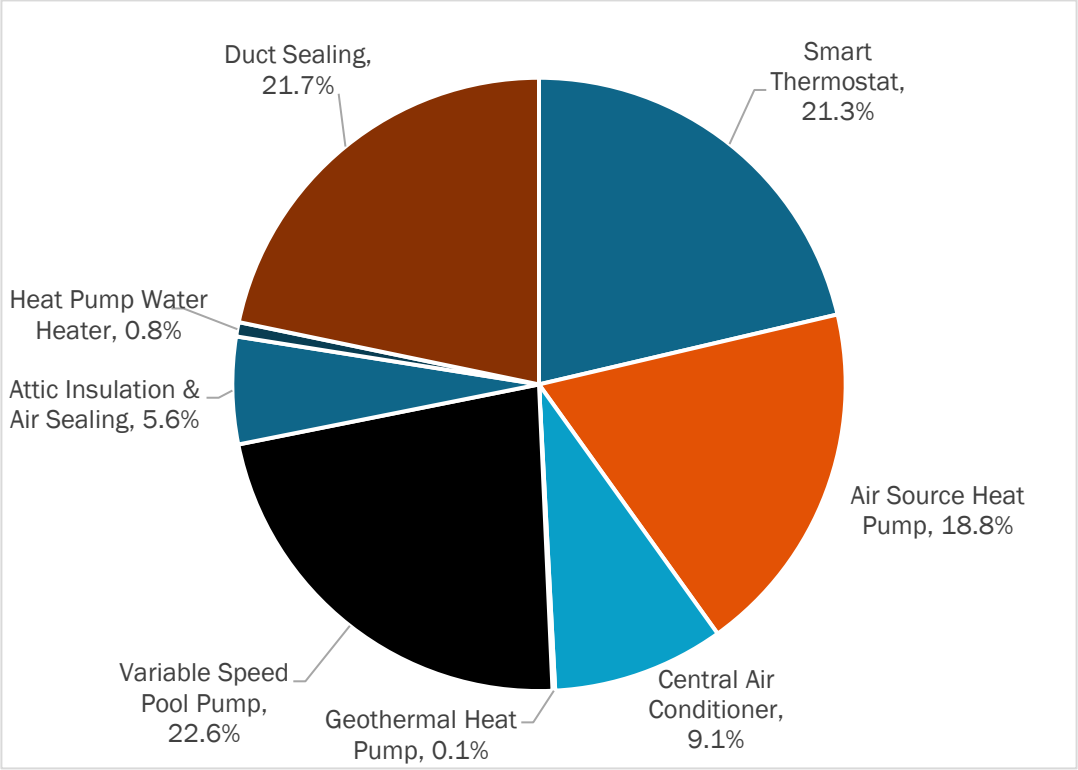


Table 1-2 presents per-unit reported and verified gross energy and demand savings for each rebated measure in DEC territory. These savings are given by measure and represent weighted average savings including all measure tiers and program entry (referral) steams.

Table 1-2: DEC Gross Verified Impacts by Measure (Per Unit)

Measure	Energy Savings (kWh)			Summer Demand Savings (kW)			Winter Demand Savings (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Central Air Conditioner	249.350	98%	243.716	0.1389	50%	0.0697	0.1641	0%	0.0000
Smart Thermostat	341.110	177%	605.081	0.0000	N/A	0.0000	0.0000	N/A	0.0332
Air Source Heat Pump	537.523	116%	622.666	0.1654	33%	0.0548	0.2312	53%	0.1221
Geothermal Heat Pump	980.833	230%	2,251.210	0.3060	148%	0.4524	0.4183	125%	0.5232
Variable Speed Pool Pump	2,430.000	331%	8,039.954	0.5270	527%	2.7797	0.0000	N/A	0.0000
Attic Insulation & Air Sealing	979.676	111%	1,087.384	0.2101	163%	0.3417	0.3081	41%	0.1274
Heat Pump Water Heater	1,616.000	97%	1,571.126	0.1240	130%	0.1614	0.1780	11%	0.0192
Duct Sealing	429.845	299%	1,284.182	0.1735	257%	0.4453	0.1388	126%	0.1746

Table 1-3 provides program-level results for the DEP Smart $aver program.

Table 1-3: DEP Program Impact Results

Measurement	Reported	Realization Rate	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (kWh)	8,340,427	188%	15,719,244	83.84%	13,179,760
Summer Demand (kW)	2,476	109%	2,695	80.34%	2,165
Winter Demand (kW)	807	186%	1,498	82.77%	1,240

During the evaluation period of July 1, 2020 – March 31, 2022, the DEP program provided rebates for 22,967 measures installed in single-family homes, resulting in 15,719 MWh in gross verified energy savings, and 13,180 MWh in net verified energy savings. As shown in Figure 1-3 and Figure

1-4, the program primarily incentivized HVAC equipment and add-on smart thermostats, accounting for approximately 66% of verified energy savings.

Figure 1-3: Count of DEP Smart $aver Rebated Measures

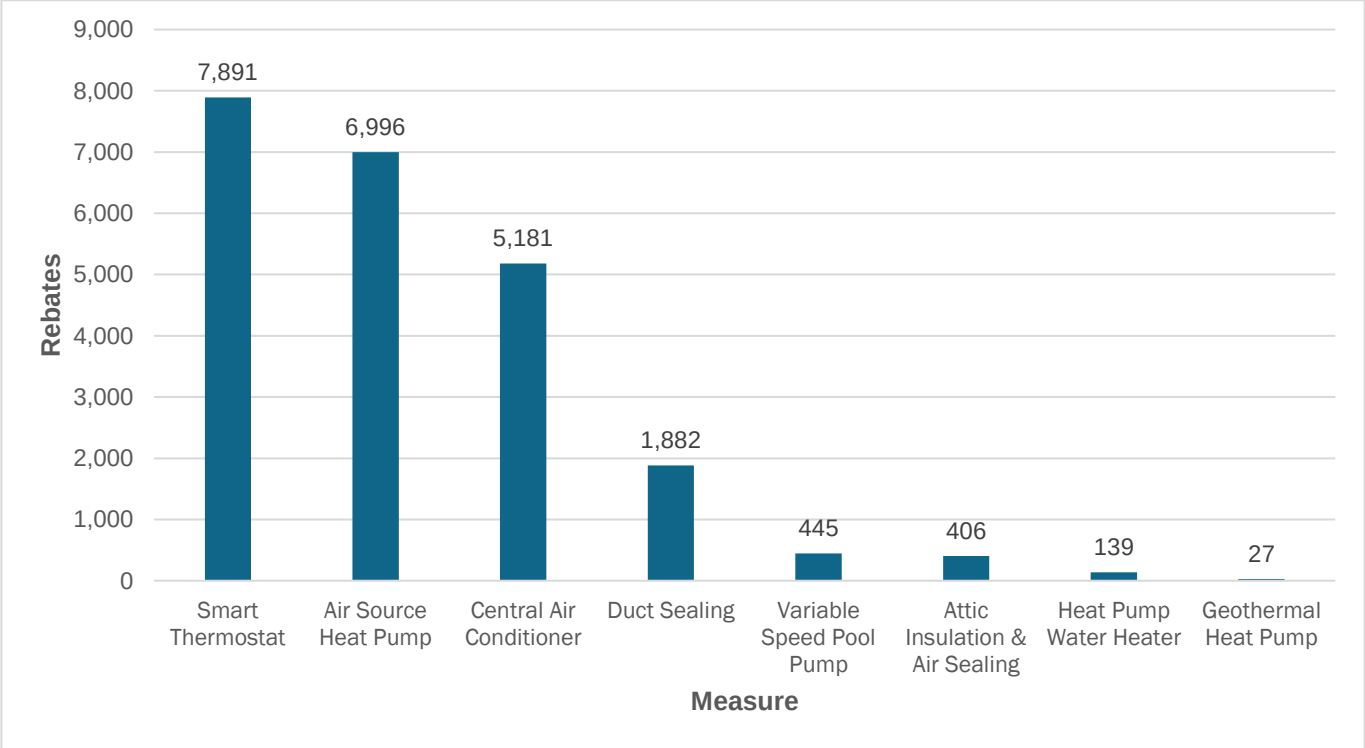


Figure 1-4: DEP Smart $aver Verified Energy Savings Portion by Measure

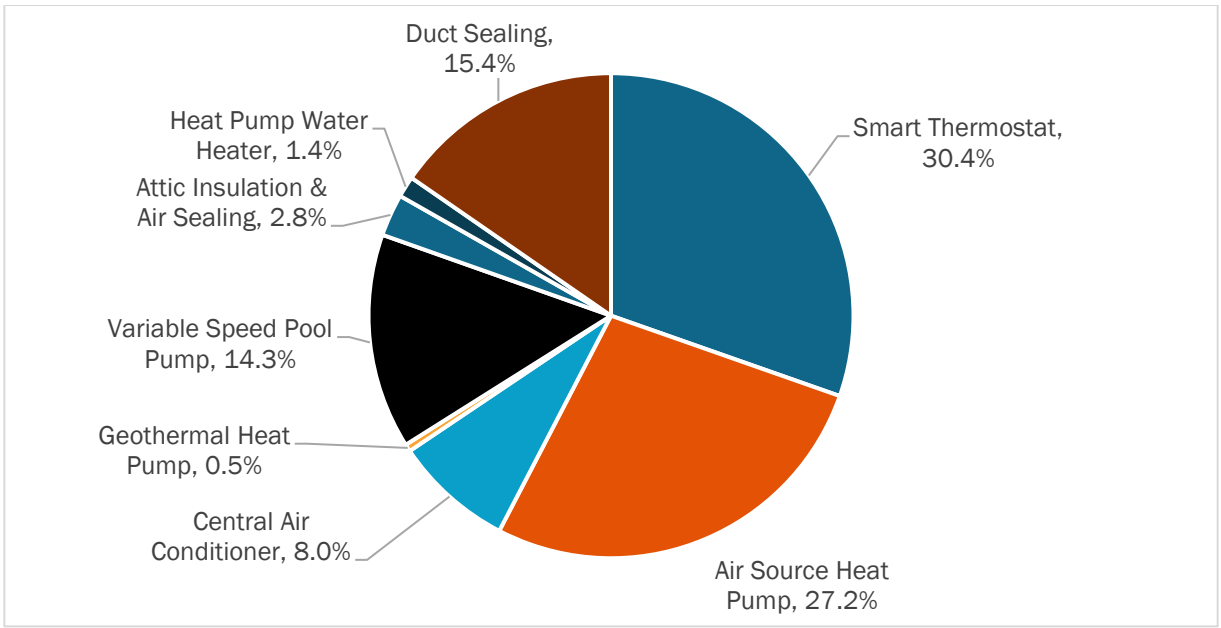


Table 1-4 presents per-unit verified gross energy and demand savings for each rebated measure in DEP territory. These savings are given by measure and represent weighted average savings including all measure tiers and program entry (referral) steams.

Table 1-4: DEP Gross Verified Impacts by Measure (Per Unit)

Measure	Energy Savings (kWh)			Summer Demand Savings (kW)			Winter Demand Savings (kW)		
	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified	Reported	Realization Rate	Gross Verified
Central Air Conditioner	234.395	103%	241.388	0.1420	41%	0.0585	0.0179	0%	0.0000
Smart Thermostat	306.485	197%	605.081	0.0000	N/A	0.0000	0.0000	N/A	0.0332
Air Source Heat Pump	320.763	191%	612.238	0.1221	42%	0.0507	0.0796	150%	0.1194
Geothermal Heat Pump	415.849	679%	2,823.628	0.1650	335%	0.5521	0.0240	2,732%	0.6554
Variable Speed Pool Pump	2,351.700	216%	5,068.519	0.5900	390%	2.2983	0.0000	N/A	0.0000
Attic Insulation & Air Sealing	1,163.000	93%	1,087.384	0.1922	178%	0.3417	0.2020	63%	0.1274
Heat Pump Water Heater	1,977.562	80%	1,587.505	0.0937	174%	0.1631	0.5410	4%	0.0194
Duct Sealing	350.000	367%	1,284.182	0.2805	159%	0.4453	0.0000	N/A	0.1746

The evaluation resulted in a wide range of realization rates. Specific findings for measure savings include the following:

- The **smart thermostat** measure achieved 177% and 197% energy realization rates in DEC and DEP, respectively, given advanced metering infrastructure (AMI) analysis results described in Section 3.4.1. Additionally, this analysis attempted to determine summer and winter peak demand savings attributable to smart thermostats. Though the analysis showed verified winter peak demand savings, it did not show verifiable summer peak demand savings.

- **Central air conditioner** savings decreased significantly due to a change in the federal code governing fan efficiency ratio, reducing winter demand savings to zero and reducing energy savings.

- Gross verified savings for **air source heat pumps** are relatively consistent between DEC and DEP, leading to high energy realization rates in DEP (as reported savings were much lower in DEP relative to DEC).

- **Geothermal heat pumps** achieved very high realization rates due to low reported savings for the measure.

- **Variable speed pool pump** energy savings increased significantly. This primarily resulted from data collected through participant surveys, which indicated that pool pumps in DEC and DEP territories are programmed to run 13 to 17 hours per day. This is two times longer than assumed pool pump runtimes provided in many technical reference manuals (TRMs).

- **Attic insulation and air sealing** showed relatively steady energy realization rates, despite use of an AMI-based consumption analysis to verify savings in place of TRM algorithms.

- The evaluation team updated **heat pump water heater** demand savings using recent data sources, resulting in high verified summer demand savings due to reductions in household cooling loads as well as low verified winter demand savings due to increases in household heating loads.

- An AMI-based consumption analysis was applied to **duct sealing** measures. This showed high realization rates across all measurements, while relying on a methodology that is based on household utility meter data.

1.2.2. Net-to-Gross

Net-to-gross (NTG) assessments measure the extent that a utility program motivates customers to undertake energy-saving installations they would not otherwise have performed. The NTG formula is comprised of free-ridership, participant spillover, and nonparticipant spillover (NTG = 100% - FR + PSO + NPSO). The overall program weighted average NTG calculates to a higher value from the three AMI analyzed measures as they already had participant free ridership and participant spillover embedded in their results, so it would be double counting to add additional self-report values to those measures.

Table 1-5: Net-to-Gross Results

Measure	Method	Total FR	PSO	NPSO	NTG
Central Air Conditioner Tier 2	Self-Report	48.35%	11.27%	10.32%	73.24%
Central Air Conditioner Tier 3	Self-Report	50.99%	7.19%	10.32%	66.52%
Heat Pump Tier 2	Self-Report	49.14%	9.18%	12.01%	72.05%
Heat Pump Tier 3	Self-Report	51.90%	1.10%	12.01%	61.21%
Heat Pump Water Heater	Self-Report	37.49%	2.16%	7.14%	71.82%
Variable Speed Pool Pump	Self-Report	38.37%	0.66%	0.00%	62.29%
Smart Thermostat	AMI Analysis	0%	0%	0%	100.00%
Attic Insulation and Air Sealing	AMI Analysis	0%	0%	2.35%	102.35%
Duct Sealing	AMI Analysis	0%	0%	6.72%	106.72%

* Note that to achieve the measure level NTG results, the DEC and DEP populations were combined for data collection. The DEC and DEP results utilize the measure level results but given the different mix of measures within each jurisdiction, the NTG ratios differ for each jurisdiction and savings variable shown in Table 1-1 and Table 1-3.

NTG component estimates derived from the following sources:

- **Free Ridership**: the participant survey included a free ridership battery, consisting of change and influence components, to assess actions participants would have taken in the program's absence. Smart thermostat, attic insulation and air sealing, and duct sealing measures were all assigned 0% because they are considered a net result from the AMI billing analysis.

- **Participant Spillover**: participant surveys assessed whether participants installed additional measures after program participation, that did not receive an incentive, and were directly attributed to the Smart $aver program. Measures analyzed through AMI have spillover savings embedded and thus are also assigned 0%.

- **Nonparticipant Spillover (NPSO)**: trade ally surveys assessed whether trade allies installed energy-efficient measures for nonparticipating customers, while attributing their efficient recommendations to their program participation. NPSO was reported by participating trade allies for all measure types from nonparticipating customers, including those measures using AMI analysis, as those are not reflected in participants usage data. Smart thermostats are not an independent measure, and require a primary piece of participating HVAC equipment, so no NPSO was assigned to smart thermostats.

1.2.3. Process Evaluation

The process evaluation assessed customer and trade ally experiences, why and how rebated energy-saving measures were implemented through Smart $aver, and ways to improve the program's design and implementation. To answer these questions, the evaluation team interviewed program and implementer staff (n=2) and "high volume" trade allies (n=5) and surveyed a random sample of trade allies (n=51), and participants (n=834).[1]

1.2.3.1. Program Successes

The DEC/DEP Smart $aver Program succeeded in the following areas:

- **Overall, participants were highly satisfied with Smart $aver.** Participants especially expressed satisfaction with their contractors, their upgrade projects, rebate amounts, and Duke Energy overall.

- **Smart $aver influenced energy-efficiency contracting services in DEC/DEP service territory.** Trade allies reported that participating in Smart $aver at least partially influenced them to recommend and implement qualifying measures and generally increased their knowledge of energy-efficient technologies.

- **Trade allies appreciated the enhanced trade ally portal.** Trade allies reported high satisfaction levels with the incentive application submission process and the trade ally portal application tracking system. The majority of trade allies (86%) did not experience challenges with the portal.

- **Trade allies served as Smart $aver's most successful marketing channel.** Participant surveys identified trade allies as their primary source of program awareness as well as the most influential factor on customers' decisions to implement rebated measures. Furthermore, most trade allies reported that their customers typically had not heard of Smart $aver rebates until they raised the subject with the customer. This emphasizes trade allies' importance to the Smart $aver program.

1.2.3.2. Program Challenges

Trade allies and participants highlighted the following concerns:

- **Some customers noted continuing issues with program incentives expiring before they could use them.** While most customers expressed satisfaction with the rebates' form (87%), a

[1] High-volume trade allies include companies in the top 20% of trade allies, in terms of the number of rebated measures for a given measure type.

number of respondents noted that gift cards expired by the time they received them or before they could use them.

- **Participants noted challenges resulting from COVID-19.** While only 5% of participants reported participation challenges related to COVID-19, the following challenges provided insights into the program:
    - Supply chain issues
    - Installation cancellations
    - Safety issues
    - Equipment costs
- **Portal updates may still be necessary to ensure trade allies' complete satisfaction.** Despite high satisfaction ratings from the trade allies regarding the portal, respondents offered the following suggestions to further enhance the portal experience:
    - Customers should be able to submit the application themselves (as this required a great deal of effort for trade allies)
    - Allow instant rebates (these still must be approved through the portal)
    - Better explanations if applications are returned as invalid
    - The ability to search for customer account numbers by using their name or address[2]

1.3. Evaluation Conclusions and Recommendations

Based on the reported findings, the evaluation team suggests the following recommendations to achieve program improvements.

Conclusion 1: The market has changed since the last program update.

Recommendation 1: Consider the following updates to the program's design:

- Remove the SEER 15 central air conditioners (CAC) and air source heat pumps (ASHP) tier offering
- Add an additional tier for SEER 18+ for CAC and ASHP
- Add a ductless mini-split heat pump offering
- Consider adding an EER requirement in addition to SEER (as this impacts summer kW)

[2] Though trade allies requested this capability, providing it remains inadvisable due to personally identifiable information concerns.

- Separate GSHP from ASHP, and assign specific savings to each

Conclusion 2: Smart thermostats produce high savings. The AMI analysis showed very robust savings for smart thermostats installed through the program. Many trade allies noted that smart thermostat incentives used to be higher.

Recommendation 2: Consider returning to a higher incentive for smart thermostats, such as that offered previously.

Conclusion 3: Trade allies appreciate the new portal. Most respondents (86%) reported not having issues with the enhanced Rebate Application Entry and Tracking Platform, compared to 37% of trade allies who reported that they occasionally experienced challenges or frustrations with the previous platform.

Recommendation 3: Trade allies' suggestions for application improvements included the following:

- Better explanations if applications are returned as invalid
- Auto-population of referral information

Recommendation 4: Enhance the application system's lookup features and ensure proper communication with trade allies regarding submission problems.

Conclusion 4: Though most customers and trade allies expressed satisfaction with the incentives, some respondents voiced alternatives.

Recommendation 5a: Decrease processing times and increase gift card expiration dates (past six months). Consider a "payment in check" option as the default, as issues sometimes occurred with gift cards expiring before people could use them. If this is not possible, communicate with customers that should their gift card expire before use, they may request a reissue up to one year after participation.

Recommendation 5b: As customers commonly cited learning about the program through trade allies and the trade allies completed the incentive application process for most measures, consider reinstating a direct incentive for trade allies.

Recommendation 5c: For high-volume trade allies submitting a great deal of applications as well as those preferring to do so financially, consider allowing an instant incentive (though this still must be approved through the portal). Some trade allies noted that the time and cost they incurred from serving as the "middle man" between customers and the gift card processor posed a substantial burden, and they preferred to present the incentive as an invoice credit. Consequently, on a regular cadence, trade allies could bundle incentive payments into one incentive that Duke could pay back directly. This could save on gift card processing costs and would alleviate issues with long incentive wait times.

Conclusion 5: Thermostat AMI analysis did not show statistically significant summer peak demand impacts, but it did show winter peak demand savings.

> **Consideration 1:** Continue to attempt peak demand savings AMI analysis where energy savings AMI analysis is successful.

Conclusion 6: AMI analysis showed statistically significant savings for building shell (envelope) measures.

> **Consideration 2:** Attempt AMI analysis of other measures that are expected to show large impacts and significant measure populations, such as central air conditioners and air source heat pumps.

2. Introduction

2.1. Program Description

2.1.1. Overview

The Smart $aver program offers incentives to Duke Energy Carolinas and Duke Energy Progress (DEC/DEP) existing and new construction residential customers for improving their home's energy efficiency through installation of energy-efficient heating, ventilating, and air conditioning (HVAC) units, smart thermostats, heat pump water heaters, variable-speed pool pumps, duct sealing, and attic insulation with air sealing. A tiered incentive structure for eligible HVAC equipment, along with an optional smart thermostat, offers larger rebates for higher-efficiency units, though the program does not offer smart thermostat incentives as a standalone incentive (they are, however, available in the online marketplace). Customers must receive a rebate for a new HVAC system to become eligible for this additional incentive.

Independent prequalified contractors—known as "trade allies"—install eligible energy-efficiency measures consistent with program standards and guidelines. Additionally, they submit the rebate application documentation on the customer's behalf. Though trade allies receive no monetary incentives for measures they install in existing buildings, builders become eligible to receive rebates for qualified HVAC equipment installed in residential new construction projects.

2.1.2. Energy Efficiency Measures

Table 2-1 summarizes energy-efficiency measures included in the Smart $aver program.

Table 2-1: 2021 Smart $aver Measures and Incentives

Measures		Rebate Amount	Details
Central Air Conditioner		Tier 2: $300 Tier 3: $400	Tier 2: 15 and 16 SEER, with electrically commutated motor (ECM) Tier 3: 17 SEER or greater, with ECM
Heat Pump	*Air Source*	Tier 2: $300 Tier 3: $400	Tier 2: 15 and 16 SEER, with ECM Tier 3: 17 SEER or greater, with ECM
	Geothermal	Tier 3: $400	Tier 3: 19 EER or greater, with ECM
Smart Thermostat		$50	Add-on incentive for HVAC participants
Attic Insulation & Air Seal		$250	R-19 or below to R-30 or greater; decrease home air leakage by 5% or more; at least 1,000 square feet of air-conditioned attic space
Variable Speed Pool Pump		$300	Equipment must be an ENERGY STAR® qualified variable-speed pool pump for use with main filtration of in-ground residential swimming pool
Heat Pump Water Heater		$350	ENERGY STAR® qualified units. Must have an EF ≥ 2
Duct Sealing		$100/duct system	Decrease air duct leakage by 12% or more

2.2. Program Implementation

Blackhawk Engagement Solutions (BES) chiefly implements the Smart $aver program, managing the trade ally registration process, incentive application submissions and fulfillments, the trade ally online portal, and the program call center.

As part of the prequalification process, all contractors seeking to participate must agree to the Smart $aver terms and conditions for participation in the program. A prequalified contractor listing identified through internal Duke reporting highlights contractors that meet program requirements. Prequalified contractors have permission to promote Smart $aver program measures and to identify themselves as program contractors.

Upon selection by the customer, contractors complete requested installations in accordance with all Smart $aver Program standards and guidelines as well as all applicable building codes. Contractors use the online portal to submit incentive applications. Prequalified contractors provide itemized invoices that sufficiently detail the measures installed.

Upon receipt of applications, BES verifies the applications are complete and accurate, and follows up with customers or contractors to resolve any discrepancies. DEC/DEP staff conduct quality-control inspections on a random sample (10%+) of installed measures.

Inspections are shared across all contractors, with new contractors and those with quality issues inspected at a higher rate. Upon application approvals, participating customers receive incentives (as do, when applicable, builders or trade allies).

DEC/DEP provides marketing through several channels, including the following: direct-mail campaigns, the utility website, participating contractor outreach and advertising, and contractor associations. DEC/DEP also performs trade ally outreach and training services.

2.2.1. Eligibility

DEC/DEP residential account holders residing in DEC/DEP electric service territory are eligible for Smart $aver rebates. The program is open to existing residential electric service customers living in single-family homes, condominiums, mobile homes, townhomes and duplexes. Builders may also apply for HVAC rebates for their residential new construction projects.

2.3. Key Research Objectives

Overarching project goals follow the evaluation definition established in the "Model Energy-Efficiency Program Impact Evaluation Guide—A Resource of the National Action Plan for Energy Efficiency," November 2007:

> *"Evaluation is the process of determining and documenting the results, benefits, and lessons learned from an energy-efficiency program. Evaluation results can be used in planning future programs and determining the value and potential of a portfolio of energy-efficiency programs in an integrated resource planning process. It can also be used in retrospectively determining the performance (and resulting payments, incentives, or penalties) of contractors and administrators responsible for implementing efficiency programs."*

Thus, evaluation has two key objectives:

1) Document and measure program effects and determine whether these meet goals with respect to providing a reliable energy resource (impact evaluation).
2) Help understand why those effects occurred (net-to-gross) and identify ways to improve the program (process evaluation).

2.3.1. Impact

Project impact evaluation processes followed standard industry protocols and definitions, where applicable, and included the Department of Energy Uniform Methods Protocol as an

example. As part of evaluation planning, the evaluation team outlined the following activities:

Quantify accurate and supportable energy (kWh) and demand (kW) savings for energy-efficient measures and equipment implemented in participants' homes.

Assess the free-rider rate from customers and determine spillover effects from customers' and contractors' perspectives.

Benchmark verified measure-level energy impacts against applicable technical reference manuals (TRMs) and Duke Energy programs in other jurisdictions.

For program planning purposes, the evaluation team will provide, to the extent possible, estimated per-unit savings by measure.

2.3.2. Process

The evaluation team designed the process evaluation to support organizational learning and program adaptation. Consequently, the team sought to research several program delivery and customer experience elements, as discussed below.

Awareness and Engagement:

- How aware are customers of the Smart $aver program?
- What are the primary information sources that customers use to learn more about the program (e.g., trade allies, program website, bill inserts)?
- How do customers typically learn about energy-efficient technologies?
- How do trade allies become engaged in the Smart $aver program, and what engagement source proves the most effective (e.g., implementer, program website)?
- Should additional program marketing be conducted and/or marketing support be provided to trade allies?

Program Satisfaction:

- How satisfied are participants with their overall program experiences, their contractors, the installation quality, incentive turnaround, and energy savings after work completion, and Duke Energy?
- How satisfied are trade allies with the program?

Program Influence:

- Does the program influence participants to engage in other Duke Energy energy-efficiency programs?
- Does the program increase contractor's knowledge of energy-efficient technologies?
- Does the program increase how often participating contractors promote energy-efficient equipment and services to their customers?

Challenges and Improvement Opportunities:

- Do inefficiencies or challenges occur with the application, incentive turnaround, or trade allies?
- What training opportunities could be offered to trade allies to help them more effectively sell rebated equipment?
- How engaged are trade allies in using the implementer web portal or other program resources?

Participant Characteristics:

- What are program participants' demographic characteristics?

2.4. Evaluation Overview

To meet the outlined goals, the evaluation team divided its approach into the following key tasks:

Task 1. Develop and manage an evaluation plan to describe processes that will be followed to complete the evaluation tasks outlined in this project.

Task 2. Conduct a process review to determine the program's marketing success and to identify improvement opportunities.

Task 3. Verify gross energy and peak demand savings resulting from the Smart $aver program through on-site measurements and verification activities for a sample of program participants and perform engineering and consumption analysis on the population.

Task 4. Determine the Smart $aver program's net savings through on-line surveys with a sample of participants and trade allies.

As the evaluation plan has been completed and approved previously, the following two subsections provide a more detailed description of the impact and process evaluations.

2.4.1. Impact Evaluation

The impact evaluation included a gross savings analysis and a net savings analysis. Techniques used to conduct the evaluation, measurement, and verification (EM&V) activities included the following: a database review; an *ex ante* savings review; on-site metering for central air conditioners and air-source heat pumps; AMI analysis of select measures; TRM-based engineering analysis, and web surveys with participants and trade allies to determine net-to-gross (NTG).

Net impacts reflect the degree to which gross savings result from program efforts and incentives. The evaluation team estimated free-ridership and spillover for the sample utilizing self-report methods through surveys with program participants and nonparticipant spillover from trade allies. The ratio of net verified savings to gross verified savings provides the NTG ratio as an applied scaling factor to reported savings. As an enhancement to this evaluation round, NTG values were estimated by measure as opposed to an overall program value.

Table 2-2 in Section 2.4.3 summarizes the number of surveys and on-site inspections completed. Samples were drawn to meet a 90% confidence and 10% precision at the program level.

2.4.2. Process Evaluation

Process evaluations tell the qualitative story behind a quantitative impact evaluation by understanding the program in its unique context. The goal of a process evaluation is to systematically assess an energy-efficiency program by generating responses that achieve the following outcomes:

- Documenting program operations
- Recommending improvements to increase the program's efficiency and effectiveness
- Assessing stakeholder satisfaction

These outcomes can inform program planning, existing program implementation, or efforts in program redesign. Process evaluations typically cover all program aspects, including the following: design; implementation; marketing and outreach; data tracking; quality assurance; customer and stakeholder feedback; and market conditions. Evaluating the broad context in which a program operates allows evaluators to recommend realistic program improvements. Typically, evaluators examine program aspects through the following mechanisms:

- Database and document reviews
- Interviews with program staff and key stakeholders (such as trade allies)
- Customer surveys
- Benchmarking research

Through process evaluation, activities can measure and analyze information gathered from participating customers and trade allies to form the basis of a NTG ratio. For example, participant surveys used to assess participant satisfaction also provide opportunities to ask participants about their participation motivations and the program's influence on their decisions, both of which serve as key components in free-ridership calculation. Similarly,

participant surveys can be used to assess whether participants installed additional energy-savings measures, indicating possible spillover.

2.4.3. Summary of Activities

Techniques utilized to conduct the EM&V activities and to meet the evaluation's goals included the following: field inspections and metering; AMI consumption analysis, web surveys with program participants and trade allies; program database reviews; and in-depth interviews (IDI) with utility staff, implementers, and trade allies. Table 2-2 summarizes the activities that Resource Innovations conducted as part of the Smart $aver program process and impact evaluations for the July 1, 2020—March 31, 2022, period.

Table 2-2: Summary of DEC/DEP Evaluation Activities

Target Group	Method	Population	Targeted Sample	Achieved Sample
Central Air Conditioner and Air Source Heat Pump	Field Inspection and Metering	37,137	70	70
Participants (rebated measures)	Online Survey	70,454	391	834
Duke Energy Program Staff	IDI	N/A	1	1
Implementer Staff	IDI	N/A	1	1
Most Active Trade Allies	IDI	342	5	5
Trade Allies	Online Survey	342	63	51
Engineering Analysis	Analysis	38,990	N/A	Census
Smart Thermostats	AMI Analysis	20,971	N/A	Census
Attic Insulation & Air Sealing	AMI Analysis	2,331	N/A	Census
Duct Sealing	AMI Analysis	8,162	N/A	Census

3. Impact Evaluation

3.1. Methodology

The evaluation team performed an impact evaluation to evaluate energy and demand savings attributable to the Smart $aver program, dividing the evaluation into two research areas: determining gross savings and net savings.

Gross savings are energy and demand savings found at a participant's home that directly result from a measure installed and rebated through the program. Net savings reflect the degree to which gross savings result from program efforts and funds. The evaluation team verified energy and demand savings attributable to the Smart $aver program by conducting the following impact evaluation activities:

- Database and *ex ante* savings review.
- Performing on-site metering for air-source heat pump and central air conditioner replacements to estimate hours of operation and associated loads.
- Consumption AMI data analysis via a difference-in-differences regression modeling approach with matched control groups.[3]
- Estimating gross verified savings using data collected in previous tasks and applying appropriate TRM algorithms to complete the engineering analysis.
- Comparing DEC and DEP *ex ante* savings to gross-verified savings to determine program- and measure-level realization rates.
- Applying attribution surveys to estimate NTG ratios and net-verified savings at the program level.

The impact evaluation activities resulted in calculating realization rates, which are applied to reported savings documented in the program tracking records. A realization rate is the ratio of savings determined from the EM&V activities to program-reported savings.

3.2. Database and *Ex Ante* Review

A program database review provided details that informed all evaluation activities. The evaluation's scope was based on information referenced from the program database, including the number of rebates for each measure and measure-specific installation details. The team considered this data in designing program evaluation approaches and methods.

[3] This impact evaluation activity was used to estimate savings for the smart thermostat, attic insulation and air sealing, and duct sealing measures.

The team also conducted a review of *ex ante* savings values (i.e., program reported savings for each measure rebated during the evaluation period). This review benchmarked *ex ante* savings against previous DEC-DEP Smart $aver program evaluation results and regional TRMs. This review allowed the team to understand if the program's assumed savings values aligned with expectations.

3.3. Sampling Plan and Achievement

For the evaluation period (July 1, 2020—March 31, 2022), smart thermostats, air-source heat pumps, and central air conditioners contributed the largest reported energy savings. Therefore, research activities primarily focused on these measures with the highest rigor level with on-site equipment measurement (air conditioning and heat pumps) or AMI analysis (smart thermostats).

The evaluation team requested a participation database extract of 2020, 2021, and 2022 program results, including counts and details on installed measures. The distribution of reported energy savings, based on measure counts from the participation database, provided insights into measures with the greatest influence on total program savings, as shown in Figure 3-1 and Figure 3-2.

Figure 3-1: DEC Smart $aver Reported Energy Savings Portion by Measure

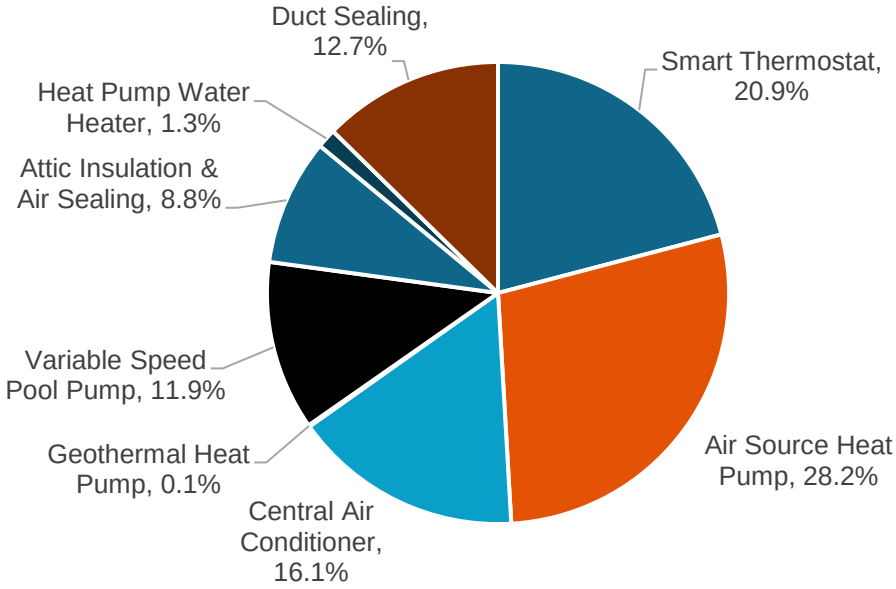


Figure 3-2: DEP Smart $aver Reported Energy Savings Portion by Measure

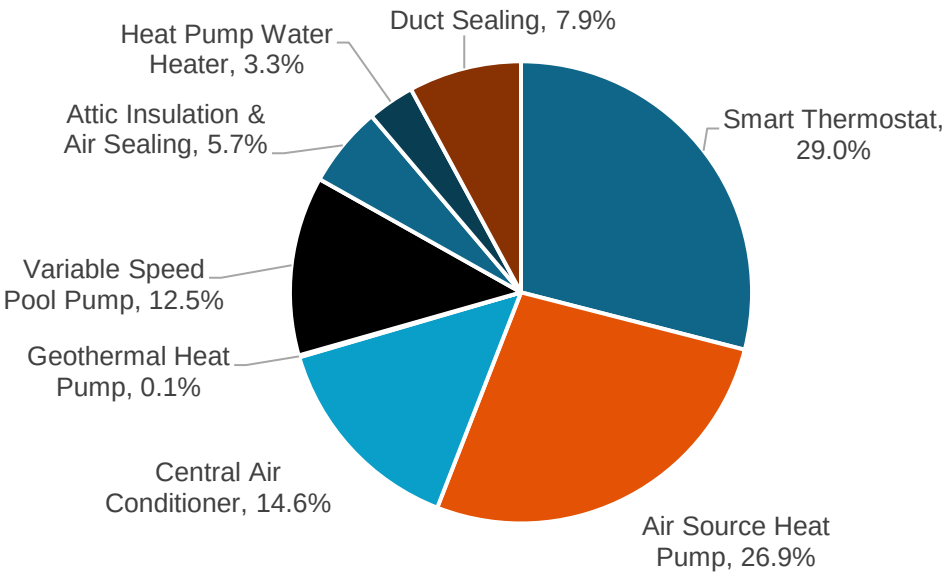


Table 3-1 includes the sampling plan designed for the evaluation period. Note that the web surveys were targeting a 90% confidence and 10% precision with a finite correction factor at the measure level. Only variable speed pool pumps and heat pump water heaters narrowly missed the target. All others were met or exceeded.

