ATTACHMENT 4

REPORT

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Smart $aver Program Year 2016 Evaluation Report

Submitted to Duke Energy Ohio
in partnership with Research into Action

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1.1 Program Summary

The Smart $aver program offers Duke Energy Ohio ("Duke" or "DEO") existing and new construction residential customers incentives for improving their home's energy efficiency through the installation of energy efficient heating, ventilating, and air conditioning (HVAC), water heating equipment, pool pump replacements, duct sealing, and attic insulation with air sealing[1]. The program is provided through independent, prequalified contractors who will install the eligible energy efficiency measures consistent with the program standards and guidelines.

1.2 Evaluation Objectives and Results

This report presents the results and findings of evaluation activities for the Smart $aver program conducted by the evaluation team, collectively Nexant Inc. and our subcontracting partner, Research into Action, in the program year 2016 (January 1, 2016 – December 31, 2016).

1.2.1 Impact Evaluation

We conducted this evaluation of the Smart $aver program to estimate gross and net energy, summer demand, and winter demand savings for the entire program and for each major measure type. The evaluation team reviewed available program databases to help inform the design of the evaluation effort and sampling approach. Activities included an in-situ metering study (n=37) to estimate operational hours of air source heat pumps and central air conditioners, on-site verification of attic insulation and air sealing projects, and verification surveys with program participants paired with engineering desk analyses to estimate gross savings for all measures in the program during the 2016 program year. Net savings are a reflection of the degree to which the gross impacts are a result of the program-specific efforts and incentives. Therefore, we implemented attribution surveys with program participants and contractors to estimate the rates of free ridership and spillover. Program level results for the 2016 Smart $aver program are provided in Table 1-1.

Table 1-1: Program Year 2016 Impact Results

Measurement	Reported	Realization Rate	Gross Verified	Net-to-Gross Ratio	Net Verified
Energy (MWh)	3,461	68.3%	2,362	57.5%	1,358
Summer Demand (MW)	1.72	47.4%	0.82		0.47
Winter Demand (MW)	0.66	39.0%	0.26		0.15

[1] HVAC tune-ups were also included in the program offering; however, there was no participation for this service in the 2016 program year.

In 2016, the program provided rebates for 3,789 measures installed in single family homes, resulting in 2,362 MWh in gross verified energy savings. The program primarily incentivized HVAC equipment, which accounted for over 90% of rebated measures and 85% of verified energy savings, as shown in Figure 1-1 and Figure 1-2.

Figure 1-1: 2016 Smart $aver Rebated Measures

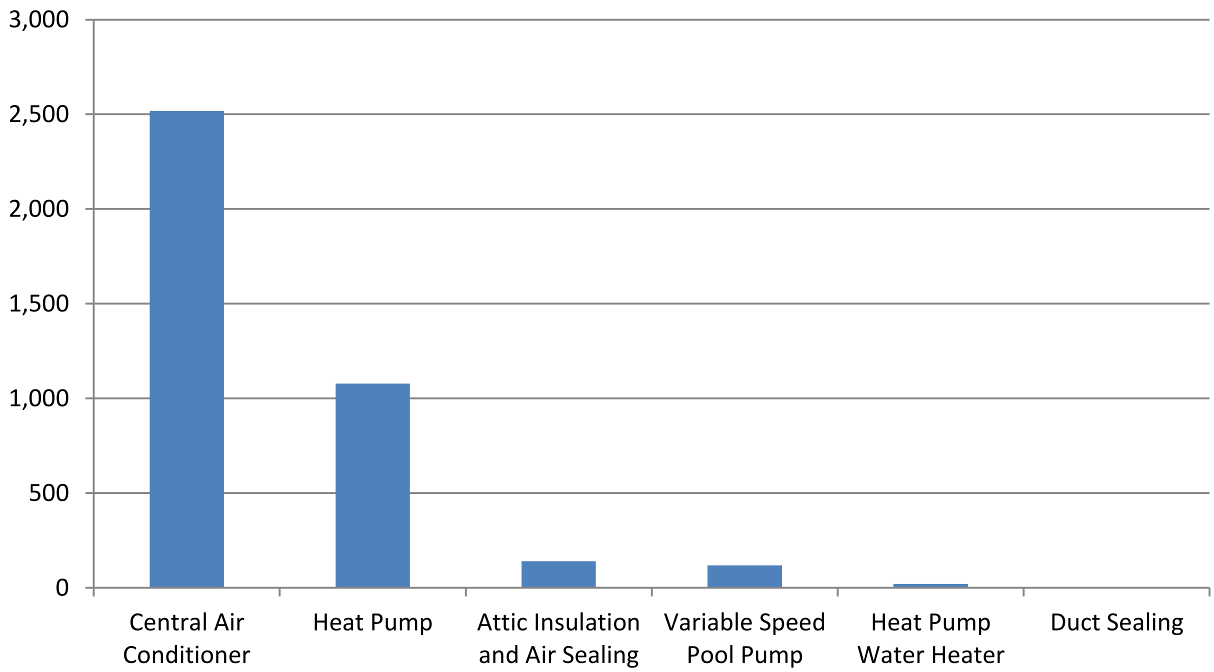


Figure 1-2: 2016 Smart $aver Verified Energy Savings

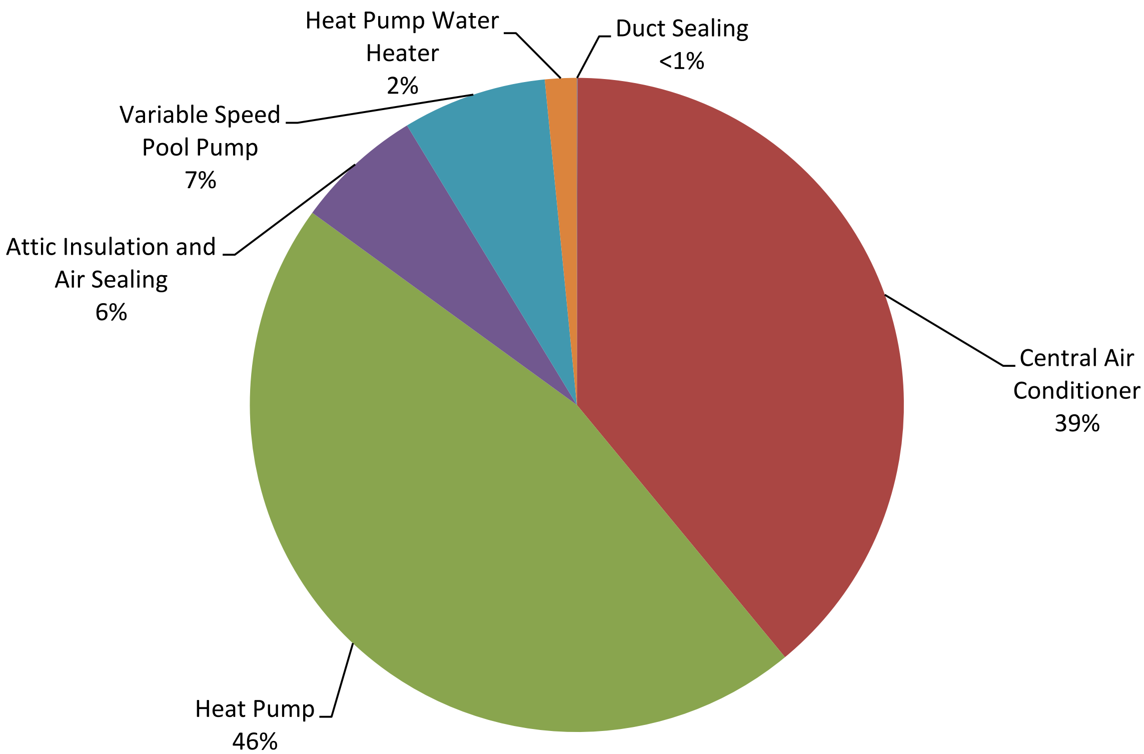


Table 1-2 below presents per unit verified gross energy and demand savings with the calculated net-to-gross ratio for each rebated measure.

Table 1-2: Program Year 2016 Verified Impacts by Measure

Measure	Reported Energy Savings per unit (kWh)	Realization Rate	Verified Gross Energy Savings per unit (kWh)	Reported Summer Coincident Demand Savings per unit (kW)	Realization Rate	Verified Gross Summer Coincident Demand per unit (kW)	Reported Winter Coincident Demand Savings per unit (kW)	Realization Rate	Verified Gross Winter Coincident Demand per unit (kW)	Net to Gross Ratio
Central Air Conditioner	784	46.7%	366	0.481	44.5%	0.214	0.096	27.4%	0.026	57.5%
Heat Pump*	1,113	90.4%**	1,007	0.393	43.9%**	0.158	0.373	46.3%**	0.158	
Attic Insulation & Air Seal	1,162	91.6%	1,065	0.358	94.5%	0.338	0.351	36.3%	0.127	
Variable Speed Pool Pump	1,580	90.3%	1,427	0.590	80.6%	0.476	0.000	100.0%	0.000	
Heat Pump Water Heater	1,763	100.0%	1,763	0.135	100.0%	0.135	0.199	100.0%	0.199	
Duct Sealing	410	58.1%	238	0.381	20.7%	0.079	0.000	100.0%	0.028	

*The Smart$aver program filing stipulates heat pumps as a certified measure. However, because the program rebated both air source and geothermal heat pumps during the 2016 program year, the evaluation team assessed savings separately for each technology type and presents findings in Section 3 for both technology types. References to "heat pump" in subsequent tables and figures in this evaluation report reflect the combined findings for air source and geothermal heat pumps unless otherwise noted.

**Realization rates for Heat Pumps reflects the weighted average verified savings for both air source heat pumps and geothermal heat pumps. Per unit verified savings for each technology type are provided in Section 3.

1.2.1.1 State Bill 310 Compliance

In the state of Ohio, electric distribution utilities (EDUs), including DEO, are required to achieve a cumulative annual energy savings of more than 22% by 2027 per Ohio Senate Bill (SB) 310[1]. SB 310 also introduced new mechanisms that adjust how EDUs may estimate their energy savings achieved through demand side management programs. Specifically, SB 310 requires the Ohio Public Utilities Commission (PUC) to permit EDUs to account for energy-efficiency savings estimated on an "as-found" or a deemed basis. That is, an EDU may claim savings based on the baseline operating conditions found at the location where the energy-efficiency measure was installed, or the EDU may claim a deemed savings estimate. For example, if a DEO customer installed an electronically commutated motor fan, DEO can claim energy savings based on its own assumed deemed or calculated energy savings value associated with the fan upgrade irrespectively of third party evaluation, measurement, and verification, which could show a higher or lower level of energy savings from observed conditions. The relevant language from SB 310 is provided in Appendix C.

Table 1-3 provides the gross savings per measure that DEO will claim per SB 310 for the Smart$aver 2016 program year.

Table 1-3: SB 310 Compliance Gross Savings per Measure

Measure	Claimed Gross Savings (kWh)	Claimed Gross Savings (kW - summer)	Claimed Gross Savings (kW - winter)	Source
Central Air Conditioner	784	0.481	0.096	DEO program reported savings
Heat Pump	1,113	0.393	0.373	DEO program reported savings
Attic Insulation & Air Seal	1,162	0.358	0.351	DEO program reported savings
Variable Speed Pool Pump	1,580	0.590	0.000	DEO program reported savings
Heat Pump Water Heater	1,763	0.135	0.199	DEO program reported savings
Duct Sealing	410	0.381	0.000	DEO program reported savings

1.2.2 Process Evaluation

This process evaluation assessed why and how rebated energy saving measures were implemented through Smart $aver and identified ways to improve the program design and implementation. To answer these research questions, the evaluation team interviewed program

[1] State of Ohio Substitute Senate Bill 310 Section 4928.662, sections (A) through (G), pages 30 and 31.

and implementer staff (n=2) and “high volume” trade allies (n=5), and surveyed stratified random samples of trade allies (n=41) and participants (n=71).[2]

Program Successes

The 2016 Smart $aver Program found success in the following areas.

Overall, participants are highly satisfied with Smart $aver. Participants were especially satisfied with their contractors, their upgrade project, and the program overall.

Smart $aver influences energy efficiency contracting services in DEO service territory. Trade allies reported that participating in Smart $aver influenced them to recommend and implement qualifying measures and has increased their knowledge of energy efficient technologies.

Trade allies are Smart $aver’s most successful marketing channel. Participant surveys demonstrated that trade allies are the primary source of program awareness (Table 1-4) and are the most influential factor on the customer’s decision to implement rebated measures. Further demonstrating the importance of trade allies on spurring awareness and bringing in participants, most trade allies reported their customers typically have not heard of Smart $aver rebates until they mention them to the customer.

Table 1-4: Source of Program Awareness (Multiple Responses Allowed; n=71)

Source of Program Awareness	Percent
Trade ally	73%
Online	14%
Mailer	4%
Advertisement, news, or social media	4%
Neighbor, friend, or family	4%
Other	4%

Program Challenges

The following concerns were highlighted by trade allies and participants.

Consumer awareness of Smart $aver appears to be low. Trade allies reported that most of their customers are unfamiliar with the program and cited this as a primary reason as to why they were dissatisfied with DEO’s marketing of the program. Few (18%) participants were familiar with the Smart $aver measures outside of the ones they received the rebate for and about one-

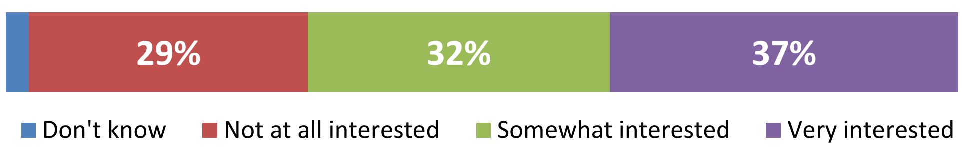
[2] High volume trade allies are companies in the top 20% of trade allies in terms of number of rebated measures, for a given campaign, in 2016.

third (30%) of participants offering suggestions for improvement said more program outreach to consumers is needed.

Smart $aver is not a strong gateway program. None of the participant respondents reported going on to participate in additional DEO programs following their experience in Smart $aver. However, about one-quarter (23%) of participants reported program-influenced spillover actions.

Trade allies could benefit from additional sales training. Most trade allies expressed interest in training to help them sell qualified measures (Figure 1-3).

Figure 1-3: Trade Ally Interest in Sales Training (n=41)



The transition to the online portal has been challenging for trade allies. The portal was the biggest sticking point for trade allies, with 90% reporting problems or frustrations with the new rebate application process. Trade allies most commonly reported the following issues:

- data entry and form upload problems (which causes them to resubmit forms)
- more project tracking information is needed
- the application process takes too much time

However, nearly two-thirds of trade allies said portal issues have gotten at least somewhat better over time.

1.3 Evaluation Conclusions and Recommendations

Based on evaluation findings, the evaluation team concluded the following and provides several recommendations for program improvement.

Conclusion 1: Duke Energy's marketing efforts appear to have limited impact on participation. There is little evidence that participants learned of Smart $aver via DEO marketing efforts. Instead, most found out after hiring a contractor affiliated with the program. Further, no participants reported subsequently participating in other DEO energy efficiency programs.

- **Recommendation 1:** Re-visit ongoing marketing efforts (paid Google ads, direct mail and email campaigns, etc.) to assess if those could be improved to be more effective within the constraints of the marketing budget. Even though trade allies are chiefly instrumental in generating consumer awareness, effective marketing via other channels could further increase customer awareness and ultimately participation in the program.

- **Recommendation 2:** Continue working with trade allies to cross promote other DEO programs, incentives, or campaigns. To measure the effectiveness of cross promotion efforts, create measurements or indicators to ascertain whether cross promotional efforts are generating any effect. For example, track the percentage of customers that participate in multiple DEO programs.

Conclusion 2: Trade allies need additional support to be more effective. Trade allies are the primary mechanism for bringing participants into the program, yet trade ally satisfaction with certain program elements is relatively low.

- **Recommendation:**
  - Continue to improve portal experience – trade allies want smoother submission processes and better tracking information.
  - Provide additional training opportunities – trade allies are dissatisfied with amount of training offered by DEO and many expressed interest in additional sales training.
  - Continue investigating opportunities to leverage the online portal to better communicate with and engage less active trade allies – due to comparatively increased direct communication with their trade ally representatives, high volume trade allies were considerably more satisfied with their trade ally representative than less active trade allies.[3] Leveraging the online portal to enhance communication with less active trade allies – which make up the majority of trade ally firms registered in the program but less than 30% of program participation – may improve overall contractor satisfaction with the program. Consider establishing metrics that monitor effects of portal-based communication with less active trade allies (ex: are less active trade allies becoming more active over time following increased communication?).

Conclusion 3: Freeridership is higher for replacement upon burnout scenarios. Participants replacing broken HVAC systems tend to have higher FR scores, which is likely tied to emergency replacement conditions and thus may explain why these respondents were more likely to report they would have taken the same action even if the incentive did not exist. Specifically, we found that free ridership for air source heat pumps and central air conditioners decreased by 7% when replacement upon burnout participants were removed from the analysis.

- **Recommendation 1:** Continue investigating innovative program approaches to encourage early replacement. Incentives specifically targeted at encouraging early equipment replacement may bring more early replacement participants into the program which can thus increase gross and net savings. Other utilities such as Ameren Illinois and Dayton Power & Light currently offer incentives for early HVAC replacements;

[3] High volume trade allies constitute a minority of firms registered in the program, yet do the bulk of rebated projects: about 35 trade allies represent about 70% of program participation.

consult program administrators of these or other early replacement programs to gather insights on effective strategies for encouraging early replacement.[4]

- **Recommendation 2:** Continue offering rebates for replacement upon burnout though, as these cases constitute a significant source of participation in the current market.

Conclusion 4: Revised federal efficiency standards for split system heat pumps affects minimum efficiency requirements in the state of Ohio. On January 1, 2015, new federal standards raised the required Seasonal Energy Efficiency Ratio (SEER) rating for split system heat pumps to 14 and the Heating Seasonal Performance Factor (HSPF) to 8.2 across the northern region of the United States, including Ohio. This change impacts the minimum efficiency level heat pump systems offered in the Smart $aver program, and therefore also impacts the savings.

- **Recommendation:** Ensure ex ante savings for air source heat pumps reflect the federal efficiency standard for the next program cycle. Because the evaluation period spanned the sell-through period for the updated federal standard, the verified energy savings for air source and geothermal heat pumps is representative a mixed code baseline (i.e., SEER 13 and 14 and HSPF 8.0 and 8.2). However, the program should base future program savings on the new federal standard baseline. The estimated gross savings impacts for air source heat pumps using the new federal standard as baseline is presented in Table 3-15.

Conclusion 5: Over 90% of program participation occurred between rebated air source heat pumps and central air conditioners. However, the per unit savings for these programs are less than all other rebated measures with the exception of duct sealing.

- **Recommendation:** Investigate options to reallocate program resources to other existing program measures or new program measures, as these measures have potential to increase the program's overall savings. Higher participation for other measures may be obtainable through more concerted marketing and outreach toward targeted customer segments.

[4] See the following program websites for current examples of early replacement incentives:

http://actonenergy.com/for-my-home/explore-incentives/heating-and-air-conditioning-rebates

https://www.dpandl.com/save-money/residential/heating-cooling-rebates-for-your-home/heating-rebates/

https://www.kcpl.com/-/media/indexedmedia/save_energy_and_money/home/mo_energy_efficiency/kcpl_rebateincentivechart_0314_2017v43.pdf?la=en

https://www.xcelenergy.com/programs_and_rebates/residential_programs_and_rebates/heating_and_cooling/cooling

2 Introduction and Program Description

2.1 Program Description

The Smart $aver program offers Duke Energy Ohio (“Duke” or “DEO”) existing and new construction residential customers incentives for improving their home’s energy efficiency through the installation of energy efficient heating, ventilating, and air conditioning (HVAC), water heating equipment, pool pump replacements, duct sealing, and attic insulation with air sealing[1].

The program is provided through independent prequalified contractors – called “trade allies” – who install the eligible energy efficiency measures consistent with the program standards and guidelines. Trade allies receive monetary incentives for every rebated HVAC system they install, and builders are also eligible to receive rebates for qualified HVAC equipment installed in residential new construction projects.

2.1.1 Energy Efficiency Measures

Energy efficiency measures included in the Smart $aver program year 2016 are summarized in Table 2-1.

[1] HVAC tune-ups were also included in the program offering; however, there was no participation for this service in the 2016 program year.

Table 2-1: 2016 Smart $aver Measures and Incentives

Measures		Rebate Amount	Details
Central Air Conditioner		Homeowner: $200 Trade ally: $100 Builder: $300	14 SEER or greater, ECM fan on indoor unit
Heat Pump*	*Air Source*	Homeowner: $200 Trade ally: $100 Builder: $300	15 SEER or greater, HSPF of 8.2, ECM fan on indoor unit
	Geothermal	Homeowner: $200 Trade ally: $100 Builder: $300	10.5 EER or greater, ECM fan on indoor unit
Attic Insulation & Air Seal		Homeowner: $250	R-19 or below to R-30 or greater; decrease home air leakage by 5% or more
Variable Speed Pool Pump		Homeowner: $300	Equipment must be an ENERGY STAR® qualified variable-speed pool pump for use with main filtration of in-ground residential swimming pool; applications for motor replacements only are not eligible.
Heat Pump Water Heater		Homeowner: $350	ENERGY STAR® qualified units. Must have an EF ≥ 2
Duct Sealing		Homeowner: $100/duct system	Decrease air duct leakage by 12% or more
Duct insulation*		Homeowner: $75/duct system	For unconditioned attic: R-4.2 to R-19 or greater; for unconditioned crawl space or basement: R-0 to R-6 or greater
HVAC Tune-up**		$50	Available once per unit's life

*The Smart$aver program filing stipulates heat pumps as a certified measure. However, because the program rebated both air source and geothermal heat pumps during the 2016 program year, the evaluation team assessed savings separately for each technology type. References to "heat pump" in subsequent tables and figures in this evaluation report reflect the combined findings for air source and geothermal heat pumps unless otherwise noted.
**No Duct Insulation or HVAC Tune-ups were completed during the 2016 program year.

2.2 Program Implementation

The Smart $aver program is largely implemented by Blackhawk Engagement Solutions (BES). BES manages the trade ally registration process, incentive application submission and fulfillment, the trade ally online portal, and the program call center. As part of the prequalification process, all contractors who wish to participate are required to enter into a Letter of Agreement or Prequalified Contractor Participation Agreement for participation in the program. Contractors who meet program requirements are included in a prequalified contractor listing on the program website. Prequalified contractors have permission to promote Smart $aver program measures and identify themselves as a program contractor.

Upon selection by the customer, contractors will complete the requested installation in accordance with all Smart $aver Program standards and guidelines, and all applicable building codes. Contractors use the online portal to submit incentive applications. Paper format incentive applications are also accepted, but discouraged. Prequalified contractors provide itemized invoices with sufficient detail describing what was installed.

Upon receipt of the application, BES verifies that the application is complete and accurate, and will follow up with customers or contractors to resolve any discrepancies. DEO staff conduct quality control inspections on a small share of installed measures; it was noted to be approximately 10% of installed measures. Inspections are to be shared across all contractors, with new contractors and those who have had quality issues being inspected at a higher rate. Upon approval of applications, incentives are issued to participating customers (and, when applicable, builders or trade allies) for the incentive value.

DEO provides marketing through several channels, including: direct mail campaigns, utility website, participating contractor outreach and advertising, and contractor associations. DEO also performs trade ally outreach and training services.

Eligibility

DEO residential account holders residing in DEO electric service territories are eligible for the Smart $aver rebates. All customers participating in the program must be on a DEO residential electric rate. 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.

2.2.1 Program Goals

The 2016 Smart $aver Program did not meet its targets for participation and energy savings (Table 2-2). The program achieved 42% of anticipated participation and 60% of anticipated savings.

Table 2-2: 2016 Smart $aver Filed Targets

Measurement	Filed Target	Achievement
Participation (rebates)	9,290	3,879
Savings (MWh)	5,770	3,461*

*Based on program gross reported savings.

2.3 Key Research Objectives

Over-arching project goals will follow the definition of impact evaluation 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."

Evaluation has two key objectives:

1) To document and measure the effects of a program and determine whether it met its goals with respect to being a reliable energy resource.
2) To help understand why those effects occurred and identify ways to improve.

2.3.1 Impact

Over-arching project impact evaluation processes followed standard industry protocols and definitions, where applicable, and include the Department of Energy Uniform Methods Protocol, as an example. As part of evaluation planning, the evaluation team outlined the following activities for this program evaluation:

- Quantify accurate and supportable energy (kWh) and demand (kW) savings for energy efficient measures and equipment implemented in participants' homes;
- Assess the rate of free riders from customer and contractor perspective and determine spillover effects;
- Benchmark verified measure level energy impacts to applicable technical reference manuals (TRMs) and other Duke-similar programs in other jurisdictions;
- Consider and verify that measure installation vintage aligns with measure baseline definitions, i.e. early replacement, burnout on failure, etc.; and,
- To the extent possible for the purposes of program planning, the evaluation team will seek to provide estimated per-unit savings by measure.

2.3.2 Process

The process evaluation was designed to support organizational learning and program adaptation. To this end, the evaluation team sought to research several elements of the program delivery and customer experience as outlined below:

- **Awareness and Engagement:** How aware are customers of the Smart $aver program? What are the primary sources of information (e.g., trade allies, program website, bill inserts) that customers use to learn more about the program? How do customers typically learn about energy efficient technologies? How are trade allies engaged in the Smart $aver program, and what is the most effective engagement source (e.g., implementer, program website). Is there a need to conduct any additional marketing of the program and/or provide marketing support to trade allies?
- **Program Satisfaction:** How satisfied are participants with the overall program experience, their contractor and the quality of the installation, incentive turnaround,

energy savings after the work was performed, 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? How has the contractor's equipment stock changed, if at all, since participating in the program?
- **Challenges and opportunities for improvement:** Are there any inefficiencies or challenges 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 and potential:** What are the demographic characteristics of those participating in the program? Are there segments of the population that are not participating but have high participation potential and should be reached?
- **Code Changes:** New Seasonal Energy Efficiency Ratio (SEER) standards were enforced for heat pumps manufactured or distributed on or after January 1, 2015. What are trade ally perspectives on how this change will affect the market and the program?