Table 3-1: DEC/DEP Impact Sampling Plan

Measure	Metering Sites		Web Survey	
	Achieved	Targeted	Achieved	Targeted
Central Air Conditioner	35	70	232	68
Air Source Heat Pump	35		240	68
Geothermal Heat Pump	n/a	n/a	3	n/a
Smart Thermostat	n/a	n/a	262**	n/a
Attic Insulation & Air Seal	n/a	n/a	144	66
Variable Speed Pool Pump	n/a	n/a	62	65
Duct Sealing	n/a	n/a	83	68
Heat Pump Water Heater	n/a	n/a	55	56
Total	**67***	**70**	**819**	**391**

*Data from three sites were not used in the final metering analysis.
**The total achieved reflects only 819 as Smart Thermostats were an add-on measure.

3.4. Analysis Description

The evaluation team applied varying analysis techniques, based on the measure's technology, its prominence within the program, and the availability of baseline and retrofit savings data. The program participation database provided useful information about measures installed, participants, and some measure-specific parameters. Table 3-2 shows the analysis type applied to each measure.

Table 3-2: Impact Analysis Approach

Measure	Approach
Central Air Conditioner	Metering study and engineering analysis
Air Source Heat Pump	Metering study and engineering analysis
Geothermal Heat Pump	Engineering analysis
Smart Thermostat	AMI Analysis
Attic Insulation & Air Seal	AMI analysis
Variable Speed Pool Pump	Engineering analysis
Heat Pump Water Heater	Engineering analysis
Duct Sealing	AMI analysis

The following sections describe different impact analysis approaches used for each analyzed program measure.

3.4.1. AMI Analysis

Advanced metering infrastructure (AMI) consumption data provides utility meter data that can be used to estimate energy savings. These data were provided for program participants and for a selection of nonparticipating Duke customers to estimate savings for smart thermostats, duct sealing, and attic insulation and air-sealing measures, using a difference-in-differences methodology.

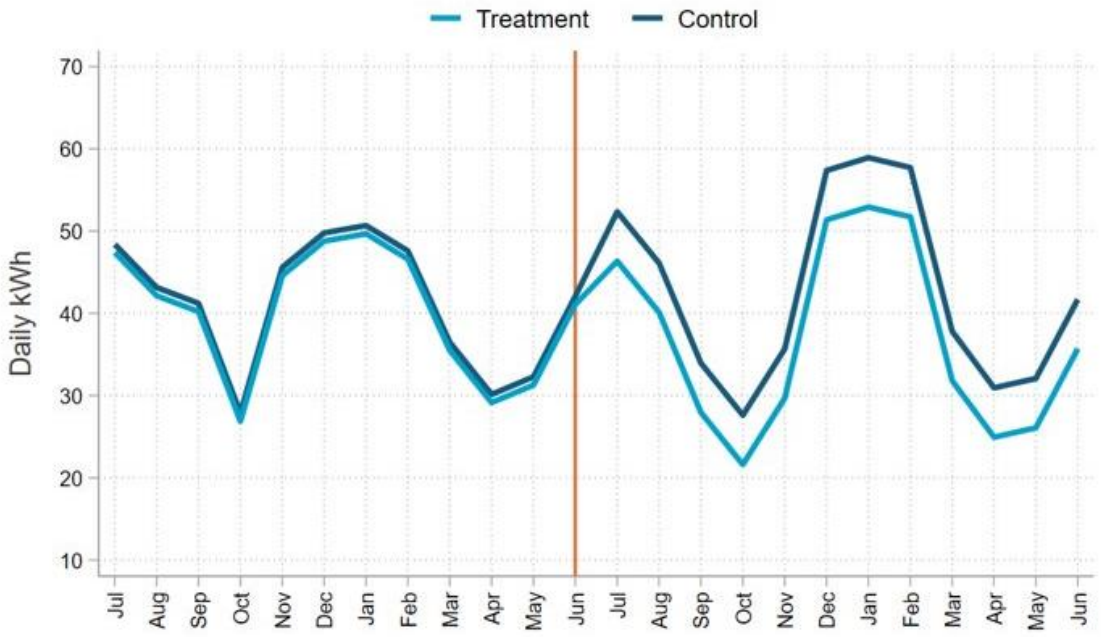
A difference-in-differences methodology compares consumption patterns between treatment and control groups during periods before and after measure implementation. Groups are identical to one another in all observable ways, except that one group received the intervention (treatment) while the other did not (control).

A properly constructed control group should display usage patterns similar to the treatment group's during the pre-intervention period; this provides a baseline during the post-intervention period against which the treatment group's usage can be compared. The evaluation team calculated savings as the difference in post-treatment usage minus the difference in pre-treatment usage. This

way, any pre-existing differences between groups are effectively netted from the calculation, resulting in a net savings estimate.

Figure 3-3 shows a simplified example of the difference-in-differences framework. Both groups exhibit similar usage patterns in the pre-treatment period, illustrating the congruence between groups. After the intervention (indicated by the orange line), an observed reduction in consumption occurs among the treatment group relative to the control group. The growth in the gap between the two blue lines (from the pre-treatment period to the post-treatment period) represents measure savings.

Figure 3-3: Difference-in-Differences Example



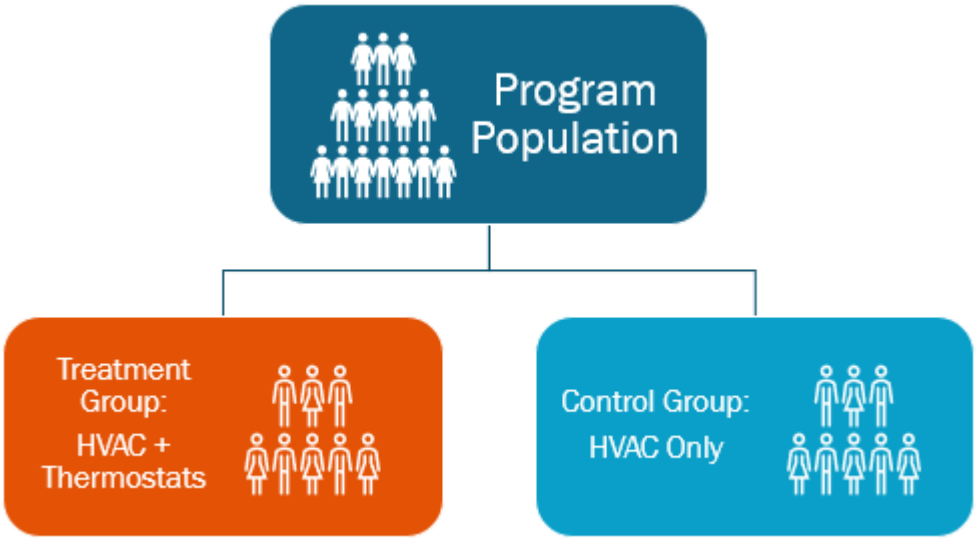
The following subsections outline the analysis for each measure evaluated using a difference-in-differences methodology. The measure populations of DEC and DEP were combined for these analyses, as larger populations can contribute to improving the precision of savings estimates.

3.4.1.1. Smart Thermostats

Resource Innovations estimated savings derived from smart thermostats independently from other program measures, though no standalone smart thermostat option was available to participants. Rather, customers who enrolled in the smart thermostat option through the program also had to enroll in a HVAC upgrade measure. This framework led to some difficulty in isolating savings directly attributable to smart thermostats from savings derived from the HVAC upgrade.

To overcome this challenge, the evaluation team applied a difference-in-differences regression analysis approach, where a control group was constructed of program participants who received an HVAC upgrade but *no* other measures, including smart thermostats. The treatment group consisted of all participants who only received HVAC upgrades *and* smart thermostats.

Figure 3-4: Smart Thermostats Treatment and Control Group Framework



During the 2020-2022 program year, over 37,000 HVAC upgrades were installed for DEC and DEP customers. Of those, over 50% received a smart thermostat. Due to sample sizes, analysis excluded HVAC participants that received gas pack units and geothermal systems. The measure populations of DEC and DEP were combined for smart thermostats, as a larger population can contribute to improved precision of savings estimates.

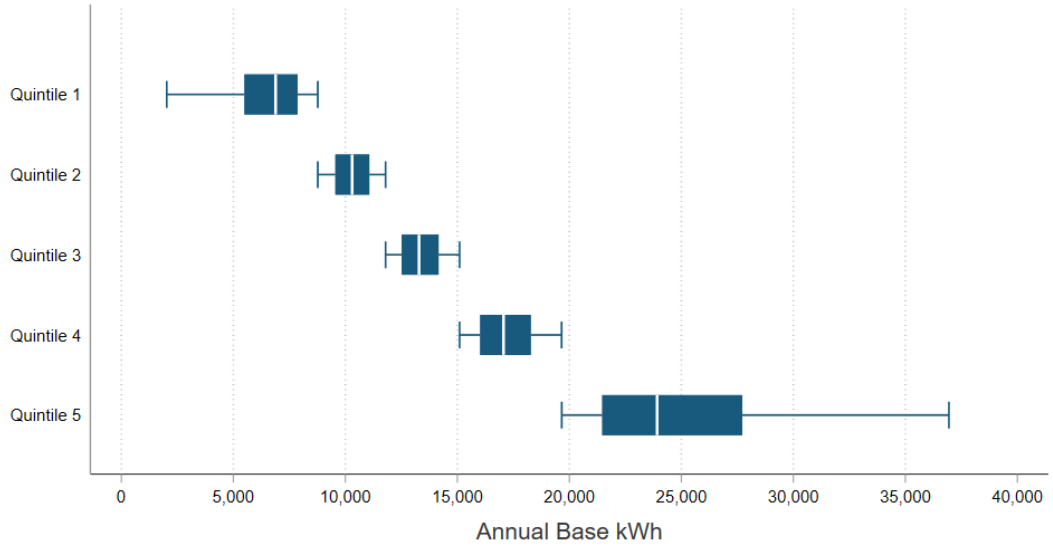
Table 3-3: HVAC and Smart Thermostat Measure Counts

	Total Measures	HVAC Measures
2020 - 2022 Program	49,297	37,171
	Central Air Conditioners	**Air Source Heat Pumps**
HVAC Measures*	16,462	17,004
Thermostats	9,284	9,377

*Does not include gas pack units or geothermal systems.

As space conditioning often makes up the majority of a household's overall energy consumption, HVAC measure savings are generally tethered to a home's total annual energy consumption. Usage data indicates that DEC and DEP participants exhibited a wide range of annual base consumption, with 20% of participants above 20,000 kWh. Figure 3-5 presents the relative distribution of annual consumption (kWh) for smart thermostat enrollees by quintile. For each box-and-whisker plot, the white line represents the mean value, while the outer boundaries of the box serve as the 25th and 75th percentiles. The whiskers extend to the 5th and 95th percentiles.

Figure 3-5: Annual Base Consumption by Quintile



The regression analysis produced the results shown in Table 3-4. The term of interest is the coefficient 1.657, representing the average daily kWh impact attributable to smart thermostats. AMI data analysis results show average annual household savings of 4.2% (605 kWh).

Table 3-4: Smart Thermostat Regression Analysis Results

Coefficient	Annual Base kWh	Annual Savings (kWh)	% Savings	90% Confidence Bounds (kWh)
1.657	14,554	605.081	4.2%	522.102 – 688.059

As discussed, savings derived from smart thermostats largely tie to a home's annual consumption. To illustrate this, Resource Innovations performed a segmented analysis to estimate measure savings as a function of annual household consumption. The team evenly split the population, including treatment and control customers, into five groups (quintiles), and separate regressions were performed on each group. The segmented analysis results indicated that the largest savings (in terms of percentage and kWh) were achieved by the largest consumers.

Table 3-5: Smart Thermostat Regression Analysis Results, by Quintile

Quintile	Coefficient	Annual Base (kWh)	Annual Savings (kWh)	% Savings	90% Confidence Bounds (kWh)
1	0.127	6,497	46.356	0.7%	-113.786 – 206.498
2	1.201	10,304	438.712	4.3%	306.667 – 570.756
3	2.062	13,350	753.215	5.6%	603.005 – 903.425
4	1.959	17,164	715.375	4.2%	528.446 – 902.304
5	2.917	24,455	1,065.401	4.2%	830.640 – 1,300.162

Finally, Resource Innovations performed separate analyses to distinguish savings achieved by equipment types (i.e., CAC vs. ASHP). Customers receiving air source heat pump (ASHP) upgrades with the thermostat option achieved greater kWh savings than customers who received central air conditioner (CAC) upgrades with the thermostat option, as the heat pump is used in heating and cooling seasons. However, on a percentage basis, CAC savings exceeded ASHP savings, which logically stands as customers heating with a heat pump would have a larger overall electric load.

Table 3-6: Smart Thermostat Regression Analysis Results, by Equipment Type

Equipment Type	Annual Base (kWh)	Annual Savings (kWh)	% Savings	90% Confidence Bounds (kWh)
Central Air Conditioners	11,521	562.983	4.9%	465.876 – 660.089
Air-Source Heat Pumps	15,656	638.285	4.1%	503.319 – 773.251

To provide an additional frame of reference, the evaluation team collected a brief list of resources that indicate annual savings for smart thermostats falling within a range of 2.6% to 7.3% across the listed jurisdictions.

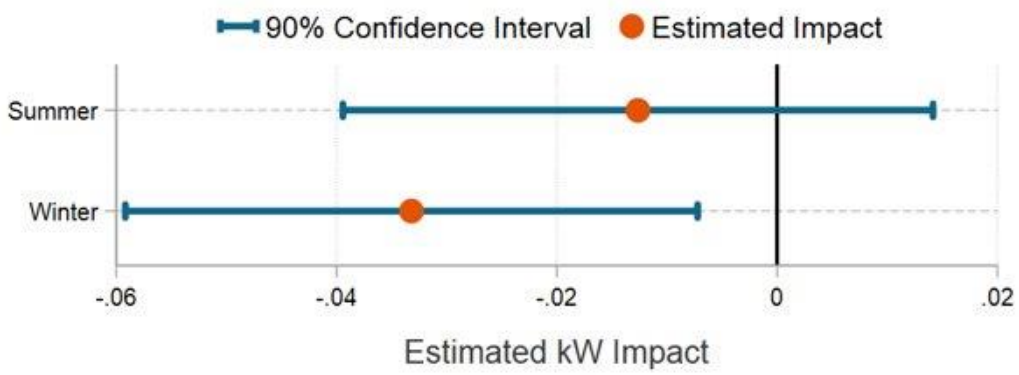
Table 3-7: Smart Thermostats Annual Savings Benchmarks

Source	Annual Savings (kWh)	Percent Savings	Notes
Pennsylvania TRM (2021)	408	4.00%	
Avista Utilities (WA and ID) HVAC Program Evaluation	549	2.60%	Resource Innovations EM&V, 2017
Duke Energy Carolinas/Progress Smart$aver Program Evaluation	605	**4.20%**	**Resource Innovations EM&V, 2023**
Georgia Power Company Home Energy Improvement Program Evaluation	612	4.30%	Resource Innovations EM&V, 2017
Missouri TRM (2017)	614	5.00%	
Arkansas TRM	668	5.30%	
Iowa TRM (v5.0)	724	7.00%	Assumes electric heat; direct install program
Indiana TRM (v2.2)	832	7.30%	
Duke Energy Indiana Smart$aver Program Evaluation	922	6.20%	Resource Innovations EM&V, 2021
Illinois TRM (v10)	1,103	6.20%	Heating consumption only

In addition to the overall savings analysis, the team performed a peak demand analysis for smart thermostats. Hourly AMI data were analyzed to determine if DEC and DEP summer and winter peak periods realized statistically significant savings. DEC and DEP define the summer peak period as weekdays in July from 4:00 PM—5:00 PM and the winter period as weekdays in January from 7:00 AM—8:00 AM.

Figure 3-6 presents estimated kW impacts for summer and winter peak demand analyses. The winter peak demand analysis showed statistically significant savings of 0.033 kW, while the summer peak demand analysis did not show statistically significant savings. Note that TRMs generally state that there are no expected peak demand impacts for smart thermostats unless used in conjunction with a demand-response program.

Figure 3-6: Peak Demand for Summer and Winter Season



A summary table showing verified savings and realization rates for Smart Thermostats is presented in Table 3-8.

Table 3-8: Smart Thermostat Verified Savings (Per Unit)

Service Territory	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	Energy (kWh)	341.110	177%	605.081
	Summer Demand (kW)	0.0000	N/A	0.0000
	Winter Demand (kW)	0.0000	N/A	0.0332
Duke Energy Progress	Energy (kWh)	306.485	197%	605.081
	Summer Demand (kW)	0.0000	N/A	0.0000
	Winter Demand (kW)	0.0000	N/A	0.0332

3.4.1.2. Attic Insulation and Air Sealing, Duct Sealing

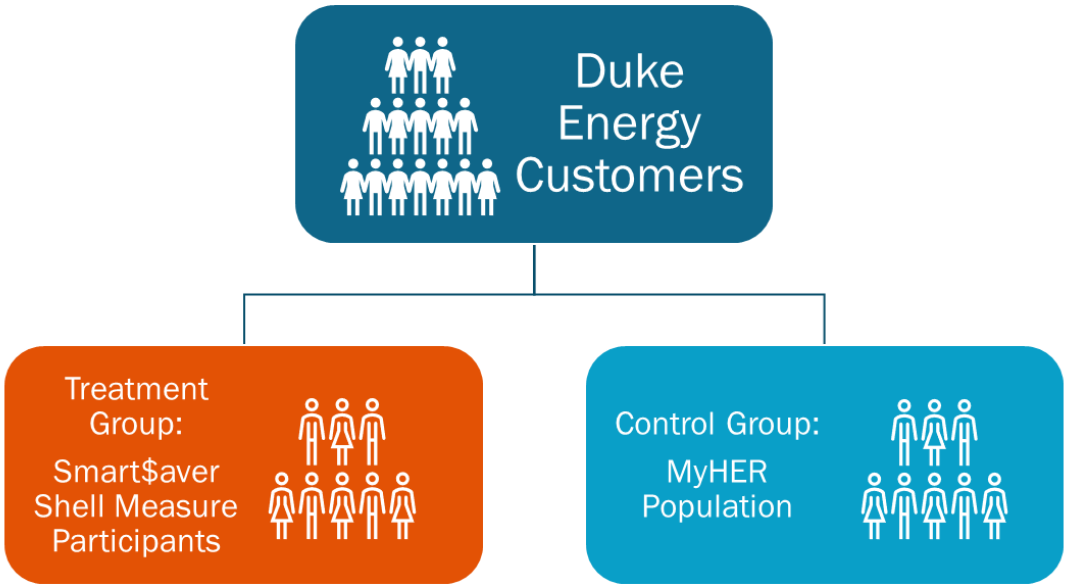
The evaluation team estimated savings derived from building envelope measures using AMI consumption data in a difference-in-differences methodology. Building envelope measures offered through the Smart $aver program include the following:

- Attic Insulation and Air Sealing
- Duct Sealing

AMI analysis differs from algorithm-based engineering approaches, as it is not subject to potential biases stemming from assumptions, customer surveys, and/or secondary studies. In addition, air leakage data, which serves as a necessary parameter in the algorithm used to estimate savings, was not collected for participants receiving these measures during the evaluation period. As a result, the team applied AMI consumption analysis for these measures as an alternative solution. The measure populations of DEC and DEP were combined for attic insulation and air sealing, as a larger population can contribute to improved precision of savings estimates. DEC and DEP measure populations were also combined for duct sealing.

For each measure, the team constructed treatment and control groups, which form the basis of a difference-in-differences analysis. Treatment groups consisted of participants who received the program intervention - duct sealing or attic insulation and air sealing - but no other measures through the Smart $aver program. Control groups were comprised of Duke Energy customers who did not participate in the Smart $aver program. Data from Duke Energy's My Home Energy Report (MyHER) program was utilized to construct these control groups.

Figure 3-7: Attic Insulation and Air Sealing, Duct Sealing Treatment and Control Group Framework



The evaluation team applied the same modeling technique to consumption data to estimate annual savings attributable to a measure. Energy savings were estimated per the model provided in Equation 3-1.

Equation 3-1: Energy Savings Model Specification

$$kWh = \beta_0 + \beta_1 \times month + \beta_2 \times partpost + \varepsilon$$

The model's key output was the β_2 coefficient of the *partpost* term, which represents the estimated change in average daily energy consumption among participants in the post-enrollment period. This modelling approach accounted for changes related and not related to the program, thus representing net savings.

Hourly load impacts during summer and winter peak periods were estimated by applying a similar difference-in-differences modeling approach. The model specification used to estimate hourly peak load impacts is shown in Equation 3-2.

Equation 3-2: Peak Demand Savings Model Specification

$$kW = \beta_0 + \beta_1 \times partpost + \varepsilon$$

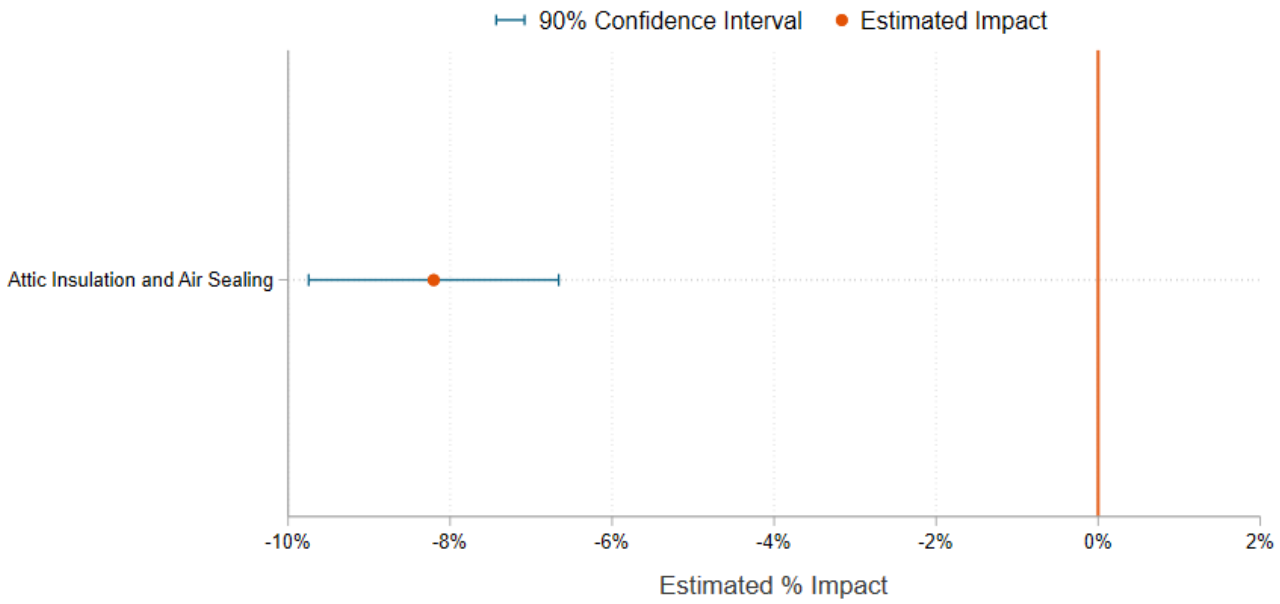
The model's key output was the β_1 coefficient of the *partpost* term. This coefficient represented the estimated change in average hourly energy consumption among participants in the post-enrollment period.

The following subsections discuss annual savings results for attic insulation and air sealing and for duct sealing.

3.4.1.2.1. Attic Insulation and Air Sealing

As noted, the evaluation team applied an energy savings model specification to AMI-based consumption data. Figure 3-8 shows the energy impact result for attic insulation and air sealing.

Figure 3-8: Attic Insulation and Air Sealing Energy Savings



The results provided assurance that the estimation approach effectively detected measure impacts, as the model estimates a 6.6% to 9.7% reduction in home energy use. Model specifications used to estimate energy and peak demand impacts have been described in Equation 3-1 and Equation 3-2, respectively. Table 3-9 shows model outputs for energy and demand savings.

Table 3-9: Attic Insulation and Air Sealing Savings Estimates (DEC/DEP)

Measurement	Annual Savings	Upper Bound	Lower Bound	% Savings
Energy (kWh)	1,087.384	1,291.991	882.776	8.2%
Summer Demand (kW)	0.3417	0.3847	0.2987	11.4%
Winter Demand (kW)	0.1274	0.1693	0.0854	6.8%

Comparing verified savings to reported savings indicated energy realization rates of 111% in DEC and 93% in DEP. Demand realization rates varied significantly, with summer demand realization rates above 160% and winter demand realization rates below 65%. Verified peak demand impacts, however, aligned with savings expectations for this measure, as over 98% of Duke Energy customers possess an electrically powered cooling system, while only 70% of customers use electricity as their

home's main energy source to heat their home.[4] As such, electrical savings were expected to be higher in the cooling season relative to the heating season.

Table 3-10: Attic Insulation & and Air Sealing Verified Savings (Per Unit)

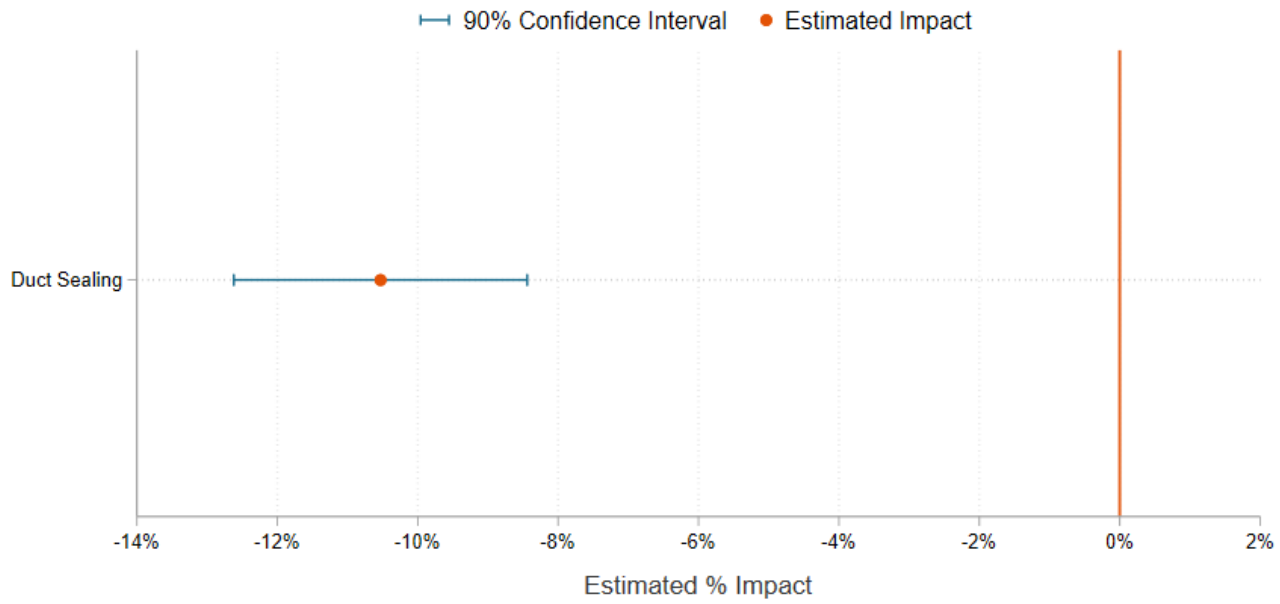
Service Territory	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	Energy (kWh)	979.676	111%	1,087.384
	Summer Demand (kW)	0.2101	163%	0.3417
	Winter Demand (kW)	0.3081	41%	0.1274
Duke Energy Progress	Energy (kWh)	1,163.000	93%	1,087.384
	Summer Demand (kW)	0.1922	178%	0.3417
	Winter Demand (kW)	0.2020	63%	0.1274

3.4.1.2.2. Duct Sealing

The evaluation team applied an energy savings model specification to AMI-based consumption data. Energy savings results for duct sealing are shown in Figure 3-9.

[4] 2022 Residential End-Use Appliance Study, Duke Energy, December 2022.

Figure 3-9: Duct Sealing Energy Savings



The results provided assurance that the estimation approach effectively detected measure impacts, as the model estimates a 10.5% to 12.6% reduction in home energy use. Model specifications used to estimate energy and peak demand impacts are shown in Equation 3-1 and Equation 3-2, respectively. Model outputs are shown below in Table 3-11.

Table 3-11: Duct Sealing Savings Estimates (DEC/DEP)

Measurement	Annual Savings	Upper Bound	Lower Bound	% Savings
Energy (kWh)	1,284.182	1,538.989	1,029.374	10.5%
Summer Demand (kW)	0.4453	0.5008	0.3897	14.4%
Winter Demand (kW)	0.1746	0.2244	0.1247	12.2%

Realization rates were extremely high for the duct sealing measure across all measurements. This suggests that engineering algorithms used to develop reported savings estimates may have severely underestimated savings attributable to duct sealing. Note that these engineering algorithms rely heavily on assumptions from secondary sources to estimate energy saved due to reductions in air leaks as well as measurements of air leakage collected before and after installation. This contrasts to the AMI-based consumption analysis, which only relied on utility meter data and installation dates.

Table 3-12: Duct Sealing Verified Savings (Per Unit)

Service Territory	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	Energy (kWh)	429.845	299%	1,284.182
	Summer Demand (kW)	0.1735	257%	0.4453
	Winter Demand (kW)	0.1388	126%	0.1746
Duke Energy Progress	Energy (kWh)	350.000	367%	1,284.182
	Summer Demand (kW)	0.2805	159%	0.4453
	Winter Demand (kW)	0.0000	N/A	0.1746

3.4.2. Metering Study

Given that a large share of overall program savings derives from ASHPs and CACs, the evaluation team applied an end-use metering approach for analysis of these two measures. The units' heating/cooling efficiencies and capacities were provided by the program database or obtained from the Air-Conditioning, Heating, & Refrigeration Institute (AHRI). The evaluation team collected system usage data through a data logging device installed directly on the household's HVAC equipment. The metering study enabled an estimate of cooling and heating Equivalent Full Load Hours (EFLH) for the program. The metering study's methodology followed the Uniform Methods Project (UMP) and most closely resembles *IPMVP Option A: Partial Retrofit Isolation/Metered Equipment*.

3.4.2.1. Data Collection

To complete the metering study, field engineers were dispatched to recruited homes of Smart $aver participants who received a rebate for an air source heat pump or central air conditioner replacement. Participants taking part in the metering study were provided with a $100 incentive, divided across two visits to their home. Seventy sites were metered across the combined DEC and DEP territories. Three sites were dropped due to data quality and ultimately 67 sites were used in the analysis, including 34 central air conditioners and 33 air source heat pumps. All meters were installed in August and September 2022 and collected in February and March 2023.

During site visits, field engineers performed various data collection activities. Voltage, amperage, and power factor spot measurements were taken on each unit while in operation. The field team obtained unit specifications (including capacity) from each system's nameplate information. Finally, the team connected a HOBO CTV-A current transducer (CT) on conductors supplying electricity to condensing units located on the exteriors of the homes to record electrical current measurements. By pairing the CT with a U12-006 data logger that stored each data point at 10-minute intervals, the team collected a trended data log of electrical current over the metered period.

The evaluation team used data collected through the metering study in a regression analysis that supplied an estimated EFLH for both cooling and heating periods.

3.4.3. Analysis, Regression, EFLH Calculation

Estimating annual cooling and heating savings for air source heat pumps and central air conditioners required three primary inputs:

1. Capacity: the size (kBtuh) of the efficient unit.
2. Efficiency: the SEER or Heating Seasonal Performance Factor (HSPF) value of the efficient unit.
3. Equivalent Full Load Hours (EFLH): a measurement of unit operation relative to the unit's full capacity.

EFLH provides an effective measure for estimating cooling and heating requirements for a specific region as well as a comparison of energy use between regions and equipment types. Equation 3-3 shows the general form for the EFLH term.

Equation 3-3: Effective Full Load Hours

$$EFLH_{cool} = \sum_{h=1}^{8760} \frac{Estimated\ Hourly\ Load\ (kW)}{Connected\ Load\ (kW)}$$

Where:

Estimated Hourly Load = Electric demand of the unit in hour h
Connected Load = Electric demand draw of the unit when operating at full power

The evaluation team assigned a connected load to each unit sampled using its metered amperage data, with the full load set as the 99th percentile amperage reading. The underlying assumption is that, for a given HVAC unit, the maximum amperage value represented the electric load required to operate the system at full capacity (or full load). The 99th percentile value allowed a margin of deviation in the meter data. The hourly load, also obtained from the logger data, was divided by the full connected load to calculate the unit's runtime for each hour during the metered period.

The team collected hourly weather records for the full metering period (August 2022 through March 2023) from the closest airport weather station[5] to develop a relationship between observed HVAC system usage runtimes and outdoor temperatures. In addition, the team obtained data for

[5] Airport weather stations included Asheville Regional Airport, Charlotte Douglas International Airport, Piedmont Triad International Airport (Greensboro, NC), Raleigh-Durham International Airport, and Wilmington International Airport

typical meteorological year (TMY3) weather and applied the observed relationship between runtimes and weather to the TMY3 data to estimate annual $EFLH_{heat}$ and $EFLH_{cool}$ for a typical year.

Due to the timing of the metered period, the data loggers captured only a few months of the cooling season. This produced fewer observations for the $EFLH_{cool}$ analysis, leading to marginally greater uncertainty in the results. Nevertheless, as the metering period covered portions of cooling and heating seasons, the team performed the regression analysis twice to estimate annual $EFLH_{cool}$ and annual $EFLH_{heat}$ separately.

The team split the meter data into two separate datasets. The first only contained observations where average daily temperatures exceeded the base temperature of 65 °F or where temperatures indicated cooling. The second contained observations where average daily temperatures fell below the base temperature of 65 °F or where outdoor temperatures indicated heating.

The evaluation team developed weather-normalized estimates of $EFLH_{cool}$ for each unit in the sample using a linear regression model of observed runtimes as a function of observed cooling degree days (base 65 °F) during the cooling season. Figure 3-10 shows the relationship between average daily runtimes (hours) and cooling degree days. Each blue + represents the average air conditioning runtime in hours for each day in the cooling dataset (i.e., each day with an average temperature exceeding 65 °F).

Figure 3-10: Cooling Runtime as a Function of Temperature

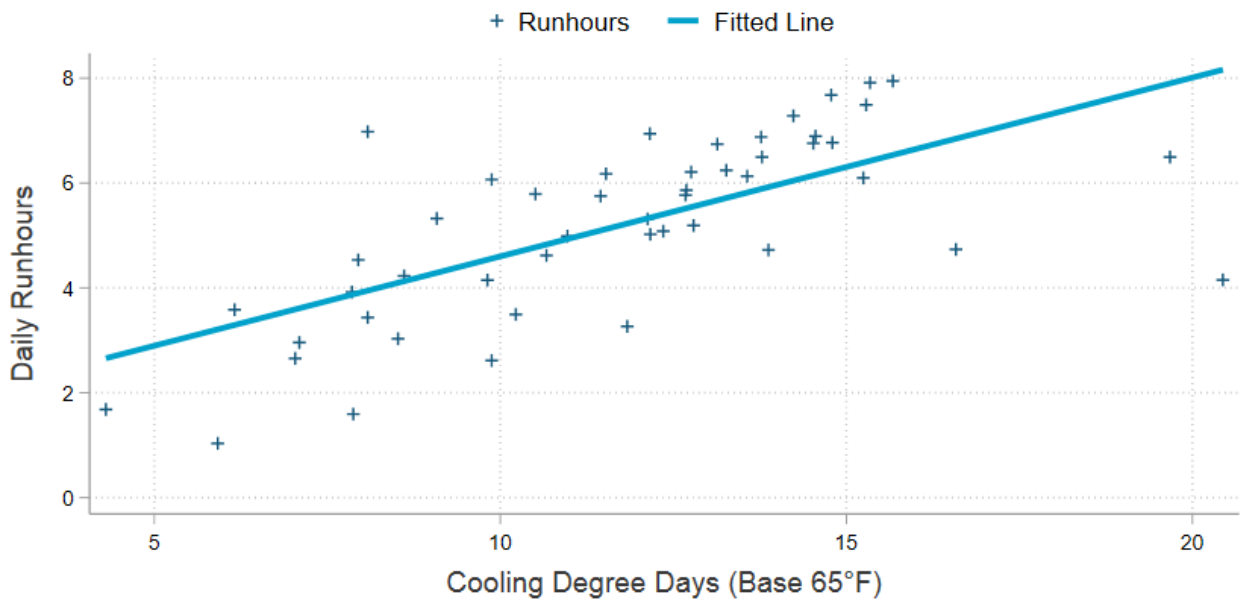


Table 3-13 shows the regression output for the relationship described in Figure 3-10. The key value for consideration is the Cooling Degree Day (CDD) coefficient of 0.46. This term indicates that DEC

and DEP customers used an average of 0.46 hours, or approximately 28 minutes, of additional cooling per CDD.

Table 3-13: $EFLH_{cool}$ Regression Output

Model Term	Coefficient	Std. Err.	t-stat	P-value	[90% Confidence Interval]
CDD	0.46	0.007	64.25	0.000	± 2.56%

The evaluation team ran a similar linear regression model to develop weather-normalized estimates of $EFLH_{heat}$ for each air source heat pump unit. This differed in a key manner: instead of CDD, the model estimated runtimes as a function of observed Heating Degree Days (HDD) during the heating season.

Figure 3-11 shows the relationship between average daily runtimes and HDDs. Each blue + represents the average air source heat pump runtime in hours for each day in the heating dataset (i.e., each day with an average daily temperature below 65°F).