2.4 Evaluation Overview

The evaluation team divided the approach into key tasks to meet the goals outlined:

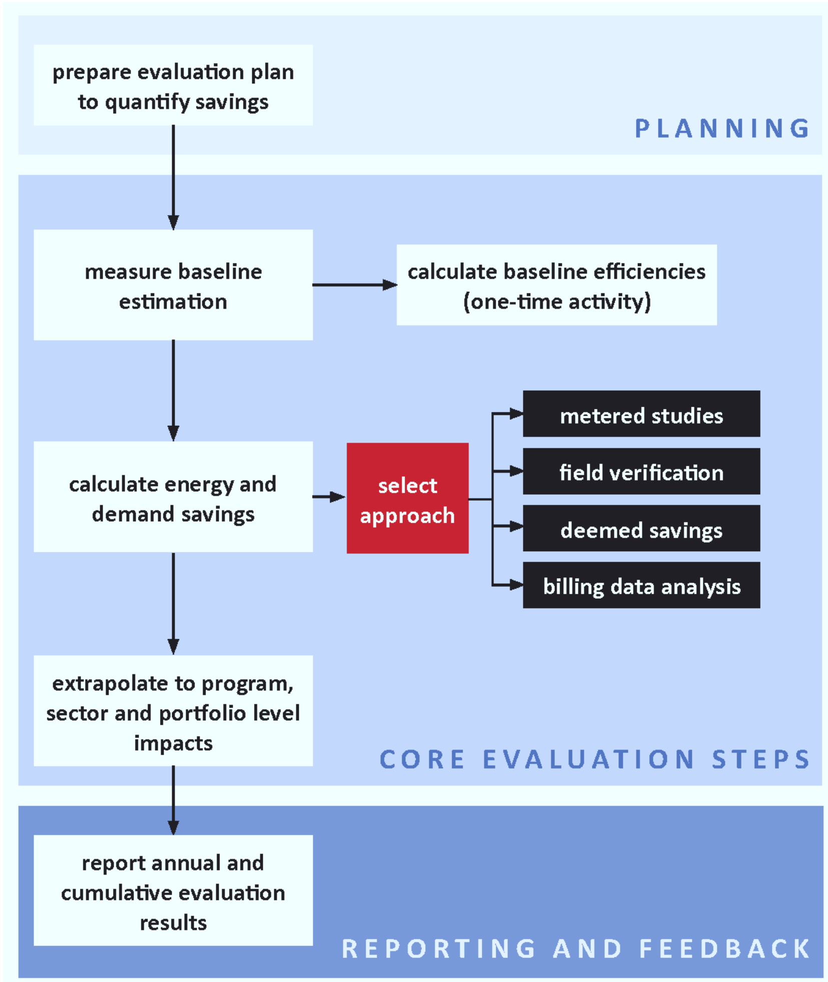
- **Task 1 –** Develop and manage evaluation plan to describe the processes that will be followed to complete the evaluation tasks outlined in this project;
- **Task 2 –** Conduct a process review to determine how successfully the program is being delivered to market and identify opportunities for improvement;
- **Task 3 –** Verify gross and net energy and peak demand savings resulting from the Smart $aver program through on-site measurements and verification activities of a sample of 2016 program participants and projects.

2.4.1 Impact Evaluation

The primary determinants of impact evaluation costs are the sample size and the level of rigor employed in collecting the data used in the impact analysis. The accuracy of the study findings is in turn dependent on these parameters. Techniques that we used to conduct our evaluation, measurement, and verification (EM&V) activities, and to meet the goals for this evaluation, include on-site inspections and measurements, telephone surveys, database review, best practice review, and interviews with implementation staff, trade allies, and program participants.

Figure 2-1 demonstrates the principle evaluation steps organized through planning, core evaluation activities, and final reporting.

Figure 2-1: Impact Evaluation Process



The evaluation team targeted sample sizes for on-site activities based upon the evaluation team's understanding of the expected significance (or magnitude) of expected participation, the level of certainty of savings, and the variety of measures.

The evaluation generally comprised the following steps, which are described in further detail throughout this report:

- **Design the Sample for Measurement and Verification (M&V):** The review, measurement, and verification of all implemented projects is not plausible or cost-effective given the size of this program. Consequently, a sample of projects was established for M&V. In order to provide the most cost-effective sample, the evaluation team employed a Value of Information (VOI) approach. VOI is used to balance cost and rigor and follows a process to allocate the bulk of the evaluation funds to programs and projects with high impact and high uncertainty.
- **Develop Measure-Specific M&V Plans**: Upon review of the program documents, a unique M&V plan was developed for each program and measure, including a metering

protocol, as applicable. M&V methods were developed with adherence to the International Performance Measurement and Verification Protocol (IPMVP) and other well-established engineering analysis procedures.

- **Participant Surveys and On-site Inspections:** The database review provided the necessary information to design a sample of projects to review. All sampled projects received a telephone survey with the participant. Additionally, a portion of the sampled projects received on-site audits and measurement to further detail the information obtained during the database review and ultimately used to calculate energy savings. Table 2-3, in Section 2.4.3 below summarizes the number of surveys and on-site inspections completed. The samples were drawn to meet a 90% confidence and 10% precision at the program level.
- **Calculate Impacts and Analyze Load Shapes:** Data collected via the on-site visits, database reviews and telephone surveys enabled the evaluation team to calculate gross verified energy and demand savings for each project or measure. Hourly load shapes are important in calculating system on-peak demand savings, especially when the measures installed have daily and seasonal variations in the operating schedule.
- **Estimate Net Savings**: Net impacts are a reflection of the degree to which the gross savings are a result of the program efforts and incentives. The evaluation team estimated free-ridership and spillover for each project in the impact sample utilizing self-report methods through surveys with program participants. The ratio of net verified savings to gross verified savings is the net-to-gross ratio as an applied scaling factor to the reported savings.

2.4.2 Process Evaluation

Process evaluation tells the qualitative story behind the quantitative impact evaluation by understanding the program in its unique context. The goal of process evaluation is to perform a systematic assessment of an energy efficiency program by generating feedback that achieves the following outcomes:

- Document program operations
- Recommend improvements to increase the program’s efficiency and effectiveness
- Assess stakeholder satisfaction

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

- Database and document review
- Interviews with program staff and key stakeholders, such as trade allies

- Surveys with customers
- Benchmarking research
- Marketing review

Process evaluation activities also inform the calculation of a NTG ratio. Information gathered from participating customers and trade allies can be measured and analyzed to form the basis of a NTG ratio. For example, participant surveys used to assess participant satisfaction also provide opportunity to ask participants about their motivations for participating and the influence of the program on their decisions, both of which are key components of a free ridership calculation. Similarly, the participant surveys are used to assess whether participants installed additional energy savings measures, which could be attributed to spillover.

2.4.3 Summary of Activities

Techniques we utilized to conduct the evaluation, measurement, and verification (EM&V) activities, and to meet the goals for this evaluation, included field inspection and metering, telephone surveys with program participants, program database reviews and in-depth interviews (IDI) with utility staff, implementer, and trade allies. Table 2-3 provides a summary of the activities Nexant conducted as part of the Smart $aver program process and impact evaluation.

Table 2-3: Summary of Evaluation Activities

Target Group	2016 Population	Sample	Method
Attic Insulation & Air Seal	140	8	Field inspection
Central Air Conditioner and Air Source Heat Pump	3,506	37	Field inspection and metering
Participants (rebated measures)	3,879	71	Telephone Survey
Duke Energy Program Staff	N/A	1	In-depth interview (IDI)
Implementer Staff	N/A	1	IDI
Most Active Trade Allies	~20	5	IDI
Trade Allies	119	41	Telephone survey
Participants (rebated measures)	3,879	75	Telephone survey

2.5 Sample and Estimation

The gross and net verified energy and demand savings estimates presented for the majority of the Smart $aver program participation were generally determined through the observation of key measure parameters among a sample of program participants. A census evaluation would involve surveying, measuring, or otherwise evaluating the entire population of projects within a population. Although a census approach would eliminate the sampling uncertainty for an entire program, the reality is that M&V takes many resources both on the part of the evaluation team and the program participants who agree to be surveyed or have site inspections conducted in their home. When a sample of projects is selected and analyzed, the sample statistics can be extrapolated to provide a reasonable estimate of the population parameters. Therefore, when used effectively, sampling can improve the overall quality of an evaluation study. By limiting resource-intensive data collection and analysis to a random sample of all projects, more attention can be devoted to each project surveyed.

The nuances and tradeoffs considered by the evaluation team when developing sampling approaches varied by measure across the program and are discussed in more detail in Section 3 and Section 4. However, several common objectives were shared across measures and research objectives. The most important sampling objective was representativeness – that is that the projects selected in the evaluation were representative of the population they were selected from and would produce unbiased estimates of population parameters. A second key sampling objective was to consider the value of information being collected and align sample allocations accordingly. This effort generally involves considering the size (contribution to program savings) and uncertainty associated with the measure being studied and making a determination about the appropriate level of evaluation resources to allocate.

The evaluation team relied primarily on mean-per-unit estimation for the Smart $aver program and separated the program population into a series of homogenous measure categories. This approach works well for residential programs that include a large number of rebates for similar equipment types where the evaluation objective is to determine an average kWh savings per rebated measure. With mean-per-unit estimation, the average kWh savings and NTG ratio observed within the sample is applied to all projects in the population. For several measures the characteristics observed within the evaluation sample were supplemented with parameter values that were available for all members of the population in the program database. For example, the program database stores the capacity (BTU/hour) for every rebated air source heat pump so the evaluation team used the population mean capacity when calculating average per-unit energy savings rather than the sample mean.

2.5.1 Stratification

The evaluation team used sample stratification for the gross impact, net impact, and process evaluation sampling. Stratification is a departure from simple random sampling, where each sampling unit (customer/project/rebate/measure) has an identical likelihood of being selected in the sample. Stratified random sampling refers to the designation of two or more sub-groups (strata) from within a program population prior to the selection process. The evaluation team felt that stratification was advantageous and utilized this approach in the sample design for a variety of reasons across the program, including:

- Increased precision of the within-stratum variability was expected to be small compared to the variability of the population as a whole. Stratification in this case allows for increased precision or smaller total sample sizes, which lowered evaluation costs.

- Ensured a minimum number of units within a particular stratum will be verified. For example, Smart $aver participation in 2016 was dominated by air source heat pump and central air conditioner installations. A simple random sample would have likely returned zero heat pump water heaters or pool pump samples. The evaluation team felt it was important to develop primary research results for less common offerings; therefore, separate strata were created.
- Allowed for a value-of-information approach to be implemented through which the largest measures are sampled at a much higher rate than smaller projects by creating size-based strata.

2.5.2 Presentation of Uncertainty

There is an inherent risk, or uncertainty, that accompanies sampling, because the projects selected in the evaluation sample may not be representative of the program population as a whole with respect to the parameters of interest. As the proportion of projects in the program population that are sampled increases, the amount of sampling uncertainty in the findings decreases. The amount of variability in the sample also affects the amount of uncertainty introduced by sampling. A small sample drawn from a homogeneous population will provide a more reliable estimate of the true population characteristics than a small sample drawn from a heterogeneous population. Variability is expressed using the coefficient of variation (C_v) for programs that use simple random sampling, and an error ratio for programs that use ratio estimation. The C_v of a population is equal to the standard deviation (σ) divided by the mean (μ) as shown in Equation 2-1.

Equation 2-1: Coefficient of Variation

$$C_v = \frac{\sigma}{\mu}$$

Equation 2-2 shows the formula used to calculate the required sample size for each evaluation sample, based on the desired level of confidence and precision. Notice that the C_v term is in the numerator, so the required sample size will increase as the level of variability increases. For programs that rely on ratio estimation error ratio replaces the C_v term in Equation 2-2. Results of the previous Duke Energy evaluations and Nexant evaluations from other jurisdictions were the primary source of error ratio and C_v assumptions for the 2016 Smart $aver evaluation.

Equation 2-2: Required Sample Size

$$n_0 = (\frac{z * C_v}{D})^2$$

Where:

n_0	=	*The required sample size before adjusting for the size of the population*
Z	=	*A constant based on the desired level of confidence (equal to 1.645 for 90% confidence two-tailed test)*
C_v	=	*Coefficient of variation (error ratio for ratio estimation)*

D = *Desired relative precision*

The sample size formula shown in Equation 2-2 assumes that the population of the program is infinite and that the sample being drawn is reasonably large. In practice, this assumption is not always met. For sampling purposes, any population greater than approximately 7,000 may be considered infinite for the purposes of sampling. For smaller, or finite, populations, the use of a finite population correction factor (FPC) is warranted. This adjustment accounts for the extra precision that is gained when the sampled projects make up more than about 5% of the program savings. Multiplying the results of Equation 2-2 by the FPC formula shown in Equation 2-3 will produce the required sample size for a finite population.