Figure 3-11: Heating Runtime as a Function of Temperature

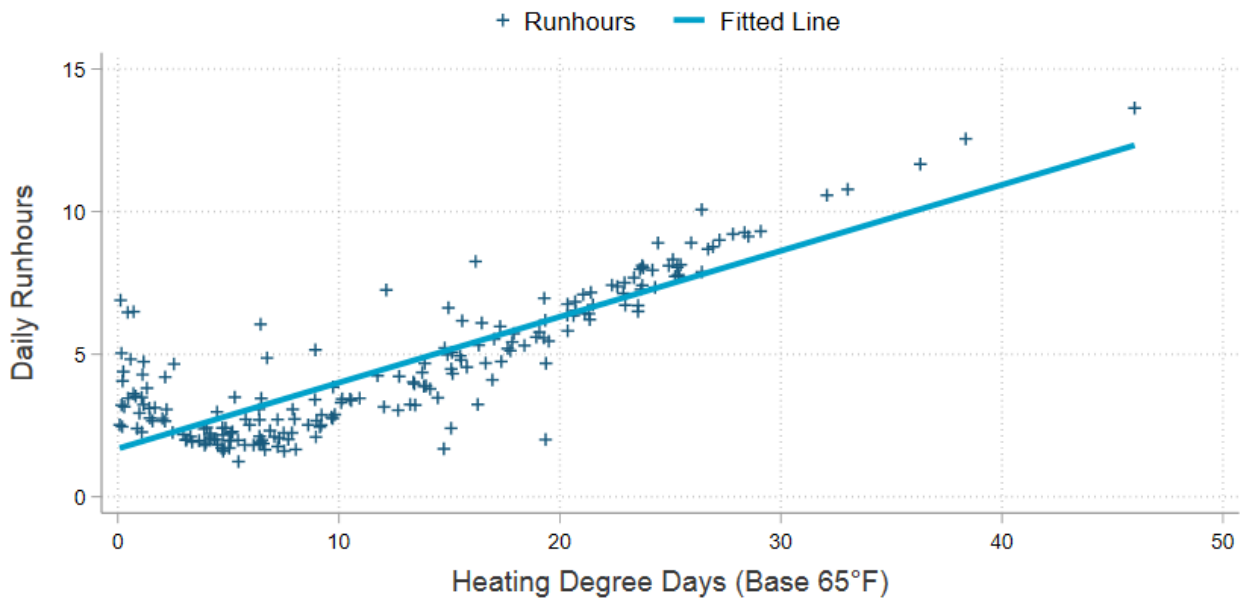


Table 3-14 shows the regression output for the relationship described in Figure 3-11. The coefficient term 0.31 indicates that DEC and DEP customers used an average of 0.31 hours, or approximately 19 minutes, of additional heating per HDD.

Table 3-14: $EFLH_{heat}$ Regression Output

Model Term	Coefficient	Std. Err.	t-stat	P-value	[90% Confidence Interval]
HDD	0.31	0.003	102.99	0.000	± 1.60%

The evaluation team utilized hourly TMY3 data for the closest airport weather station[6] to calculate annual CDD and HDD, employing those values to estimate $EFLH_{cool}$ and $EFLH_{heat}$ for each region. Table 3-15 shows regression coefficients, annual CDD, annual HDD, and estimated EFLH values for each season. $EFLH_{cool}$ and $EFLH_{heat}$ were calculated by multiplying each term's regression coefficient by average CDD and HDD values, determined using TMY3 data.

Table 3-15: EFLH Calculations

Term	Regression Coefficient	Annual Degree Days	EFLH	Relative Precision (at 90% CI)
CDD	0.46	1,907	877	2.56%
HDD	0.31	3,475	1,089	1.60%

Field data collected also provided the peak summer cooling demand coincidence factor (CF_{summer}). Just as the EFLH is a necessary component of the annual energy savings calculations, the peak coincidence factor is a necessary component of the peak demand savings calculation. Peak demand coincidence factor is defined here as the probability that cooling equipment operates during system peak hours. The CF term takes the basic form of a ratio of hourly load to full load during a given hour of the day, as shown in Equation 3-4.

Equation 3-4: Coincidence Factor

$$CF_h = \frac{Hourly\ Load_h\ (kW)}{Full\ Load\ (kW)}$$

Where:

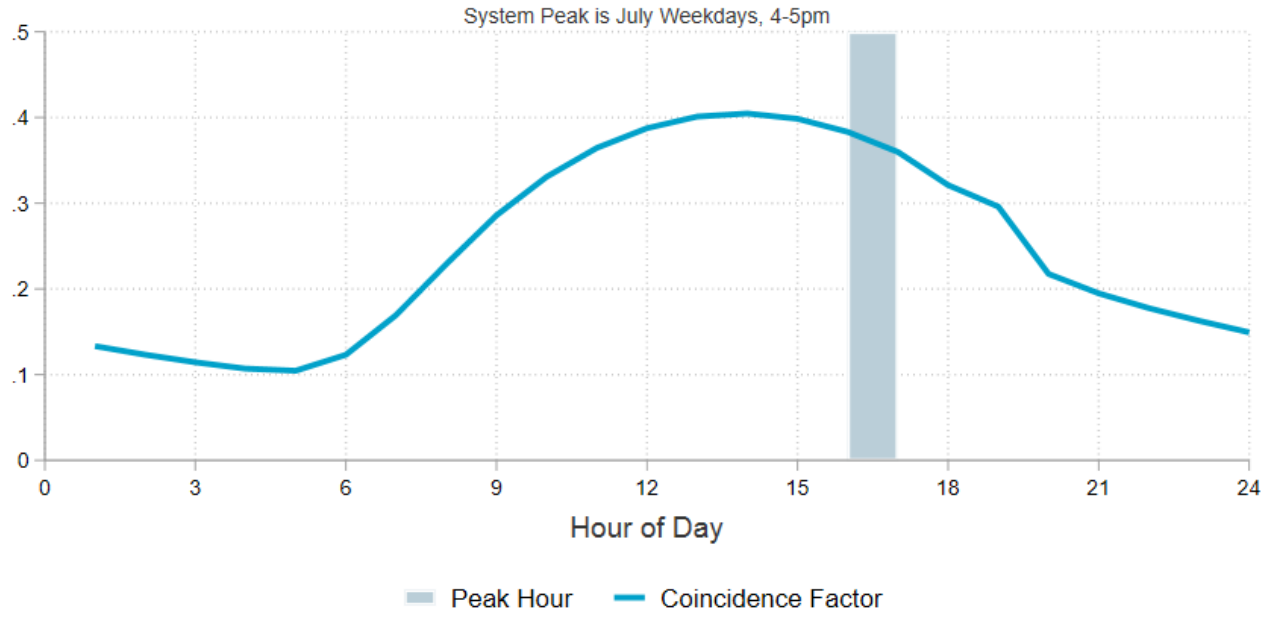
Hourly Load = Electric demand of the unit at hour h
Full Load = Electric demand draw of the unit when operating at full power

The evaluation team calculated the peak demand coincidence factor to estimate peak demand savings for the sample. A system's peak demand period refers to the period during which the highest power level is required to satisfy its electric demand requirement. DEC and DEP define the summer

[6] Airport weather stations included Asheville Regional Airport, Charlotte Douglas International Airport, Piedmont Triad International Airport (Greensboro, NC), Raleigh-Durham International Airport, and Wilmington International Airport

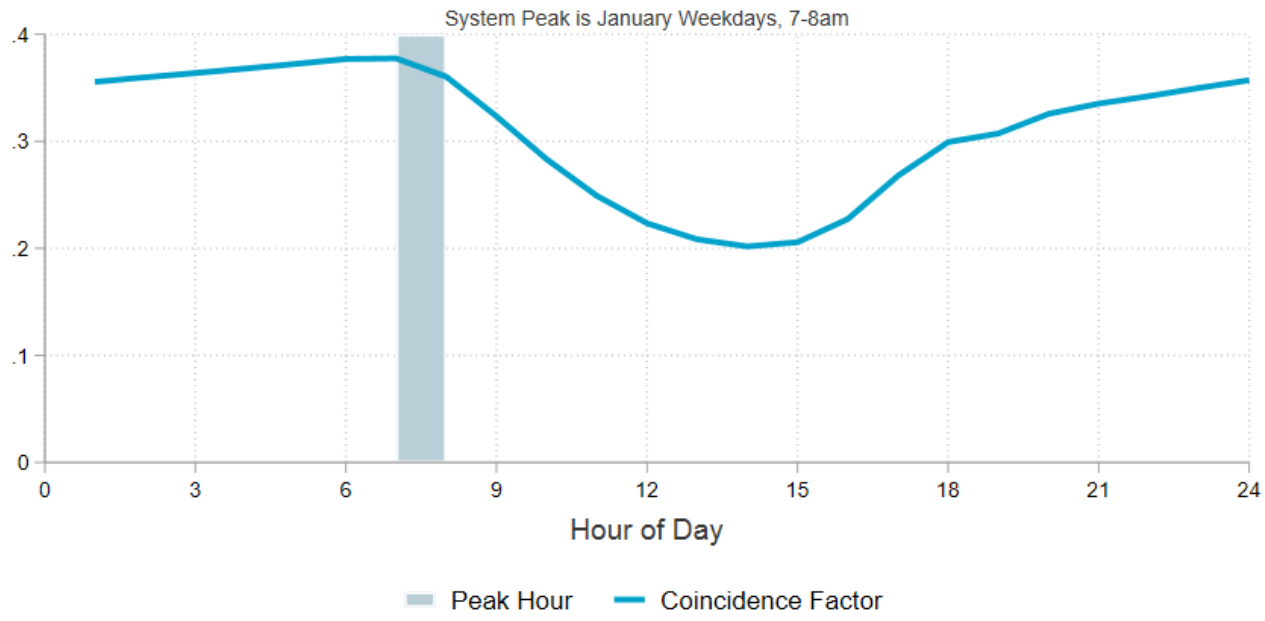
peak period as July weekdays, between 4:00 pm and 5:00 pm (hour ending 17). Figure 3-12 shows the average CF_{summer} load curve for the metered sample and highlights the system's peak period in light blue. The CF_{summer} during the system peak was 0.3599.

Figure 3-12: Summer Peak Demand Coincidence Factor



Additionally, the evaluation team calculated the peak winter heating demand coincidence factor. DEC and DEP define the winter peak period as January weekdays, between 7:00 am and 8:00 am (hour ending 8). Figure 3-13 shows the average CF_{winter} load curve for each weekday of January and highlights the system's winter peak period in light blue. The CF_{winter} during the system peak was 0.3604.

Figure 3-13: Winter Peak Demand Coincidence Factor



3.4.4. Engineering Analysis

The following sections describe engineering analyses performed for each remaining measure type in the Smart $aver program:

- Central Air Conditioners
- Air Source Heat Pumps
- Geothermal Heat Pumps
- Variable Speed Pool Pumps
- Heat Pump Water Heaters

3.4.4.1. Central Air Conditioner Savings Calculation

The team evaluated central air conditioner measures using an engineering analysis of each participant using algorithms provided in the Mid-Atlantic TRM V10, as outlined in Equation 3-5 and Equation 3-6.

Equation 3-5: Central Air Conditioner Energy Savings Algorithm

$$\Delta kWh = EFLH_{cool} \times kBtuh_{cool} \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right)$$

Equation 3-6: Central Air Conditioner Demand Savings Algorithm

$$\Delta kW_{Summer} = kBtuh_{cool} \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times CF_{Summer}$$

Table 3-16 provides savings parameter inputs for central air conditioner measures and their sources. For comparison purposes, the evaluation also examined algorithm input parameters from the 2018 DEC Smart $aver evaluation and 2014 DEP Home Energy Improvement Program (HEIP) evaluation. The team sourced parameters from the Mid-Atlantic TRM V10 or the metering study discussed in Section 3.4.2 and applied these to each participant in the dataset. This allowed savings to be calculated for each participant using these parameters as well as the efficiency ratios and capacities specific to the participant. For comparison purposes, this report provides population averages from the program dataset.

Table 3-16: Inputs for Central Air Conditioning Energy and Demand Savings

Variable	Source	2023 DEC Evaluation		2023 DEP Evaluation		2018 DEC Evaluation		2014 DEP Evaluation	
		Tier 2	Tier 3	Tier 2	Tier 3	Tier 2	Tier 3	Single Family	Multi-Family
$EFLH_{cool}$	Metering Study	877				752		688	619
$kBtuh_{cool}$	Population Average	31.6	35.2	30.9	34.7	32.0	32.8	31.6	28.1
$SEER_{base}$	Mid-Atlantic TRM V10	14				14		13	
$SEER_{ee}$	Population Average	15.6	17.9	15.6	18.1	15.7	18.1	15.8	15.4
EER_{base}	Mid-Atlantic TRM V10	11.8				-		-	
EER_{ee}	Population Average	12.7	12.9	12.6	12.7	-		-	
CF_{Summer}	Metering Study	0.360				0.475		0.486	
ECM kWh Savings	Secondary Sources	0				31		-	
ECM Winter kW Savings	Secondary Sources	0				0.167		-	

Additionally, Table 3-16 shows a decrease in the summer peak coincidence factor, relative to previous evaluations, leading to a decrease in summer peak demand savings. The 2018 DEC Smart $aver evaluation determined that energy and winter demand savings from electrically commutated motor (ECM) furnace fans were attributable to program participation due to the more efficient

furnace fan motor operating year-round as part of the HVAC system. On July 3, 2019, however, the federal code governing fan efficiency ratios (FERs) of residential furnace fans was updated, which included an increase to the minimum FER required of a furnace fan, such that ECM furnace fans are now an effective baseline for residential furnace fan motors. Therefore, savings could no longer be attributed to ECM furnace fans, unless it could be shown that the installed fan's FER exceeded the federal code minimum. Thus, winter demand savings were set to zero.

Table 3-17 presents energy and demand savings for central air conditioners.

Table 3-17: Central Air Conditioner Gross Verified Savings (Per Unit)

Service Territory	Tier	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	2	Energy (kWh)	213.481	92%	196.086
		Summer Demand (kW)	0.1162	58%	0.0668
		Winter Demand (kW)	0.1643	0%	0.000
	3	Energy (kWh)	426.380	112%	478.786
		Summer Demand (kW)	0.2511	33%	0.0839
		Winter Demand (kW)	0.1630	0%	0.0000
Duke Energy Progress	2	Energy (kWh)	223.558	86%	193.171
		Summer Demand (kW)	0.1305	45%	0.0586
		Winter Demand (kW)	0.0307	0%	0.0000
	3	Energy (kWh)	289.844	168%	488.111
		Summer Demand (kW)	0.2009	29%	0.0578
		Winter Demand (kW)	-0.0477	0%	0.0000

3.4.4.2. Air Source Heat Pump Savings Calculation

The evaluation team conducted an engineering analysis for air source heat pump measures for each participant using algorithms given in Mid-Atlantic TRM V10, as outlined in Equation 3-7 and Equation 3-8.

Equation 3-7: Air Source Heat Pump Energy Savings Algorithm

$$\Delta kWh = EFLH_{cool} \times kBtuh_{cool} \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right) + EFLH_{heat} \times kBtuh_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right)$$

Equation 3-8: Air Source Heat Pump Demand Savings Algorithms

$$\Delta kW_{Summer} = kBtuh_{cool} \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times CF_{Summer}$$

$$\Delta kW_{Winter} = kBtuh_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right) \times CF_{Winter}$$

Table 3-18 shows savings parameter inputs for air source heat pump measures. Algorithm input parameters from the 2018 DEC Smart $aver evaluation and 2014 DEP HEIP evaluation are provided for comparison. Parameters sourced from Mid-Atlantic TRM V10 or the metering study discussed in Section 3.4.2 were applied to each participant in the dataset. Savings were calculated for each participant using these parameters as well as participant-specific efficiency ratios and capacities. The report includes population averages from the program dataset for comparison.

Table 3-18: Inputs for Air Source Heat Pump Energy and Demand Savings

Variable	Source	2023 DEC Evaluation		2023 DEP Evaluation		2018 DEC Evaluation		2014 DEP Evaluation	
		Tier 2	Tier 3	Tier 2	Tier 3	Tier 2	Tier 3	Single Family	Multi-Family
$EFLH_{cool}$	Metering Study	877				752		688	619
$kBtuh_{cool}$	Population Average	29.9	34.1	30.1	34.5	30.2	32.8	31.8	28.4
$SEER_{base}$	Mid-Atlantic TRM V10	14				10/14		13	
$SEER_{ee}$	Population Average	15.5	18.2	15.4	18.3	15.5	18.3	15.8	15.4
EER_{base}	Mid-Atlantic TRM V10	11.8				-		-	
EER_{ee}	Population Average	12.6	12.5	12.6	12.5	-		-	
$EFLH_{heat}$	Metering Study	1,089				698		1,295	1,283
$kBtuh_{heat}$	Population Average	28.6	32.5	29.0	32.9	30.2	32.8	29.7	26.5
$HSPF_{base}$	Mid-Atlantic TRM V10	8.2				6.8/8.2		7.7	
$HSPF_{ee}$	Population Average	8.9	9.6	8.8	9.7	8.8	9.7	8.9	8.6
CF_{Summer}	Metering Study	0.360				0.475		0.486	
CF_{Winter}	Metering Study	0.360				0.588		0.432	

Table 3-18 shows that baseline SEER and baseline HSPF have increased since previous evaluations, leading to lower savings during the heating season. Summer and winter peak coincidence factors decreased, which reduced summer and winter peak demand savings. Within DEP's territory, energy realization rates were very high, primarily due to low reported energy savings in DEP relative to DEC.

Table 3-19 and Table 3-20 show energy and demand savings for air source heat pumps.

Table 3-19: Air Source Heat Pump Gross Verified Savings by Season (Per Unit)

Service Territory	Season	Tier	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Duke Energy Carolinas	Cooling	2	184.901	0.0572	0.0000
		3	490.004	0.0468	
	Heating	2	290.165	0.0000	0.0961
		3	638.997		0.2115
	Total	**2**	**475.066**	**0.0572**	**0.0961**
		3	**1,129.001**	**0.0468**	**0.2115**
Duke Energy Progress	Cooling	2	176.209	0.0525	0.0000
		3	497.149	0.0448	
	Heating	2	261.409	0.0000	0.0865
		3	684.467		0.2266
	Total	**2**	**437.618**	**0.0525**	**0.0865**
		3	**1,181.616**	**0.0448**	**0.2266**

Table 3-20: Air Source Heat Pump Gross Verified Savings (Per Unit)

Service Territory	Tier	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	2	Energy (kWh)	413.289	115%	475.066
		Summer Demand (kW)	0.1258	45%	0.0572
		Winter Demand (kW)	0.1810	53%	0.0961
	3	Energy (kWh)	963.698	117%	1,129.001
		Summer Demand (kW)	0.3013	16%	0.0468
		Winter Demand (kW)	0.4034	52%	0.2115
Duke Energy Progress	2	Energy (kWh)	292.602	150%	437.618
		Summer Demand (kW)	0.1090	48%	0.0525
		Winter Demand (kW)	0.0966	90%	0.0865
	3	Energy (kWh)	415.849	284%	1,181.616
		Summer Demand (kW)	0.1650	27%	0.0448
		Winter Demand (kW)	0.0240	945%	0.2266

3.4.4.3. Geothermal Heat Pump Savings Calculation

Geothermal heat pumps, which make use of constant ground temperatures to provide heating and cooling, operate at higher efficiency levels than air source heat pumps. The Smart $aver Program provided incentives for these systems to encourage participants to install higher-efficiency HVAC systems for their homes. Geothermal heat pumps, however, were excluded from the EFLH metering study. Rather, the evaluation team estimated savings based on the assumption that heating and cooling EFLH for a geothermal heat pump would be equivalent to an air source heat pump. Equation 3-9 and Equation 3-10 provide savings algorithms for geothermal heat pump measures.

Equation 3-9: Geothermal Heat Pump Energy Savings Algorithm

$$\Delta kWh = EFLH_{cool} \times kBtuh_{cool} \times \left(\frac{1}{SEER_{base}} - \frac{1}{EER_{ee}}\right) + EFLH_{heat} \times kButh_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{COP_{ee} \times 3.412}\right)$$

Equation 3-10: Geothermal Heat Pump Demand Savings Algorithms

$$\Delta kW_{Summer} = kBtuh_{cool} \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right) \times CF_{Summer}$$

$$\Delta kW_{Winter} = kBtuh_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{COP_{ee} \times 3.412}\right) \times CF_{Winter}$$

Table 3-21 shows savings parameter inputs for geothermal heat pump measures. Algorithm input parameters from the 2018 DEC Smart $aver evaluation and 2014 DEP HEIP evaluation are provided for comparison. The evaluation team applied parameters sourced from Mid-Atlantic TRM V10 or the metering study discussed in Section 3.4.2 to each participant in the dataset. Savings were calculated for each participant using these parameters, as well as efficiency ratios and capacities specific to the participant. Population averages from the program dataset are provided for comparison.

Table 3-21: Inputs for Geothermal Heat Pump Gross Verified Savings

Variable	Source	2023 DEC Evaluation	2023 DEP Evaluation	2018 DEC Evaluation	2014 DEP Evaluation[7]
$EFLH_{cool}$	Metering Study	877		752	-
$kBtuh_{cool}$	Population Average	36.9	42.9	49.6	-
$SEER_{base}$	Mid-Atlantic TRM V10	14		14.0	-
EER_{base}	Mid-Atlantic TRM V10	11.8		-	-
EER_{ee}	Population Average	20.0	20.7	-	-
$SEER_{ee}$	Population Average	-	-	24.2	-
$EFLH_{heat}$	Metering Study	1,089		698	-
$kBtuh_{heat}$	Population Average	32.5	36.0	49.6	-
$HSPF_{base}$	Mid-Atlantic TRM V10	8.2		8.2	-
COP_{ee}	Population Average	3.9	4.1	3.7	-
CF_{Summer}	Metering Study	0.360		0.475	-
CF_{Winter}	Metering Study	0.360		0.588	-

[7] Input parameters are not provided for the 2014 DEP evaluation, as deemed savings were applied for geothermal heat pump measures.

Input parameters noted in Table 3-21 compare the 2023 and 2018 evaluations. This measure's reported savings, however, were not based on results from previous evaluations as geothermal heat pumps were reported with the same savings as Tier 3 air source heat pumps. Comparisons of these input parameters are not expected to directly correlate to this measure's realization rates.

Table 3-22 and Table 3-23 provide energy and demand savings for geothermal heat pumps.

Table 3-22: Geothermal Heat Pump Gross Verified Savings by Season (Per Unit)

Service Territory	Season	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Duke Energy Carolinas	Cooling	670.827	0.4524	0.0000
	Heating	1,580.382	0.0000	0.5232
	Total	**2,251.210**	**0.4524**	**0.5232**
Duke Energy Progress	Cooling	843.858	0.5521	0.0000
	Heating	1,980.770	0.0000	0.6554
	Total	2,823.628	0.5521	0.6554

Table 3-23: Geothermal Heat Pump Gross Verified Savings (Per Unit)

Service Territory	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	Energy (kWh)	980.833	230%	2,251.210
	Summer Demand (kW)	0.3060	148%	0.4524
	Winter Demand (kW)	0.4183	125%	0.5232
Duke Energy Progress	Energy (kWh)	415.849	679%	2,823.628
	Summer Demand (kW)	0.1650	335%	0.5521
	Winter Demand (kW)	0.0240	2,732%	0.6554

3.4.4.4. Variable Speed Pool Pumps

Variable speed pool pumps save the participant energy by reducing flow rates through a pump. Reducing the pump's flow by 50% is expected to save 87% of the energy needed to operate the system.

The evaluation team applied model number data provided by the Duke Energy Carolinas and Duke Energy Progress Smart $aver Program databases to estimate pump horsepower. The algorithms provided by Indiana TRM V2.2 estimate the consumption of a standard, single-speed pool pump, then applies an energy savings factor (ESF) and a demand savings factor (DSF), based on expected usage of a variable-speed motor. These algorithms allowed the evaluation team to calculate savings based on the actual horsepower of pool pumps rebated through the program, while also utilizing pool pump usage data collected in participant surveys. Equation 3-11 and Equation 3-12 provide the savings algorithms.

Equation 3-11: Variable Speed Pool Pump Energy Savings Algorithm

$$\Delta kWh = \frac{HP \times LF \times 0.746}{\eta_{pump}} \times \frac{Hrs}{Day} \times \frac{Days}{Year} \times ESF$$

Equation 3-12: Variable Speed Pool Pump Demand Savings Algorithm

$$\Delta kW_{Summer} = \frac{HP \times LF \times 0.746}{\eta_{pump}} \times DSF \times CF_{Summer}$$

Table 3-24 provides input parameters for the above algorithms.

Table 3-24: Inputs for Variable Speed Pool Pump Gross Verified Savings

Variable	Source	2023 DEC Evaluation	2023 DEP Evaluation	2018 DEC Evaluation
HP	Population Average	2.43	2.01	2.02
LF	Indiana TRM V2.2	66%		66%
η_{Pump}	Indiana TRM V2.2	33%		33%
Hours/Day	Participant Survey	16.6	13.5	6.0
Days/Year	Participant Survey	153.5	143.5	154.0
ESF	Indiana TRM V2.2	86%		-
DSF	Indiana TRM V2.2	91%		91%
CF_{Summer}	Indiana TRM V2.2	0.83		0.20

Table 3-24 shows input parameters for variable speed pool pumps. The evaluation team sourced time-of-use variables, including hours per day and days per year, from participant survey data. This represented a change from previous evaluations, which relied on TRM inputs for these variables. Analysis of participant survey data showed significantly higher pool pump time of use relative to assumptions listed in TRMs. Duke Energy Smart $aver participants indicated that their pool pumps

are programmed to run for 13 to 17 hours per day on average, an amount much higher than the six hours per day assumed by Indiana TRM V2.2. Mid-Atlantic TRM V10, which cites a study completed by Southern California Edison (SCE), gives average daily operating hours of four to six hours per day.[8] Time-of-use data collected through participant surveys is a significant contributor to high realization rates for this measure.

Pump horsepower presented the other parameter of interest. Indiana TRM V2.2 assumes a 1.5 HP pump would be installed, and that the base pump replaced had the same horsepower as the energy-efficient pump. Mid-Atlantic TRM V10 cited a study completed by SCE, which produced an average horsepower rating of 1.31 HP.[9] Table 3-24 shows average horsepower of 2.43 and 2.01 in DEC and DEP, respectively. A review of the program database showed that the majority of pumps installed were larger than TRM assumptions.

Figure 3-14: Distribution of Variable Speed Pool Pumps Horsepower

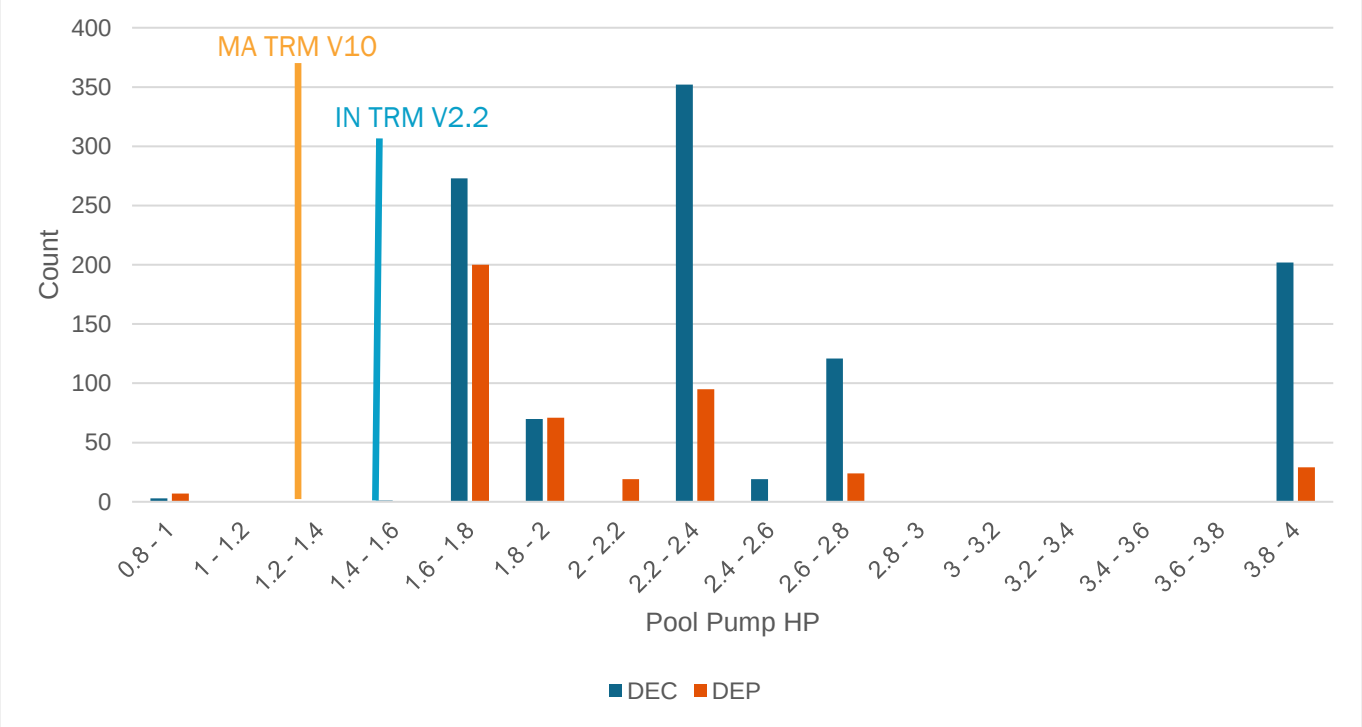


Figure 3-14 shows nearly all pool pumps installed had a larger horsepower than the Indiana TRM V2.2's and the Mid-Atlantic TRM V10's assumed horsepower, given 99% of pumps installed in DEC and 98% of pumps installed in DEP were greater than 1.3 HP. This also contributed significantly to high verified savings for variable speed pool pumps.

[8] Integration of Demand Response into Title 20 for Residential Pool Pumps, Southern California Edison, November 2009
[9] Ibid

Table 3-25 presents energy and demand savings for variable speed pool pumps.

Table 3-25: Variable Speed Pool Pump Gross Verified Savings (Per Unit)

Service Territory	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	Energy (kWh)	2,430.000	331%	8,039.954
	Summer Demand (kW)	0.5270	528%	2.7797
	Winter Demand (kW)	0.0000	N/A	0.0000
Duke Energy Progress	Energy (kWh)	2,351.700	216%	5,068.519
	Summer Demand (kW)	0.5900	390%	2.2983
	Winter Demand (kW)	0.0000	N/A	0.0000

3.4.4.5. Heat Pump Water Heater

The evaluation team conducted an engineering analysis to determine average savings of heat pump water heaters in DEC and DEP territories. The Mid-Atlantic TRM V10 provided an energy savings algorithm that included energy saved from heating water, energy saved from reducing cooling loads on air conditioners, and an energy penalty from increasing heating loads. The team discovered, however, that the Mid-Atlantic TRM V10 did not include algorithms for calculating cooling energy savings and heating energy penalties. Rather, the team sourced cooling and heating algorithms from the Mid-Atlantic TRM V9. The team also developed peak demand savings algorithms, such that Duke Energy participant survey data could be applied to summer and winter peak demand savings. Equation 3-13 and Equation 3-14 provide the savings algorithms, and Table 3-26 provides input parameters for these algorithms.

Equation 3-13: Heat Pump Water Heater Energy Savings Algorithms

$$\Delta kWh = kWh_{water} + kWh_{cooling} - kWh_{heating}$$

$$kWh_{water} = \frac{MMBTU}{year} \times \left(\frac{1}{UEF_{base}} - \frac{1}{UEF_{ee}}\right) \times 293.1$$

$$kWh_{cooling} = \left(\frac{1}{UEF_{ee}} \times \frac{MMBTU}{year} \times LF_{cooling} \times 33\%\right) / COP_{cool}$$

$$kWh_{heating} = \%_{electric\ heat} \left(\frac{1}{UEF_{ee}} \times \frac{MMBTU}{year} \times LF_{heating} \times 47\%\right) / COP_{heat}$$

$$Where, \quad \frac{MMBTU}{year} = 0.195 \times GPD$$

Equation 3-14: Heat Pump Water Heater Demand Savings Algorithm

$$\Delta kW_{Summer} = \frac{\Delta kWh_{water} + \Delta kWh_{cooling}}{Hours} \times CF_{Summer}$$

$$\Delta kW_{Winter} = \frac{\Delta kWh_{water} - \Delta kWh_{heating}}{Hours} \times CF_{Winter}$$

Table 3-26: Inputs for Heat Pump Water Heater Gross Verified Savings

Variable	Source	2023 DEC Evaluation	2023 DEP Evaluation	2018 DEC Evaluation[10]	2014 DEP Evaluation
GPD	Mid-Atlantic TRM V10, adjusted	45.4	45.3	-	25.1
MMBTU/year	Mid-Atlantic TRM V10, adjusted	8.85	8.83	-	-
UEF_{base}	Mid-Atlantic TRM V10, adjusted	1.27	1.26	-	0.98
UEF_{ee}	Population Average	3.67	3.70	-	2.29
$LF_{cooling}$	Mid-Atlantic TRM V9	0.30	0.26	-	1.33
COP_{cool}	Mid-Atlantic TRM V9	3.08		-	3.1
$LF_{heating}$	Mid-Atlantic TRM V9	0.30	0.26	-	1.33
COP_{heat}	Participant Survey	0.88	1.23	-	2.0
$\%_{electric\ heat}$	Participant Survey	48%	61%	-	-
Hours	Hours per Year	8,760		-	-
CF_{Summer}	Mid-Atlantic TRM V10, adjusted[11]	0.90		-	-
CF_{Winter}	Mid-Atlantic TRM V10, adjusted[12]	0.11		-	-

[10] Input parameters are not provided for the 2018 DEC evaluation, as deemed savings were applied for heat pump water heater measures.
[11] Calculated for DEC and DEP peak periods using load shapes from *Field Testing of Pre-Production Prototype Residential Heat Pump Water Heaters*, Federal Energy Management Program, United States Department of Energy, May 2007.
[12] Ibid

Table 3-26 shows input parameters for heat pump water heaters. The evaluation team used participant survey data to determine the fraction of heat pump water heater participants who installed water heaters in a conditioned space as well as the fraction of participants who primarily used electricity to heat their homes. The team also considered the types of space heating devices to estimate heating system efficiencies (COP_{heat}), and calculated coincidence factors for Duke Energy peak periods using the original reference cited in the Mid-Atlantic TRM V10.

Realization rates varied significantly for this measure. The previous DEC evaluation applied deemed savings due to low participation rates, while the previous DEP evaluation applied algorithms that are significantly different than those currently listed in the updated Mid-Atlantic TRMs. Verified energy savings were consistent with those calculated in other Duke Energy service territories, though verified summer demand savings were much higher than verified winter demand savings—an expected result for this measure. Heat pump water heaters transfer heat from air to water for domestic uses, reducing cooling loads in summer months while increasing heating loads in winter months, which would be expected to increase summer savings while decreasing winter savings. Table 3-27 provides energy and demand savings for heat pump water heaters.

Table 3-27: Heat Pump Water Heater Gross Verified Savings (Per Unit)

Service Territory	Measurement	Reported Savings	Realization Rate	Verified Savings
Duke Energy Carolinas	Energy (kWh)	1,616.000	97%	1,571.126
	Summer Demand (kW)	0.1240	130%	0.1614
	Winter Demand (kW)	0.1780	11%	0.0192
Duke Energy Progress	Energy (kWh)	1,977.562	80%	1,587.505
	Summer Demand (kW)	0.0937	174%	0.1631
	Winter Demand (kW)	0.5410	4%	0.0194

3.5. Targeted and Achieved Confidence and Precision

In a departure from previous evaluations that sought a program level precision target, the Smart $aver evaluation plan was developed to achieve a target goal of 10% relative precision at the 90% confidence interval for each of the primary measure types, which would greatly exceed the 90%/10% threshold for the program overall. As shown in Table 3-28, the team reported confidence and precision for the program overall at +/- 2.9% for the 90% confidence level.

Table 3-28: Targeted and Achieved Confidence and Precision

Measure	Population	Targeted	Achieved	Precision at 90% Confidence
Central Air Conditioner	18,963	68	232	5.4%
Air Source Heat Pump	18,174	68	240	5.3%
Attic Insulation & Air Seal	2,331	66	144	6.7%
Variable Speed Pool Pump	1,486	65	62	10.3%
Duct Sealing	8,162	68	83	9.0%
Heat Pump Water Heater	317	56	55	10.1%
Smart $aver Program*	**49,433**	**391**	**816**	**2.9%**

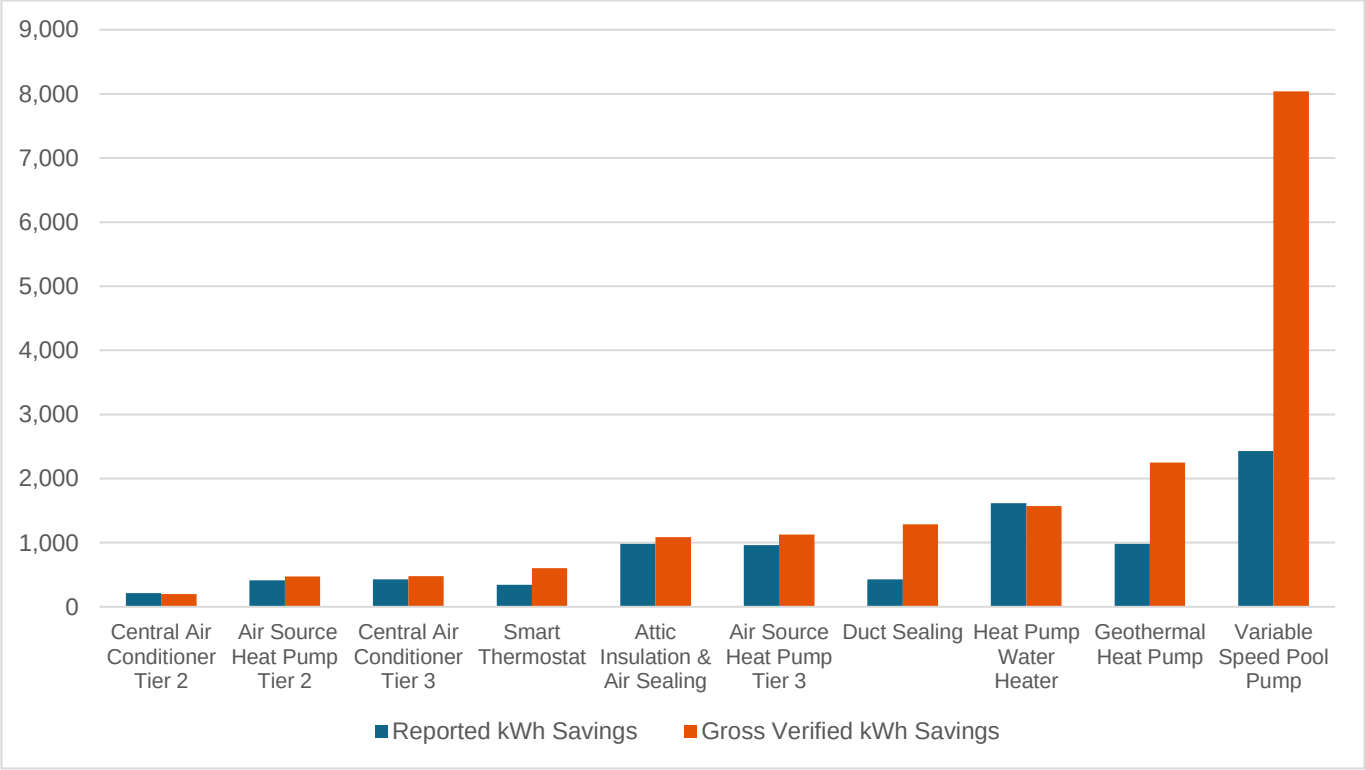
Not including smart thermostats, as they are not a stand-alone measure.