Equation 2-3: Finite Population Correction Factor

$$fpc = \sqrt{\frac{N - n_0}{N - 1}}$$

Where:

N = *Size of the population*

n_0 = *The required sample size before adjusting for the size of the population*

The required sample size (*n*) after adjusting for the size of the population is given by Equation 2-4.

Equation 2-4: Application of the Finite Population Correction Factor

$$n = n_0 * fpc$$

Verified savings estimates always represent the point estimate of total savings, or the midpoint of the confidence interval around the verified savings estimate for the program. Equation 2-5 shows the formula used to calculate the margin of error for a parameter estimate.

Equation 2-5: Error Bound of the Savings Estimate

$$Error\ Bound = se * (z - statistic)$$

Where:

se = *The standard error of the population parameter of interest (proportion of customers installing a measure, realization rate, total energy savings, etc.) This formula will differ according to the sampling technique utilized.*

$z - statistic$ = *Calculated based on the desired confidence level and the standard normal distribution.*

The 90% confidence level is a widely accepted industry standard for reporting program-level uncertainty in evaluation findings. The z-statistic associated with 90% confidence is 1.645.

When evaluators or regulators use the term “90/10”, the 10 refers to the relative precision of the estimate. The formula for relative precision shown in Equation 2-6:

Equation 2-6: Relative Precision of the Savings Estimate

$$Relative\ Precision_{Verified\ Savings} = \frac{Error\ Bound_{(kWh\ or\ kW)}}{Verified\ Impact_{(kWh\ or\ kW)}}$$

An important attribute of relative precision to consider when reviewing achieved precision values is that it is “relative” to the impact estimate. Therefore measures with low realization rates are likely to have larger relative precision values because the error bound (in kWh or kW) is being divided by a smaller number. This means two measures with exactly the same reported savings and sampling error in absolute terms, will have very different relative precision values, as shown in Table 2-4.

Table 2-4: Relative Precision Example

Program	Reported kWh	Realization Rate	Error Bound (kWh)	Verified kWh	Relative Precision (90%)
Measure #1	4,000,000	0.5	400,000	2,000,000	± 20%
Measure #2	4,000,000	1.0	400,000	4,000,000	± 10%

To calculate a Smart $aver program-level savings estimate requires summation of the verified savings estimates from several strata. In order to calculate the relative precision for these program-level savings estimates, the Evaluation Team used Equation 2-7 to estimate the error bound for the program as a whole from the stratum-level error bounds.

Equation 2-7: Combining Error Bounds across Strata

$$Error\ Bound_{Program} = \sqrt{Error\ Bound^2_{Stratum1} + Error\ Bound^2_{Stratum2} + Error\ Bound^2_{Stratum3}}$$

Using this methodology, the evaluation team developed verified savings estimates for the program and an error bound for that estimate. The relative precision of the verified savings for the program is then calculated by dividing the error bound by the verified savings estimate.

3 Impact Evaluation

3.1 Methodology

An impact evaluation was performed to evaluate energy and demand savings attributable to the Smart $aver program. The evaluation was divided into two research areas; determining gross and net savings (or impacts). Gross impacts are energy and demand savings found at a participant's home that are the direct result of a measure installed and rebated through the program. Net impacts are a reflection of the degree to which the gross savings are a result of the 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.
- Sampling of participating measures.
- Performing on-site metering for air source heat pump and central air conditioner replacements to estimate hours of operation and associated amperage.
- Completing telephone surveys to verify database inputs and collect supplemental information.
- Estimating gross verified savings using data collected in previous tasks.
- Comparing the DEO ex ante savings to gross-verified savings to determine program- and measure-level realization rates.
- Applying attribution surveys to estimate net-to-gross ratios and net-verified savings at the program level.

The impact evaluation activities result in the calculation of an adjustment factor called a realization rate, which is applied to the reported savings documented in the program tracking records. The realization rate is the ratio of the savings determined from the site inspections, M&V activities, or engineering calculations to the program-reported savings.. The adjusted savings obtained by multiplying the realization rate by the program-reported savings are termed the verified gross savings and they reflect the direct energy and demand impact of the program's operations.

3.2 Database and Ex Ante Review

Review of the program database provided details that informed all evaluation activities. The scope of the evaluation was oriented based on information referenced from the program database, including; the rebate count for each measure and measure specific installation details. These data were considered when designing approaches and methods to evaluate the program. For example, the database included baseline efficiencies for existing equipment; however, it did not include details regarding the working condition of that equipment. Therefore, the participant survey included questions to understand the condition of participants' original equipment to inform the type of baseline the evaluation should use when calculating savings (i.e., early replacement or burnout).

The evaluation team also conducted a review of ex ante savings, i.e., program reported savings, values for each measure rebated in the 2016 program. This review consisted of benchmarking the ex ante value against other evaluation results of similar programs from nearby Duke Energy jurisdictions as well as against regional technical reference manuals (TRMs). This review allowed the evaluation team to understand if the program's assumed savings values are or are not in line with expectations. The details of the ex ante review are referenced in Table 3-1.

This benchmarking exercise exposed concerns regarding the program's two most active measures: central air conditioners and air source heat pumps. Both of these measures had significantly larger ex ante values when compared to each TRM as well as a recently completed evaluation for a very similar HVAC program in Duke Energy Progress. The central air conditioner ex ante value was 270% greater than the median benchmarked values. While not as dramatic, the air source heat pump was 167% greater than the median of benchmarked values. Due to this, additional emphasis was placed these measures during the evaluation.

Table 3-1: Comparison of DEO Smart $aver Energy Savings Estimates to Peer Group Estimates

Measure		DEO Smart $aver 2010 PY Evaluation (kWh)	DEO Smart $aver 2014 PY Evaluation/PY 2016 Ex Ante (kWh)	Ohio 2010 TRM (kWh)[1]	Indiana 2012 TRM (kWh)[2]	Illinois 2015 TRM (kWh)[3]	Pennsylvania 2015 TRM (kWh)[4]
Central Air Conditioner		606	784	328	253	379	224
Heat Pump	*Air Source*	2,682	1,113	764	680	657	570
	Geothermal	N/A	N/A	2,744	2,501	5,316	N/A
Attic Insulation & Air Seal		N/A	1,162	725	3,476	972	1,322
Variable Speed Pool Pump		N/A	1,580	1,170	1,173	N/A	556
Heat Pump Water Heater		N/A	1,763	1,842	1,842	1,759	1,693
Duct Sealing		N/A	410	68	314	217	381

[1] State of Ohio Energy Efficiency Technical Reference Manual. August 6, 2010.
[2] Indiana Technical Reference Manual, version 1.0. December, 2012.
[3] Illinois Statewide Technical Reference Manual, version 4.0, effective February 24, 2015.
[4] Pennsylvania PUC Technical Reference Manual, June 2015.

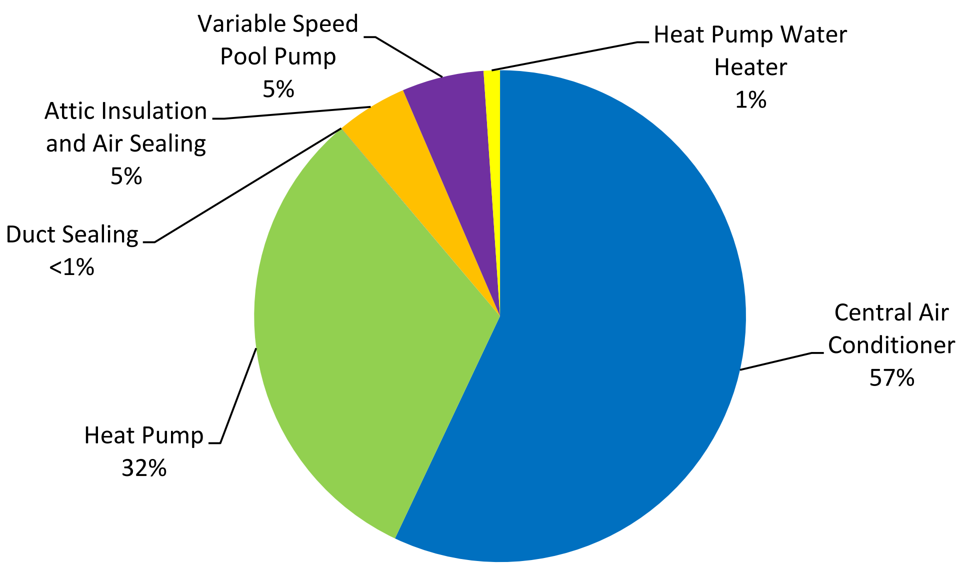
3.3 Sampling Plan and Achievement

To provide representative results, and meet program evaluation goals, a sampling plan was created to guide all evaluation activity. A random sample was created to target 90/10 confidence and precision at the program-level, assuming a coefficient of variation (C_v) equal to 0.5.

For program year 2016, rebated air source heat pumps and central air conditioners were the largest measure contributors for both reported energy and demand savings. Therefore, these measures received the largest share of research activities and the highest level of rigor with on-site equipment measurement.

The evaluation team requested a participation database extract of 2016 program results, which included counts and details on installed measures. The distribution of ex ante energy savings based on measure counts from the participation database, shown in Figure 3-1, provided insight to measures with greater influence on total program savings.

Figure 3-1: Reported Energy Savings



Central air conditioners and heat pumps accounted for 89% of reported energy savings. The sampling plan designed for the 2016 evaluation is included in Table 3-2.

Table 3-2: Impact Sampling Plan

Measure		Metering and/or Verification Sites		Phone Survey	
		Achieved	Targeted	Achieved	Targeted
Central Air Conditioner		26	25	45	45
Heat Pump	*Air Source*	11	11	18	17
	Geothermal	0	0	2	2
Attic Insulation & Air Seal		8	5	2	2
Variable Speed Pool Pump		0	0	2	2
Heat Pump Water Heater		0	0	1	1
Duct Sealing		0	0	1	1
Total		**45**	**41**	**71**	**70**

3.4 Description of Analysis

The evaluation team applied varying analysis techniques depending on the measure, the measure's prominence within the program, and the availability of data on baseline and retrofit savings. A database of program participation provided useful information about measures installed, participants, as well as additional inputs that varied by measure and informed the analysis. Table 3-3 shows the type of analysis applied to each measure.

Table 3-3: Analysis Approach

Measure		Analysis Approach
Central Air Conditioner		Metering study and desk analysis
Heat Pump	*Air Source*	Metering study and desk analysis
	Geothermal	Desk analysis
Attic Insulation & Air Seal		Desk analysis
Variable Speed Pool Pump		Desk analysis
Heat Pump Water Heater		Deemed
Duct Sealing		Desk analysis

3.4.1 Metering study

Given the large share of program savings from air source heat pumps and central air conditioners, a metering approach was applied for the analysis of these two measures. The program database provided thorough detail on the cooling/heating efficiency and capacity of the retrofit HVAC systems, and these data points are two of the three inputs applied to the engineering calculation for residential HVAC savings. The remaining data point, hours of operation, has the highest level of uncertainty, and the metering study focused on this to estimate the cooling and heating Effective Full Load Hours (EFLH) for the program. The methodology applied for this evaluation follows the M&V Plan presented in Chapter 4 of the

Uniform Methods Project[1]. The approach most closely resembles IPMVP Option A: Partial Retrofit Isolation/Metered Equipment.

3.4.1.1 Data Collection

To complete the metering study, field engineers were dispatched to the homes of Smart $aver participants who received a 2016 rebate for either an air source heat pump or central air conditioner replacement. Participants who took part in the metering study were provided a $75 incentive divided across the two visits to their home. In total 37 sites, including 26 central air conditioners and 11 air source heat pumps, were metered across all the DEO territory. All meters were installed in June 2016. Metering equipment was collected from central air conditioners after the end of the cooling season, in late-October 2016. Loggers were collected from air source heat pumps in late January 2017, ensuring that ample data was available during both the cooling and heating seasons.

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. Unit specifications, including capacity, were obtained from each system's nameplate information. Finally, a HOBO CTV-A current transducer (CT) was connected on the conductors supplying electricity to the condensing unit located on the exterior of the home to record electrical current measurements. The CT was paired with a U12-006 data logger that stored each data point at 10 minute intervals. The result was a trended data log of electrical current over the period between when the logger was placed and read-out.

Data collected during the metering study was used in a regression analysis that supplied an estimated EFLH for both the cooling and heating seasons. This analysis is discussed below in section 3.4.2.

3.4.2 Analysis, Regression, ELFH Calculation

Three primary inputs were required to estimate annual cooling and heating savings for air source heat pumps and central air conditioners:

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) - how often the unit is in operation at full capacity

EFLH is an effective measure for estimating the cooling and heating requirement for a specific region and provides a comparison of energy use between regions and equipment types. The general form for the EFLH term is shown in Equation 3-1.

[1] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. Chapter 4: Small Commercial and Residential Unitary Split System HVAC Cooling Equipment Protocol. National Renewable Energy Lab, April 2013.

Equation 3-1: 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 in the sample using nameplate size, efficiency, and spot measurements of voltage and power factor collected on-site. The hourly load was obtained from the logger data and was divided by the connected load to calculate the unit's runtime for each hour in the evaluated period.

The evaluation team collected hourly weather records for the full metering period (June 2016 through January 2017) from the Cincinnati/Northern Kentucky International Airport (CVG) weather station to develop a relationship between observed HVAC system usage runtimes and outdoor temperature. In addition, The evaluation team obtained data for Cincinnati's 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.

As mentioned above, units were metered from June 2016 through January 2017. Because the metering period covered both cooling and heating seasons, the regression analysis was performed twice to estimate annual $EFLH_{cool}$ and annual $EFLH_{heat}$ separately. The evaluation team split the meter data into two separate datasets. The first dataset contained only observations where average daily temperatures exceeded the base temperature of 64°F, or where temperatures indicated cooling. The second dataset contained observations where average daily temperatures fell below the base temperature of 65°F, or where outdoor temperatures indicated heating.[2]

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 the observed cooling degree days (base 64°F) during the cooling season. Figure 3-2 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 64°F.

[2] Nexant lowered the base CDD temperature to 64°F in order to force the regression trend line through the origin – the data showed that cooling was still occurring when outdoor air temperature was 65°F. The difference in base temperatures for CDD (64°F) and HDD (65°F) indicate that there is a small temperature range of approximately one degree where customers use neither heating nor cooling.

Figure 3-2: Cooling Runtime as a Function of Temperature

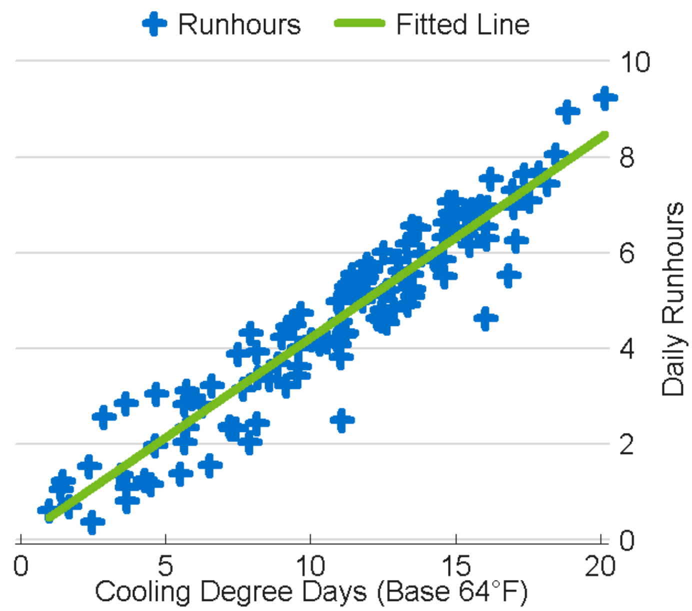


Table 3-4 shows the regression output for the relationship described in Figure 3-2. The key value to consider is the Cooling Degree Day (CDD) coefficient of 0.42. This term indicates that DEO customers use an average of 0.42 hours, or approximately 25 minutes, of additional cooling per CDD.

Table 3-4: $EFLH_{cool}$ Regression Output

Model Term	Coefficient	Std. Err.	t-stat	P-value	[95% Confidence Interval]
CDD	0.42	0.005	84.98	0.000	0.41 – 0.43

The evaluation team ran a similar linear regression model to develop weather-normalized estimates of EFLHheat for each air source heat pump unit. The key difference is that instead of CDD, the model estimated runtimes as a function of observed Heating Degree Day (HDD) (base 65F) during the heating season.

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

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

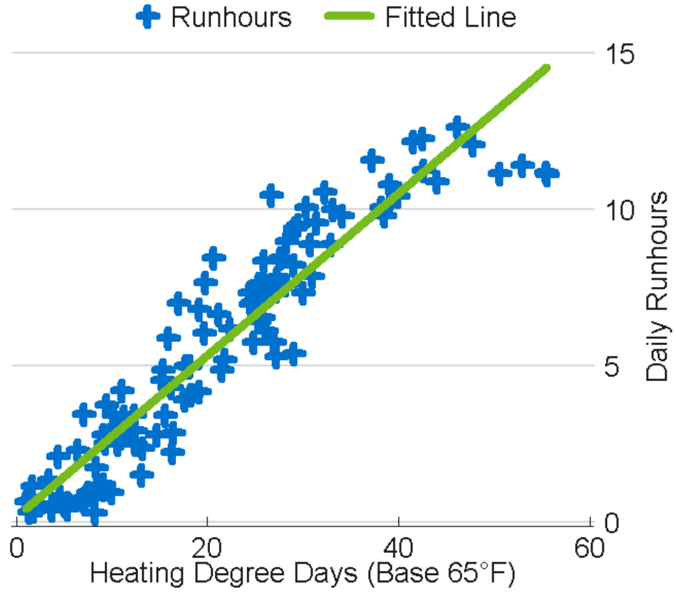


Table 3-5 shows the regression output for the relationship described in Figure 3-3. The coefficient term 0.26 indicates that DEO customers use an average of 0.26 hours, or approximately 16 minutes, of additional heating per HDD.

Table 3-5: $EFLH_{heat}$ Regression Output

Model Term	Coefficient	Std. Err.	t-stat	P-value	[95% Confidence Interval]
HDD	0.26	0.006	47.47	0.000	0.25 – 0.28

The evaluation team utilized hourly TMY3 data for Cincinnati to calculate average CDD and HDD and used those values to estimate $EFLH_{cool}$ and $EFLH_{heat}$ for the region. Table 3-6 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 the average CDD and HDD values determined by TMY3 data.[3]

Table 3-6: EFLH Calculations

Term	Regression Coefficient	Annual CDD (Base 64°F)	Annual HDD (Base 65°F)	$EFLH_{cool}$ (hours)	$EFLH_{heat}$ (hours)
CDD	0.4233	1,093	-	463	-
HDD	0.2645	-	5,235		1,385

The field data collected by Nexant also provided the peak summer cooling demand coincidence factor (CF_{summer}) and the peak winter heating demand coincidence factor (CF_{winter}). Just as EFLH

[3] EFLH values shown in Table 3-6 are corrected for rounding errors.

is a necessary component of the annual energy savings calculation, peak coincidence factor is a necessary component of the peak demand savings calculation. Peak demand coincidence factor is defined here as the probability that the cooling/heating equipment is operating during system peak hours. The basic form for the CF term is similar to the EFLH form shown in Equation 3-1. The form for the CF term is shown in Equation 3-2.

Equation 3-2: Coincidence Factor

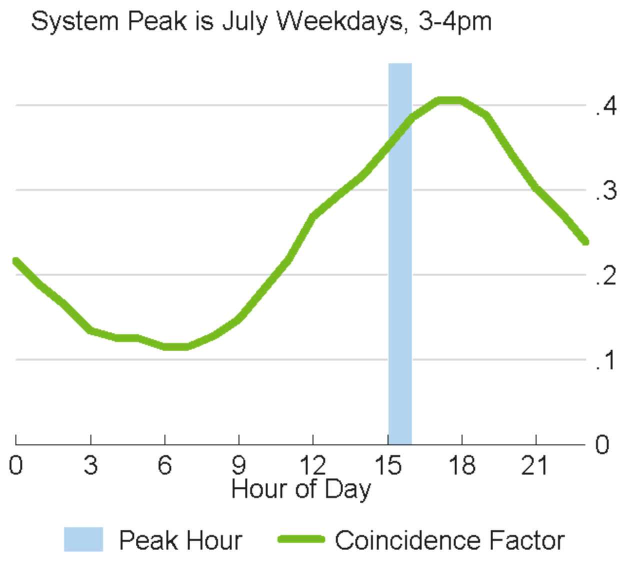
$$CF_h = \frac{Hourly\ Load_h\ (kW)}{Full\ Load\ (kW)}$$

Where:

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

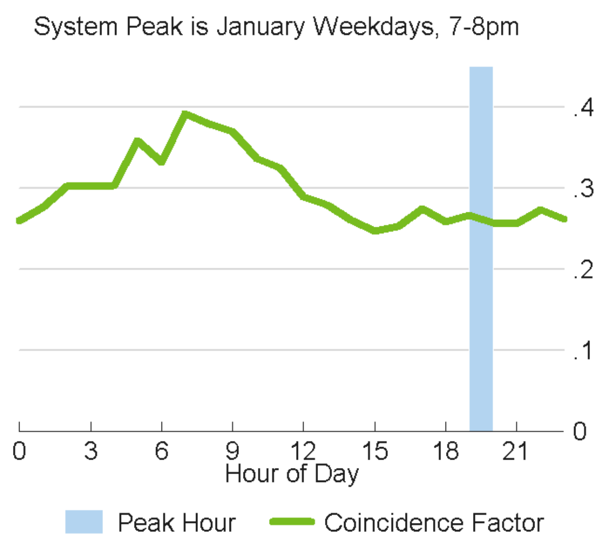
The evaluation team calculated the peak demand coincidence factor to estimate peak demand savings for the sample. A system's peak demand period refers to the period during which the highest level of power is needed to satisfy its electric demand requirement. DEO defines its summer peak period as July weekdays between 3:00pm and 4:00pm (hour ending 16). Figure 3-4 shows the average CF_{summer} load curve for each weekday of July 2016 for the 37 metered homes. The system's peak period is highlighted. The CF_{summer} during the system peak is 0.39.

Figure 3-4: Summer Peak Demand Coincidence Factor



The evaluation team also calculated the peak winter heating demand coincidence factor. DEO defines its winter peak period as January weekdays between 7:00pm and 8:00pm (hour ending 20). Figure 3-5 shows the average CF_{winter} load curve for each weekday of January 2017. The system's winter peak period is highlighted. The CF_{winter} during the system peak is 0.27.

Figure 3-5: Winter Peak Demand Coincidence Factor



3.4.2.1 Central Air Conditioner and Air Source Heat Pump Savings Calculation

Energy and demand savings for central air conditioners s and air source heat pumps were determined by engineering algorithms shown in Table 3-7, using the inputs provided in Table 3-8 and Table 3-10.

Table 3-7: Algorithms for HVAC Energy and Demand Savings

Calculation	Equation
Summer Cooling Energy Savings	$\Delta kWh_{cool} = EFLH_{cool} \times Cap_{cool} \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right)$
Summer Cooling Demand Savings	$\Delta kW_{cool} = Cap_{cool} \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right) \times CF_{cool}$
Winter Heating Energy Savings	$\Delta kWh_{heat} = EFLH_{heat} \times Cap_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right)$
Winter Heating Demand Savings	$\Delta kW_{heat} = Cap_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{ee}}\right) \times CF_{heat}$

Table 3-8: Inputs for Central AC Energy and Demand Savings

Input	Units	Value	Source
$EFLH_{cool}$	Hours	463	Metering study
$Capacity_{cool}$	kBtuh	37.4	Sample average
$SEER_{base}$	SEER	10/13[4]	Code minimum
$SEER_{ee}$	SEER	15.6	Sample average
CF_{summer}	N/A	0.3862	Metering study
CF_{winter}	N/A	0.2674	Metering study

Electrically Commutated Motor Savings

For participants who received an electrically commutated motor (ECM) as part of their central air conditioner replacement, the evaluation team estimated the savings impacts resulting from the fan operation in conjunction with a furnace during the heating season. To estimate this impact, we leveraged primary ECM metered data collected previously by the evaluation team in Duke Energy's Progress territory as well as secondary research to establish baseline conditions. The ECM metered data provided five minute amperage intervals which we used in combination with recorded voltage and power factor measurements to estimate the average power draw of an ECM in operating mode. Our secondary research[5] found that ECMs use half the energy of a

[4] The process survey found just under 9% of central air conditioners were in good working condition when replaced. Savings for these units applied an early replacement savings calculation with baseline SEER of 10.

[5] Pigg, Scott and Talerico, Tom. 2004. "Electricity Savings from Variable-Speed Furnaces in Cold Climates" in *ACEEE 2004 Summer Study on Energy Efficiency in Buildings*, *Panel 1, Paper 23*, http://aceee.org/files/proceedings/2004/data/papers/SS04_Panel1_Paper23.pdf

standard fan motor when used in residential furnace applications. This insight was applied to estimate baseline fan usage.

To calculate savings, we applied the annual effective full load hours (EFLH) for furnaces as cited in the 2010 Ohio TRM to our estimated baseline and ECM power draw. The evaluation team calculated the ECM savings as the difference in consumption between the baseline and ECM fans. We further adjusted the estimated ECM savings by applying the percentage of customers in the program who received an ECM with their new system (92%) as well as by the saturation of residential customers with central air conditioners and forced air furnaces (88%) based on Duke Energy's 2013 residential appliance saturation study.

Energy and demand savings for central air conditioners are presented in Table 3-9 below.

Table 3-9: Central AC Gross Verified Savings

Season	Energy Savings (kWh)*	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Cooling	256	0.214	0.026
Heating	109		
Total	**366**		

*Rounding error present.