3.6. Program Results

3.6.1. Results per Unit

Figure 3-15 shows reported and verified per-unit energy savings for the DEC territory. Discussions on measure realization rates can be found in earlier subsections.

Figure 3-15: DEC Smart $aver 2020-2022 Reported and Verified Energy Savings (Per Unit)



The evaluation indicated energy realization rates above 100% for the majority of DEC Smart $aver measures, with Tier 2 central air conditioners as the only exception. Variable speed pool pumps showed high realization rates, resulting from high daily hours of use reported by survey respondents. Low summer demand realization rates for HVAC measures primarily resulted from reduced summer peak coincidence factors. The evaluation of central air conditioner measures resulted in no verified winter demand savings, as ECM furnace fans reduced savings to zero, given an update in federal efficiency regulations. Table 3-29, Table 3-30, and Table 3-31 provide per-unit energy and demand savings and realization rates for each measure.

Table 3-29: DEC Average Reported and Gross Verified Energy Savings (Per Unit)

Measure	Reported Energy Savings per Unit (kWh)	Realization Rate	Verified Gross Energy Savings per Unit (kWh)
Central Air Conditioner Tier 2	213.481	92%	196.086
Central Air Conditioner Tier 3	426.380	112%	478.786
Air Source Heat Pump Tier 2	413.289	115%	475.066
Air Source Heat Pump Tier 3	963.698	117%	1,129.001
Geothermal Heat Pump	980.833	230%	2,251.210
Smart Thermostat	341.110	177%	605.081
Variable Speed Pool Pump	2,430.000	331%	8,039.954
Attic Insulation and Air Sealing	979.676	111%	1,087.384
Heat Pump Water Heater	1,616.000	97%	1,571.126
Duct Sealing	429.845	299%	1,284.182

Table 3-30: DEC Reported and Gross Verified Summer Demand Savings (Per Unit)

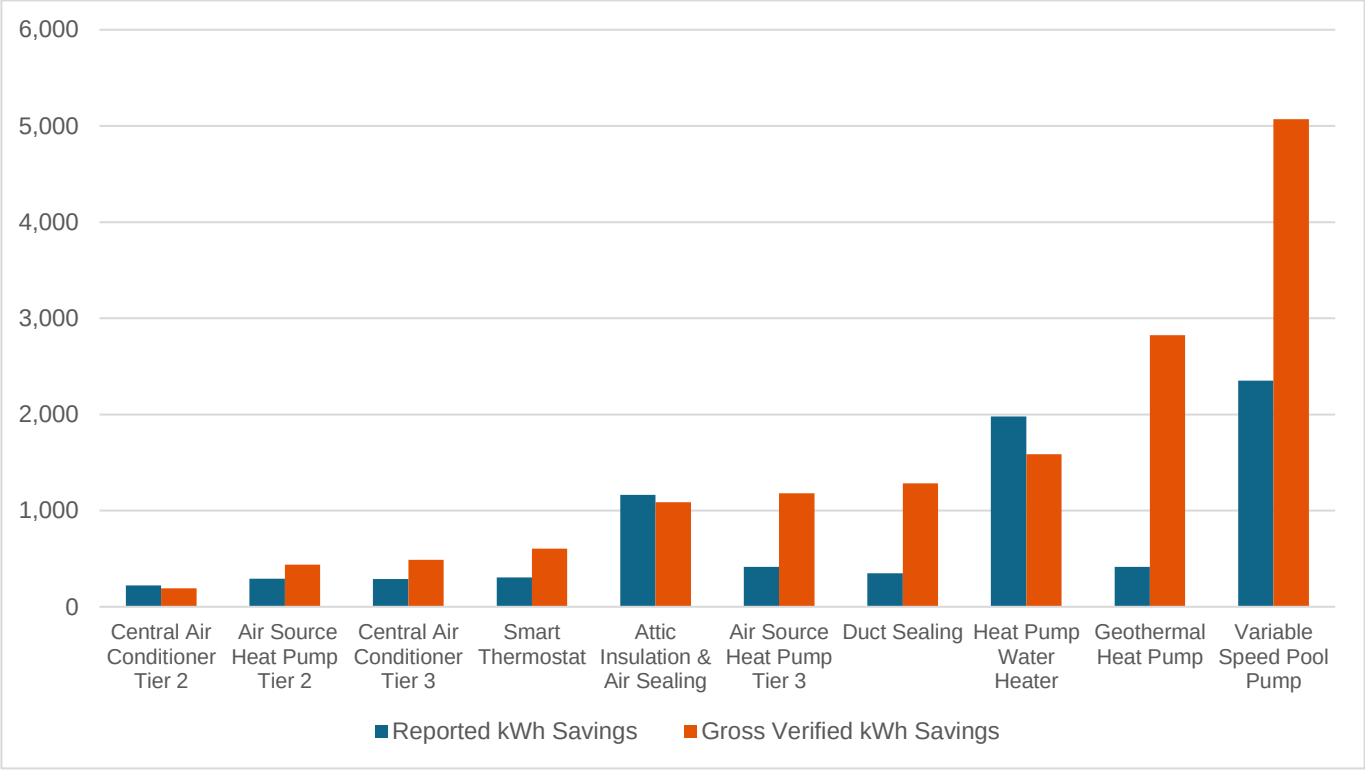
Measure	Reported Summer Demand Savings per Unit (kW)	Realization Rate	Verified Gross Summer Demand Savings per Unit (kW)
Central Air Conditioner Tier 2	0.1162	58%	0.0668
Central Air Conditioner Tier 3	0.2511	33%	0.0839
Air Source Heat Pump Tier 2	0.1258	45%	0.0572
Air Source Heat Pump Tier 3	0.3013	16%	0.0468
Geothermal Heat Pump	0.3060	148%	0.4524
Smart Thermostat	0.0000	N/A	0.0000
Variable Speed Pool Pump	0.5270	527%	2.7797
Attic Insulation & Air Sealing	0.2101	163%	0.3417
Heat Pump Water Heater	0.1240	130%	0.1614
Duct Sealing	0.1735	257%	0.4453

Table 3-31: DEC Reported and Gross Verified Winter Demand Savings (Per Unit)

Measure	Reported Winter Demand Savings per Unit (kW)	Realization Rate	Verified Gross Winter Demand Savings per Unit (kW)
Central Air Conditioner Tier 2	0.1643	0%	0.0000
Central Air Conditioner Tier 3	0.1630	0%	0.0000
Air Source Heat Pump Tier 2	0.1810	53%	0.0961
Air Source Heat Pump Tier 3	0.4034	52%	0.2115
Geothermal Heat Pump	0.4183	125%	0.5232
Smart Thermostat	0.0000	N/A	0.0332
Variable Speed Pool Pump	0.0000	N/A	0.0000
Attic Insulation and Air Sealing	0.3081	41%	0.1274
Heat Pump Water Heater	0.1780	11%	0.0192
Duct Sealing	0.1388	126%	0.1746

Figure 3-16 shows reported and verified per-unit energy savings for the DEP territory. Discussions on measure realization rates can be found in earlier subsections.

Figure 3-16: DEP Smart $aver 2020-2022 Reported and Verified Energy Savings (Per Unit)



The evaluation indicated energy realization rates above 100% for the majority of DEP Smart $aver measures, with Tier 2 central air conditioners, attic insulation and air sealing, and heat pump water heaters as the exceptions. Variable speed pool pumps showed high realization rates due to high daily hours of use reported by survey respondents. Low summer demand realization rates for HVAC measures primarily resulted from reduced summer peak coincidence factors. The evaluation of central air conditioner measures resulted in no verified winter demand savings, as savings from ECM furnace fans have reduced to zero due to an update in federal efficiency regulations. Table 3-32, Table 3-33, and Table 3-34 provide per-unit energy and demand savings and realization rates for each measure.

Table 3-32: DEP Average Reported and Gross Verified Energy Savings (Per Unit)

Measure	Reported Energy Savings per Unit (kWh)	Realization Rate	Verified Gross Energy Savings per Unit (kWh)
Central Air Conditioner Tier 2	223.558	86%	193.171
Central Air Conditioner Tier 3	289.844	168%	488.111
Air Source Heat Pump Tier 2	291.602	150%	437.618
Air Source Heat Pump Tier 3	415.849	284%	1,181.616
Geothermal Heat Pump	415.849	679%	2,823.628
Smart Thermostat	306.485	197%	605.081
Variable Speed Pool Pump	2,351.700	216%	5,068.519
Attic Insulation and Air Sealing	1,163.000	93%	1,087.384
Heat Pump Water Heater	1,977.562	80%	1,587.505
Duct Sealing	350.000	367%	1,284.182

Table 3-33: DEP Reported and Gross Verified Summer Demand Savings (Per Unit)

Measure	Reported Summer Demand Savings per Unit (kW)	Realization Rate	Verified Gross Summer Demand Savings per Unit (kW)
Central Air Conditioner Tier 2	0.1305	45%	0.0586
Central Air Conditioner Tier 3	0.2009	29%	0.0578
Air Source Heat Pump Tier 2	0.1090	48%	0.0525
Air Source Heat Pump Tier 3	0.1650	27%	0.0448
Geothermal Heat Pump	0.1650	335%	0.5521
Smart Thermostat	0.0000	N/A	0.0000
Variable Speed Pool Pump	0.5900	390%	2.2983
Attic Insulation and Air Sealing	0.1922	178%	0.3417
Heat Pump Water Heater	0.0937	174%	0.1631
Duct Sealing	0.2805	159%	0.4453

Table 3-34: DEP Reported and Gross Verified Winter Demand Savings (Per Unit)

Measure	Reported Winter Demand Savings per Unit (kW)	Realization Rate	Verified Gross Winter Demand Savings per Unit (kW)
Central Air Conditioner Tier 2	0.0307	0%	0.0000
Central Air Conditioner Tier 3	-0.0477	N/A	0.0000
Air Source Heat Pump Tier 2	0.0966	90%	0.0865
Air Source Heat Pump Tier 3	0.0240	945%	0.2266
Geothermal Heat Pump	0.0240	2,732%	0.6554
Smart Thermostat	0.0000	N/A	0.0332
Variable Speed Pool Pump	0.0000	N/A	0.0000
Attic Insulation and Air Sealing	0.2020	63%	0.1274
Heat Pump Water Heater	0.5410	4%	0.0194
Duct Sealing	0.0000	N/A	0.1746

3.6.2. Impact Results Summary

Table 3-35, Table 3-36, and Table 3-37 provide program-level energy savings, demand savings, and realization rates for each measure in the DEC territory.

Table 3-35: DEC Reported and Verified Gross Energy Savings

Measure	Rebates	Reported Energy Savings (kWh)	Realization Rate	Gross Verified Energy Savings (kWh)
Central Air Conditioner Tier 2	11,460	2,446,491	92%	2,247,150
Central Air Conditioner Tier 3	2,322	990,054	112%	1,111,740
Air Source Heat Pump Tier 2	8,655	3,577,016	115%	4,111,693
Air Source Heat Pump Tier 3	2,523	2,431,411	117%	2,848,470
Geothermal Heat Pump	23	22,559	230%	51,778
Smart Thermostat	13,080	4,461,724	177%	7,914,455
Variable Speed Pool Pump	1,041	2,529,630	331%	8,369,592
Attic Insulation and Air Sealing	1,925	1,885,876	111%	2,093,214
Heat Pump Water Heater	178	287,648	97%	279,660
Duct Sealing	6,280	2,699,424	299%	8,064,660
TOTAL	**47,487**	**21,331,833**	**174%**	**37,092,413**

Table 3-36: DEC Reported and Verified Summer Demand Gross Savings

Measure	Rebates	Reported Summer Demand Savings (kW)	Realization Rate	Gross Verified Winter Demand Savings (kW)
Central Air Conditioner Tier 2	11,460	1,331.6	58%	765.6
Central Air Conditioner Tier 3	2,322	583.1	33%	194.8
Air Source Heat Pump Tier 2	8,655	1,088.6	45%	494.7
Air Source Heat Pump Tier 3	2,523	760.2	16%	118.1
Geothermal Heat Pump	23	7.0	148%	10.4
Smart Thermostat	13,080	0	N/A	0.0
Variable Speed Pool Pump	1,041	548.6	527%	2,893.7
Attic Insulation and Air Sealing	1,925	404.5	163%	657.8
Heat Pump Water Heater	178	22.1	130%	28.7
Duct Sealing	6,280	1,089.6	257%	2,796.2
TOTAL	**47,487**	**5,835.3**	**136%**	**7,960.2**

Table 3-37: DEC Reported and Verified Winter Demand Gross Savings

Measure	Rebates	Reported Winter Demand Savings (kW)	Realization Rate	Gross Verified Winter Demand Savings (kW)
Central Air Conditioner Tier 2	11,460	1,883.3	0%	0.0
Central Air Conditioner Tier 3	2,322	378.5	0%	0.0
Air Source Heat Pump Tier 2	8,655	1,566.6	53%	831.3
Air Source Heat Pump Tier 3	2,523	1,017.7	52%	533.7
Geothermal Heat Pump	23	9.6	125%	12.0
Smart Thermostat	13,080	0	N/A	434.3
Variable Speed Pool Pump	1,041	0	N/A	0
Attic Insulation and Air Sealing	1,925	593.1	41%	245.2
Heat Pump Water Heater	178	31.7	11%	3.4
Duct Sealing	6,280	871.8	126%	1,096.4
TOTAL	**47,487**	**6,352.3**	**50%**	**3,156.3**

Variable speed pool pumps, smart thermostats, and duct sealing contributed significantly to DEC's 174% program energy realization rate, primarily due to high per-unit verified energy savings for each of these measures as well as the large number of smart thermostats rebated through the Smart $aver program. The 136% DEC program summer demand realization rate primarily resulted from the increased savings attributable to variable speed pool pumps and duct sealing measures. Central air conditioners contributed no winter demand savings, resulting in significant decreases in DEC program-level winter demand savings.

Table 3-38 presents total DEC program reported and verified savings.

Table 3-38: DEC Smart $aver 2021 Gross Program Savings

Measurement	Rebates	Reported	Realization Rate	Gross Verified
Energy (kWh)	47,487	21,331,833	174%	37,092,413
Summer Demand (kW)		5,835	136%	7,960
Winter Demand (kW)		6,352	50%	3,156

Table 3-39, Table 3-40, and Table 3-41 provide program-level energy savings, demand savings, and realization rates for each measure in DEP's territory.

Table 3-39: DEP Reported and Verified Gross Energy Savings

Measure	Rebates	Reported Energy Savings (kWh)	Realization Rate	Gross Verified Energy Savings (kWh)
Central Air Conditioner Tier 2	4,334	968,901	86%	837,203
Central Air Conditioner Tier 3	847	245,498	168%	413,430
Air Source Heat Pump Tier 2	5,354	1,561,235	150%	2,343,007
Air Source Heat Pump Tier 3	1,642	682,824	284%	1,940,213
Geothermal Heat Pump	27	11,228	679%	76,238
Smart Thermostat	7,891	2,418,476	197%	4,774,691
Variable Speed Pool Pump	445	1,046,506	216%	2,255,491
Attic Insulation and Air Sealing	406	472,178	93%	441,478
Heat Pump Water Heater	139	274,881	80%	220,663
Duct Sealing	1,882	658,700	367%	2,416,830
TOTAL	**22,967**	**8,340,427**	**188%**	**15,719,244**

Table 3-40: DEP Reported and Verified Summer Demand Gross Savings

Measure	Rebates	Reported Summer Demand Savings (kW)	Realization Rate	Gross Verified Winter Demand Savings (kW)
Central Air Conditioner Tier 2	4,334	565.6	45%	254.1
Central Air Conditioner Tier 3	847	170.2	29%	49.0
Air Source Heat Pump Tier 2	5,354	583.5	48%	281.1
Air Source Heat Pump Tier 3	1,642	270.9	27%	73.5
Geothermal Heat Pump	27	4.5	335%	14.9
Smart Thermostat	7,891	0	N/A	0.0
Variable Speed Pool Pump	445	262.6	390%	1,022.7
Attic Insulation and Air Sealing	406	78.1	178%	138.7
Heat Pump Water Heater	139	13.0	174%	22.7
Duct Sealing	1,882	527.8	159%	838.0
TOTAL	**22,967**	**2,476.0**	**109%**	**2,694.7**

Table 3-41: DEP Reported and Verified Winter Demand Gross Savings

Measure	Rebates	Reported Winter Demand Savings (kW)	Realization Rate	Gross Verified Winter Demand Savings (kW)
Central Air Conditioner Tier 2	4,334	133.1	0%	0.0
Central Air Conditioner Tier 3	847	-40.4	N/A	0.0
Air Source Heat Pump Tier 2	5,354	517.3	90%	463.3
Air Source Heat Pump Tier 3	1,642	39.4	945%	372.0
Geothermal Heat Pump	27	0.6	2732%	17.7
Smart Thermostat	7,891	0	N/A	262.0
Variable Speed Pool Pump	445	0	N/A	0
Attic Insulation and Air Sealing	406	82.0	63%	51.7
Heat Pump Water Heater	139	75.2	4%	2.7
Duct Sealing	1,882	0.0	N/A	328.6
TOTAL	**22,967**	**807.3**	**186%**	**1,498.0**

Smart thermostats, air source heat pumps, variable speed pool pumps, and duct sealing measures contributed significantly to DEP's 188% program energy realization rate due to high per-unit verified energy savings as well as the large number of smart thermostats rebated through the Smart $aver program. Variable speed pool pumps and duct sealing also showed high verified savings. Air source heat pump savings increased significantly due to unrealistically low reported savings per-unit. DEP's 109% program summer demand realization rate primarily resulted from increased savings attributable to variable speed pool pump measures. DEP's 186% program winter demand realization rate primarily resulted from low reported winter demand savings for Tier 3 air source heat pumps.

Table 3-42 presents total program reported and verified savings.

Table 3-42: DEP Smart $aver 2021 Gross Program Savings

Measurement	Rebates	Reported	Realization Rate	Gross Verified
Energy (kWh)	22,967	8,340,427	188%	15,719,244
Summer Demand (kW)		2,476	109%	2,695
Winter Demand (kW)		807	186%	1,498

4. Net-To-Gross

The evaluation team used participant survey data to calculate an NTG ratio for the Smart $aver program. NTG reflects the effects of free ridership (FR), participant spillover (PSO), and nonparticipant spillover (NPSO) on gross savings. FR refers to the portion of energy savings that participants would have achieved in the program's absence through their own initiatives and expenditures (U.S. DOE, 2014).[13] Spillover refers to program-induced adoption of additional energy-saving measures by customers who did not receive financial incentives or technical assistance for additional measures installed (U.S. DOE, 2014). The evaluation team used the following formula to calculate the NTG ratio:

$$NTG = 100\% - FR + PSO + NPSO$$

It is important to note that the three measures analyzed through AMI analysis (smart thermostats, attic insulation and air sealing, and duct sealing) used a comparison group and therefore participant free ridership and spillover are inherently factored into the savings, and thus considered a net value.

4.1. Free Ridership

Free ridership estimates the extent that the program influenced participants to participate in the Smart $aver initiative. Free ridership ranges from 0% to 100%, with 0% being no free ridership and 100% being total free ridership. The evaluation team used participant survey data to estimate free ridership. The survey used several questions to identify what participants would have installed in the absence of an incentive.

The evaluation team's methodology for calculating free ridership consists of two components, free ridership change (FRC) and free ridership influence (FRI).

$$FR = 50\% \times FRC + 50\% \times FRI$$

4.1.1. Free Ridership Change

FRC reflects what participants reported they would have done had the program not provided an incentive to participate. For each respondent, the survey assessed FRC for actions the participant would have taken had Duke Energy rebates and information not been available and when the participant would have likely purchased the unit.

[13] The U.S. Department of Energy (DOE) (2014). *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. Chapter 23: Estimating Net Savings: Common Practices*

Specifically, the survey asked respondents to indicate, in the incentive's absence, the following: whether they would not have installed a unit; would they have bought a less-expensive or less-efficient unit; would they have bought the exact same efficiency and paid the full cost; or they "don't know" what they would have done. For participants who would have bought a unit, whether less expensive/less efficient or the same efficiency, or if they did not know what they would do, the survey included a follow-up question to determine when they would likely have purchased the unit.

For each participant and each measure, the evaluation team assigned one of the FRC values presented in Table 4-1.

Table 4-1: Free Ridership Change Values

Q1 Response	Q2 Response	FRC Value
Would not have installed	N/A	0%
Would have bought a less expensive or less efficient unit	At the same time Within 6 months Within a year Later than a year Don't know	75% 50% 25% 0% 25%
Would have bought the exact same efficiency and paid the full cost	At the same time Within 6 months Within a year Later than a year Don't know	100% 67% 33% 0% 50%
Don't know	At the same time Within 6 months Within a year Later than a year Don't know	50% 37.5% 12.5% 0% N/A

Each respondents' answers to the FR change questions were calculated at the measure level, then savings weighted to derive an overall program average.

4.1.2. Free Ridership Influence

FRI assesses the program's influence on a participant's decision to purchase the measure. The survey asked respondents to rate how much influence four program-related factors had on their respective decisions to install measures, using a scale from 0 ("not at all influential") to 10 ("extremely influential"). The program-related factors included the following:

- The rebate received

- Information or ads from DEC/DEP, including the website
- Recommendations from contractors
- Other reasons [specified]

FRI was based on the highest-rated item in the FRI battery. From that rating, the evaluation team assigned the FRI scores shown in Table 4-2.

Table 4-2: Free Ridership Influence Values

Highest Influence Rating	FRI Value
0	100%
1	90%
2	80%
3	70%
4	60%
5	50%
6	40%
7	30%
8	20%
9	10%
10	0%

4.1.3. Total Free Ridership

The evaluation team calculated the total FR by measure by calculating the average between each measure's change and influence score, then savings-weighting each result with evaluated per-unit savings for each unit installed by respondents, thus deriving the overall total.

Table 4-3 presents the measure-specific and overall FR estimates. Note these values do not include those measures calculated using AMI analysis.

Table 4-3: Self-Report Free Ridership Results

Measure	FRC	FRI	Full FR
Central Air Conditioner Tier 2	80.38%	16.32%	48.35%
Central Air Conditioner Tier 3	80.68%	21.29%	50.99%
Heat Pump Tier 2	82.39%	15.88%	49.14%
Heat Pump Tier 3	87.76%	16.03%	51.90%
Heat Pump Water Heater	62.98%	12.00%	37.49%
Variable Speed Pool Pump	65.76%	10.97%	38.37%
Savings Weighted	**76.11%**	**14.26%**	**45.18%**

4.2. Spillover

4.2.1. Participant Spillover

Participant spillover estimates energy savings from additional energy improvements made by participants influenced by the program. It is used to adjust gross savings. The evaluation team used participant survey data to estimate spillover. The survey asked respondents to indicate what non-rebated, energy-saving measures they implemented since their program participation. The team then asked participants to rate the program's influence on their decision to purchase these additional energy-saving measures on a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential."

The team converted these ratings to a percentage, representing the program-attributable percentage of measure savings, from 0% to 100%. The team then applied the program-attributable percentage to savings associated with each reported spillover measure to calculate the PSO for that measure. The team defined per-unit energy savings for reported spillover measures primarily based on previous Duke Energy Smart $aver and other recent program evaluations in order to remain consistent across programs (which draw upon ENERGY STAR® calculators, algorithms, and parameter assumptions listed in TRM's and other sources).

PSO is calculated as follows:

$$Participant\ SO = \frac{\sum PSO\ \ kWh}{Sample\ Gross\ Program\ Savings\ kWh}$$

Where:

$$PSO = (Number\ Installed * Deemed\ Measure\ Savings) * Program\ Influence\ on\ Non - Rebated\ Measure$$

In this evaluation, PSO was calculated for each measure that did not receive AMI analysis, as shown in Table 4-4.

Table 4-4: Self Report Participant Spillover Results

Measure	Spillover Savings (kWh)	Program Sample Savings (kWh)	PSO
Central Air Conditioner Tier 2	4,422	39,243	11.27%
Central Air Conditioner Tier 3	1,073	14,919	7.19%
Heat Pump Tier 2	7,698	83,884	9.18%
Heat Pump Tier 3	734	66,694	1.10%
Heat Pump Water Heater	1,879	86,819	2.16%
Variable Speed Pool Pump	2,914	443,317	0.66%
Savings Weighted	**18,720**	**734,876**	**4.39%**

4.2.2. Nonparticipant Spillover

The evaluation team calculated eligible equipment installs made by nonparticipants who were influenced by participating trade allies but did not receive rebates. The survey asked trade allies to indicate which non-rebated, energy-saving measures they recommended to their customers within DEC or DEP territory. The team then asked trade allies to rate the program's influence on their business practice of recommending those measures to customers on a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential." The team converted the ratings to a percentage that represented the program-attributable percentage of measure savings, from 0% to 100%.

In calculating the NPSO for a measure, the team applied the program-attributable percentage to savings associated with each reported SO measure. The team then defined the per-unit energy savings for reported SO measures from verified gross measure savings.

The survey asked each trade ally a series of questions to determine the number of measures installed within Duke Energy's territory that qualified as energy-efficient measures and did not receive a rebate. The 56 surveyed trade allies represented 12% of the programs installed measures

(not including the secondary smart thermostat measure). As the survey did not reach the entire program population of trade allies, the evaluation team extrapolated the results to the population based on each measure type. Table 4-5 lists the resulting NPSO counts and value for each measure.

Table 4-5: Nonparticipating Spillover Measures Claimed by Trade Allies

Measure Category	Program Measure Representation	NPSO Measure Count	Extrapolated NPSO Count	Average Per Unit Savings (kWh)	NPSO Savings (kWh)	NPSO
Central Air Conditioner	9%	180	1,956	243	475,411	10.32%
Air-Source Heat Pump	15%	321	2,182	619	1,350,370	12.01%
Attic Insulation and Air Sealing	25%	14	55	1,087	59,506	2.35%
Duct Sealing	10%	57	548	1,284	704,144	6.72%
Heat Pump Water Heater	9%	2	23	1,579	35,742	7.14%
Pool Pump	6%	0	0	7,150	0	0.0%
TOTAL	**12%**	**572**	**4,764**	**N/A**	**2,625,174**	**4.18%**

4.3. Total Net-to-Gross

Inserting the NTG component estimates into the NTG formula (NTG = 100% – FR + PSO + NPSO) produces the following measure level NTG values as shown in Table 4-6. As discussed above, the measures that received AMI analysis had participant free ridership and participant spillover already embedded in their results, so it would be double counting to add additional self-report values to those measures, therefore the table below shows “0%”. However, NPSO was reported by participating trade allies for other customers for attic insulation and air sealing as well as duct sealing, therefore NPSO is applied to those measures. Smart thermostats are not an independent measure, and require a primary piece of participating HVAC equipment, so no NPSO was assigned to smart thermostats.

Table 4-6: DEC/DEP Net-to-Gross Results

Measure	FR Method	Total FR	PSO	NPSO	NTG
Central Air Conditioner Tier 2	Self-Report	48.35%	11.27%	10.32%	73.24%
Central Air Conditioner Tier 3	Self-Report	50.99%	7.19%	10.32%	66.52%
Heat Pump Tier 2	Self-Report	49.14%	9.18%	12.01%	72.05%
Heat Pump Tier 3	Self-Report	51.90%	1.10%	12.01%	61.21%
Heat Pump Water Heater	Self-Report	37.49%	2.16%	7.14%	71.82%
Variable Speed Pool Pump	Self-Report	38.37%	0.66%	0.00%	62.29%
Smart Thermostat	AMI Analysis	0%	0%	0%	100.00%
Attic Insulation and Air Sealing	AMI Analysis	0%	0%	2.35%	102.35%
Duct Sealing	AMI Analysis	0%	0%	6.72%	106.72%

The calculated NTG values are within the industry standard range, as seen in Table 4-7.

Table 4-7: NTG Benchmarks

Jurisdiction/ Program Name	Measure	Year	NTG
NIPSCO – Residential HVAC	Whole Program	2020, 2021	60%
DEK Smart $aver	Whole Program	2020-2022	65.33%
DEI Smart $Saver Self-Report Only	Whole Program	2020-2021	68.85%
Excel Energy-Colorado Residential Heating and Cooling Product Impact & Process Evaluation	Air Conditioning Units	2021	73%
Vectren – Residential Prescriptive	Whole Program	2020	78%
ComEd – Midstream Heating and Cooling	HVAC, Smart T-stat, HPWH	2021	80.7%
ComEd – Home Efficiency	Envelope	2021	83.3%
DEP Smart $aver Program	**Whole Program**	**2020-2022**	**83.84%**
DEI Smart $aver Overall	Whole Program	2020-2021	84.01%
DEC Smart $aver Program	**Whole Program**	**2020-2022**	**84.12%**
IPL Marketplace	Smart Thermostat	2020	99%

The evaluation team applied this NTG ratio to program-wide, verified gross savings to calculate Smart $aver net savings, as shown in Table 4-8 and Table 4-9. Note that to achieve the measure level NTG results, the DEC and DEP populations were combined for data collection. The DEC and DEP results utilize the measure level results but given the different mix of measures within each jurisdiction, the NTG ratios differ for each savings variable.

Table 4-8: DEC Program-Level Savings

Measurement	Population	Gross Verified	NTG Ratio	Net Verified
Energy (kWh)	47,487	37,092,413	84.12%	31,200,786
Summer Demand (kW)		7,960	82.99%	6,606
Winter Demand (kW)		3,156	88.42%	2,791

Table 4-9: DEP Program-Level Savings

Measurement	Population	Gross Verified	NTG Ratio	Net Verified
Energy (kWh)	22,967	15,719,244	83.84%	13,179,760
Summer Demand (kW)		2,695	80.34%	2,165
Winter Demand (kW)		1,498	82.77%	1,240

5. Process Evaluation

The following sections describe methods used to collect data for the process evaluation as well as important evaluation findings.

5.1. Summary of Data Collection Activities

The evaluation team based the process evaluation on telephone interviews and on telephone and web surveys with program and implementer staff, trade allies, and participants, as shown in Table 5-1.

Table 5-1: Summary of Process Evaluation Data Collection Activities

Target Group	Method	Sample Size	Precision at 90% Confidence
Program Staff	Phone in-depth interview	1	N/A
Implementation Staff	Phone in-depth interview	1	N/A
High Volume Trade Allies[a]	Phone in-depth interview	5	N/A
Trade Allies (various rebate volumes)	Web/Phone survey	52	11.5%
Program Participants	Web survey	834	7.6%

[a] High-volume trade allies include companies in the top 20% of trade allies in terms of number of rebated measures for a given campaign.

5.1.1. Program and Implementer Staff

The evaluation team conducted interviews with the Smart $aver Program Manager and with an implementation staff senior manager to understand how the program worked and to capture their insights about program operations, challenges, expectations, and interactions with market actors and customers.

5.1.2. Trade Allies

Participating contractors —"trade allies"— served as the primary program delivery channel for Smart $aver. In spring 2023, the evaluation team conducted five in-depth interviews with high-volume Smart $aver trade allies. The team also used a web instrument to survey 52 trade allies, asking about various program topics (e.g., satisfaction with program and program-related challenges) (Figure 5-1). All reported trade ally results derived from the initial survey, unless otherwise noted.

Figure 5-1: Trade Ally Research Objectives

The evaluation team found that trade ally specializations (e.g., insulation) could significantly shape trade ally experiences with the program. The distribution of trade ally sample's measure experiences generally reflects the larger trade ally population, as shown in Table 5-2.

Table 5-2: Trade Ally Experience with Smart $aver Measures in 2020-2022

Measure	Measures Installed in Evaluation Timeframe	Number Installed by TAs in Survey Sample
Central Air Conditioner	18,963	1,743
Air-Source Heat Pump	18,174	2,670
Geothermal Heat Pump	50	0
Attic Insulation and Air Sealing	2,331	575

Measure	Measures Installed in Evaluation Timeframe	Number Installed by TAs in Survey Sample
Variable Speed Pool Pump	1,486	92
Heat Pump Water Heater	317	28
Duct Sealing	8,162	841

5.1.3. Participants

The evaluation team surveyed 834 Smart $aver participants who received rebates through the program. This number included 15 responses from customers who completed the survey's measure-specific questions but not all the final demographic questions. This data collection activity sought to obtain a more detailed understanding of the customer's program experience, identify potential areas for program improvements, and collect data to inform NTG estimates. Table 5-3 documents specific research objectives for the participant survey.

Table 5-3: Participant Research Objectives

Research Objectives
Assess program outreach and marketing
Document customer experience with the program, equipment, and trade allies
Document reasons for participation and program influence
Gather feedback needed to estimate NTG
Assess population segments that the program reaches
Gather demographic information

Table 5-4 shows the number of completes compared to the total population, with precision at 90% confidence. This table includes only the 834 respondents who completed the entire survey. It does not include smart thermostats as their own line, given they were an add-on measure.

Table 5-4: Survey Completes Compared to Population

Measure	Population	Completes	Precision at 90% Confidence
Air Source Heat Pump*	18,224	248	5.2%
Central Air Conditioner	18,963	236	5.3%
Attic Insulation & Air Sealing	2,331	145	6.6%
Duct Sealing	8,162	86	8.8%
Heat Pump Water Heater	317	55	10.1%
Pool Pump	1,486	64	10.1%
Total	**49,483**	**834****	**2.8%**

*Includes geothermal heat pumps.
**The process analysis was performed on 834 surveys, whereas the NTG analysis was performed on 816 completes.

5.2. Process Evaluation Findings

The following subsections describe program successes and challenges as well as opportunities for program improvements.

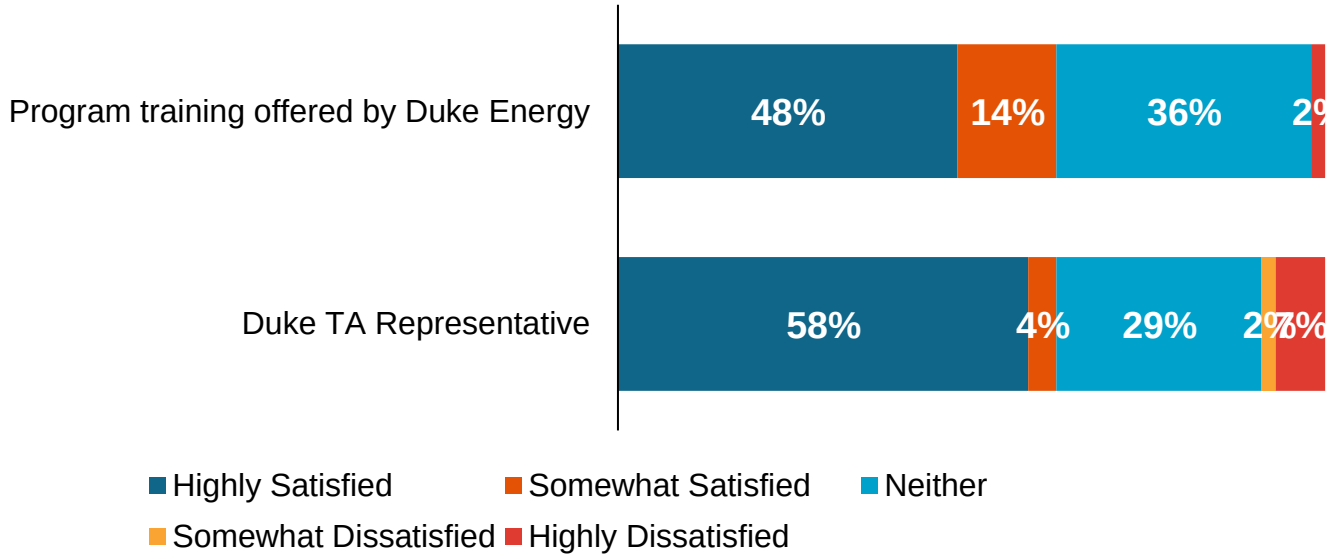
5.2.1. Trade Ally Perspective

This section reports results from trade ally surveys regarding their Smart $aver program participation experiences within DEC/DEP.

5.2.1.1. Training

The evaluation team asked trade allies about their satisfaction with program-assistance measures, such as their relationships with Duke Energy trade ally representatives as well as program training offered by Duke. Overall, trade allies were largely satisfied with these elements, as shown in Figure 5-2. Dissatisfied respondents noted that they remained unaware of training opportunities or that their TA representative was not communicative.

Figure 5-2: Satisfaction with Program Assistance Factors (n=52)



5.2.1.2. Recruiting Customers into Smart $aver

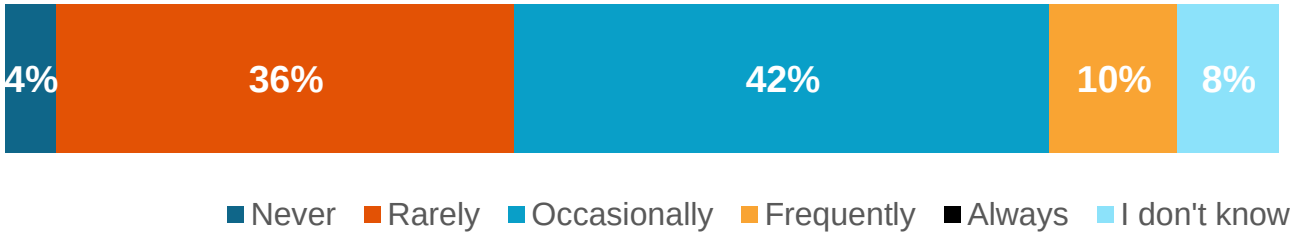
The evaluation team asked trade allies about the primary reasons why their customers replaced HVAC, water heating, or pool pump equipment as well as why their customers insulated and sealed their ducts or attics.

While insulation trade allies reported that their customers added insulation to save money on energy bills and to improve comfort, HVAC trade allies reported that most new HVAC units replaced broken or aging systems, and few customers replaced fully functional, standard-efficiency HVAC units with high-efficiency units just for energy savings.