Table 3-10: Inputs for Air Source Heat Pump Energy and Demand Savings

Input	Units	Value (pre/post baselineshift)	Source
$EFLH_{cool}$	Hours	463	Metering study
$EFLH_{heat}$	Hours	1,385	Metering study
$Capacity_{cool\ and\ heat}$	kBtuh	31.2/33.4	Sample average
$SEER_{base}$	SEER	13/14[6]	Program minimum
$SEER_{ee}$	SEER	15.3/16.1	Sample average
$HSPF_{base}$	HSPF	7.7/8.2[7]	Program minimum
$HSPF_{ee}$	HSPF	8.7/9.0	Sample average
CF_{summer}	N/A	0.3862	Metering study
CF_{winter}	N/A	0.2674	Metering study

Table 3-11: Air Source Heat Pump Gross Verified Savings

Season	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Cooling	156	0.130	0.114
Heating	593		
Total	**749**		

3.4.2.2 Geothermal Heat Pump Savings Calculation

Geothermal heat pumps make use of constant ground temperature to provide heating and cooling and operate at higher efficiency levels than air source heat pumps. The Smart $aver Program provides incentives for these systems to encourage participants to install higher efficiency HVAC systems in their homes. Geothermal heat pumps were excluded from the EFLH metering study; however, the evaluation team estimated savings based on the assumption that heating and cooling EFLH for a geothermal heat pump are equivalent to an air source heat pump.

6 Air source heat pump baseline SEER increased from 13 to 14 when the code change went into effect.

7 Air source heat pump baseline HSPF increased from 7.7 to 8.2 when the code change went into effect.

Table 3-12: Algorithms for Geothermal Heat Pump Energy and Demand Savings

Calculation	Equation
Summer Cooling Energy Savings	$\Delta kWh_{cool} = EFLH_{cool} \times Cap_{cool} \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right)$
Summer Cooling Demand Savings	$\Delta kW_{cool} = Cap_{cool} \times \left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right) \times CF_{cool}$
Winter Heating Energy Savings	$\Delta kWh_{heat} = EFLH_{heat} \times Cap_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{COP_{retrofit} \times 3.412}\right)$
Winter Heating Demand Savings	$\Delta kW_{heat} = Cap_{heat} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{COP_{retrofit} \times 3.412}\right) \times CF_{heat}$

Table 3-13: Inputs for Geothermal Heat Pump Gross Verified Savings

Input	Units	Value (pre/post baseline shift)	Source
$EFLH_{cool}$	Hours	463	Metering study
$EFLH_{heat}$	Hours	1,385	Metering study
$Capacity_{cool\ and\ heat}$	kBtuh	48.4	Sample average
$SEER_{base}$	SEER	13/14[8]	Program minimum
$SEER_{ee}$	SEER	20	Sample average
$HSPF_{base}$	HSPF	7.7/8.2[9]	Program minimum
$COP_{retrofit}$	COP	3.7	Sample average
CF_{cool}	N/A	0.3862	Metering study
CF_{heat}	N/A	0.2674	Metering study

Table 3-14: Geothermal Heat Pump Gross Verified Savings

Season	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Cooling	553	0.462	0.629
Heating	3,256		
Total	**3,809**		

[8] Air source heat pump baseline SEER increased from 13 to 14 when the code change went into effect

[9] Air source heat pump baseline HSPF increased from 7.7 to 8.2 when the code change went into effect

3.4.2.3 Federal Minimum Efficiency Standard Change

Starting on January 1, 2015 there was a shift in minimum efficiency standards for residential heat pumps and a transition towards new minimum requirements of 14 SEER and 8.2 HSPF in Duke Energy Ohio's service territory. The Smart $aver program permitted a sell through period that ended on April 15th, 2016. After this date all heat pumps installed through the program were required to surpass the new, higher SEER and HSPF efficiency standards. Due to this change, the evaluation team assigned different code-based efficiency baselines for the participation prior to and after April 15th, 2016. The results provided in Table 3-11 above for air source heat pumps as well as Table 3-14 for ground source heat pumps are a weighted average of systems installed before and after this code baseline shift. For future program years, the Smart $aver program should deem air source and ground source heat pump savings based on the newly revised federal standard as provided in Table 3-15.

Table 3-15: Post Code Change Air Source Heat Pump Gross Verified Savings

Technology	Season	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Air Source Heat Pump	Cooling	142	0.118	0.102
	Heating	528		
	Total	**669**		
Ground Source Heat Pump	Cooling	477.4	0.398	0.566
	Heating	2,929.4		
	Total	**3,406.9**		

3.4.3 Engineering Analysis

3.4.3.1 Attic Insulation and Air Sealing

In addition to system verification completed during the EFLH metering study, the evaluation team conducted attic insulation and air sealing verification at eight homes from the program population. These visits confirmed the post-retrofit insulation R-value and attic area to inform the analysis of the measure. Publically available housing information was also reviewed to confirm the attic area of homes in the program.

For other parameters, such as baseline conditions and system efficiencies, data from the program tracking database was combined with primary, secondary, and TRM inputs to calculate energy and demand savings.

Table 3-16: Algorithms for Attic Insulation Energy and Demand Savings

Calculation	Equation
Cooling Energy Savings	$\Delta kWh_{cool} = CDD \times 24 \times Area \times DUA \times (1 - FramingFactor_{attic}) \times \left(\frac{1}{Rvalue_{base}} - \frac{1}{Rvalue_{retrofit}}\right) \times \frac{1}{\eta_{cool} \times 1000}$
Heating Energy Savings	$\Delta kWh_{heat} = HDD \times 24 \times Area \times (1 - FramingFactor_{attic}) \times ADJ_{attic} \times \left(\frac{1}{Rvalue_{base}} - \frac{1}{Rvalue_{retrofit}}\right) \times \frac{1}{COP \times 3412} \times Ratio_{ASHP}$
Summer Demand Savings	$\Delta kW_{summer} = \frac{\Delta kWh_{cool}}{EFLH_{cool}} \times CF_{summer}$
Winter Demand Savings	$\Delta kW_{winter} = \frac{\Delta kWh_{heat}}{EFLH_{heat}} \times CF_{winter}$

Table 3-17: Inputs for Attic Insulation Energy and Demand Savings

Input	Units	Value	Source
R_{base}	R-value	12.5	Program database average
$R_{retrofit}$	R-value	48.6	Site visit; program database average
Area	ft^2	1,268	Site visit; DEO program database average; secondary research
CDD	CDD	1,128	TMY3 data
HDD	HDD	4,278	TMY3 data
η_{cool}	SEER	13	Code minimum
COP	COP	1.9	TRM
ADJ_{attic}	%	74%	TRM
DUA	%	75%	TRM
Framing Factor	%	7%	TRM
air source heat pump Ratio	%	30%	DEO program database ratio
CF_{summer}	N/A	0.3862	Metering study
CF_{winter}	N/A	0.2674	Metering study

Table 3-18: Attic Insulation Gross Verified Savings

Season	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Cooling	110	0.092	0.056
Heating	288		
Total	**398**		

All participants who installed attic insulation were also required to air seal the attic plane to reduce air leakage from conditioned areas of the home. Savings for this component of the measure are separated from the insulation improvement and calculated using pre- and post-retrofit blower door results provided by the program database. Air sealing provided significant energy savings that exceed the savings contribution from the insulation component (Table 3-21).

Table 3-19: Algorithms for Air Sealing Energy and Demand Savings

Calculation	Equation
Cooling Energy Savings	$\Delta kWh_{cool} = CDH \times DUA \times 60 \times 0.018 \times LM \times \frac{CFM50_{base} - CFM50_{retrofit}}{n - Factor} \times \frac{1}{\eta_{cool} \times 1000}$
Heating Energy Savings	$\Delta kWh_{heat} = HDD \times 60 \times 24 \times 0.018 \times (CFM50_{base} - CFM50_{retrofit}) \times \frac{1}{COP \times 3412} \times Ratio_{ASHP} \times \frac{1}{n - Factor}$
Summer Demand Savings	$\Delta kW_{summer} = \frac{\Delta kWh_{cool}}{EFLH_{cool}} \times CF_{summer}$
Winter Demand Savings	$\Delta kW_{winter} = \frac{\Delta kWh_{heat}}{EFLH_{heat}} \times CF_{winter}$

Table 3-20: Inputs for Air Sealing Energy and Demand Savings

Input	Units	Value	Source
CFM_{base}	CFM_{50}	5,811	Program database average
$CFM_{retrofit}$	CFM_{50}	4,374	Program database average
n-Factor	N/A	16.7	Secondary research
CDH	CDH	6,685	TMY3 data
HDD	HDD	4,278	TMY3 data
η_{cool}	SEER	13	Code minimum
COP	COP	2.3	TRM
Air source heat pump Ratio	%	30%	DEO program database ratio
CF_{summer}	N/A	0.3862	Metering study
CF_{winter}	N/A	0.2674	Metering study

Table 3-21: Air Sealing Gross Verified Savings

Season	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Cooling	296	0.247	0.072
Heating	371		
Total	**667**		

3.4.3.2 Variable Speed Pool Pumps

Variable speed pool pumps save the participant energy by reducing flow rates through a pump and achieving significant energy savings. Reducing pump flow by 50% is expected to save 87% of the energy needed to operate the system. The algorithm use by the evaluation team and the associated parameters are presented in Table 3-22 and Table 3-23. Final verified gross savings are provided in Table 3-24.

Table 3-22: Algorithms for Variable Speed Pool Pump Energy and Demand Savings

Calculation	Equation
Summer Cooling Energy Savings	$\Delta kWh = \frac{HP \times LF \times 0.746}{\eta_{pump}} \times \frac{Hrs}{Day} \times \frac{Days}{Year} \times ESF$
Summer Demand Savings	$\Delta kW_{summer} = \frac{\Delta kWh}{\frac{Hrs}{Day} \times \frac{Days}{Year}} \times CF_{summer}$

Table 3-23: Inputs for Variable Speed Pool Pump Gross Verified Savings

Input	Units	Value	Source
HP	Horsepower	1.72	Program database average
Load Factor	%	0.66	TRM
Pump Efficiency	%	33%	TRM
Hours of Use per Day	Hours	6.0	TRM
Days of Use per Year	Days	100	TRM
Energy Savings Factor	%	91%	TRM
CF_{summer}	N/A	0.20	TRM

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

Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
1,427	0.048	0.000

3.4.3.3 Duct Sealing

Duct sealing improves the distribution efficiency of a heating or cooling system by patching any openings in the duct system that prevent conditioned air from reaching its intended destination. This results in savings from an HVAC system that can operate less often and still maintain the consistent, comfortable temperature desired by the homeowner. The algorithm use by the evaluation team and the associated parameters are presented in Table 3-25 and Table 3-26. Final verified gross savings are provided in Table 3-27.

Table 3-25: Algorithms for Duct Sealing Energy and Demand Savings

Calculation	Equation
Summer Cooling Energy Savings	$\Delta kWh_{cool} = EFLH_{cool} \times Cap_{cool} \times \frac{\Delta CFM25_{DL}}{System\ CFM} \times \frac{1}{\eta_{cool}}$
Summer Cooling Demand Savings	$\Delta kWh_{heat} = EFLH_{heat} \times Cap_{heat} \times \frac{\Delta CFM25_{DL}}{System\ CFM} \times \frac{1}{COP \times 3{,}412} \times Ratio_{ASHP}$
Winter Heating Energy Savings	$\Delta kW_{summer} = \frac{\Delta kWh_{cool}}{EFLH_{cool}} \times CF_{summer}$
Winter Heating Demand Savings	$\Delta kW_{winter} = \frac{\Delta kWh_{heat}}{EFLH_{heat}} \times CF_{winter}$

Table 3-26: Inputs for Duct Sealing Gross Verified Savings

Input	Units	Value	Source
ΔCFM_{25}	CFM_{25}	88.6	Program database
System CFM	CFM	1,079	Program database
$EFLH_{cool}$	Hours	463	Metering study
$EFLH_{heat}$	Hours	1,385	Metering study
$Capacity_{cool\ and\ heat}$	kBtuh	32.4	Program database
SEER	SEER	13	TRM
COP	COP	2.3	TRM
CF_{cool}	N/A	0.3862	Metering study
CF_{heat}	N/A	0.2674	Metering study

Table 3-27: Duct Sealing Gross Verified Savings

Season	Energy Savings (kWh)	Summer Demand Savings (kW)	Winter Demand Savings (kW)
Cooling	95	0.079	0.028
Heating	144		
Total	**233**		

3.4.4 Deemed Analysis

Due to low uncertainty on measure savings and low program participation the evaluation team applied deemed savings from the previous evaluation for the heat pump water heater.

3.4.4.1 Heat Pump Water Heater

Energy and demand savings for heat pump water heaters are provided in Table 3-28.

Table 3-28: Heat Pump Water Heater Gross Verified Savings

Energy Savings (kWh)	Summer Demand (kW)	Winter Demand (kW)
1,763	0.135	0.199

3.5 Targeted and Achieved Confidence and Precision

The Smart $aver evaluation plan was developed with the goal of achieving a target goal of 10% relative precision at the 90% confidence interval for the program as a whole. As the program is composed of different measures, and the energy savings estimation approach varies by measure, the evaluation team assigned sampling, verification, and impact estimate effort among the program measures in accordance with the measures' contribution to total reported Smart $aver savings. The evaluation team calculated the relative precision for each of these samples and combined the error bound to calculate a program-level relative precision. As presented in Table 3-29, the evaluation team reported confidence and precision for the program is +/- 9.3% at the 90% confidence level.

Table 3-29: Targeted and Achieved Confidence and Precision

Program	Targeted Confidence/Precision	Achieved Confidence/Precision
Smart $aver	90/10.0	90/9.3

3.6 Results

Measure level, per unit energy savings values are detailed in Figure 3-6 and Table 3-30. The program's two most active measures in terms of participation, central air conditioners and air source heat pumps, realized a substantially lower per unit savings compared to the reported values. Also, the program did not provide a reported savings estimate for ground source heat pumps. Therefore, the evaluation team deemed a 100% realization rate for this measure.

Figure 3-6: Per Unit Energy Savings

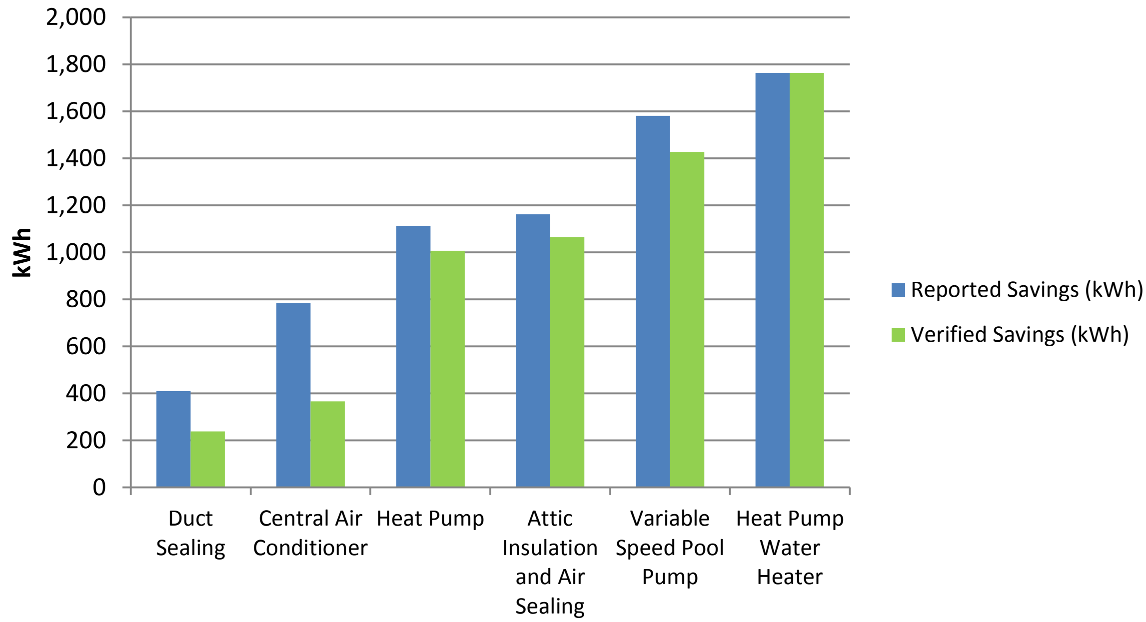


Table 3-30: Measure-Level Reported and Verified Gross Energy Savings

Measure	Rebated Measures	Reported Energy Savings, per unit (kWh)	Realization Rate	Gross Verified Energy Savings, per unit (kWh)	Total Gross Verified Energy Savings (MWh)
Central Air Conditioner	2,518	784	46.7%	366	921,014
Heat Pump	1,079	1,113	90.4%	1,007	1,086,222
Attic Insulation & Air Seal	140	1,162	91.6%	1,065	149,070
Variable Speed Pool Pump	118	1,580	90.3%	1,427	168,345
Heat Pump Water Heater	21	1,763	100.0%	1,763	37,023
Duct Sealing	3	410	58.1%	238	714
Total	**3,879**	**-**	**68.3%**	**-**	**2,362,389**

The low program realization rate of 68.3% is driven by the results of the central air conditioners and the air source heat pumps. Both of these measures' savings performance was significantly lower than the expected reported savings. In the case of central air conditioners, the evaluation team estimated per unit savings at less than half the reported savings per unit assumption. Moreover, both measures comprised over 90% of the program participation. These two factors – low savings per unit and high participation – ultimately drove the program realization downwards.

Table 3-31 and Table 3-32 provide the per unit and total verified gross demand savings for the summer and winter seasons. The program realization rates for summer and winter were 47.4%

and 39.0%, respectively. Similar to the energy savings realization rate, the demand realizations were driven downwards by the performance of the central air conditioners and air source heat pumps. For heat pumps, the results of the evaluation team's metering study found the peak period to be offset by 13 hours from DEO's defined peak period, which also drove down savings[10].

Table 3-31: Measure-Level Reported and Verified Summer Demand Gross Savings[11]

Measure	Reported Summer Demand Savings, per unit (kW)	Realization Rate	Gross Verified Summer Demand Savings, per unit (kW)	Total Gross Verified Summer Demand Savings (MW)
Central Air Conditioner	0.481	44.5%	0.214	538.97
Heat Pump	0.393	43.9%	0.158	170.51
Attic Insulation & Air Seal	0.358	94.5%	0.338	47.39
Variable Speed Pool Pump	0.590	80.6%	0.476	56.12
Heat Pump Water Heater	0.135	100.0%	0.135	2.84
Duct Sealing	0.381	20.7%	0.079	0.24
Total	**-**	**47.4%**	**-**	**816.1**

Table 3-32: Measure-Level Reported and Verified Winter Demand Gross Savings

Measure	Reported Winter Demand Savings, per unit (kW)	Realization Rate	Gross Verified Winter Demand Savings, per unit (kW)	Total Gross Verified Winter Demand Savings (MW)
Central Air Conditioner	0.096	27.4%	0.026	65.96
Heat Pump	0.373	30.7%	0.158	170.27
Attic Insulation & Air Seal	0.351	36.3%	0.127	17.82
Variable Speed Pool Pump	0.000	100.0%	0.000	0.00
Heat Pump Water Heater	0.199	100.0%	0.199	4.18
Duct Sealing	0.000	100.0%	0.028	0.08
Total	**-**	**39.0%**	**-**	**258.3**

10 DEO defines its winter peak period as January weekdays between 7:00pm and 8:00pm.

11 Summer demand savings for all HVAC dependent measures are based on the summer coincident peak determined by the EFLH study.

Table 3-33 and Table 3-34 present the reported and verified energy and demand savings for 2016.

Table 3-33: 2016 Program Level Energy Savings

Measures Installed	Reported Energy (MWh)	Realization Rate	Gross Verified Energy (MWh)	Net-to-Gross Ratio	Net Verified Energy (MWh)
3,879	3,461	68.3%	2,362	57.5%	1,358

Table 3-34: 2016 Program Level Demand Savings

Measurement	Reported Demand (MW)	Realization Rate	Gross Verified Demand (MW)	Net-to-Gross Ratio	Net Verified Energy (MWh)
Summer Demand	1.72	47.4%	0.82	57.5%	0.47
Winter Demand	0.66	39.0%	0.26		0.15

3.6.1 State Bill 310 Compliance

As noted in Section 1.2.1.1, DEO may claim alternate savings values for each program measure per the terms of Ohio Senate Bill 310 in order to comply with its energy savings goals. The relevant language from Senate Bill 310 is provided in Appendix C.

Table 3-35 provides the gross savings per measure that DEO will claim per SB 310 for the Smart$aver 2016 program year.

Table 3-35: SB 310 Compliance Gross Savings per Measure

Measure	Claimed Gross Savings (kWh)	Claimed Gross Savings (kW - summer)	Claimed Gross Savings (kW - winter)	Source
Central Air Conditioner	784	0.481	0.096	DEO program reported savings
Heat Pump	1,113	0.393	0.373	DEO program reported savings
Attic Insulation & Air Seal	1,162	0.358	0.351	DEO program reported savings
Variable Speed Pool Pump	1,580	0.590	0.000	DEO program reported savings
Heat Pump Water Heater	1,763	0.135	0.199	DEO program reported savings
Duct Sealing	410	0.381	0.000	DEO program reported savings

4 Net-to-Gross Methodology and Results

The evaluation team calculated the net savings, which are the amount of savings that occurred as a direct result of influence attributable to the program, by applying net-to-gross (NTG) adjustments to the gross savings. The evaluation team determined the NTG adjustment value via data collected from participant and trade ally surveys.

To calculate net savings, a NTG ratio must first be established. NTG consists of free ridership (FR) and spillover (SO). Free ridership refers to the portion of energy savings that participants would have achieved in the absence of the program through their own initiatives and expenditures (U.S. DOE, 2014).[1] Spillover refers to the program-induced adoption of measures by non-participants and participants who did not receive financial incentives or technical assistance for installations of measures supported by the program (U.S. DOE, 2014). The evaluation team used the following formula to calculate a NTG ratio:

$$NTG = 1 - FR + SO$$

Once the NTG ratio is established, the evaluation team used the following formula to calculate net savings:

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

The evaluation team estimated nonparticipant spillover from trade ally survey data and estimated participant free ridership and spillover from participant surveys. The following sections describe how the evaluation team estimated participant free ridership and spillover values.

4.1 Free Ridership

Free ridership estimates how much the program influenced participants to make the energy saving improvements that the program incents, which is then used to adjust gross savings by the level of attribution the program is able to claim. Free ridership ranges from 0 to 1, with 0 being no free ridership (or, total program attribution), 1 being total free ridership (or, no program attribution) and values in between represent varying degrees of partial free ridership. The evaluation team used participant survey data to inform free ridership estimates. The evaluation team conducted surveys with a stratified random sample of 71 participants (Table 4-1). The participant sample was stratified by measure and is similar to the distribution of measures installed in the program in 2016. The participant sample satisfies 90/10 confidence/precision at the program-level.

1 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.* Retrieved August 29, 2016 from http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter23-estimating-net-savings_0.pdf.

Table 4-1: Proportion of Participant Sample and Population that Installed Each Measure (n=71)

Measure		Sample	Participant Population
Central Air Conditioner		64%	65%
Heat Pump	*Air Source*	25%	25%
	Geothermal	3%	2%
Attic Insulation & Air Sealing		3%	4%
Pool Pump		3%	3%
Heat Pump Water Heater		1%	1%
Duct Sealing		1%	<1%

Since some respondents may have received rebates for multiple measure types and since an individual's free ridership may differ between different measure types, free ridership was first calculated individually for each measure associated with each participant survey respondent. The evaluation team then used this participant-measure-level free ridership values to derive a program-level free ridership estimate. This chapter describes this process.

4.1.1 Participant-Measure-Level Free Ridership

Participant-measure-level free ridership consists of two components – change (FRC) and influence (FRI) – which both range from 0 to .5. The following formula uses these two components to calculate participant-measure-level free ridership:

$$FR = FRC + FRI$$

4.1.1.1 Free Ridership Change

Free ridership change demonstrates what the participant would have likely done if the program had not provided an incentive for their energy upgrade. To determine this, the evaluation team asked participant survey respondents FRC questions specific to the measures they installed. The generic example below exemplifies how the evaluation team collected FRC data (see Appendix C for the measure-specific FRC questions in the participant survey).

Q1. If you had not received a Duke Energy incentive for your [PIPE IN INCENTED MEASURE], which of the following is most likely: Would you have…? [READ ALL, SELECT ONE]

1. *Not purchased a [PIPE IN INCENTED MEASURE]*
2. *Delayed purchasing a new [PIPE IN INCENTED MEASURE] for at least a year*
3. *Purchased a new [PIPE IN INCENTED MEASURE] but a less efficient or less expensive model*
4. *Bought the exact same [PIPE IN INCENTED MEASURE] anyway, and paid the full cost yourself*
5. *Or done something else, specify:_______*

98. *Don't know*

99. Refused

For insulation[2] and replacement equipment with less efficient options,[3] the evaluation team asked a follow up question to respondents that reported the third response option above (purchased a less efficient or less expensive measure), as exemplified below:

Q2. [ASK IF Q1=3] You said you would have bought a [PIPE IN INCENTED MEASURE] that was less expensive or less energy efficient if you had not received the rebate or information from Duke Energy. Do you think it is more likely that you would have bought equipment that was…?

1. Almost as efficient as the one you bought, or

2. Significantly less efficient than the one you bought

98. Don't know
99. Refused

The evaluation team then assigned the following FRC values to each respondent for each rebated measure, based on their response to the questions above, as shown in the Table 4-2.

Table 4-2: Free Ridership Change Values

Q1 Response	Q2 Response	FRC Value
Not purchased a [MEASURE]		0.0
Delayed purchase for at least one year		0.0
Purchased a new [MEASURE] but a less efficient or less expensive model	Almost as efficient as the one you bought	0.375
	Significantly less efficient than the one you bought	0.125
	Don't know / Refused	0.25
Bought the exact same [MEASURE] anyway, and paid the full cost yourself		0.50
Or done something else		FRC values assigned on a case by case basis, depending on which pre-coded response item they most resemble
Don't know / Refused		Measure average

2 Respondents that report they would have installed less insulation will then be asked to report how much less insulation they would have purchased in a percentage format (e.g.: 50% less). This reported value will be subtracted from 100% and then divided in half; the result will serve as their FRC value.