Participant findings (see Section 5.2.2) corroborated these trade ally reports, with only 4% of HVAC replacement participants reported replacing HVAC units in good working condition. Of respondents who replaced HVAC equipment, one-half (50%) replaced units over 15 years old, while the remaining respondents replaced newer systems. However, the highest remaining proportion of replaced systems (32%) fell between 11 and 15 years old.

Trade ally survey data, further corroborated by participant survey data (see Section 5.2.2) revealed that trade allies largely recruited customers into the program. As shown in Figure 5-3, the majority of surveyed trade allies said that their customers “occasionally” or “rarely” asked about Smart $aver. Instead, trade allies typically introduced their customers to Smart $aver rebate opportunities.

Figure 5-3: How Often Customers Ask about Smart $aver Rebates (n=52)



Further, nearly two-thirds of surveyed trade allies (63%) expressed satisfaction with DEC/DEP's program marketing. Despite this marketing, trade allies remained critical in making participants aware of the program and in educating their customers about energy-efficiency benefits and Smart $aver rebates availability to bring new households into the program.

5.2.1.3. Rebate Application Process

In April 2016, Smart $aver transitioned to an online application system (i.e., the trade ally portal), with an enhanced version of the system introduced in 2021. The evaluation team asked trade allies how frequently they experienced problems or frustrations using the old portal and the new, enhanced portal, with 37% of surveyed trade allies reporting that they occasionally or frequently experienced problems or frustrations with the old Rebate Application Entry and Tracking Platform.

Over one-half of the respondents (51%) reported that these issues became somewhat better over time, with 28% reporting that issues had been completely resolved by the enhanced portal. When asked specifically about the enhanced trade ally portal, the majority of respondents (86%) reported that they did not have any issues. Further, four out of five interviewed high volume trade allies reported that they remained satisfied with the enhanced portal, stating it increased the ease of submitting applications and they found it user-friendly.

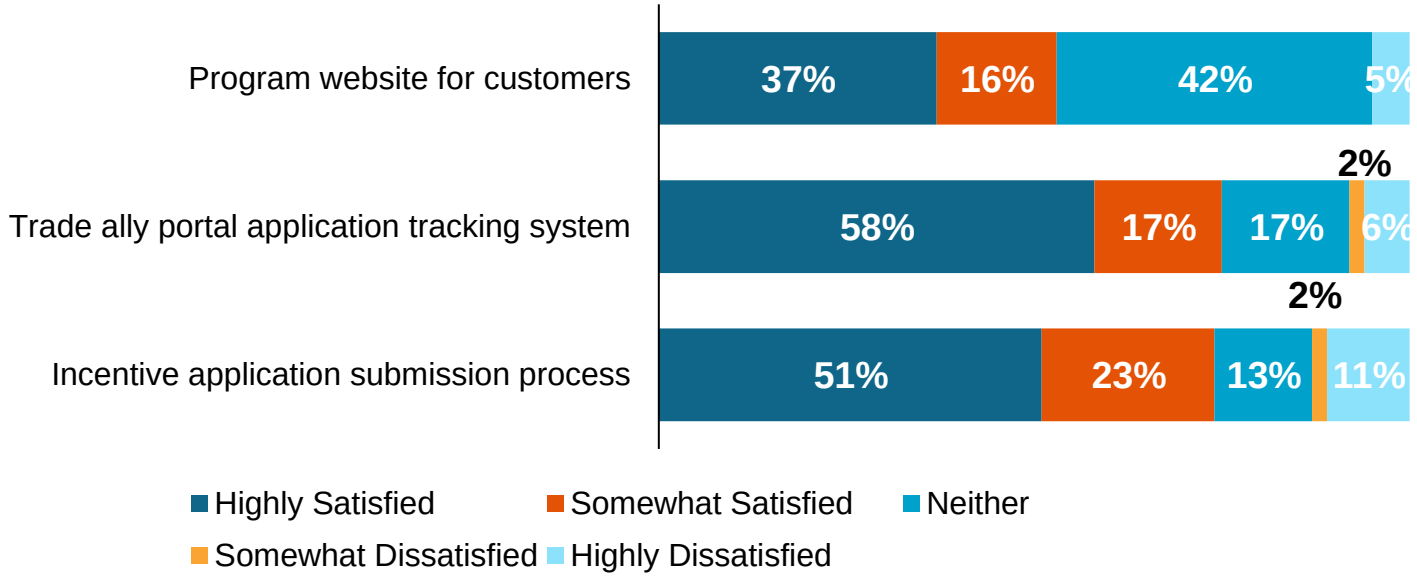
Trade allies that reported problems or frustrations with the rebate application process typically cited challenges with finding customer accounts due to address formatting, challenges in looking up previously filed rebates, repetitive processes, and various submission issues. For example, they reported receiving notices about missing attachments, even though they had been attached, or they had issues with the platform being slow.

Despite these problems and frustrations, the rebate application process and the trade ally portal received high rating in the trade ally satisfaction battery, with 75% of trade allies satisfied with the incentive application submission process and 74% satisfied with the trade ally portal, as shown in Figure 5-4.

Those reporting dissatisfaction with the customer program website stated it was not user friendly, while those reporting dissatisfaction with the trade ally portal also found the portal not user friendly and experienced submission difficulties.

Finally, those reporting dissatisfaction with the incentive application submission process reported difficulties in applying for incentives.

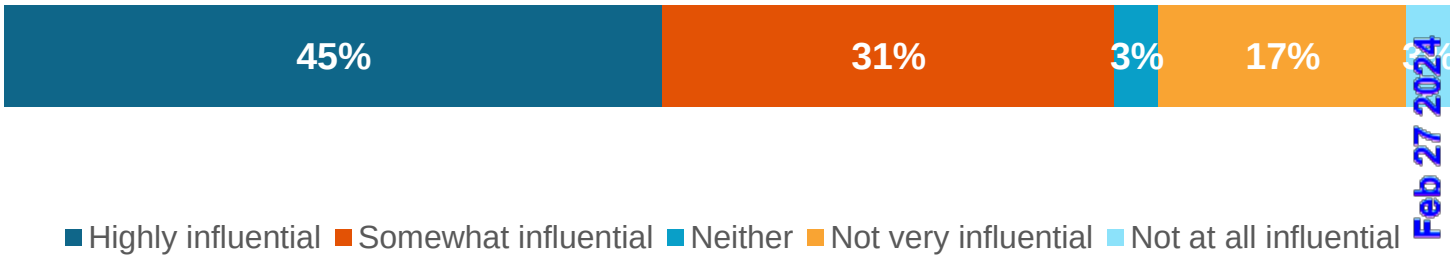
Figure 5-4: Trade Ally Satisfaction with Online Systems (n=52)



5.2.1.4. Program Influence on Trade Allies

Trade ally survey results revealed that the program influenced energy-efficiency contracting services offered by contractors in the trade ally network. Over one-half of surveyed trade allies (58%) reported their knowledge of energy-efficient products and services increased since they became involved with Smart $aver, with 45% of which saying the program proved highly influential in increasing their knowledge, as shown in Figure 5-5.

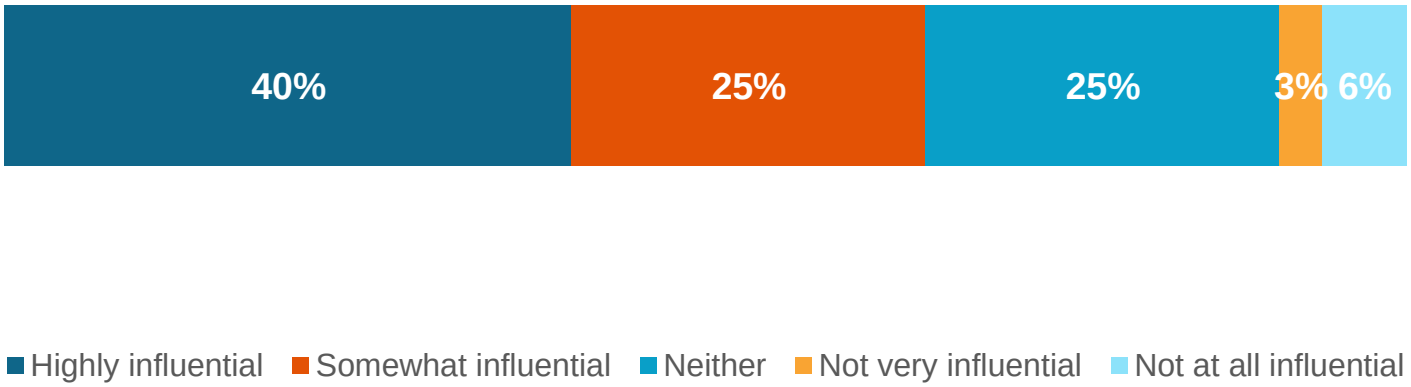
Figure 5-5: Smart $aver Influence on Increased Trade Ally Knowledge of Energy-Efficient Products and Services (n=29)*



*Asked on a 0-10 scale, where 0 was "not at all influential" and 10 was "extremely influential." Not at all influential represented responses ranging from 0 to 2, not very influential represented responses ranging from 3 to 4, neither represented responses of 5, somewhat influential represented responses of 6 and 7, and high influence represented responses ranging from 8 to 10.

Most HVAC trade allies reported that Smart $aver at least partially influenced their practice of recommending qualifying HVAC measures, with the majority (65%) indicating that Smart $aver was moderately or highly influential, as shown in Figure 5-6.

Figure 5-6: Program Influence on Trade Ally Practice of Recommending Program Qualified Measure (n=63)*



*Asked on a 0-10 scale, where 0 was "not at all influential" and 10 was "extremely influential." Not at all influential represented responses ranging from 0 to 2, not very influential represented responses ranging from 3 to 4, neither represented responses of 5, somewhat influential represented responses of 6 and 7, and high influence represented responses ranging from 8 to 10.

Smart $aver, however, had limited influence on stocking energy-efficient equipment, with 67% of trade allies installing equipment measures through the program reporting no changes in their stocking practices since participating in the Smart $aver program.

5.2.1.5. Suggestions for Improvements

Despite these high satisfaction ratings, trade allies offered the following suggestions for program improvements:

- Just under one-half of surveyed trade allies (44%) believed mini-splits should be offered through Smart $aver. The survey question asked what additional measures should be offered through Smart $aver; so this did not imply that 56% of trade allies did not want ductless mini-splits included. Rather, 44% of trade allies mentioned this explicitly. Of five trade allies interviewed, three provided other suggestions for technologies to offer through Smart $aver including mini-splits, crawl space insulation, and sound walls.
- Offer better explanations for applications returned invalid through the portal; auto-populate referral information.
- Shorten processing times for rebates and applications; simplify the rebate process so it takes less time.
- Allow instant rebates and rebates for trade allies as they are currently responsible for the majority of the work involved with applying for rebates through Smart $aver.
- Provide customers with the ability to fill out rebate applications by themselves without intervention from trade allies.

5.2.2. Participant Experience

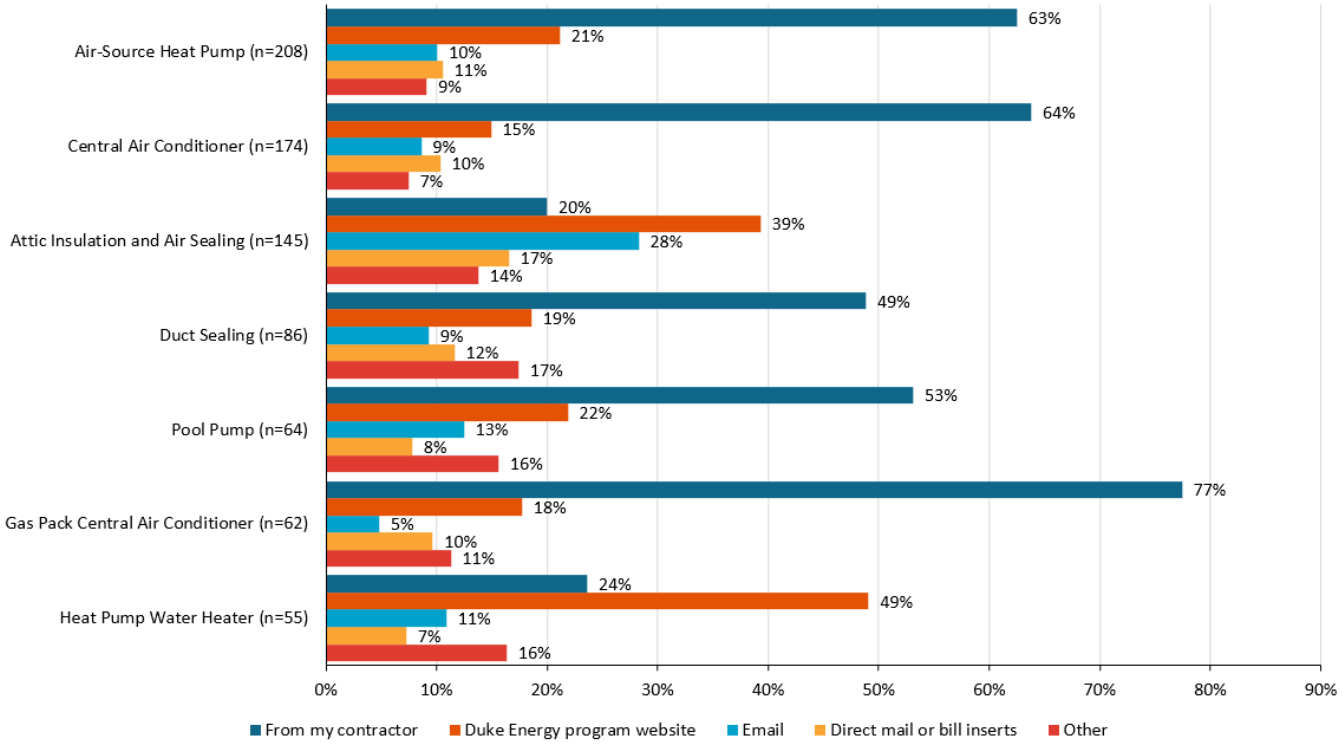
5.2.2.1. Participant Awareness

Contractors served as the primary way consumers learned about the program, as evidenced by more than one-half of overall participants (52%) citing that their contractor served as their program awareness source, as shown in Table 5-5. The evaluation team also examined these results by measure type and found that contractors remained the primary awareness source for all customers except for those who installed attic insulation and air sealing, and heat pump water heaters. Figure 5-7 breaks down awareness sources by the measure type respondents installed.

Table 5-5: Source of Smart $aver Program Awareness (Multiple Responses Allowed)

Source of Program Awareness	n=834
Contractor	52%
Duke Energy website	24%
Email	13%
Direct mail	11%
Other	5%
Word of mouth	4%
Online advertisement	2%

Figure 5-7. Source of Smart $aver Program Awareness (By Measure Installed)

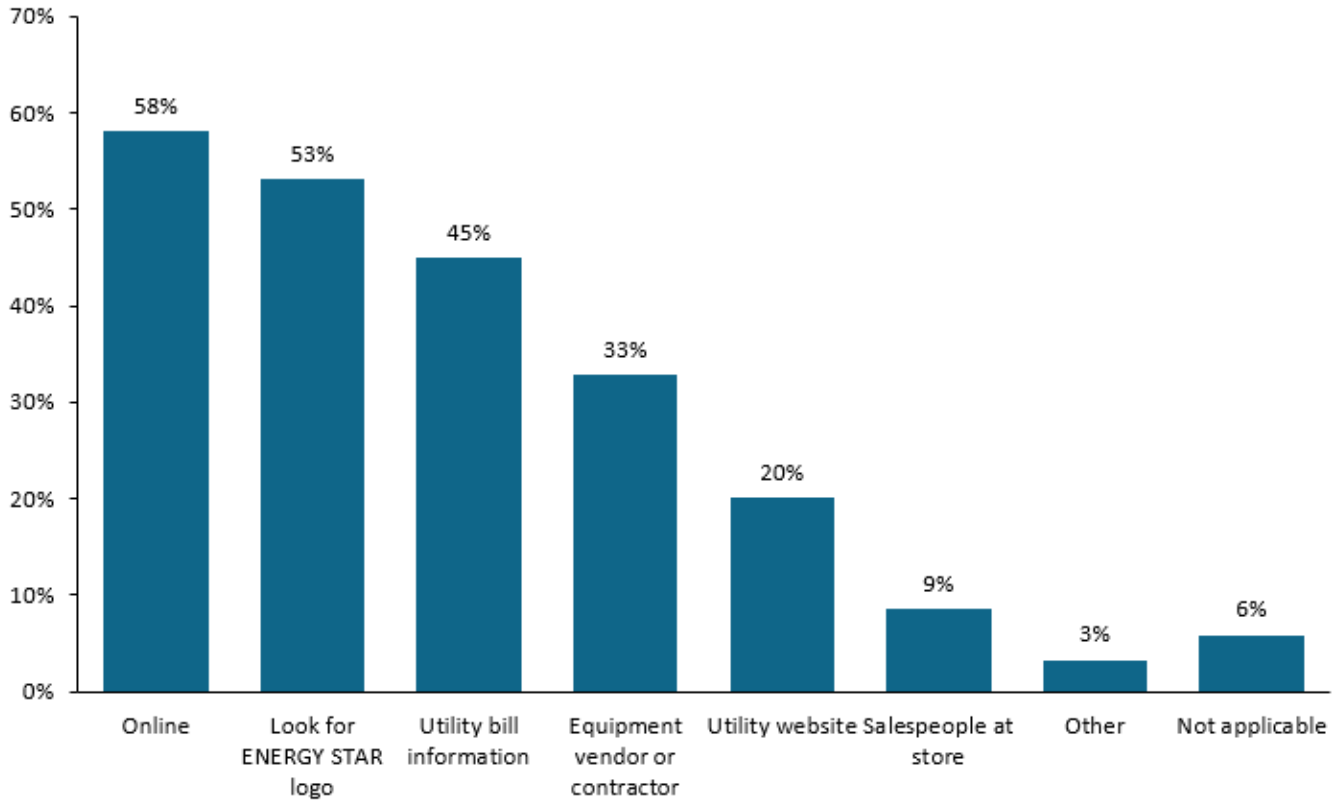


2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 2: "How did you hear about the Duke Energy Smart $aver rebate(s) that you received? Please select all that apply." (n=834).

Respondents typically reported searching for information over the internet on ways to save energy at their residences, with the highest proportion of surveyed participants (58%) reporting reading online

reviews of products for information regarding energy savings. Figure 5-8 shows the full breakdown of overall responses. When split out by measure type installed, the top three sources remain the same across measures.

Figure 5-8. Source of Energy Savings Information



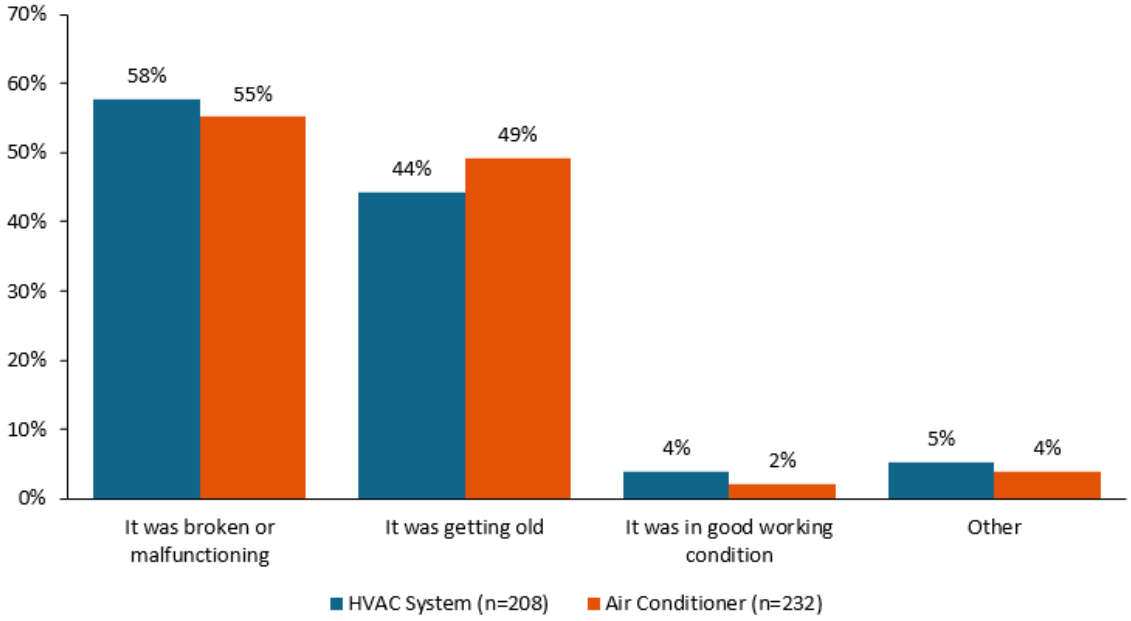
2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 58: "Where do you typically search for information on how to save energy at your residence?" Multiple Response (n=822).

5.2.2.2. Motivation to Participate

The evaluation team asked participants a series of questions to determine why they selected their qualifying Smart $aver measures. For participants who installed air conditioning or other HVAC-equipment measures, the evaluation team asked about the condition and age of the replaced equipment.

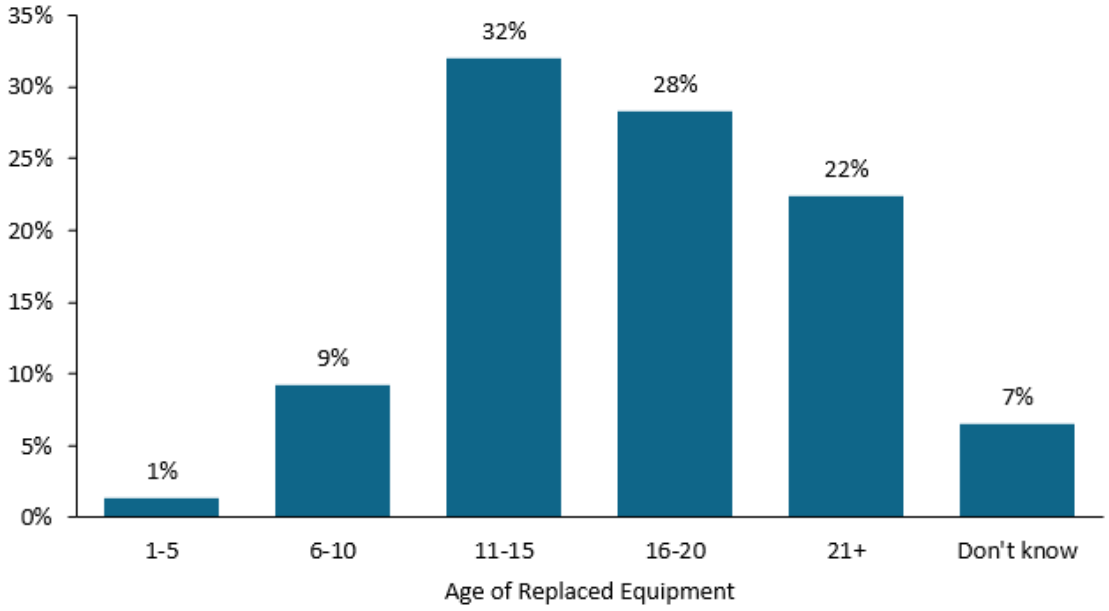
As shown in Figure 5-9, both participant groups most commonly replaced their equipment as it was broken or malfunctioning, followed closely by the equipment's age. Additionally, Figure 5-10 shows the breakdown of replaced equipment ages. While 50% of respondents said they replaced an HVAC that was 16+ years old, the most common equipment age range fell between 11 to 15 years old.

Figure 5-9. Reasons for Equipment Replacement



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 10: "Which of the following best describes the condition of the previous [HVAC system/air conditioner] that you replaced with a [Measure Installed]?"

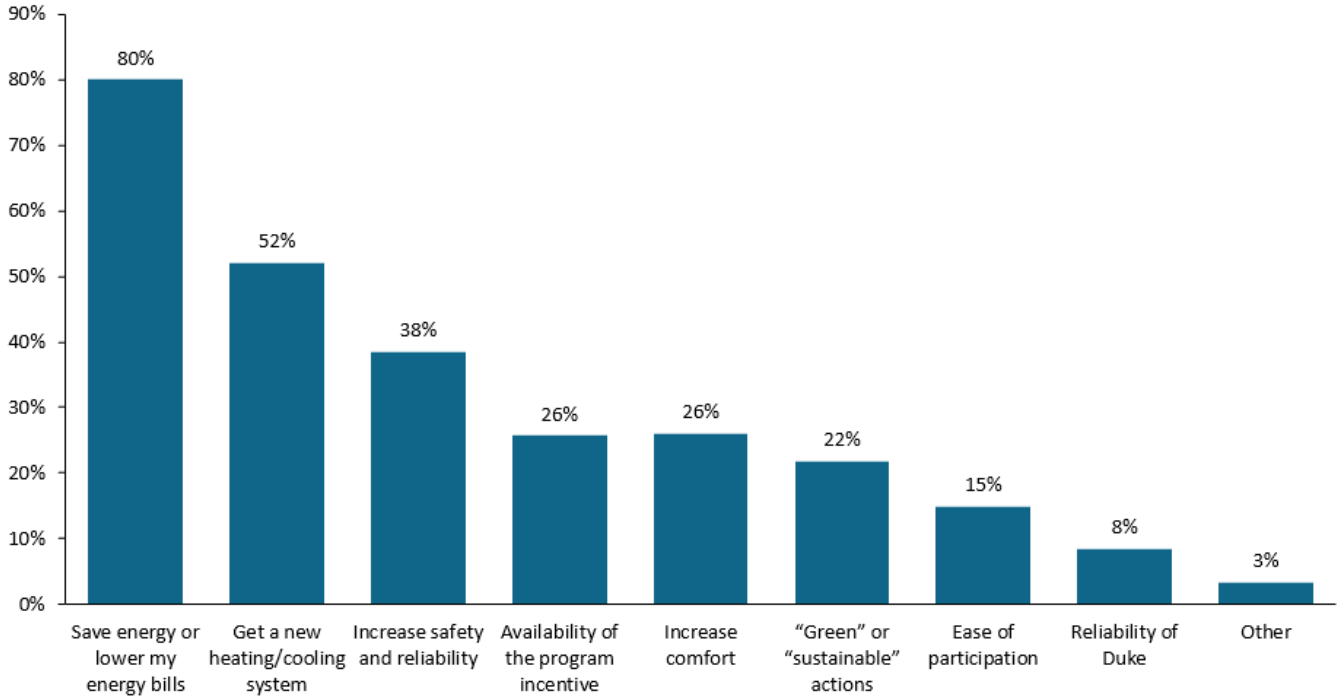
Figure 5-10. Age of Replaced Equipment



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 11: "Approximately, how many years old was the previous HVAC unit that you replaced with your new [Measure Installed]?" (n=441).

The evaluation team also asked participants about their motivations to install the measures they chose. Respondents who installed an energy-efficient heating or cooling system primarily sought to save energy or lower their energy bills, get a new system, and increase safety and reliability. Figure 5-11 breaks down the responses.

Figure 5-11. Motivation for Installing a Heating/Cooling System

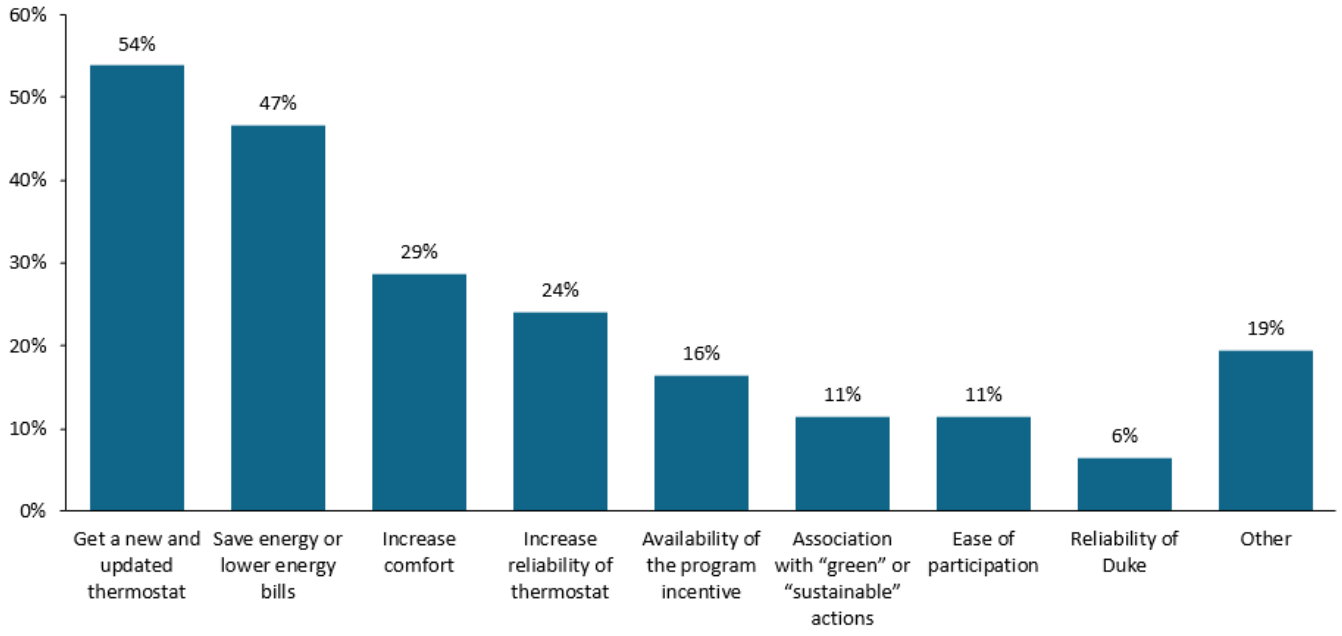


2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 12: "What motivated you to install an energy efficient heating/cooling system rather than a less efficient one that would use more energy? Please select all that apply." (n=440)

Respondents who installed a Wi-Fi enabled thermostat primarily wanted a new and updated thermostat, to save energy or lower energy bills, and to increase comfort. Figure 5-12 shows the full response breakdown. As shown, a larger percentage of respondents indicated other reasons for replacing their thermostats, most commonly responding that the Wi-Fi enabled thermostat came as part of a package, along with other HVAC equipment upgrades purchased by the respondent and installed by their contractor as part of those upgrades. Other common reasons included achieving greater control over their home's temperature and the ease of using the thermostat.

Additionally, customers indicated the type of thermostats they replaced. Most replaced a non-Wi-Fi enabled, programmable thermostat (42%) or a manual, non-programmable thermostat (35%), while additional respondents replaced a Wi-Fi enabled, programmable thermostat (20%) or some other type of thermostat (3%, n=262).

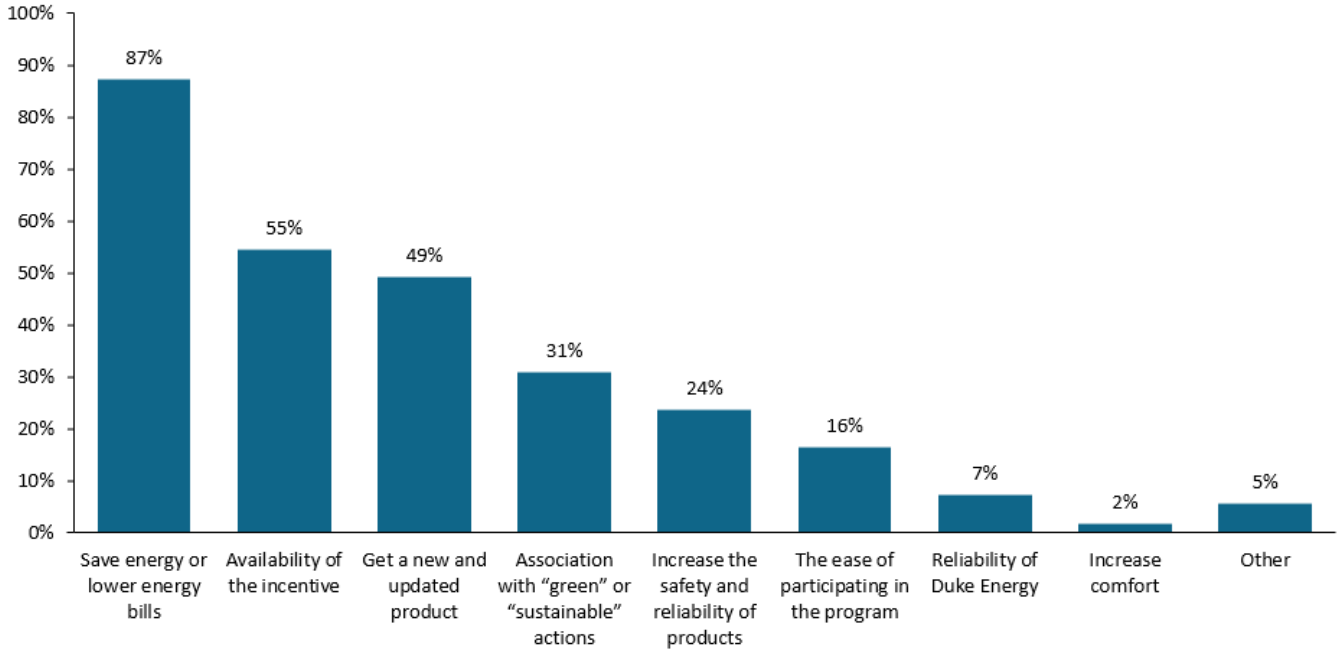
Figure 5-12. Motivation for Installing a Wi-Fi Enabled Thermostat



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 16: "What motivated you to install a Wi-Fi enabled thermostat? Please select all that apply." (n=262)

Respondents who installed an energy-efficient water heater indicated that their primary motivations included saving energy or lowering their energy bills, taking advantage of the incentive's availability, and receiving a new, updated product. Figure 5-13 shows the full breakdown of responses. Additionally, respondents who indicated they installed a new heat pump water heater were asked where it was installed. The most common locations included basements (45%) and garages (40%), though other locations included a closet (5%), laundry room (4%), or some other room (5%, n=55).

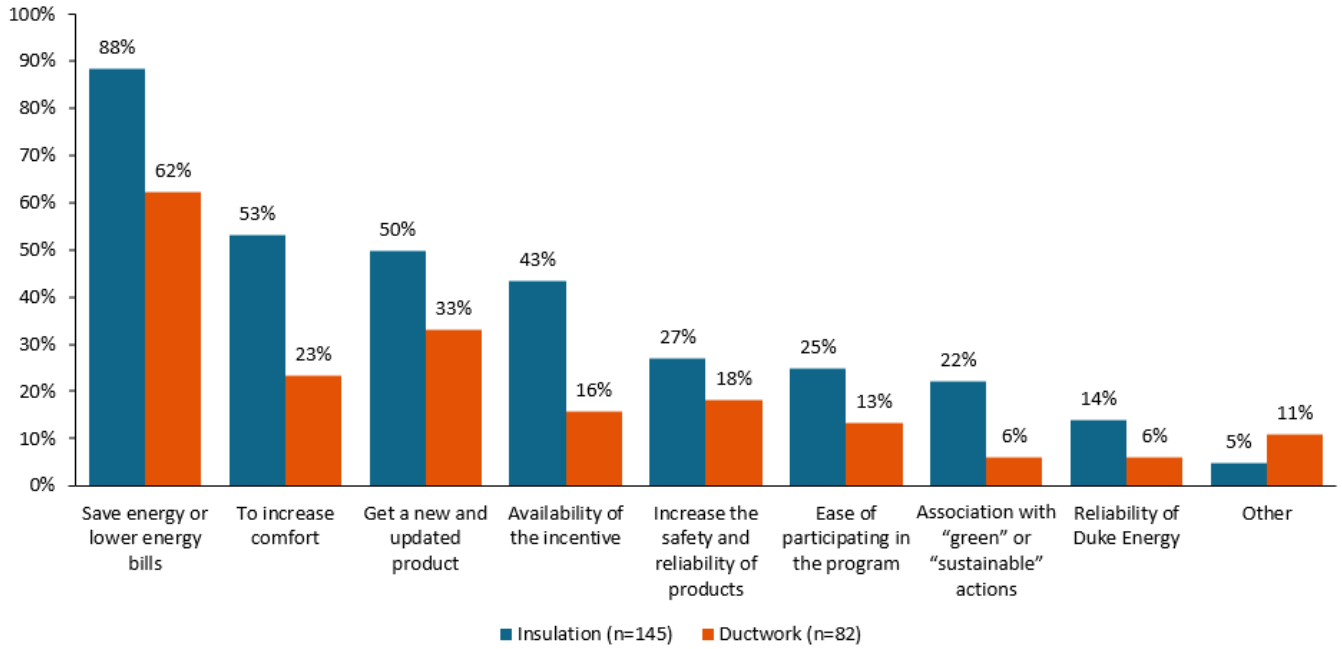
Figure 5-13. Motivation for Installing a Heat Pump Water Heater



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 21: "What motivated you to install an energy efficient water heater rather than a less efficient one that would use more energy? Please select all that apply" (n=55)

Respondents who repaired their ductwork or added insulation to their attic indicated the same primary motivations, but their secondary motivations slightly differed. Each group primarily sought to save energy or lower their energy bills. Figure 5-14 shows the full breakdown of responses among both groups.

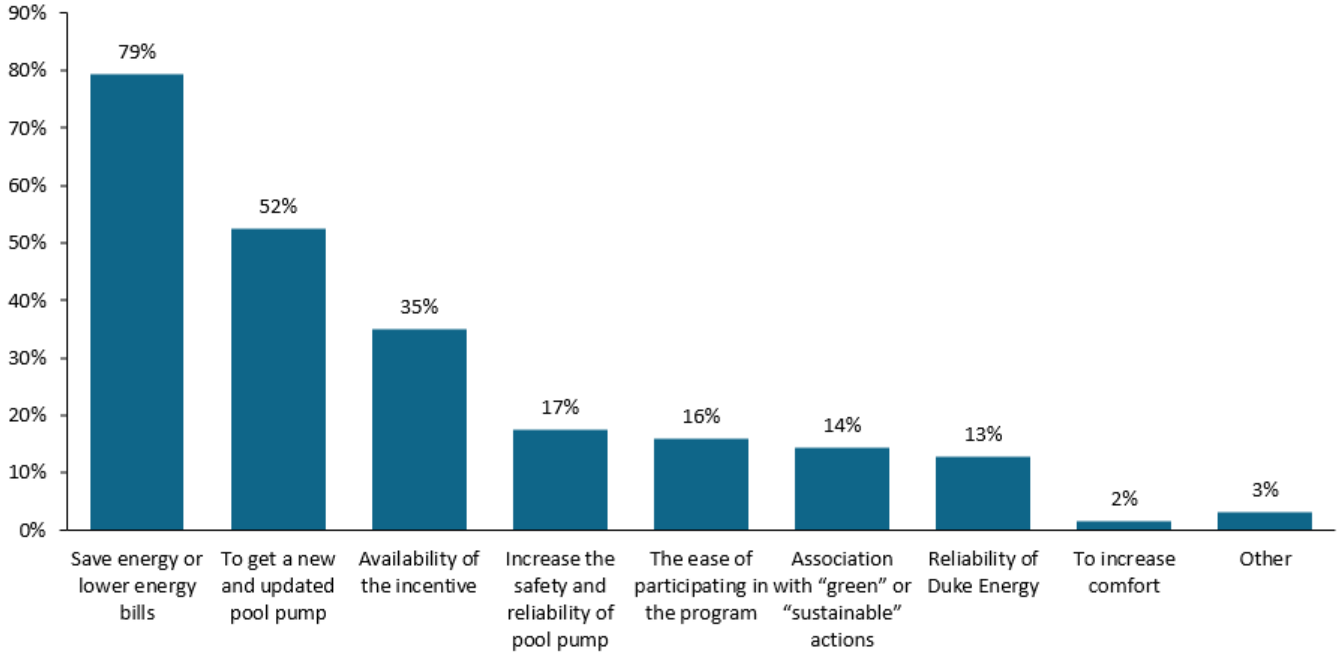
Figure 5-14. Motivation for Upgrading Insulation or Ductwork



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 22: "What motivated you to [repair your ductwork or add insulation to your attic]? Please select all that apply."

Similar to other respondent groups, respondents who installed an ENERGY STAR® pool pump indicated that they primarily sought to save energy or lower their energy bills, get a new and updated pool pump, and take advantage of the incentive's availability. Figure 5-15 shows the full breakdown of responses.

Figure 5-15. Motivation for Installing a Pool Pump

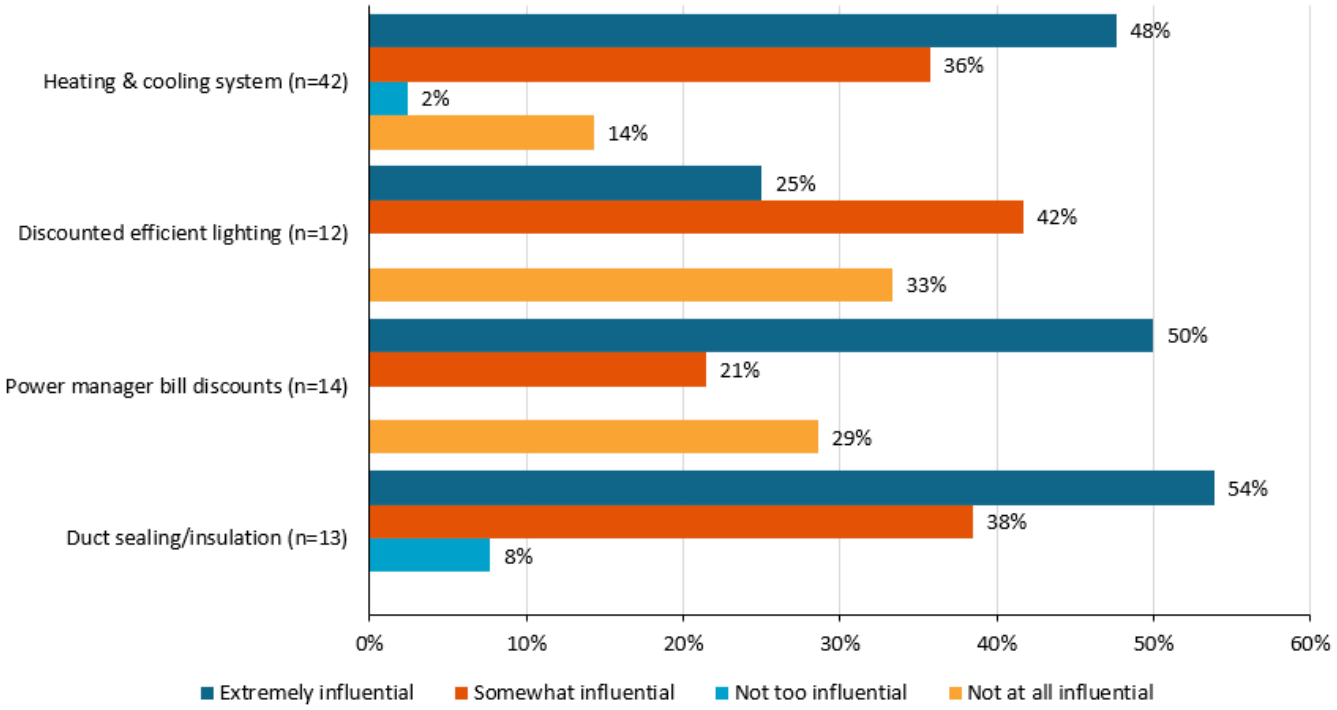


2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 23: "What motivated you to install an ENERGY STAR pool pump? Please select all that apply." (n=63)

5.2.2.3. Program Influence

Some Smart $aver participants claimed that participating in the program lead them to pursue additional Duke Energy rebates. Figure 5-16 shows the top four most-received additional rebate types and their influence level as reported by respondents.

Figure 5-16. Influence of Rebates on Participation

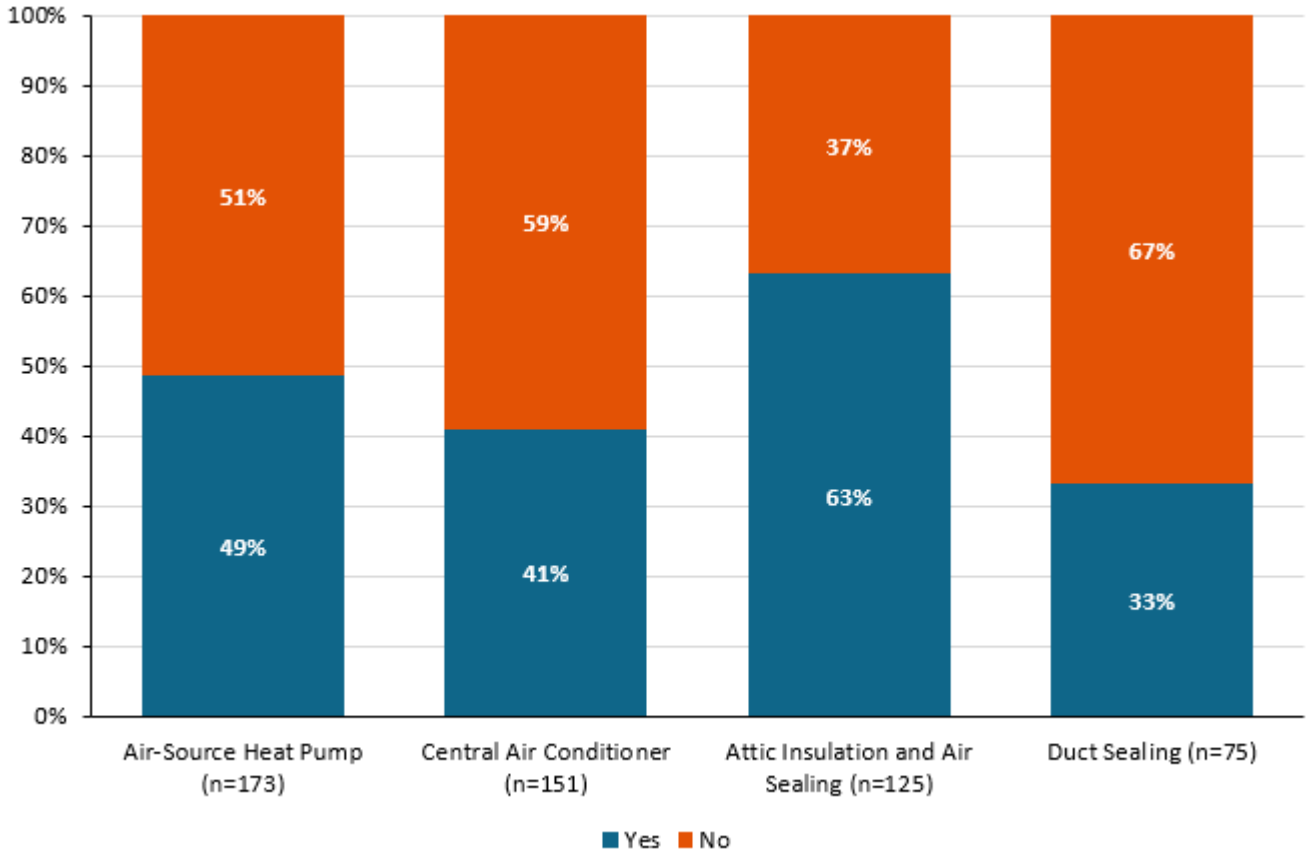


2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 8: "Using a scale from 0 to 10, where 0 means "Not at all influential" and 10 means "Extremely influential," how influential was the rebate for the [Measure Installed] in your decision to take advantage of Duke Energy's rebate for [Rebate Type]?"

The evaluation team also asked participants who installed HVAC measures how they decided which product to install through the Smart $aver program. For all measures, most participants (64%) reported selecting the product based on a list of recommendations provided by their contractors. Additionally, more than three-quarters of participants (80%) reported that, if their contractors did not offer high-efficiency products, they would have sought different contractors that could install a rebate-qualified, high-efficiency unit.

Nearly one-half of overall respondents (48%) reported familiarity with other Duke energy-efficiency rebates. The evaluation team examined the four most commonly installed measures and found slight variations. As shown in Figure 5-17, respondents who installed measures such as air-source heat pumps or attic insulation and air sealing were more likely to have heard of other rebates than participants who installed CACs and duct sealing. Customers most commonly learned of the following rebates: discounted efficient lighting (65%); heating and cooling system rebates (63%); and in-home energy assessments (59%, n=344).

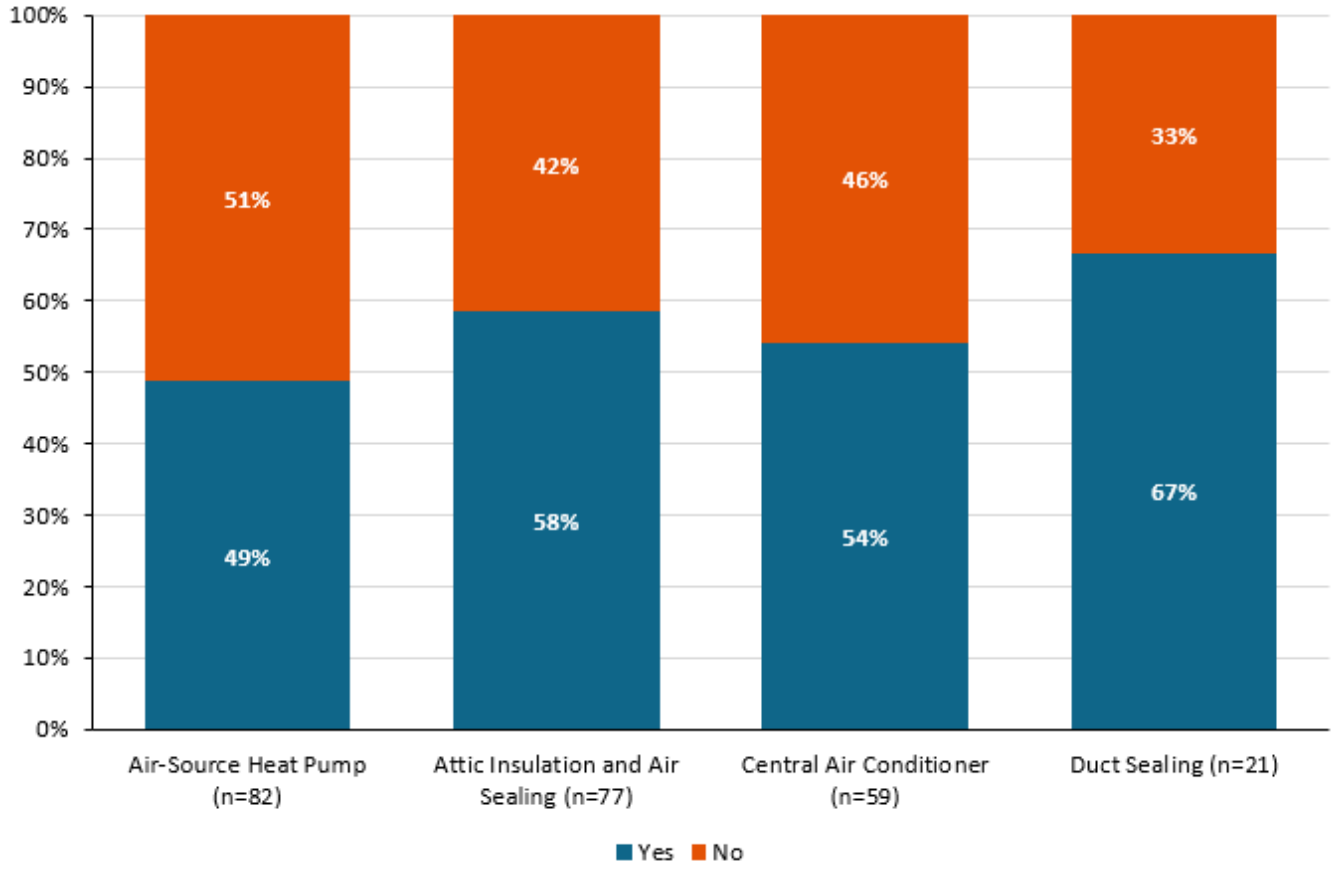
Figure 5-17. Familiarity with Other Rebates



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 3: "Are you familiar with other energy-efficiency rebates that Duke Energy offers, aside from the rebate(s) your received?" (n=724)

Of respondents indicating they had heard of other rebates, just over one-half (52%) indicated that they received one of the other rebates. Again, some slight variations occurred among the top four most-installed measures. As shown in Figure 5-18, duct-sealing respondents were most likely to have received another rebate, with the most commonly received rebates including heating and cooling systems rebates (49%), discounted efficient lighting (42%), and in-home energy assessments (29%, n=157)

Figure 5-18. Other Rebates Received

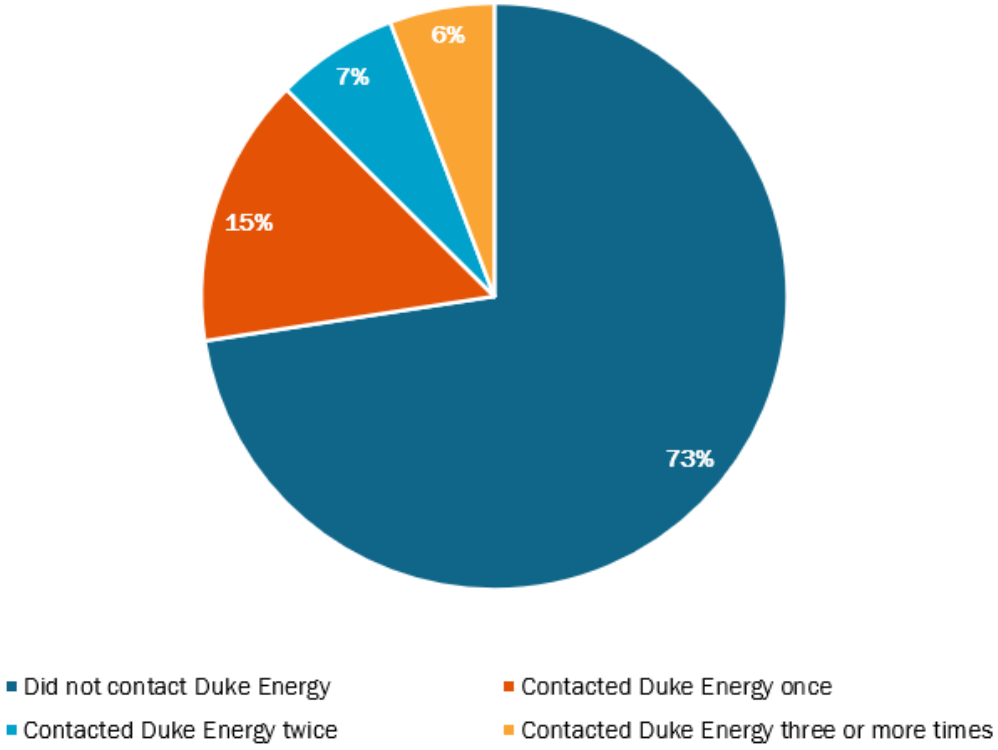


2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 5: "Have you received any of these other rebates?" (n=328)

5.2.2.4. Participant Program Experiences

Almost three-quarters of surveyed participants (73%) reported they did not contact Duke Energy program staff with questions during their program participation. Figure 5-19 shows the full breakdown of responses. Of the 27% of participants that contacted program staff, most (15%) contacted them only once. Of those contacting program staff, most (89%) reported doing so over the phone.

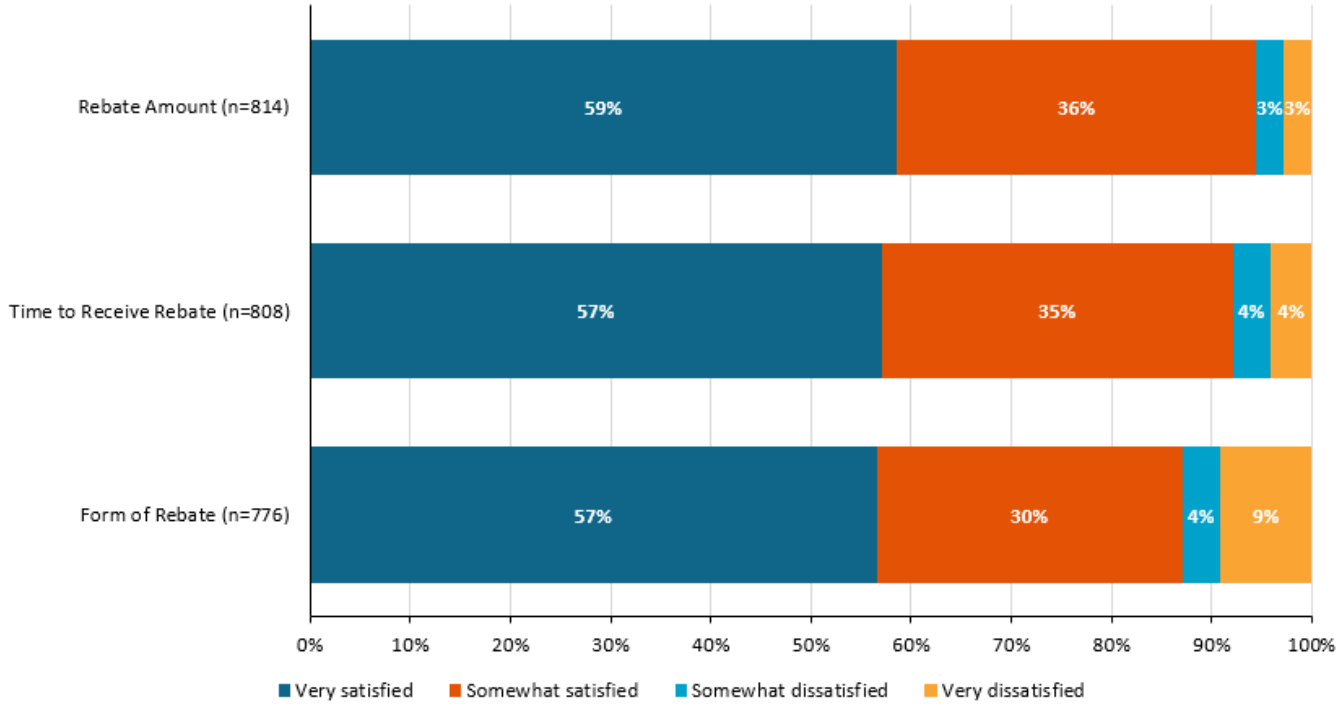
Figure 5-19. Frequency of Communication with Duke Energy



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 65: "In the course of participating in the Duke Smart $aver program, how often did you contact Duke Energy or program staff with questions?" (n=805)

Most participants reported high satisfaction levels with the Smart $aver rebates. As shown in Figure 5-20, a majority of respondents reported satisfaction with rebate amounts (95%), the time required to receive their rebate (92%), and their rebate's form (87%). Some customers noted challenges with rebates as some gift cards expired before or shortly after they received them, leading to a slightly higher percentage of respondents expressing dissatisfaction with the form.

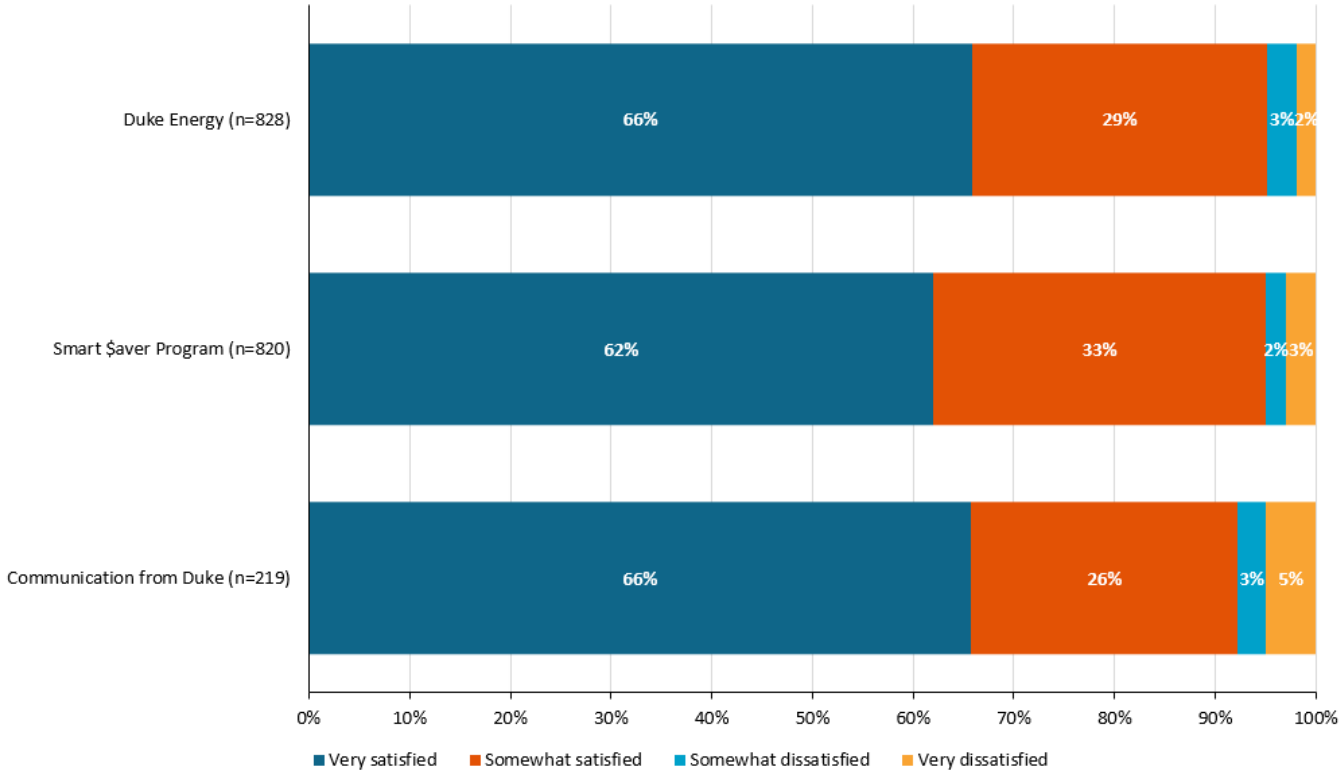
Figure 5-20. Participant Satisfaction with Rebate Aspects



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 59: "How satisfied were you with the rebate dollar amount for [Measure Installed]?", Question 60: "How satisfied were you with how long it took to receive that rebate?", Question 63: "How satisfied were you with the form of payment for the rebate amount you received?"

Similarly, most participants reported high satisfaction levels with Duke Energy and the Smart $aver rebate program as a whole. As shown in Figure 5-21, a majority of respondents reported satisfaction with Duke Energy (95%), the Smart $aver program (95%), and communications from Duke Energy (92%). Customers reporting issues with communications most commonly cited issues related to problems with incentives and requiring repeated calls for specific problems.

Figure 5-21. Participant Satisfaction with Program Aspects



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 74: "If you were rating your overall satisfaction with the Duke Energy Smart $aver Rebate Program, would you say you were Very Satisfied, Somewhat Satisfied, Neither Satisfied nor Dissatisfied, Somewhat Dissatisfied, or Very Dissatisfied?", Question 76: "How satisfied are you with Duke Energy's overall performance as your electricity supplier?", Question 67: "Using the 0 to 10 scale, how satisfied were you with these communications?"

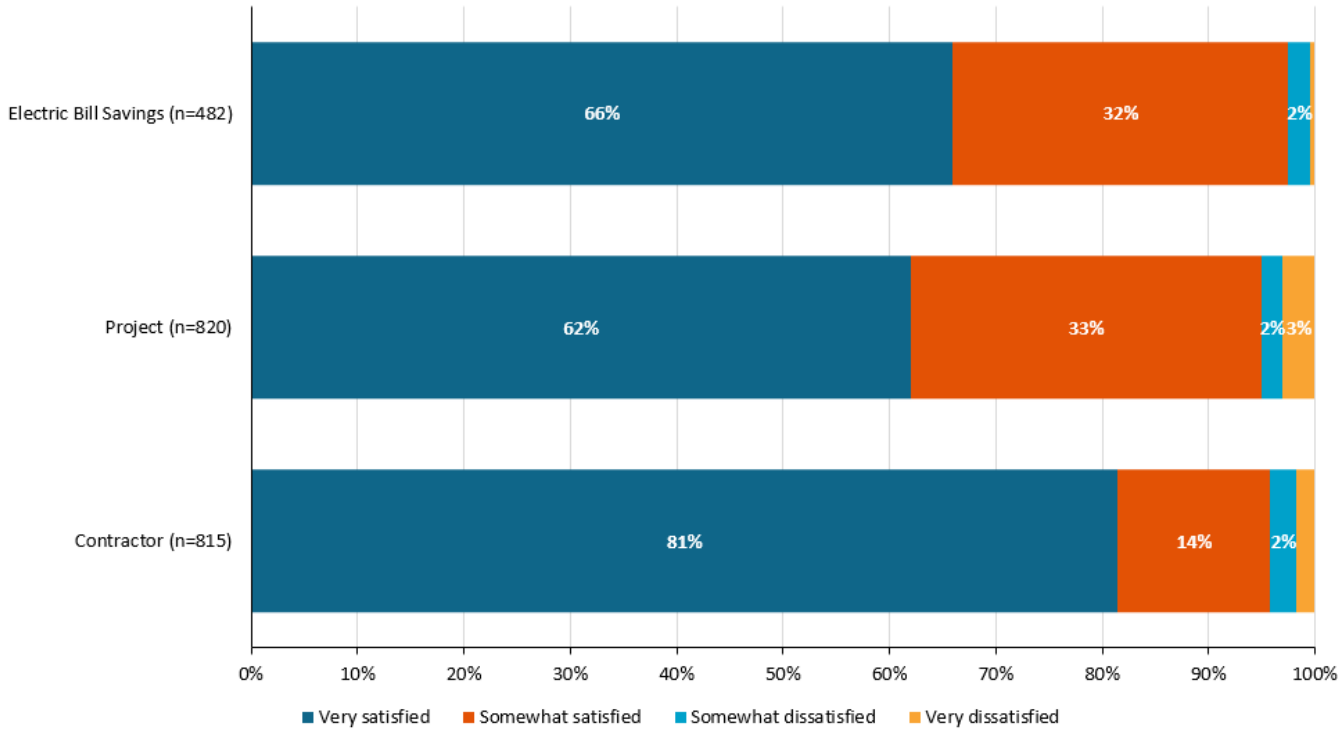
Although savings did not play a driving role in participants' program satisfaction, more than one-half (64%) reported noticing savings on their electric bills following completion of their last project, as shown in Table 5-6.

Table 5-6: Resulting Energy Savings on Electric Bill

Experienced Savings on Electric Bill	n=752
Yes, they noticed savings	64%
No, they looked but did not notice any savings	19%
No, they looked but it is too soon to tell	6%
They did not look yet but planned to	6%
They did not look yet and did not plan to	4%
Total	**100%**

Among respondents reporting electric bill savings, most expressed satisfaction with the results. Figure 5-22 shows the breakdown of satisfaction results along with participants' satisfaction levels with their projects and with the contractors installing them. Both program aspects produced high satisfaction levels as well.

Figure 5-22. Participant Satisfaction with Project Aspects



2020-2022 DEC-DEP HVAC Smart $aver Evaluation: Participant Survey Question 69B: "How satisfied are you with any savings you noticed on your electric bill since the project?", Question 70: "How satisfied are you with your project?", Question 72: "How satisfied are you with the interaction with the contractors who worked on the project?"

The evaluation team asked respondents for suggestions to improve the program. Table 5-7 lists the most common themes among participants' responses.

Table 5-7: Suggestions for Improving Smart $aver Program (Multiple Responses Allowed)

Suggestions for Improving the Program
More/better advertising
Improve webpage
Higher dollar amounts for rebates
Make it easier to identify approved contractors
List all rebates and energy savings on mailers
Allow customers to submit rebate applications
Longer expiry dates on incentives
Additional rebate forms, such as account credits or checks

5.2.3. Participant Demographics

Additionally, the evaluation team collected demographic information from respondents to better understand the examined population. Nearly all surveyed participants reported owning their homes (99.9%), with only 0.1% of respondents reporting that they rented (n=810). Additionally, 97% of respondents reported that they lived at the residence where the project was installed (n=834). Nearly all (92%) reported living in a single-family detached home, as shown in Table 5-8.

Table 5-8: Participant Housing Type

Housing Type	n=834
Single-family detached home	92%
Row house, townhouse, or condo, with two or more units but no common area(s)	5%
Factory-manufactured single-family home	1%
Multifamily apartment or condo buildings with four or more units and a common area(s)	1%
Other	1%
Total	100%

Demographics indicated that the participant sample was highly educated, with over half of respondents having a bachelor's degree (32%) or a graduate degree (32%, n=770). Of respondents who reported their income, the highest proportion earned between $100k to <$150k a year (25%,

n=592). Additionally, of respondents reporting their age, the highest proportion were born between 1950-1959 (33%, n=805).

The highest proportion of homes were built between 2000-2009 (28%) or between 1990-1999 (20%, n=825). Over one-half of the homes measured between 2,001-3,000 (40%) or 1,001-2,000 (36%, n=817) square feet. Most respondents indicated they had a natural gas furnace as their heating system (52%) and a CAC as their cooling system (67%). Nearly half (49%), however, indicated they used a heat pump for heating, and a similar percentage (41%) used a heat pump for cooling. More than one-half of respondents reported their heating equipment fuel source as electric (53%).

6. Conclusions and Recommendations

Based on the reported findings, the evaluation team suggest the following recommendations to achieve program improvements.

Conclusion 1: The market has changed since the last program update.

Recommendation 1: Consider the following updates to the program's design:

- Remove the SEER 15 central air conditioners (CAC) and air source heat pumps (ASHP) tier offering
- Add an additional tier for SEER 18+ for CAC and ASHP
- Add a ductless mini-split heat pump offering
- Consider adding an EER requirement in addition to SEER (as this impacts summer kW)
- Separate GSHP from ASHP, and assign specific savings to each

Conclusion 2: Smart thermostats produce high savings. The AMI analysis showed very robust savings for smart thermostats installed through the program. Many trade allies noted that smart thermostat incentives used to be higher.

Recommendation 2: Consider providing incentives for stand-alone smart thermostats.

Recommendation 3: Consider returning to a higher incentive for smart thermostats, such as that offered previously.

Conclusion 3: Trade allies appreciate the new portal. Most respondents (86%) reported not having issues with the enhanced Rebate Application Entry and Tracking Platform, compared to 37% of trade allies who reported that they occasionally experienced challenges or frustrations with the previous platform.

Recommendation 4: Trade allies' suggestions for application improvements included the following:

- Better explanations if applications are returned as invalid
- Auto-population of referral information

Recommendation 5: Enhance the application system's lookup features and ensure proper communication with trade allies regarding submission problems.

Conclusion 4: Though most customers and trade allies expressed satisfaction with the incentives, some respondents voiced alternatives.

Recommendation 6a: Decrease processing times and increase gift card expiration dates (past six months). Consider a "payment in check" option as the default, as issues sometimes occurred with gift cards expiring before people could use them. If this is not possible, communicate with customers that should their gift card expire before use, they may request a reissue up to one year after participation.

Recommendation 6b: As customers commonly cited learning about the program through trade allies and the trade allies completed the incentive application process for most measures, consider reinstating a direct incentive for trade allies.

Recommendation 6c: For high-volume trade allies submitting a great deal of applications as well as those preferring to do so financially, consider allowing an instant incentive (though this still must be approved through the portal). Some trade allies noted that the time and cost they incurred from serving as the "middle man" between customers and the gift card processor posed a substantial burden, and they preferred to present the incentive as an invoice credit. Consequently, on a regular cadence, trade allies could bundle incentive payments into one incentive that Duke could pay back directly. This could save on gift card processing costs and would alleviate issues with long incentive wait times.

Conclusion 5: Thermostat AMI analysis did not show statistically significant summer peak demand impacts, but it did show winter peak demand savings.

Consideration 1: Continue to attempt peak demand savings AMI analysis where energy savings AMI analysis is successful.

Conclusion 6: AMI analysis showed statistically significant savings for building shell (envelope) measures.

Consideration 2: Attempt AMI analysis of other measures that are expected to show large impacts and significant measure populations, such as central air conditioners and air source heat pumps.

Appendix A Summary Form

Description of program

The Smart $aver program offers Duke Energy existing residential customers incentives for improving their homes' energy efficiency through the installation of energy-efficient heating, ventilation, and air conditioning (HVAC), smart thermostats, pool pump, and water-heating equipment replacements, duct sealing, duct insulation, and attic insulation with air sealing.

Date	2020-2022
Region(s)	Carolinas/Progress
Evaluation Period	July 1st, 2020 – March 31st, 2022
Annual Gross MWh Savings	DEC: 37,092 MWh/year DEP: 15,719 MWh/year
Annual Gross MW Savings	DEC: 7.96 (summer), 3.16 (winter) DEP: 2.69 (summer), 1.50 (winter)
Net-to-Gross Ratio	84.09%
Process Evaluation	Yes
Previous Evaluation(s)	2016-2017 (DEC), 2014 (DEP)

Evaluation Methodology

Impact Evaluation Activities

Web surveys (n=834) and analysis of 10 unique measures

Impact Evaluation Findings

- Realization rates:
  - DEC: 174% (energy); 136% (summer demand); 50% (winter demand)
  - DEC: 188% (energy); 109% (summer demand); 186% (winter demand)

Process Evaluation Activities

- Participant web surveys (n=834)
- Trade ally web and phone surveys (n=52)
- One interview with program staff
- One interview with program implementer
- Five interviews with high-volume trade allies

Process Evaluation Findings

- Overall, participants and trade allies are satisfied with the Smart $aver program.
- Trade allies serve as an important source of program awareness for customers, with most participants hearing about rebates from their contractors.
- Customers are primarily motivated to install energy-efficient equipment by their desire to save energy or lower energy bills.
- Trade allies are satisfied with the enhanced trade ally portal.
- Trade allies believe that ductless mini-splits should be added to the program.

Appendix B Measure Impact Results

Table B-1: DEC Per-Unit Verified Impacts by Measure—Key Measure Parameters

Measure Category	Gross Energy Savings (kWh)	Gross Summer Demand (kW)	Gross Winter Demand (kW)	Realization Rate (Energy)	FR	PSO	NPSO	Net-to-Gross Ratio (Energy)
Central Air Conditioner Tier 2	196.086	0.0668	0.0000	91.9%	48.35%	11.27%	10.32%	73.24%
Central Air Conditioner Tier 3	478.786	0.0839	0.0000	112.3%	50.99%	7.19%	10.32%	66.52%
Air Source Heat Pump Tier 2	475.066	0.0572	0.0961	114.9%	49.14%	9.18%	12.01%	72.05%
Air Source Heat Pump Tier 3	1,129.001	0.0468	0.2115	117.2%	51.90%	1.10%	12.01%	61.21%
Geothermal Heat Pump	2,251.210	0.4524	0.5232	229.5%	51.90%	1.10%	12.01%	61.21%
Smart Thermostat	605.081	0.0000	0.0332	177.4%	0.00%	0.00%	0.00%	100.00%
Variable Speed Pool Pump	8,039.954	2.7797	0.0000	330.9%	38.37%	0.66%	0.00%	62.29%
Attic Insulation and Air Sealing	1,087.384	0.3417	0.1274	111.0%	0.00%	0.00%	2.35%	102.35%
Heat Pump Water Heater	1,571.126	0.1614	0.0192	97.2%	37.49%	2.16%	7.14%	71.82%
Duct Sealing	1,284.182	0.4453	0.1746	298.8%	0.00%	0.00%	6.72%	106.72%

DEC%20Res%20HV
AC%20Smart$aver%2

Table B-2: DEP Per-Unit Verified Impacts by Measure—Key Measure Parameters

Measure Category	Gross Energy Savings (kWh)	Gross Summer Demand (kW)	Gross Winter Demand (kW)	Realization Rate (Energy)	FR	PSO	NPSO	Net-to-Gross Ratio (Energy)
Central Air Conditioner Tier 2	193.171	0.0586	0.0000	86.4%	48.35%	11.27%	10.32%	73.24%
Central Air Conditioner Tier 3	488.111	0.0578	0.0000	168.4%	50.99%	7.19%	10.32%	66.52%
Air Source Heat Pump Tier 2	437.618	0.0525	0.0865	150.1%	49.14%	9.18%	12.01%	72.05%
Air Source Heat Pump Tier 3	1,181.616	0.0448	0.2266	284.1%	51.90%	1.10%	12.01%	61.21%
Geothermal Heat Pump	2,823.628	0.5521	0.6554	679.0%	51.90%	1.10%	12.01%	61.21%
Smart Thermostat	605.081	0.0000	0.0332	197.4%	0.00%	0.00%	0.00%	100.00%
Variable Speed Pool Pump	5,068.519	2.2983	0.0000	215.5%	38.37%	0.66%	0.00%	62.29%
Attic Insulation and Air Sealing	1,087.384	0.3417	0.1274	93.5%	0.00%	0.00%	2.35%	102.35%
Heat Pump Water Heater	1,587.505	0.1631	0.0194	80.3%	37.49%	2.16%	7.14%	71.82%
Duct Sealing	1,284.182	0.4453	0.1746	366.9%	0.00%	0.00%	6.72%	106.72%

DEP%20Res%20HVAC%20Smart$aver%20(

Appendix C Participant Demographics

Figure C-1: Participant Demographics

Ownership Status	
Own	99.9%
Rent	0.1%

Living Arrangement	
Live at residence	97%
Do not live at residence	3%

Education	
High school or less	5%
Trade School	2%
Some college	14%
Bachelor's degree	32%
Some graduate school	6%
Graduate degree	32%
Doctorate	8%

Income	
<$35k	8%
$35k to <$50k	10%
$50k to <$75k	15%
$75k to <$100k	18%
$100k+	49%

Figure C-2: Participant Household Characteristics

Year Home was Built	
Before 1960	10%
1960-1969	6%
1970-1979	14%
1980-1989	15%
1990-1999	20%
2000-2009	28%
2010-2019	6%
2020-2021	1%

Heating Fuel Source	
Electric	53%
Natural Gas	42%
Other	5%

Home Square Feet	
Less than 1,000	1%
1,001-2,000	36%
2,001-3,000	40%
3,001-4,000	16%
4,001-5,000	5%
>5,000	3%

Heating System	
Natural gas furnace	52%
Heat pump	49%
Other	10%

Cooling System	
Central air conditioner	67%
Heat pump	41%
Other	4%

Appendix D Survey Instruments and In-Depth Interview Guides

Program Staff In-Depth Interview Guide

Introduction

Today, we'll be discussing your role in the Carolinas/Progress Smart $aver Program. We would like to learn about your experiences in administering this program during the time period between July 1, 2020, and March 31, 2022.

Your comments are confidential. If I ask about areas you are unsure about, please feel free to tell me and we will move on. Also, if you want to refer me to specific documents to answer any of my questions, that's great. I'm happy to look things up if I know where to find the information.

I would like to record this interview for my note-taking purposes. Do I have your permission?

Roles & Responsibilities

Q1. Can you briefly describe your role(s) in the Carolinas/Progress Smart $aver program and provide your current job title? How long have you been in this role?

Program Changes and Targets

Q2. Have any aspects of the program changed during this time period? Why were these changes made?

Q3. How well do you think the Carolinas/Progress Smart $aver program is structured now to meet your energy savings goals in 2022?

If not mentioned, ask:

a. Are you considering any measures or incentive structures to add to the program? If so, what and why?
b. Are you considering offering any financing options to encourage more customers to participate in the program? If so, what are your thoughts as to how the program might implement this?
c. Are there any other program enhancements you are considering?
d. Do you feel the program has engaged enough trade allies to generate enough participation to reach your 2022 savings goals?

Application Processing

Now I'd like to hear about program processes.

Q4. We understand your implementer is responsible for rebate application processing, rebate incentive fulfillment, and customer care call center services. They also provide the IT platform for the Trade Ally Portal. Is this correct? Do they provide any other services?

Q5. Please describe the application processing process. Specifically, what happens after an application is received? *(Probes: Do implementers log receipt of submission, verify there are no errors on the application, approve or reject application, mail/email/deposit funds, provide report to Duke Energy, etc.? Are trade allies still submitting paper applications or are all applications submitted online now?)*

a. Comparing Indiana's to Ohio's or Carolinas' Smart $aver program, are there any differences in how applications are processed between these programs? If so, what are the differences?
b. *[If the application processing varies between Indiana and Ohio/Carolinas programs, ask:]* Is there anything that you have learned from the differences that has led to you wanting to make changes to the Carolinas/Progress program? If so, what would you like to change?
    - Is Duke Energy trying to standardize the application tracking and processing across all Duke Energy Smart $aver/HVAC programs?

Q6. What are the most common errors or problems with rebate applications?

b. How often do these occur?
c. How are these application errors tracked/monitored internally with your implementer?
d. Are these issues reported to Duke Energy?
e. Does Duke Energy get involved at any point or does the implementer handle these issues?
f. Is there a certain time or times of year when you see the most problems?
g. Are there some trade allies or types of trade allies that generally have more errors/problems than others?
h. In the last few years, what actions have been taken by Duke Energy and/or the Implementer to reduce issues with application submissions? *(Probes: Education, training, changes in forms, submission process changes, etc.)*
    - Have these actions been effective?

Q7. Which parts of the application processing do you think work particularly well? Why?

a. Which parts work less well? Why?

Q8. What is the satisfaction amongst recipients of the mode (digital payment, gift/credit card, etc.) and timeline of rebate payments? How do you know?

QA/QC

Now, let's talk briefly about Quality Assurance/Quality Control.

Q9. Does Duke Energy require on-site inspections of at least some number of HVAC or other projects done through the Carolinas/Progress program? If so, what proportion of projects are inspected? Has COVID impacted this?

Q10. We have heard that Duke Energy staff conducts these inspections. Is this correct?

Q11. What are typical types of QA/QC issues that come up?

a. How often do these come up?
b. Are the issues more common with certain trade allies or certain equipment?
c. How are the issues addressed?

Communication

Next, I'd like to hear briefly about how communication processes are working between Duke Energy, the implementer, and trade allies.

Q12. How often do you interact with implementer staff? What do you discuss during these meetings? (*Probe: What types of issues come up during the meetings?*)

Q13. How do you and/or your implementer communicate program changes to trade allies? What challenges, if any, have you had in communicating program changes to trade allies?

Q14. How often do you have to resolve an issue with a trade ally or a customer? What types of issues come up?

Tracking and Reporting

Q15. Can you tell me about the tracking and reporting data that you receive from the implementer or internally about the program?

a. In what form are these data provided? To whom are they provided? How often are they provided?

b. Is there information that you need about the program but are not getting?

c. What reports or other information provided by the implementer or internally that you find to be most useful? Least useful (if anything)? Why?

d. Do you or the implementer collect and track any information on baseline equipment, such as efficiency or age of replaced equipment? If not, is this baseline information collected by the trade allies?

e. Thinking of the smart thermostat measure, what information do you collect and track on that measure?

- [*If not addressed*] Does the program require trade allies to program the temperature setting on the new thermostat? [*If yes*] At what setting do contractors program the thermostat? [*If not*] Do you track the default temperature setting of the installed thermostats? Are you able to collect this information via the Wi-Fi connection?

Trade Allies

From what we know, participation of the trade ally network is vital to the success of the program. I'd like to hear a bit more detail about how the program works with trade allies.

Q16. How are trade allies recruited to participate in your program? (*Note to interviewer: contractors must complete a Trade Ally registration form to be considered a Trade Ally. There are two separate forms: one for HVAC and one for Insulate and Seal measures.*)

a. Do you know what percent of potentially qualified trade allies are in the program? Has this percent increased, decreased, or stayed the same? [*If increased or decreased*] Why did it increase/decrease?

Q17. What is your sense of what motivates trade allies to prequalify and participate in the program? How do you know?

Q18. What services or support do you offer to your participating trade allies? Let's start with:

a. Marketing support? Do you offer co-op advertising materials? Anything else?
b. How about training support? (*Probe about sales, program, or other training*)
c. Anything else?

Q19. Do contractors use the Duke Energy Carolinas/Progress website and/or trade ally portal to locate information about the program? How do you know?

Q20. Are there any other services you would like to provide to trade allies in the near future? If so, what?

Q21. Have you recently had to remove any trade allies from your list of participating contractors due to disengagement or inability to perform according to program requirements? If so, how many did you have to remove? (*Probe: Do you have a list?)*

Q22. What have you heard from trade allies regarding their interest in any new equipment/ technology or any new incentives/offerings?

Marketing and Outreach

Now, I'd like to hear about the current status of marketing activities for the program.

Q23. How do you market the program?

Q24. Could you provide us with blocking charts, marketing expenditures, or reach and frequency of marketing for the Carolinas/Progress Smart $aver HVAC program?

Q25. How does Duke Energy decide which marketing strategy to implement?

a. How do you typically measure the success of the marketing campaign(s)?

Q26. [*If they offer co-op marketing materials to trade allies*] How many trade allies use these co-op marketing materials? Do you have a goal for how many should use these materials?

Q27. Have you recently begun or are planning to include expanded marketing efforts to non-English speaking customers? Or any other recent and/or planned Diversity, Equity, Inclusion strategies?

Q28. Thinking about customers, are there any additional opportunities for expanding market penetration that the program is currently pursuing or planning to pursue?

[Probe as needed] For example, are there other…?

a. Population segments to target?

b Trade allies to target?

Q29. Do you survey and track residential customer and/or business customer satisfaction metrics? If so, when? How? What have you been seeing, generally, regarding customer satisfaction with the Smart $aver program?

Wrap-up

Q30. What would you say are the greatest strengths of the Smart $aver Program?

Q31. What challenges are you facing in delivering this program to the market—currently or in the near future?

Q32. What would you say most needs to be changed about the program?

Q33. What would you say is the single best thing you have done during this time period (July 1, 2020 to March 31, 2022) to foster program participation and customer satisfaction?

Q34. What would you say is the main thing you are planning in the short term to foster program participation and customer satisfaction?

Q35. What would you personally like to learn from this program evaluation?

Q36. Is there anything else about the program that we have not discussed that you feel should be mentioned?

Close:

Those are all of my questions. Thank you very much for your time.

Implementer Staff In-Depth Interview Guide

Introduction

My firm, Resource Innovations, on behalf of Duke Energy Carolinas/Progress (DEC/DEP), is conducting an evaluation of the Smart $aver program. Since your organization is involved in rebate application processing, fulfillment, and customer call center services for this program, we would like to get your valuable perspective on how the program works.

Before we begin the interview, I would like to record this interview for my note-taking purposes. Do I have your permission? *[If needed: It is simply so that I can go back and clean up my notes after we are done talking, as to ensure I accurately captured everything you said.]*

Roles and Responsibilities

Q37. Let's start with a bit about you. What is your job title?

Q38. How long have you been at your current company?

Q39. What are your responsibilities with regards to the Smart $aver program?

- How long have you had those responsibilities?

Program Expectations and Market Response

First, I'd like to discuss a few questions about program participation and program performance. The timeframe I'll be asking you about in this survey is July 1, 2020, through March 31, 2022.

Q40. Thinking of Duke Energy program participation goals, how have participation levels been during this timeframe, relative to program expectations?

Q41. Have you noticed any differences in the participation rates by things such as geography, home type, age, ethnicity/race, measures installed, or something else? [*If any, ask*] What accounts for these differences?

Q42. Are there any additional opportunities for expanding market penetration that the program is currently pursuing? If not, should the program consider expanding their market penetration?

[Probe as needed] For example, are there other…?

- Incentive structures that should be considered?
- Measures that should be considered?
- Population segments to target?
- Trade ally targets?
- Any others?

Q43. What, if any, barriers do you see to expanding market penetration? [*If any, ask*] What do you think can be done to overcome those barriers?

Communication

Now, I'd like to hear about communication processes, starting with internal communication.

Q44. What regularly scheduled program communication do you have with other implementer staff regarding the Smart $aver Program?

[If not mentioned, ask]

- With whom do you communicate and/or meet with about the program?
- What is the frequency of these meetings?
- What is the purpose/objective of these meetings?
- Have there been any challenges?

Q45. What regularly scheduled program communication do you have with Duke Energy staff regarding the program?

[If not mentioned, ask]

- With whom do you communicate and/or meet with about the program?
- What is the frequency of these meetings?
- What is the purpose/objective of these meetings?
- Have there been any challenges?

Q46. Do you have any other regular but informal communications with any Duke Energy staff regarding the program?

Q47. Overall, how would you characterize your communications with Duke Energy? [*If any issues, ask*] What are they? Any suggested improvements/solutions?

Application Processing

Next, I'd like to hear about application and rebate processing.

Q48. Please describe the application processing from the point when the application is received through the final rebate processing steps. [*Probe: Implementer log receipt of submission, verifies there are no errors on the application, approves or rejects application, mail/email/deposit funds, provide report to Duke Energy, etc.)*

- How long does it typically take? *[Probe: KPI metric versus actual (in days)]*
- Does the timeline differ for different offerings/measures?
- Do you only process online applications? Or do customers or trade allies (on behalf of customers) still submit paper applications? *[If any]* What percentage would you say are still paper? What are the timelines for online versus paper rebates?
- What is the process for ensuring applications and rebates are processed in a timely fashion?

Q49. Between July 1, 2020, and March 31, 2022, were any changes been made to the program application process? [*If yes*] What was the change? When was the change made? Why? What is the impact?

Q50. What are the most common errors/problems with applications?

- How often do these occur?
- How are these application errors tracked/monitored internally at your firm?
- How are these reported to Duke Energy?
- Is there a certain time (or times) of year when you see the most problems?
- In the last year, what actions have been taken by your firm or by Duke to reduce errors/problems with the application submissions? *(Probe: Education, training, changes in online or paper forms, submission process changes, etc.)*
- Have these actions been effective?

Q51. [*If not addressed*] What type of information is typically incorrect or missing on the application? *[If any]* Is this by the customer or Trade Ally or both? Why do you think this is?

Q52. Which parts of the application processing do you think work particularly well and why?

- Which parts work less well? *[If any]* Why?

Trade Ally Network

The next section of questions will be regarding Trade Allies.

Q53. We understand you provide an IT platform for the Trade Ally Portal where trade allies can submit applications. What, if any, feedback have you received from trade allies about this portal?

Q54. What, if any, feedback have you received from trade allies about the program in general?

Q55. Do you know how changes in the program are communicated to trade allies? Via the trade ally portal? Scheduled trainings? Newsletters? Some other way?

- [*If implementer is involved in this process*] What success or challenges are you having with communicating program changes? [*If challenges mentioned*] What could be done to resolve the challenges?

Q56. What suggestions, if any, do you have for improving the program in regard to the trade ally portal or trade allies' involvement in application processing?

Q57. What makes trade allies interested in participating in the program? What benefits do they derive from participating?

Q58. Have trade allies communicated to you additional or other perceived benefits that the program is not currently supporting? *[If any]* Can you describe? Are you considering these?

Call Center Services

Q59. Since your firm also provides customer call center services for the DEC/DEP Smart $aver program, can you describe the types of issues customers typically call about?

- How do you address or resolve these issues?
- Are there any program improvements that could help reduce the number of calls you get regarding these issues?

Q60. Duke Energy is responsible for program marketing and awareness campaigns. Are there any improvements that could help increase the number of customer calls inquiring about participation in the program?

Q61. Do you have customer service metrics you track specifically regarding the performance of your call center? *[If so]* What are they? How are you doing regarding those metrics?

Q62. Do you have customer service metrics you track outside of the call center, meaning customer program satisfaction? [If so] Who collects these data, by what method are they collected (online survey, etc.) and where is it tracked/stored?

Q63. What are customers generally saying they like the least and the best about the Smart $aver program? Does Duke Energy share this customer feedback on an established regular basis with you the implementer?

Q64. Have you received any feedback directly from customers about the program in general? If yes, please describe the feedback.

Tracking and Reporting

Now let's talk about the tracking and reporting data that you collect for Duke Energy.

Q65. Your firm likely has a database for tracking the progress and status of each application. Please tell me what type of information is in this database?

- [*If not addressed*] What type of demographic and house information do you collect and track in the database?
- [*If not addressed*] What type of information do you collect and track on the equipment that was replaced? [*Probe: age, efficiency, fuel, size/capacity*]

Q66. Are there any common data quality issues or errors that your team has encountered? *[If so]* How have you addressed this?

Q67. What data do you send to Duke Energy on a regular basis?

- In what form are these data provided?
- To whom are they provided?
- How often are they provided?

Q68. Is there information from this database that Duke Energy staff needs about the program but is not getting? If so, what?

Q69. Thinking about your tracking system, where do you feel data tracking could be improved or streamlined?

Conclusion

We are almost done. I have a few high-level questions about your overall impressions and feedback.

Q70. What would you say is/are the most effective way(s) that residential customers engage with the program? Could these or others be leveraged further?

Q71. What would you say are the greatest strengths of the Smart $aver Program?

Q72. What would you say are program areas that are in most need of update or improvement?

Q73. Is there anything else about the program that we have not yet discussed that you feel should be mentioned?

Q74. Is it okay if I get in touch with you later in case of any clarifications or if I have any additional questions?

Close

Those are all of my questions. Thank you very much for your time.

Trade Ally In-Depth Interview Guide

Introduction

Hi____, my name is ____, and I'm calling from Resource Innovations on behalf of Duke Energy Carolinas/Progress. We are evaluating the SMART $AVER program, and we are looking to speak with contractors such as yourself who have been particularly active in the program. Our program records indicate that your firm completed several projects this year for which a customer received an incentive from Duke Energy Carolinas/Progress's SMART $AVER program. Is that correct? And are you knowledgeable about those incentivized projects?

[If "no," ask to speak to someone who is knowledgeable about SMART $AVER work]

Your participation in this study is very important to Duke Energy Carolinas/Progress. This is your chance to tell us what is working well, what isn't, and how Duke Energy Carolinas/Progress can improve the program to better serve you and your customers. Do you have time to speak on the phone with me about your experiences in the program?

Great. Rest assured, your answers will be kept strictly confidential and will not be tied to you or your firm. Is it okay if I record our conversation for note keeping purposes? *[If needed: It is simply so that I can go back and clean up my notes after we are done talking, as to ensure I accurately captured everything you said.] [If asked: Our conversation is designed to take 30-60 minutes, depending on how much you have to say.]*

Background

Q1. My records show your company provides **[PIPE IN SERVICES OFFERED: HVAC, plumbing, shell]** services through SMART $AVER. Is that correct?

Q2. Have you completed any new construction projects that received incentives from the Smart Saver program?

Awareness and Engagement

Q3. How do you explain the value of energy-efficiency upgrades to your customers? What are some successful strategies?

Q4. **[ASK IF INSTALLED HVAC]** Thinking about all customers, including those that do and don't go through the program, what are the primary reasons your customers replace their HVAC equipment?

[ASK IF INSTALLED HPWH] Thinking about all customers, including those that do and don't go through the program, what are the primary reasons your customers replace their water heaters?

[ASK IF INSTALLED POOL PUMPS] Thinking about all customers, including those that do and don't go through the program, what are the primary reasons your customers install ENERGY STAR efficient pool pumps that are equipped with variable speed drives? What proportion of efficient pool pump sales are replacing used pool pumps (as compared to pool pumps that go into newly constructed pools)?

[ASK IF INSTALLED ATTIC/DUCT INSULATION] Thinking about all customers, including those that do and don't go through the program, what are the primary reasons your customers insulate and seal their attics and ducts?

Q5. How did your company first learn about the SMART $AVER program?

Q6. About what proportion of your SMART $AVER customers knew about the program prior to you mentioning it? *[If needed: about what proportion of your SMART $AVER customers requested SMART $AVER rebates before you had a chance to mention them?]*

Q7. Duke Energy conducts various marketing efforts to promote the SMART $AVER program to your customers. Would you say the program has the right amount, too much, or too little marketing?

Q8. How do you think Duke Energy Carolinas/Progress could improve their marketing and outreach efforts?

Q9. What does your company do to market the SMART $AVER program?

Q10. How can Duke Energy better support your SMART $AVER marketing efforts?

Q11. Have you attended any orientations or training events from Duke Energy Carolinas/Progress? If yes: What events did you attend? Did the training provide you with information you found useful? Is there anything that you wish had been discussed in the training, but was not?

Q12. Would you like additional training opportunities to help your team more effectively sell rebated equipment? [*Probe: what type of training: sales/marketing training*]

Q13. Tell me about your experience with the online application system. How has it worsened or improved the application process? Do you have any suggestions regarding the online application system?

Q14. Do you ever use the program's online Trade Ally portal for contractors for reasons other than submitting rebate applications? If so, for what? Is it helpful? Could it use any improvements?

Q15. A company is on contract with Duke Energy to act as the program implementer, and, as such, they take care of rebate application processing, fulfillment, and the call center. How do you feel they are doing? How does this implementer affect your experience in the program, if at all?

Q16. How satisfied are you with your Duke Energy Trade Ally Representative? *[If needed: Please explain why you said that.]*

Q17. Regarding your future engagement level with the Smart $aver program, going forward, would you say you plan to participate less, about the same, or more than your current engagement level? *[If needed: Why would you say that?]*

Q18. For completed and rebated [**MEASURE**] projects, about what percentage of your customers were replacing working equipment early versus replacing a non-functioning item?

1. Early replacement of functioning equipment [*Record percent*]
2. Replacement of non-functioning equipment [*Record percent*]

Q19. During this time period, for completed and rebated [**MEASURE**] projects, about what was the average age of the units you replaced?

1. Average age:

Nonparticipant Spillover

Q1. During July 2020-March 2022, approximately how many **[MEASURE]s** did your company install at ALL locations (in and outside of Duke Energy Carolinas/Progress territory combined)?

1. [Integer response]

Q2. Of these [pipe in answer from Q1] installations, about what percentage were completed <u>within</u> Duke Carolinas/Progress territory?

1. [Record % response]

Q3. During this time period, of all the [Q1 integer x Q2%] **[MEASURE]** projects that your company completed in Duke Carolinas/Progress territory, about what percentage would have <u>qualified for a Smart $aver rebate</u>?

1. [Record % response]

Q4. Of all these [Q1 integer x Q2% x Q3%] Duke rebate-qualified [MEASURE] projects, about what percent did you <u>actually apply</u> for Smart $aver rebates?

[Record % response]

Q5. For the roughly [Q1 x (100% - Q2%)] [MEASURE]s installed outside of Duke territory, about what percentage would you say would have qualified for Duke incentives?

1. [Record % response]

Q6. [Ask only if Q5 >0%] Of these [MEASURES] installed outside of Duke's territory but would have qualified for a Duke incentive, what percentage did receive an incentive from another utility?

1. [Record % response]

Q7. Using a 0 to 10 scale, where 0 is "not at all influential" and 10 is "extremely influential," how much influence has the Duke Smart $aver program had on your business practice of recommending rebate-qualifying [MEASURE]s to your customers?

Trade Ally Program Experience

Q20. What are the challenges you have experienced in the program?

Probes:

- QA audit process (Common fails? QA process cumbersome?)
- Variety of measures offered (ask specifically about mini/multi-split DHP)
- Customer participation rates
- Rebate application process
- Delays
- Communications with Duke Energy and implementer
- Other

Q21. Do you have any suggestions on how to improve the program process?

Program Satisfaction

Q22. What do you like *best* about the program?

Q23. What do you like *least* about the program?

Market Changes

Q24. What new energy efficient technologies do you see taking off in the near future?

Q25. What products/technology are your customers asking for?

Q26. Are there any energy-efficient technologies you think would sell better if Duke offered incentives for them? If so, what?

HVAC Offerings [ASK IF HVAC CONTRACTOR]

As you may know, Duke Energy offers additional rebates for HVAC for customers who also install smart thermostats that connect to the Internet.

Q27. Has this rebate affected the number of smart thermostats you install each year? If so, by how much?

Q28. How, if at all, has the smart thermostat rebate influenced you to recommend smart thermostats to your customers?

Q29. Do you think the smart thermostat rebate has any influence on a consumer's decision to replace their HVAC system?

Program Influence

Q30. Thinking back to *before* you were involved in the SMART $AVER program, about how often did you recommend equipment that would have qualified for SMART $AVER rebates?

Q31. And what about now?

Q32. Using a 0 to 10 scale, where 0 is "not at all influential" and 10 is "extremely influential," how much influence has the SMART $AVER program had on your business practice of recommending the equipment that qualifies for SMART $AVER rebates to your customers?

Q33. Why do you say that?

Q34. Do you keep the equipment you install in stock, or do you mostly purchase equipment on an as-needed basis?

Q35. **[IF THEY KEEP STOCK]** Would you say the energy efficiency of your equipment stock has increased, decreased, or stayed about the same since you joined the program?

Q36. **[IF INCREASED]** Using a 0 to 10 scale, where 0 is "not at all influential" and 10 is "extremely influential," how much influence has the SMART $AVER program had on your increased stocking of energy efficient equipment?

Q37. Why do you say that?

Q38. Would you say your knowledge of energy efficient equipment has increased, decreased, or stayed about the same since you joined the program?

Q39. **[IF INCREASED]** Using a 0 to 10 scale, where 0 is "not at all influential" and 10 is "extremely influential," how much influence has Duke's SMART $AVER program had on your increased knowledge of energy efficient equipment?

Q40. Why do you say that?

Q41. We're interested to know how much Duke's rebates influence your customers to purchase energy-efficient equipment and services that they otherwise wouldn't have purchased. About what proportion of your customers would purchase equipment and services that qualify for SMART $AVER rebates even if the rebates were not available?

Firmographics

Q42. Including yourself, how many employees work at your location?

Q43. How many locations does your organization have?

Q44. **[IF MORE THAN ONE LOCATION]** Including yourself, how many employees work at your organization across all locations?

Q45. And about how many residential HVAC installation jobs do you all do each year?

Closing

Q46. In closing, are there any other comments you would like to provide for feedback? Thanks so much for your time today.

Participant Survey

Instrument

Landing Page (Web)

Thank you for participating in this survey effort. It begins with a few questions about your awareness of energy-efficiency offerings available through Duke Energy, and then transitions to your experience with the Smart $aver program.

Interviewer Instructions/Introduction (Phone)

[*READ IF CONTACT NAME IS KNOWN:*]

Hello, may I speak with _____.

[*READ IF NAME IS UNKNOWN*] Hi, my name is _____.

I'm calling on behalf of Duke Energy. Our records show that you received a rebate for [**LIST ALL MEASURES**] from the Duke Energy Smart $aver Program during the timeframe of July 1, 2020, to March 31, 2022.

[*INTERVIEWER – IF PERSON ON PHONE IS UNAWARE OF THE REBATED WORK, ASK TO SPEAK WITH SOMEONE IN THE HOME WHO MIGHT RECALL RECEIVING A REBATE FROM DUKE ENERGY.*

IF PERSON ON PHONE SAYS THEY ARE A RENTER (AND/OR THEIR LANDLORD OR PROPERTY MANAGER WAS RESPONSIBLE FOR THE PROJECT), ASK FOR THE LANDLORD/PROPERTY MANAGER'S NAME AND PHONE NUMBER AND USE THAT AS THE NEW POINT OF CONTACT].

Duke Energy would like your feedback about upgrades that were completed at the residence through the program as well as feedback on your experience with the program itself. Is now a good time to talk?

[*IF NEEDED*]*:* The survey will take about 10 to 15 minutes, depending on the details you have for us.

[*IF NEEDED*: *SCHEDULE A TIME TO CALL THEM TO COMPLETE THE SURVEY*]

Please note that this call may be monitored or recorded for quality assurance purposes.

Building information and screening

[ASK ALL]

Q47. Please indicate the building type that best describes the residence where the upgrades were performed.

[SINGLE RESPONSE]

1. Single-family detached home [*IF NEEDED*: *NOT A DUPLEX, TOWNHOME, OR APARTMENT; ATTACHED GARAGE IS OK*]
2. Factory manufactured single-family home
3. Row house or town house or condo, with two or more units but no common area(s) (includes duplex, triplex, fourplex, etc.)
4. Multifamily apartment or condo building, with four or more units and a common area(s)

-96. 96. Other, please specify: [OPEN-ENDED RESPONSE]
-97. 98. I don't know

Awareness

[ASK ALL]

Q48. How did you hear about the Duke Energy Smart $aver **rebate(s)** that you received? Please select all that apply. **[LIST ALL MEASURES THEY RECEIVED FROM SMART $AVER PROGRAM [allow multiple]]**

1. Duke Energy program website
2. Direct (paper) mail or bill inserts
3. Email
4. Word of mouth: Friend, family, colleague, etc.
5. From my contractor
6. Online advertisement
7. Billboard
8. Radio
9. Advertisement on bus
10. Other; please specify: [OPEN-ENDED RESPONSE]

[ASK ALL]

Q49. Are you familiar with other energy-efficiency rebates that Duke Energy offers, aside from the **rebate(s) you received**?

[SINGLE RESPONSE]

1. Yes
2. No

-96. 98. I don't know
-97.

[ASK IF Q49= 1 (Yes)]

Q50. Which other rebates are you familiar with? Please select all that apply. [PROGRAMMER: EXCLUDE THE REBATES THAT THEY RECEIVED FROM THE LIST BELOW]

[MULTIPLE RESPONSE]

1. Heat pump water heater rebate
2. Heating and cooling system rebate
3. Geothermal heat pump rebate
4. Smart Wi-Fi enabled thermostat rebate
5. Attic insulation and air-seal rebate
6. Duct sealing/insulation rebate
7. In-home energy assessment (Home Energy House Call)
8. Pool pump rebate
9. Outdoor lighting rebate
10. Rebates for Income Eligible customers
11. Rebates available on Duke Energy's Online Store
12. Rebates available through Duke Energy at local retailers for LED bulbs
13. Power Manager bill discounts (for allowing Duke Energy to ramp down air-conditioning or heating during peak usage events, via AC device or smart thermostat)
14. Discounted efficient lighting (CFLs, LEDs, and specialty bulbs)
15. Other – please specify: [OPEN-ENDED RESPONSE]

98. Don't know

[ASK IF Q49= 1 (Yes)]

Q51. Have you received any of these other rebates?

[SINGLE RESPONSE]

1. Yes
2. No

-96. 98. I don't know
-97.

[ASK IF Q51= 1 (Yes) AND MORE THAN ONE ITEM SELECTED IN Q50; IF ONLY ONE ITEM SELECTED IN Q50 AND Q51=1, AUTOCODE Q50 RESPONSE FOR Q52]

Q52. Which rebate(s) did you receive? Please select all that apply. *[Do not read list]*

[MULTIPLE RESPONSE]

1. Heat pump water heater rebate
2. Heating and cooling system rebate
3. Geothermal heat pump rebate
4. Smart Wi-Fi enabled thermostat rebate
5. Attic insulation and air seal rebate

6. Duct sealing/insulation rebate
7. In-home energy assessment (Home Energy House Call)
8. Pool pump rebate
9. Outdoor lighting rebate
10. Rebates for Income Eligible customers
11. Rebates available on Duke Energy's Online Store
12. Rebates available through Duke Energy at local retailers for LED bulbs
13. Power Manager bill discounts (for allowing Duke Energy to ramp down air conditioning or heating during peak usage events, via AC device or smart thermostat)
14. Discounted efficient lighting (CFLs, LEDs, and specialty bulbs)
15. Other – please specify: [OPEN-ENDED RESPONSE]
98. I don't know

Program Influence

[ASK IF Q51= 1 (Yes)]

Q53. Did you receive the [**Insert rebated measures from Q52**] before or after [**PROJECT#1 LIST**] work was done? [REPEAT THIS QUESTION FOR EACH REBATE OPTION SELECTED IN Q52]

[SINGLE RESPONSE]

1. Before
2. After
3. Both before and after
4. At the same time

-96. -97. 98. Don't know

[ASK IF Q53= 2 or 3 ("After" or "Both before and after")]

Q54. Using a scale from 0 to 10, where 0 means "Not at all influential" and 10 means "Extremely influential," how influential was the rebate for [**PROJECT#1 LIST**] in your decision to take advantage of Duke Energy's rebate for [**Insert response from Q52**]? [REPEAT THIS QUESTION FOR EACH REBATE OPTION SELECTED IN Q52 WHERE RESPONSE TO Q53=2 ("After") OR Q53=3 ("Both before and after")]

[SINGLE RESPONSE]

0.	0. Not all influential
1.	1.
2.	2
3.	3
4.	4
5.	5.

6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Extremely influential
98.	I don't Know

-96.

[ASK IF RESPONDENT HAS A **PROJECT#2 LIST**]

Q55. Using a scale from 0 to 10, where 0 means "Not at all influential" and 10 means "Extremely influential," how influential was the rebate for [**PROJECT#1 LIST**] in your decision to take advantage of additional Duke Energy rebates for [**PROJECT#2 LIST**]?

[SINGLE RESPONSE]

0.	0. Not all influential
1.	1.
2.	2
3.	3
4.	4
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Extremely influential
98.	I don't Know

Motivations

Next, we'd like to know more about your motivations to participate in the Duke Energy Smart $aver Program.

[ASK IF AIR SOURCE HEAT PUMP, GEOTHERMAL HEAT PUMP, OR CENTRAL AIR CONDITIONER WAS INSTALLED]

Q56. [IF AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP WAS INSTALLED] Which of the following best describes the condition of the previous HVAC system that you replaced with a [**PIPE IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP**]?

[IF CENTRAL AIR CONDITIONER WAS INSTALLED] Which of the following best describes the condition of the previous air conditioner that you replaced?

[MULTIPLE RESPONSE]

1. It was broken or malfunctioning
2. It was getting old
3. It was in good working condition

96. Other, please specify: [OPEN-ENDED RESPONSE]
98. I don't know

Q57. [ASK IF AIR SOURCE HEAT PUMP, GEOTHERMAL HEAT PUMP, OR CENTRAL AIR CONDITIONER WAS INSTALLED] Approximately, how many years old was the previous HVAC unit that you replaced with your new [**PIPE IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP, CENTRAL AIR CONDITIONER, OR GEOTHERMAL HEAT PUMP**]?

[Allow integer response]

Q58. [ASK IF CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP, OR GEOTHERMAL HEAT PUMP WAS INSTALLED] What motivated you to install an **energy-efficient** heating/cooling system rather than a less-efficient one that would use more energy? Please select all that apply. [RANDOMIZE SELECTION CHOICES]

1. *The availability of the program incentive*
2. *The ease of participating in the program*
3. *Knowing that any equipment or service Duke Energy would incentize must be reliable*
4. *To save energy or lower your energy bills*
5. *To be associated with "green" or "sustainable" actions*
6. *To increase my comfort*
7. *To increase safety and reliability of my heating/cooling system*
8. *To get a new heating/cooling system*

96. *Other, please specify [*OPEN-ENDED RESPONSE*]*

98. *I don't know (MAKE ANSWER EXCLUSIVE)*

Q59. [ASK IF CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP, OR GEOTHERMAL HEAT PUMP WAS INSTALLED] I'd like to know how you selected the specific make and model of the [**PIPE**

IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP, CENTRAL AIR CONDITIONER, OR GEOTHERMAL HEAT PUMP] you purchased. Would you say that you chose it…?

1. Yourself, based entirely on your own research?
2. From a list of options provided by the contractor?
3. Because it was the only option recommended by your contractor?

-0. 96. In some other way, please specify: [RECORD OPEN-ENDED RESPONSE]
-1. 98. I don't know

Q60. [ASK IF CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP, OR GEOTHERMAL HEAT PUMP WAS INSTALLED] Suppose the contractor that installed your [**PIPE IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP, CENTRAL AIR CONDITIONER, OR GEOTHERMAL HEAT PUMP**] did not offer high-efficiency [**PIPE IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP, CENTRAL AIR CONDITIONER, OR GEOTHERMAL HEAT PUMP**]s that qualify for Duke rebates. Which of the following is most likely what you would have done [SINGLE RESPONSE]?

1. You would have installed the cheaper, less-efficient unit that would not have qualified for rebates if that's all your contractor offered, or
2. You would have looked for a contractor that could install a rebate-qualified, high-efficiency unit

-96. 96. Other, please specify: [OPEN-ENDED RESPONSE]
-97. 98. I don't know
-98.
-99. [ASK IF SMART THERMOSTAT WAS INSTALLED]

Q61. Which of the following best describes the old thermostat that you replaced?

1. Manual non-programmable thermostat,
2. Programmable thermostat that does not communicate with your Wi-Fi network, or
3. Programmable thermostat that communicates with your Wi-Fi network
96. Other, please specify: [OPEN-ENDED RESPONSE]
98. I don't know

[ASK IF SMART THERMOSTAT WAS INSTALLED]

Q62. What motivated you to install a Wi-Fi enabled thermostat? *Please select all that apply.*

1. *The availability of the program incentive*
2. *The ease of participating in the program*
3. *Knowing that any equipment or service Duke Energy would incentize must be reliable*
4. *To save energy or lower your energy bills*
5. *To be associated with "green" or "sustainable" actions*
6. *To increase my comfort*

7. *To increase reliability of my thermostat*
8. *To get a new and updated thermostat*
96. *Other, please specify [*OPEN-ENDED RESPONSE*]*
98. *I don't know (MAKE ANSWER EXCLUSIVE)*

[ASK IF HEAT PUMP WATER HEATER WAS INSTALLED]

Q63. Which of the following best describes the condition of the previous water heater that you replaced?

1. It was broken or malfunctioning
2. It was getting old
3. It was in good working condition
96. Other, please specify: [[OPEN-ENDED RESPONSE]
98. I don't know

Q64. [ASK IF HEAT PUMP WATER HEATER WAS INSTALLED] Approximately, how many years old was the previous water heater that you replaced with your new heat pump water heater? *[RECORD VERBATIM]*

[ASK IF HEAT PUMP WATER HEATER WAS INSTALLED]

Q65. Where did you install your new heat pump water heater?

1. Garage
2. Basement
3. Closet
4. Laundry room
96. Other, please specify: [OPEN-ENDED RESPONSE]
98. I don't know

[ASK IF HEAT PUMP WATER HEATER WAS INSTALLED and IF Q65<>98 or 99]

Q66. Do you use your HVAC system to heat and cool the [PIPE IN ANSWER FROM Q65] where the heat pump water heater is located?

1. Yes
2. No
96. Other, please specify: [[OPEN-ENDED RESPONSE]
98. I don't know

[ASK IF HEAT PUMP WATER HEATER WAS INSTALLED]

Q67. What motivated you to install an **energy-efficient** water heater rather than a less-efficient one that would use more energy? *[RECORD VERBATIM] Please select all that apply.*

1. *The availability of the program incentive*
2. *The ease of participating in the program*
3. *Knowing that any equipment or service Duke Energy would incentivize must be reliable*
4. *To save energy or lower your energy bills*
5. *To be associated with "green" or "sustainable" actions*
6. *To increase my comfort*
7. *To increase the safety and reliability of my water heater*
8. *To get a new and updated water heater*

96. *Other, please specify [*OPEN-ENDED RESPONSE*]*

98. *I don't know (MAKE ANSWER EXCLUSIVE)*

[ASK IF DUCT SEALING OR INSULATION WAS PERFORMED/INSTALLED]

Q68. A) [IF DUCT SEALING WAS PERFORMED] What motivated you to repair your ductwork?

B) [IF ATTIC INSULATION WAS INSTALLED] What motivated you to add insulation to your attic? *[RECORD VERBATIM] Please select all that apply.*

1. *The availability of the program incentive*
2. *The ease of participating in the program*
3. *Knowing that any equipment or service Duke Energy would incentivize must be reliable*
4. *To save energy or lower your energy bills*
5. *To be associated with "green" or "sustainable" actions*
6. *To increase my comfort*
7. *To increase the safety and reliability of my ducts*
8. *To get a new and updated ducts*

96. *Other, please specify [*OPEN-ENDED RESPONSE*]*

98. *I don't know (MAKE ANSWER EXCLUSIVE)*

[ASK IF POOL PUMP WAS INSTALLED]

Q69. What motivated you to install an ENERGY STAR pool pump? *Please select all that apply.*

1. *The availability of the program incentive*
2. *The ease of participating in the program*

3. *Knowing that any equipment or service Duke Energy would incentivize must be reliable*
4. *To save energy or lower your energy bills*
5. *To be associated with "green" or "sustainable" actions*
6. *To increase my comfort*
7. *To increase the safety and reliability of my pool pump*
8. *To get a new and updated pool pump*

96. *Other, please specify [*OPEN-ENDED RESPONSE*]*

98. *I don't know (MAKE ANSWER EXCLUSIVE)*

[ASK IF POOL PUMP WAS INSTALLED]

Q70. Approximately what date do you first **open** your pool for the season? [Prompt if needed: "For example June 1"]

1. [SELECT MONTH AND DAY FROM DROP DOWN]
98. I don't know

[ASK IF POOL PUMP WAS INSTALLED]

Q71. Approximately what date do you **close** your pool for the season? [Prompt if needed: "For example October 30]

1. [SELECT MONTH AND DAY FROM DROP DOWN]
98. I don't know

Q26. How many hours is the pool pump programmed to run per day? Please respond with a whole number rounded to the nearest number of hours. [Integer response]

1. Hours: [open-ended numerical response greater than or equal 0 and less than or equal to 24]

98. I don't know

Free-ridership

The next few questions ask what you most likely would have done had you NOT received assistance from Duke Energy for the **[LIST ALL MEASURES]**.

[ASK IF THEY INSTALLED: CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP]

Q73. Regarding heating and cooling, which of the following statements best describes the actions you would have taken if *Duke Energy rebates and information were not available*:

[SINGLE RESPONSE]

1. Would not have installed the [PIPE IN WHICHEVER WAS INSTALLED: CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP] at all?
2. Would have bought a less expensive or less energy-efficient heating and cooling system?
3. Would have bought the exact same high-efficiency [PIPE IN WHICHEVER WAS INSTALLED: **CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP]**, and paid the full cost?

-96. 98. I don't know

[ASK IF Q73=2 or 3]

Q74. You indicated you would have still purchased a/an [**PIPE IN WHICHEVER WAS INSTALLED: CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP**]. Without the incentive, when would you have likely done so?

1. At the same time
2. Within six months
3. Within a year
4. Later than a year

-96. 98. I don't know
-97.

[ASK IF THEY INSTALLED: SMART THERMOSTAT]

Q75. Now we want to ask you about the smart thermostat you received with your [**PIPE IN WHICHEVER WAS INSTALLED: CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP**]. Which of the following statements best describes the actions you would have taken if *Duke Energy rebates and information were not available*:

[SINGLE RESPONSE]

1. Would not have purchased a new thermostat at all
2. Would have installed a manual, non-programmable thermostat
3. A programmable thermostat that is not Wi-Fi enabled
4. Would have bought the exact same Wi-Fi thermostat, and paid the full cost

-96. 98. I don't know

[ASK IF Q75 = 2,3,4]

Q76. You indicated you would have still purchased a thermostat. Without the incentive, when would you have likely done so?

1. At the same time
2. Within six months
3. Within a year
4. Later than a year

-96. 98. I don't know

[ASK IF THEY INSTALLED: HEAT PUMP WATER HEATER]

Q77. Regarding water heating, which of the following statements best describes the actions you would have taken if *Duke Energy rebates and information were not available*?

[SINGLE RESPONSE]

1. Would not have replaced my water heater
2. Would have bought a less expensive or less energy-efficient water heater
3. Would have bought the exact same high-efficiency Heat Pump Water Heater and paid the full cost

-96. 98. I don't know

[ASK IF Q77= 2,3]

Q78. You indicated you would have still purchased a new water heater. Without the incentive, when would you have likely done so?

1. At the same time
2. Within six months
3. Within a year
4. Later than a year

-96. 98. I don't know

[ASK IF THEY UPGRADED: ATTIC INSULATION]

Q79. Regarding attic insulation, which of the following statements best describes the actions you would have taken if *Duke Energy rebates and information were not available*?

[SINGLE RESPONSE]

1. Would not have done the attic insulation
2. Would have added less insulation
3. Would have done the exact same upgrade and paid the full cost

-96. 98. Don't know

[ASK IF Q79= 2]

Q80. You said you would have added less insulation if you had not received the rebate or information from Duke Energy. How much less insulation would you have purchased? Please answer in a percentage, such as "50% less."

1. [RECORD VERBATIM:] _____
98. I don't know
-96.

[ASK IF Q79= 2 or 3]

Q81. You indicated you would have still added insulation. Without the incentive, when would you have likely done so?

1. At the same time
2. Within six months

3. Within a year
4. Later than a year
-96. 98. I don't know
-97.

[ASK IF THEY DID DUCT SEALING]

Q82. Regarding duct sealing, which of the following statements best describes the actions you would have taken if *Duke Energy rebates and information were not available*?

[SINGLE RESPONSE]

1. Would not have had ducts sealed or repaired
2. Would have had the exact same work done and paid the full cost
-96. 98. I don't know
-97.

[ASK IF Q82= 2]

Q83. You indicated you would have still had your ducts sealed or repaired. Without the incentive, when would you have likely done so?

1. At the same time
2. Within six months
3. Within a year
4. Later than a year
-96. 98. I don't know
-97.

[ASK IF THEY INSTALLED A VARIABLE SPEED POOL PUMP]

Q84. Regarding your pool pump, which of the following statements best describes the actions you would have taken if *Duke Energy rebates and information were not available*?

[SINGLE RESPONSE]

1. Would not have installed or replaced the variable speed pool pump
2. Would have bought a less expensive or less energy-efficient pool pump, or
3. Would have had the exact same high-efficiency pool pump installed and paid the full cost
-96. 98. I don't know
-97.

[ASK IFQ84 = 2 or 3]

Q85. You indicated you would have still purchased a pool pump. Without the incentive, when would you have likely done so?

1. At the same time
2. Within six months
3. Within a year
4. Later than a year
-96. 98. Don't know
-97.

[ASK ALL]

Q86. Using a scale from 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential," how influential were the following factors on your decision to purchase the [**MEASURE**]? *How influential was…?*

[*INTERVIEWER NOTE: IF RESPONDENT SAYS 'NOT APPLICABLE; I DIDN'T GET/USE THAT,' THEN FOLLOW UP WITH: "So would you say it was "not at all influential?" AND PROBE TO CODE*] [MATRIX QUESTION: SCALE]

Elements	0 – Not at all influential	1	2	3	4	5	6	7	8	9	10 – Extremely influential	98 DK	99 RF
The rebate you received													
Information or advertisements from Duke Energy, including their website													
Recommendation from your contractor													
Did anything else influence you? If so, please specify: _____ [*INTERVIEWER: PROBE IF UNCLEAR. RECORD VERBATIM RESPONSE*]													

[PROGRAMMER: REPEAT Q86 FOR EACH MEASURE IN MEASURE LIST. WHEN REPEATING, CALLERS CAN USE ABBREVIATED LANGUAGE (E.G.: "AND FOR THE INSULATION, HOW INFLUENTIAL WAS…?"]

Spillover

Q87. Since receiving your rebate from Duke Energy for the **[LIST ALL SMART $AVER MEASURES]**, have you purchased any other products or services to help save energy in your home?

1. Yes
2. No

-96. 98. I don't know

[If Q87= 1]

Q88. What **products** have you purchased and installed to help save energy in your home?

[Do not read list. After each response, ask, "Anything else?"] [MULTIPLE RESPONSE]

1. Installed energy-efficient appliances

2. Moved into an ENERGY STAR home *[VERIFY:"Is Duke Energy still your gas or electricity utility?" Yes/No/I don't know]*
3. Installed efficient heating or cooling equipment, including a smart thermostat
4. Installed efficient windows
5. Added insulation
6. Sealed air leaks in windows, walls, or doors
7. Sealed or insulated ducts
8. Installed LEDs
9. Installed an energy-efficient water heater
10. None – no other actions taken [*EXCLUSIVE ANSWER*]

-96. 96. Other, please specify: _____

-97. 98. I don't know [*EXCLUSIVE ANSWER*]

[ASK IF Q88 1 THROUGH 9, 96]

Q89. Did you get a rebate from Duke Energy or another organization for any of those products or services? If so, which ones?

YES OR NO ANSWER

[LOGIC] Item
[IF Q88.1 IS SELECTED] 1. Installed energy efficient appliances
[IF Q88.2 IS SELECTED] 2. Moved into an ENERGY STAR home
[IF Q88.3 IS SELECTED] 3. Installed efficient heating or cooling equipment, including a smart thermostat
[IF Q88.4 IS SELECTED] 4. Installed efficient windows
[IF Q88.5 IS SELECTED] 5. Installed additional insulation
[IF Q88.6 IS SELECTED] 6. Sealed air leaks in windows, walls, or doors
[IF Q88.7 IS SELECTED] 7. Sealed or insulated ducts
[IF Q88.8 IS SELECTED] 8. Installed LEDs
IF Q88.10 IS SELECTED] 10. Installed an energy efficient water heater
[IF Q88.96 IS SELECTED] **[Q88 open ended response]**
I DID NOT GET ANY DUKE REBATES *[EXCLUSIVE ANSWER]*
98. DON'T KNOW *[EXCLUSIVE ANSWER]*

[ASK IF ANY ITEM IN Q88 WAS SELECTED]

Q90. On a scale of 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential", how much influence did the **[LIST ALL SMART $AVER MEASURES]** Smart $aver program have on your decision to…?

[MATRIX QUESTION: SCALE]

[LOGIC] Item	Response
[IF Q88.1 IS SELECTED] 1. Buy energy-efficient appliances	0-10 scale with DK
[IF Q88.2 IS SELECTED] 2. Move into an ENERGY STAR home	0-10 scale with DK
[IF Q88.3 IS SELECTED] 3. Buy efficient heating or cooling equipment	0-10 scale with DK
[IF Q88.4 IS SELECTED] 4. Buy efficient windows	0-10 scale with DK
[IF Q88.5 IS SELECTED] 5. Buy additional insulation	0-10 scale with DK
[IF Q88.6 IS SELECTED] 6. Seal air leaks in windows, walls, or doors	0-10 scale with DK
[IF Q88.7 IS SELECTED] 7. Seal or insulate ducts	0-10 scale with DK
[IF Q88.8 IS SELECTED] 8. Buy LEDs	0-10 scale with DK
IF Q88.10 IS SELECTED] 10. Install an energy-efficient water heater	0-10 scale with DK
[IF Q88.96 IS SELECTED] **[Q88 open ended response]**	0-10 scale with DK

[ASK IF Q88.1 IS SELECTED AND Q90.1 =NO]

Q91. What kinds of appliance(s) did you buy?

[Do not read list] [MULTIPLE RESPONSE]

1. Refrigerator
2. Standalone freezer
3. Dishwasher
4. Clothes washer
5. Clothes dryer
6. Oven
7. Microwave

-96. 96. Other, please specify: _____
-97. 98. Don't know
-98. 99. Refused

[ASK IF Q91 = 1-96]

Q92. Was the [INSERT Q91 RESPONSE] an ENERGY STAR or high-efficiency model?

[SINGLE RESPONSE]

1. Yes
2. No

-96. 98. I don't know
-97. 99.
-98. [REPEAT THIS QUESTION FOR EACH ITEM MENTIONED IN Q91]

[ASK IF 45 = 5]

Q93. Does the new clothes dryer use natural gas?

1. Yes, it uses natural gas
2. No. it does not use natural gas
-96. 98. I don't know
-97. 99. Refused

[ASK IF Q88.3 IS SELECTED AND Q90.3 > 0]

Q94. What type of heating or cooling equipment did you buy?

[Do not read list] [MULTIPLE RESPONSE]

1. Central air conditioner
2. Window/room air conditioner unit
3. Wall air conditioner unit
4. Air source heat pump
5. Geothermal heat pump
6. Boiler
7. Furnace
8. Wi-Fi-enabled smart thermostat

-96. 96. Other, please specify: _____
-97. 98. Don't know
-98. 99. Refused

[ASK IF Q94= 6-7]

Q95. Does the new [INSERT Q94 RESPONSE] use natural gas?

1. Yes - it uses natural gas
2. No – does not use natural gas

-96. 98. Don't know
-97. 99. Refused

[ASK IF Q94= 1-7, 96]

Q96. Was the [INSERT Q94 RESPONSE] an ENERGY STAR or high-efficiency model appliance?

[SINGLE RESPONSE]

1. Yes
2. No

-96. 98. I don't know
-97. 99.
-98. [REPEAT THIS QUESTION FOR EACH ITEM MENTIONED IN Q94, EXCLUDING Wi-Fi-enabled thermostat]

[ASK IF Q88.4 IS SELECTED AND Q90.4 =NO]

Q97. How many windows did you install?

1. [RECORD VERBATIM _____]
98. Don't know
-96.

[ASK IF Q88.5 IS SELECTED AND Q90.5 =NO]

Q98. Did you add insulation to your attic, walls, or below the floor?

[Do not read list] [MULTIPLE RESPONSE]

1. Attic
2. Walls
3. Below the floor
-96. 98. I don't know
-97.

[ASK IF Q98<>98-99]

[PROGRAMMER: REPEAT Q99 FOR EACH ITEM MENTIONED IN Q98]

Q99. Approximately what proportion of the space did you add insulation? [ITEM MENTIONED IN Q98]

1. [RECORD VERBATIM AS % - INPUT MIDPOINT IF RANGE IS OFFERED:] _____
[IF NEEDED: Your best estimate is fine]
98. Don't know

[ASK IF Q88.8 IS SELECTED AND Q90.8 =NO]

Q100. How many of LEDs did you install in your property?

1. [RECORD VERBATIM:] _____ [IF NEEDED: Your best estimate is fine]
98. I don't know

[ASK IF Q88.10 IS SELECTED AND Q90.10 =NO]

Q101. Does the new water heater use natural gas?

1. Yes, it uses natural gas
2. No. it does not use natural gas
-96. 98. Don't know

[ASK IF Q88.10 IS SELECTED AND Q90.10 =NO]

Q102. Which of the following water heaters did you purchase? [read list]

1. A traditional water heater with a large tank that holds the hot water
2. A tankless water heater that provides hot water on demand

3. A solar water heater
4. Other, please specify: _____
-96. 98. I don't know

[ASK IF Q88.10 IS SELECTED AND Q90.10 =NO]

Q103. Is the new water heater an ENERGY STAR model?

[SINGLE RESPONSE]

1. Yes
2. No
-96. 98. Don't know

How Residents Search For Energy-Efficiency Information

[ASK ALL]

Q104. Where do you typically search for information on how to save energy at your residence?

[MULTIPLE RESPONSE]

1. Online—read reviews about products
2. Go to utility website
3. Read my utility bill information—it has tips on how to save energy
4. Go to the store and talk to salespeople
5. Look for ENERGY STAR logo on products
6. Talk to trusted equipment vendor or contractor
-96. 96. Other, please specify: [OPEN-ENDED RESPONSE]
-97. 97. Not applicable – I don't typically search for information on how to save energy in my home/property
-98. 98. Don't know

Program Satisfaction and Challenges

The next few questions pertain to your satisfaction with the Smart $aver program.

[ASK ALL]

Q105. How satisfied were you with the rebate dollar amount for [**LAST PROJECT**]? Please use a 0 to 10 scale where 0 means "very dissatisfied," 5 means "neither satisfied nor dissatisfied," and 10 means "very satisfied." [SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4

5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
97.	N/A
98.	I don't Know

-96.

[ASK ALL]

Q106. How satisfied were you with how long it took to receive that rebate? Please use a 0 to 10 scale where 0 means "very dissatisfied," 5 means "neither satisfied nor dissatisfied," and 10 means "very satisfied." [SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
97.	N/A
98.	Don't Know

[ASK IF Q1069<5 (Somewhat to Very Dissatisfied)]

Q107. Why did you give that rating? _____[RECORD VERBATIM]

[ASK ALL]

Q108. What was the form of payment in which you received your rebate?

1. Physical prepaid card
2. Digital prepaid card
96. Other: [RESPONSE BOX]
98. I don't know

Q109. How satisfied were you with the form of payment for the rebate amount (physical prepaid card, digital prepaid card, etc.) you received? Please use a 0 to 10 scale where 0 means "very dissatisfied," 5 means "neither satisfied nor dissatisfied," and 10 means "very satisfied." [SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
97.	N/A
98.	Don't Know

[ASK IF Q1132<5 (Somewhat to Very Dissatisfied)]

Q110. Why did you give that rating? _____[RECORD VERBATIM]

[ASK ALL]

Q111. In the course of participating in the Duke Smart $aver program, how often did you contact Duke Energy or program staff with questions?

[Do not read list] [SINGLE RESPONSE]

1. Never
2. Once
3. 2 or 3 times
4. 4 times or more
-96. 98. I don't know

[ASK IF Q108 = 2-4]

Q112. How did you contact them?

[MULTIPLE RESPONSE]

1. Phone
2. Email
3. Fax
4. Letter
5. In person

-96. 98. I don't know

[ASK IF Q65=2-4]

Q113. Using the 0 to 10 scale, how satisfied were you with these communications?

[SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
97.	N/A
98.	I don't Know

[ASK IF Q113<5 (Somewhat to Very Dissatisfied)]

Q114. Why did you give that rating? _____[RECORD VERBATIM]

[ASK ALL]

Q115. Have you noticed any savings on your electric bill since the [**ALL MEASURES**] project?

[SINGLE RESPONSE]

1. Yes, I have noticed savings
2. No, I have looked but did not notice any savings
3. No, I have looked but it is too soon to tell
4. I haven't look yet but plan to
5. I haven't looked yet and don't plan to

-96. 98. Don't know

-97.

[ASK IF Q115= Yes (if noticed savings)]

Q69_B. How satisfied are you with any savings you noticed on your electric bill since the [**ALL MEASURES**] project? [*INTERVIEWER NOTE: REPEAT SCALE IF NECESSARY: Please use a 0 to 10 scale where 0 means "very dissatisfied," 5 means "neither satisfied nor dissatisfied," and 10 means "very satisfied."*]

[SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
98.	Don't Know

[ASK ALL]

Q116. How satisfied are you with your [**ALL MEASURES**] project? [*INTERVIEWER NOTE: REPEAT SCALE IF NECESSARY: Please use a 0 to 10 scale where 0 means "very dissatisfied," 5 means "neither satisfied nor dissatisfied," and 10 means "very satisfied."*] [*INTERVIEWER NOTE: IF RESPONDENT SAYS 'TOO SOON TO TELL,' THEN FOLLOW UP WITH: "So would you say you are "Neither satisfied nor dissatisfied?" or you just don't know yet AND PROBE TO CODE*]

[SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.

8.	8.
9.	9.
10.	10. Very satisfied
98.	I don't know

[ASK IF Q70<5 (Somewhat to Very Dissatisfied)]

Q117. Why did you give that rating?

1. [*RECORD VERBATIM*] _____
-96. 98. Don't know
-97. 99. Refused

[ASK ALL]

Q118. How satisfied are you with the interaction with the contractors who worked on the [**LAST PROJECT**] project? [*INTERVIEWER NOTE: REPEAT SCALE IF NECESSARY: Please use a 0 to 10 scale where 0 means "very dissatisfied," 5 means "neither satisfied nor dissatisfied," and 10 means "very satisfied."*]

[SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
98.	Don't Know

[ASK IF Q72< 5 (Somewhat to Very Dissatisfied)]

Q119. Why did you give that rating?

1. [*RECORD VERBATIM*] _____
-96. 98. Don't know
-97.

[ASK ALL]

Q120. If you were rating your overall satisfaction with the Duke Energy Smart $aver Rebate Program, would you say you were very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied, or very dissatisfied? [SINGLE RESPONSE]

1.	Very dissatisfied
2.	Somewhat dissatisfied
3.	3. Neither satisfied nor dissatisfied
4.	Somewhat satisfied
5.	Very satisfied
98.	Don't Know

[ASK IF Q1207= 1,2]

Q121. Why do you give that rating? _____

[ASK ALL]

Q122. How satisfied you are with Duke Energy's overall performance as your electricity supplier? [*INTERVIEWER NOTE: REPEAT SCALE IF NECESSARY: Please use a 0 to 10 scale where 0 means "very dissatisfied," 5 means "neither satisfied nor dissatisfied," and 10 means "very satisfied."*]

[SINGLE RESPONSE]

0.	0. Very dissatisfied
1.	1.
2.	2
3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
98.	Don't Know
99.	Refused

Q123. Would you say that your participation in Duke Energy Smart $aver Rebate Program has had a positive effect, a negative effect, or no effect on your overall satisfaction with Duke Energy?

1. Negative effect
2. No effect
3. Positive effect
-96. 98. I don't know

Demographics/Property Characteristics

Finally, we will ask you some questions about yourself and the residence where the rebated work was done.

[ASK ALL]

Q124. Do you live at this residence where the work was performed?

1. Yes
2. No

[ASK IF Q124=2]

Q125. Are you a property manager or an owner of the residence where the work was performed?

1. Owner
2. Property manager
-96. 96. Other, please specify: [OPEN-ENDED RESPONSE]

[ASK IF Q124=1]

Q126. Do you own or rent this residence?

[SINGLE RESPONSE]

1. Own
2. Rent
-96. 98. I don't know
-97.

[ASK IF Q126=2]

Q127. Do you pay your own electric bill or is it included in your rent?

[Single RESPONSE] [*DO NOT READ*]

1. Pay own bill
2. Included in rent
-96. 98. I don't know
-97.

[ASK ALL]

Q128. Approximately when was this residence first built?

[SINGLE RESPONSE]

1. Before 1960
2. 1960-1969
3. 1970-1979
4. 1980-1989
5. 1990-1999
6. 2000-2009
7. 2010-2019
8. 2020-2021

98. I don't know

-96.

Q129. What would you estimate the residence square footage to be: [*READ LIST*]

[SINGLE RESPONSE]

1. less than 1,000 sq ft
2. 1,001-2,000 sq ft
3. 2,001-3,000 sq ft
4. 3,001-4,000 sq ft
5. 4,001-5,000 sq ft
6. Greater than 5,000 sq ft

-96. 98. Don't know

[ASK ALL]

Q130. What is the fuel source of the primary heating system at the residence?

[SINGLE RESPONSE]

1. Electricity
2. Natural gas (not propane)
3. Liquid propane gas
4. Fuel oil
5. Wood
6. Or something else, please specify: [Open-ended response]

[Do not read list]

-96. 98. I don't know

Q131. [ASK IF AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP WAS **NOT** INSTALLED] What type of system do you use to heat your home? Please select all that apply. [Multiple response allowed]

1. Heat pump
2. Electric baseboard heaters
3. Natural gas furnace
4. Plug in space heaters
5. Cadet wall heaters
96. Other, please specify: [[OPEN-ENDED RESPONSE]
98. I don't know

[ASK IF CENTRAL AIR CONDITIONER, AIR SOURCE HEAT PUMP, OR GEOTHERMAL HEAT PUMP WAS **NOT** INSTALLED]

Q132. What type of system do you use to cool your home? Please select all that apply. [Multiple response allowed]

1. Central air conditioner
2. Heat pump
3. Room/window air conditioner
4. Evaporative/swamp cooler
5. I do not have any air conditioning in my home
96. Other, please specify: [[OPEN-ENDED RESPONSE]
98. Don't know

[ASK ALL]

Q133. The following are a list of income ranges. Please identify the range that includes your annual household income.

[SINGLE RESPONSE]

1. Less than $15,000
2. $15,000 to less than $25,000
3. $25,000 to less than $35,000
4. $35,000 to less than $50,000
5. $50,000 to less than $75,000
6. $75,000 to less than $100,000
7. $100,000 to less than $150,000
8. $150,000 to less than $200,000
6. $200,000 or more
98. Don't know
99. Prefer not to say

Q134. In what year were you born?

1. [NUMERIC RESPONSE – FIELD WIDTH =4, 1900-2003]
-96.
-97. 99. Prefer not to say
-98.

Q135. What is the highest level of education achieved among those living in your household?

1 Less than high school
2 Some high school
3 High school graduate or equivalent (such as GED)
4 Trade or technical school
5 Some college (including Associate degree)
6 College degree (Bachelor's degree)

7 Some graduate school
8 Graduate degree, professional degree
9 Doctorate
-96. 98 Don't know
-97. 99. Prefer not to say

Q136. Do you feel the COVID-19 pandemic or the government or organizational responses to it presented any challenges to you regarding your participation in the Smart $aver program? If so, what were these challenges, and how do you think they might best be addressed moving forward?

1 Yes: [OPEN-ENDED RESPONSE]
2 No
-96. 98 Don't know

[ASK ALL]

Q137. In closing, do you have any other suggestions on how to improve Duke Energy's Smart $aver Program?

1. [YES, RECORD VERBATIM] _____
2. No
-96. 98. Don't know

CLOSE:

On behalf of Duke Energy Carolinas/Progress, thank you for your time in completing this survey. If you were one of the first 100 customers to complete the survey, you will receive a $5 gift card!

Have a great day!

Trade Ally Survey

Landing Page (Web)

Thank you for taking this survey! The survey covers your involvement in energy-efficiency offerings available through Duke Energy and your experience and satisfaction with the Smart $aver program.

Interviewer Instructions/Introduction (Phone)

Hi, I'm ____ calling from Resource Innovations on behalf of Duke Energy Carolinas/Progress. May I speak with whomever is most knowledgeable about the rebated [MEASURE LIST] projects that your firm has done through the Duke Energy Smart $aver rebate program?

[*If needed:*] I need to speak with someone who is knowledgeable about the sales and installation process, which is typically an installer or a salesperson.

[*Once appropriate contact is on phone:*]

We want to get some feedback on how the Duke Energy Smart $aver program is working for your firm. This is your chance to tell us what is working well, what isn't, and how Duke Energy can improve the program to better serve you and your customers. Is this a good time to talk?

[*If needed:*]

- The survey takes about 10-15 minutes, depending on how much you have to say.
- If now isn't a good time, when could I call you back?

Please note that this call may be monitored or recorded for quality assurance purposes. Rest assured, your answers will be confidential and not tied to you or your firm.

Building Information and Screening

What residential project types does your firm primarily focus on: new construction homes, existing homes, or both?

3. Existing homes
4. New construction projects
5. Both

-97. 98. *Don't know*
-98.

How many locations does your company have?

6. One
7. Two
8. Three
9. Four
10. Five
11. More than five: Specify: _____
98. Don't Know

For the questions in this survey, we would like to focus primarily on the Duke Energy Carolinas/Progress territory. Are you able to answer questions regarding the work associated with this area?

12. Yes [CONTINUE]
13. No [*Ask to forward survey link to co-worker that can*]
98. Don't know [*Ask to forward survey link to co-worker that can]*

Sources of Program Awareness

Q138. How did you originally hear about Duke Energy Carolinas/Progress Smart $aver rebate offerings?

1. Word-of-mouth (co-worker, another contractor)
2. Duke Energy website
3. Duke Energy program representative
4. TV/radio/newspaper/billboard ad

5. Event (home show, workshop, etc.)
96. Other, please specify:_____
-96. 98. Don't know

Q139. How do you stay engaged with the Smart $aver program? [Allow multiple answers]

1. Newsletters or other program marketing
2. Trade ally portal
3. Coordination with program staff
4. Program website
5. Other, specify:_____
6. None
7. Don't know

Nonparticipant Spillover

The next set of questions ask about the work your company did specifically during the time period from July 1, 2020, to March 31, 2022.

[START LOOP; LOOP THROUGH TOP THREE MOST INSTALLED MEASURE TYPES THAT TRADE ALLY INSTALLED during July 1st, 2020, to March 31st, 2022.]

Q140. Our records show your company performed [**MEASURE TYPE**] between July 1st 2020 to March 31st, 2022. Is this correct?

1. Yes [continue to Q4]
2. No [Ask Q3 again with next measure type]

Q141. During this time period, approximately how many **[MEASURE]s** did your company install at ALL locations (in and outside of Duke Energy Carolinas/Progress territory combined)?

1. [Integer response]

Q142. Of these [pipe in answer from Q4] installations, about what percentage were completed <u>within</u> Duke Carolinas/Progress territory?

1. [Record % response]

Q143. During this time period, of all the [Q4 integer x Q5%] **[MEASURE]** projects that your company completed <u>in Duke Carolinas/Progress territory</u>, about what percentage <u>would have qualified</u> for a Smart $aver rebate?

1. [Record % response]

Q144. Of all these [Q4 integer x Q5% x Q6%] Duke rebate-qualified [MEASURE] projects, about what percent did you <u>actually apply</u> for Smart $aver rebates?

[Record % response]

Q145. For the roughly [Q4 x (100% - Q5%)] [MEASURE]s installed outside of Duke territory, about what percentage would you say would have qualified for Duke incentives?

1. [Record % response]

Q146. [Ask only if Q8 >0%] Of these [MEASURES] installed outside of Duke's territory but would have qualified for a Duke incentive, what percentage did receive an incentive from another utility?

1. [Record % response]

Q147. For those Duke territory and rebate-qualified projects where you did not apply for Smart $aver rebates,

1. What are the reasons that this happens? _____
2. And what could Duke Energy do to address these issues? _____

Q148. During this time period, for completed and Duke rebated [**MEASURE**] projects, about what percentage of your customers specifically requested the **[MEASURE]** on their own and were not influenced by your recommendation?

1. [*Record percent*]

Q149. Using a 0 to 10 scale, where 0 is "not at all influential" and 10 is "extremely influential," how much influence has the Duke Smart $aver program had on your business practice of recommending rebate-qualifying [**MEASURE**]s to your customers?

[SINGLE RESPONSE]

0. Not at all influential
1.
2.
3.
4.
5.
6.
7.
8.
9.
10. Extremely influential

Q150. During this time period, for completed and rebated [**MEASURE**] projects, about what percentage of your customers were replacing working equipment early versus replacing a nonfunctioning item?

1. Early replacement of functioning equipment [*Record percent*]
2. Replacement of nonfunctioning equipment [*Record percent*]

Q151. During this time period, for completed and rebated [**MEASURE**] projects, about what was the average age of the units you replaced?

1. Average age:

[END LOOP]

Program Influence and Effects on TAs

Q152. During the time period of July 1, 2020, to March 31, 2022, how often did your customers ask about the Duke Energy rebates before you've had the chance to bring them up?

1. Never
2. Rarely
3. Occasionally
4. Frequently
5. Always
98. Don't know

[BASE: TRADE ALLIES THAT INSTALLED AIR SOURCE HEAT PUMPS, CENTRAL AIR CONDITIONERS, GEOTHERMAL HEAT PUMPS, VARIABLE SPEED POOL PUMPS, OR HEAT PUMP WATER HEATERS]

Q153. Thinking back to before you were involved in the Smart $aver program, how often did you recommend higher-efficiency equipment that uses less energy than standard models to your customers? Would you say none of the time, some of the time, most of the time, or every time?

[SINGLE RESPONSE]

1. None of the time
2. Some of the time
3. Most of the time
4. Every time

-96. 97. Not applicable – I've been involved with the Duke program since starting in the industry/this company

-97. 98. Don't know

-99. [BASE: TRADE ALLIES THAT INSTALLED AIR SOURCE HEAT PUMPS, CENTRAL AIR CONDITIONERS, GEOTHERMAL HEAT PUMPS, VARIABLE SPEED POOL PUMPS, OR HEAT PUMP WATER HEATERS]

Q154. And what about now? How often did you recommend higher-efficiency equipment that uses less energy than standard models to your customers

[SINGLE RESPONSE.]

1. None of the time
2. Some of the time
3. Most of the time
4. Every time
98. Don't know

-97.

-98.

Q155. Would you say your knowledge of energy-efficient products and services has increased, decreased, or stayed about the same since you became involved with the Smart $aver program?

[SINGLE RESPONSE]

1. Increased
2. Decreased
3. Stayed about the same

-96. 98. Don't know

-97.

-98. [ASK IF Q38=1]

Q156. Using a 0 to 10 scale, where 0 is “not at all influential” and 10 is “extremely influential,” how much influence has the Smart $aver program had on your increased knowledge of energy-efficient products and services?

[SINGLE RESPONSE]

0. Not at all influential

1.
2.
3.
4.
5.
6.
7.
8.
9.
10. Extremely influential

-96. 98. Don't know

-97.

Q157. How have your equipment stocking practices changed, if at all, after participating in the Smart $aver program?

1. [OPEN-ENDED RESPONSE]
2. 98. Don't know

Challenges and Suggestions for Improvements

Q158. What energy-efficient products, technologies, or services do you feel should be added to the Duke Energy rebate program? [MULTIPLE RESPONSE, Randomize Order]

1. Modulating furnaces
2. Heat recovery ventilation (HRV) systems
3. Boilers
4. Furnaces equipped with electronically commutated motors (ECMs)
5. Mini-split heat pumps
6. Multi-split heat pumps

7. Tankless water heaters
8. Humidifiers
9. Air handlers
10. Windows
11. Doors
12. No others should be added

96. Other, please specify: [OPEN-ENDED RESPONSE]
98. Don't know

An enhanced Rebate Application Entry and Tracking platform was launched on March 1, 2021. Please answer the next set of questions about your experience *before* this new platform.

Q159. From May 1, 2020, to April 30, 2021, have you experienced problems or frustrations with the rebate application process?

1. Never
2. Rarely
3. Occasionally
4. Frequently
5. Always
98. Don't know

[ASK IF Q22=2-5]

Q160. What types of problems or frustrations did you experience with the rebate application process?

1. [*Record response*]
98. Don't know

[ASK IF Q22=2-5]

Q161. Overall, have these problems with the rebate application process persisted or gotten better over time?

1. Persisted
2. Gotten somewhat better, or
3. Have been completely resolved at this point

-96. 98. Don't know

Q162. Now, thinking about the enhanced Rebate Application Entry and Tracking platform was launched on March 1, 2021, have you had any challenges with this platform?

1. Yes
2. No
98. Don't know

Q163. [Q26=1] What challenges did you experience, and do you have any suggestions on how Duke Energy can further improve this platform?

1. [Record response]
98. Don't know

Q164. Do you have any suggestions on how Duke Energy can improve the rebate application process?

1. [*Record response*]
98. Don't know

Q165. Do you have any suggestions on how Duke Energy can improve the project inspection process?

1. [*Record response*]
98. Don't know

Q166. Do you feel there other processes not described thus far that are critical to your program participation experience, and, if so, do you have any suggestions on how Duke Energy can improve them?

1. [*Record response*]
98. Don't know

Satisfaction

Thanks for your feedback so far, next are some questions about your satisfaction with the Smart $aver program.

Q167. Please rate the extent to which you are satisfied with the following aspects of the program, using a 0 to 10 scale where 0 means “very dissatisfied,” 5 means “neither satisfied nor dissatisfied,” and 10 means “very satisfied.” How satisfied are you with…?

A	Program training offered by Duke Energy
B	Your Duke Energy Trade Ally Representative
C	The program website for customers
D	The trade ally portal application tracking system
E	The marketing of the program
F	The incentive application submission process
G	The selection of eligible equipment and services
H	The overall program

[SINGLE RESPONSE ON EACH A-H ITEM]

0.	0. Very dissatisfied
1.	1.
2.	2

3.	3
4.	4
5.	5. Neither satisfied nor dissatisfied
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Very satisfied
97.	N/A
98.	Don't Know
99.	Refused

[PROGRAMMER'S NOTE: REPEAT Q30 FOR EACH STATEMENT FROM Q29 WHERE Q29<5]

Q168. Please explain why you were dissatisfied with [**INSERT STATEMENT FROM Q29 A-H**]:

1. [*Record response*]
98. Don't know

Wrap-up

Q169. Do you have any other feedback you would like to provide about the Smart $aver Program?

1. [*Record response*]

CLOSE:

Thank you for your time in completing this survey.

Your responses have been recorded.

Have a great day!

Appendix E Participant Demographics

	DEC/DEP	
Home type	**%**	**n**
Single-family detached	92%	765
Manufactured or mobile home	1%	6
Row house, townhouse, or condo	5%	43
Apartment or condo with four units or more	1%	11
Other	1%	9
Home size	**%**	**n**
Less than 1,000 square feet	1%	5
1,001 to under 2,000 square feet	36%	292
2,001 to under 3,000 square feet	40%	324
3,001 to under 4,000 square feet	16%	131
4,001 to under 5,000 square feet	5%	40
Greater than 5,000 square feet	3%	25
Ownership Status	**%**	**N**
Own	99.9%	809
Rent	0.1%	1
Fuel source type	**%**	**N**
Electric	53%	437
Natural Gas	42%	348
Other	5%	41
Year residence was built	**%**	**N**
Before 1960	10%	82
1960-1969	6%	53
1970-1979	14%	112
1980-1989	15%	123
1990-1999	20%	166
2000-2009	28%	228
2010-2019	6%	53
2020-2021	1%	8
Household Income	**%**	**n**
Under $15,000	0%	2
15 to under $25,000	3%	17
25 to under $35,000	5%	29
35 to under $50,000	10%	58
50 to under $75,000	15%	90
75 to under $100,000	18%	104
100 to under $150,000	25%	146

	DEC/DEP	
150 to under $200,000	13%	79
$200,000 or more	11%	67
Education Level	**%**	**n**
Less than high school	0%	1
Some high school	0%	1
High school graduate or equivalent (such as GED)	5%	40
Trade or technical school	2%	18
Some college (including Associate degree)	14%	111
College degree (Bachelor's degree)	32%	250
Some graduate school	6%	43
Graduate degree, professional degree	32%	246
Doctorate	8%	60