3 Since duct sealing/repair are service measures, as compared to equipment measures, there is no less efficient version of these measures. Thus, the counterfactual for these service measures would be to either: 1) not purchase the service, 2) wait a year or more to purchase the service, or 3) purchase the service without the assistance of a rebate. Accordingly, FRC values for these measures are either 0 (would have not purchased or would have waited a year or more to purchase) or .5 (would have purchased without assistance of a rebate).

Participants who replaced a broken HVAC system pose a particular challenge to NTG (or FRC, specifically): because there is an immediate space heating or cooling need, it is possible that free ridership could be higher for some in this group, as “replacement upon burnout” participants may be less likely to report they would not purchase or would delay purchasing a replacement measure (which are responses that traditionally garner FRC scores of 0). These issues expose the possibility of higher free ridership scores for “replacement upon burnout” participants when using the algorithm in Table 4-2. Since the counterfactual of taking no action is not a realistic scenario for “replacement upon burnout” participants, we used a special FRC algorithm for air source heat pump and central air conditioner participants that assigns FRC scores of 0 to certain “replacement upon burnout” participants that indicated they would bought a less expensive or less energy efficient heating or cooling system as their counterfactual response (Table 4-3). This is the most prudent approach since:

1) The program offers incentives for units that exceed code standards by a minimum of 1 SEER.
2) Savings are calculated based on a code SEER level baseline assumption.
3) For “replacement upon burnout” participants, the most realistic counterfactual that would result in the least efficient outcome is installing a less efficient unit than the one they installed through the program – which would be a code unit in certain counterfactual scenarios.

As seen in Table 4-3, this unique FRC algorithm takes SEER level of the incented unit into account. “Replacement upon burnout” participants who installed units exceeding program requirements that said they would have installed an “almost as efficient” unit reveal that the program did not motivate them to purchase a unit above code in the first place, but rather motivated them purchase an even more efficient unit than they would have otherwise. Thus, these “replacement upon burnout” participants are partial free riders (given that their counterfactual outcome would likely still be above code) and garner a FRC value of 0.375.

Table 4-3: Free Ridership Change Values for Air Source Heat Pumps and Central Air Conditioners

Q1 Response	Q2 Response	SEER Level	Replacement Upon Burnout*	FRC Value
Not purchased a [MEASURE]	N/A	N/A	Yes or No	0.0
Delayed purchase for at least one year	N/A	N/A	Yes or No	0.0
Bought a less expensive or less energy efficient heating and cooling system	Almost as efficient as the one you bought	Minimum program criteria	Yes	0.0
			No	0.375
		Greater than program minimum	Yes or No	0.375

Q1 Response	Q2 Response	SEER Level	Replacement Upon Burnout*	FRC Value
	Significantly less efficient than the one you bought	N/A	Yes	0.0
			No	0.125
	Don't know / Refused	Minimum program criteria	Yes	0.0
		Greater than program minimum	Yes or No	0.25
Bought the exact same [MEASURE] anyway, and paid the full cost yourself	N/A	N/A	Yes or No	0.50
Or done something else	N/A	N/A	Yes or No	FRC values assigned on a case by case basis, depending on which pre-coded response item they most resemble
Don't know / Refused	N/A	N/A	Yes or No	Measure average

* Early replacement participants are defined as respondents that indicated their previous system was "in good working condition" and did not say their previous system was "broken or malfunctioning" or was "getting old."

The following tables show the count of respondents for each measure that chose each option in Table 4-2 or Table 4-3, as well as the resulting mean FRC value for each measure.

Table 4-4: Free Ridership Change Values: Geothermal Heat Pump

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=2)
Not purchased a geothermal heat pump		0.0	0
Delayed purchase for at least one year		0.0	0
Bought a less expensive or less energy efficient heating and cooling system	Almost as efficient as the one you bought	0.375	0
	Significantly less efficient than the one you bought	0.125	0
	Don't know / Refused	0.25	0
Bought the exact same geothermal heat pump anyway, and paid the full cost yourself		0.50	2
Or done something else		Assigned on a case by case basis	0
Don't know / Refused		Measure average	0

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=2)
Mean FRC value: geothermal heat pump		**0.50**	

Table 4-5: Free Ridership Change Values: Air Source Heat Pump

Q1 Response	Q2 Response	SEER Level	Replacement Upon Burnout	FRC Value	Count Choosing Option (n=18)
Not purchased an air source heat pump	N/A	N/A	Yes or No	0.0	0
Delayed purchase for at least a year	N/A	N/A	Yes or No	0.0	2
Bought a less expensive or less energy efficient heating and cooling system	Almost as efficient as the one you bought	Minimum program criteria	Yes	0.0	0
			No	0.375	0
		Greater than program minimum	Yes or No	0.375	2
	Significantly less efficient than the one you bought	N/A	Yes	0.0	0
			No	0.125	0
	Don't know / Refused	Minimum program criteria	Yes	0.0	0
		Greater than program minimum	Yes or No	0.25	0
Bought the exact same air source heat pump anyway, and paid the full cost yourself	N/A	N/A	Yes or No	0.50	13
Or done something else	N/A	N/A	Yes or No	Assigned on a case by case basis	1
Don't know / Refused	N/A	N/A	Yes or No	Measure average	0
Mean FRC value: air source heat pump				**0.43**	

Table 4-6: Free Ridership Change Values: Central Air Conditioner

Q1 Response	Q2 Response	SEER Level	Replacement Upon Burnout	FRC Value	Count Choosing Option (n=45)
Not purchased a central air conditioner	N/A	N/A	Yes or No	0.0	0
Delayed purchase for at least a year	N/A	N/A	Yes or No	0.0	3
Bought a less expensive or less energy efficient cooling system	Almost as efficient as the one you bought	Minimum program criteria	Yes	0.0	0
			No	0.375	0
		Greater than program minimum	Yes or No	0.375	4
	Significantly less efficient than the one you bought	N/A	Yes	0.0	1
			No	0.125	1
	Don't know / Refused	Minimum program criteria	Yes	0.0	0
		Greater than program minimum	Yes or No	0.25	0
Bought the exact same central air conditioner anyway, and paid the full cost yourself	N/A	N/A	Yes or No	0.50	35
Or done something else	N/A	N/A	Yes or No	Assigned on a case by case basis	1
Don't know / Refused	N/A	N/A	Yes or No	Measure average	0
Mean FRC value: central air conditioner				**0.43**	

Table 4-7: Free Ridership Change Values: Heat Pump Water Heater

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=1)
Not installed a heat pump water heater		0.0	0
Postponed the purchase for at least one year		0.0	0
Purchased a new heat pump water heater, but a less efficient or less	Almost as efficient as the one you bought	0.375	1

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=1)
expensive model	Significantly less efficient than the one you bought	0.125	0
	Don't know / Refused	0.25	0
Bought the exact heat pump water heater anyway, and paid the full cost yourself		0.50	0
Or done something else		Assigned on a case by case basis	0
Don't know / Refused		Measure average	0
Mean FRC value: heat pump water heater		**0.38**	

Table 4-8: Free Ridership Change Values: Attic Insulation

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=3)
Would not have done the attic insulation		0.0	0
Postponed attic insulation for at least one year		0.0	2
Would have added less insulation	% less they would have added	reported value subtracted from 100% and then divided in half	0
Done the exact same upgrade, and paid the full cost yourself		0.50	1
Or done something else		Assigned on a case by case basis	0
Don't know / Refused		Measure average	0
Mean FRC value: attic insulation		**0.17**	

Table 4-9: Free Ridership Change Values: Duct Sealing

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=1)
Would not have done the duct sealing project		0.0	0
Postponed duct sealing project for at least one year		0.0	0
Done the exact same upgrade, and paid the full cost yourself		0.50	1

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=1)
Or done something else		Assigned on a case by case basis	0
Don't know / Refused		Measure average	0
Mean FRC value: duct sealing		**0.50**	

Table 4-10: Free Ridership Change Values: Pool Pump

Q1 Response	Q2 Response	FRC Value	Count Choosing Option (n=2)
Not installed/replaced a pool pump		0.0	0
Postponed the purchase for at least one year		0.0	1
Bought the exact pool pump anyway, and paid the full cost yourself		0.50	0
Or done something else		Assigned on a case by case basis	1
Don't know / Refused		Measure average	0
Mean FRC value: pool pump		**0.00**	

4.1.1.2 Free Ridership Influence

Free ridership influence demonstrates how much influence the program had on a participant's decision to perform the incented energy upgrade. To determine this, the evaluation team asked participant survey respondents the following question, repeating this battery for each unique rebated measure associated with the respondent:

> *I'm going to read a list of factors that might have influenced your decision to make the energy saving improvements to your property we have been talking about. For each factor, please indicate how influential it was in your decision, using a scale from 0 to 10, where 0 means "not at all influential" and 10 means "extremely influential."*
>
> *[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]*
>
> *[PROGRAMMER: For each factor below input 0-10 scale and don't know and refused options.]*
>
> *a. The rebate received*
> *b. Information or advertisements from Duke Energy Ohio, including their website*
> *c. Recommendation from your contractor*

d. *Did anything else influence you? If so, please specify: _______________ [INTERVIEWER: PROBE IF UNCLEAR. RECORD VERBATIM RESPONSE]*

The evaluation team then selected the highest rated program-attributable item for each respondent and assigned the following FRI scores, depending on their high score value (Table 4-11).

Table 4-11: Free Ridership Influence Values

Max Influence Rating	FRI Value
0	0.5
1	0.45
2	0.4
3	0.35
4	0.3
5	0.25
6	0.2
7	0.15
8	0.1
9	0.05
10	0
Don't know / Refused	Measure average

Table 4-12 shows the count of respondents for each measure associated with each max influence rating and FRI value in Table 4-11, as well as the resulting mean max influence and FRI values for each measure.

Table 4-12: Free Ridership Influence Values, by Measure

Max Influence Rating	FRI Value	Count with Max Influence Rating/FRI Value						
		Heat Pump (Air Source) (n=18)	Attic Insulation and Air Sealing (n=3)	Central Air Conditioner (n=45)	Duct Sealing (n=1)	Heat Pump (Geothermal) (n=2)	Heat Pump Water Heater (n=1)	Pool Pump (n=2)
0	0.5	1	1	3	1	0	0	0
1	0.45	0	0	1	0	0	0	0
2	0.4	0	0	0	0	0	0	0
3	0.35	2	0	3	0	0	0	0
4	0.3	0	0	1	0	1	0	0
5	0.25	2	0	3	0	0	0	0
6	0.2	1	0	4	0	0	0	0

Max Influence Rating	FRI Value	Count with Max Influence Rating/FRI Value						
		Heat Pump (Air Source) (n=18)	Attic Insulation and Air Sealing (n=3)	Central Air Conditioner (n=45)	Duct Sealing (n=1)	Heat Pump (Geothermal) (n=2)	Heat Pump Water Heater (n=1)	Pool Pump (n=2)
7	0.15	2	0	2	0	0	0	1
8	0.1	4	1	11	0	0	0	0
9	0.05	3	1	5	0	0	0	0
10	0	3	0	12	0	1	1	1
Don't know / Refused	Measure average	0	0	0	0	0	0	0
Mean max influence		**7**	**6**	**7**	**0**	**7**	**10**	**9**
Mean FRI score		**0.15**	**0.22**	**0.14**	**0.50**	**0.15**	**0.00**	**0.08**

4.1.2 Measure-Level Free Ridership

To provide additional insight and transparency into the free ridership analysis, the evaluation team summed the measure-specific FRC and FRI scores for each respondent resulting in participant-measure-level free ridership (FR) scores. The evaluation team used the participant-measure-level FR scores to calculate an average FR score for each measure type. Table 4-13 exhibits the resulting mean measure-level FR scores, and the number of respondents associated with each mean FR score.

While the measure-level FR scores provide additional detail behind the free ridership analysis, we note that the evaluation was not designed to provide statistically significant measure-level results but rather provide a program-level FR score based on data collected on all program measures (see section 4.1.3 below). Therefore, the measure-level FR scores presented in Table 4-13 should be interpreted as potentially indicative of the rate of FR present but with the caveat of large error bounds due to the low sample sizes. This is particularly applicable to geothermal heat pumps, attic insulation and air sealing, variable speed pool pumps, heat pump water heaters, and duct sealing. These measures comprised a very small percentage of overall program participation and savings and consequently fewer evaluation resources were dedicated to data collection for these measures. As these measures continue to mature in the program and increase their overall share to the impact of the program, additional evaluation resources should be dedicated to assess the level of free ridership.

Table 4-13: Measure-Level Free Ridership Scores (n=71)

Measure	Count of respondents with measure	Mean FRC Score	Mean FRI Score	Mean FR Score
Central air conditioner	45	0.43	0.14	0.58

Measure		Count of respondents with measure	Mean FRC Score	Mean FRI Score	Mean FR Score
Heat pump	*Air Source*	18	0.43	0.15	0.58
	Geothermal	2	0.50	0.15	0.65
Attic insulation and air sealing		3	0.17	0.22	0.38
Variable speed pool pump		2	0.00	0.08	0.08
Heat pump water heater		1	0.38	0.00	0.38
Duct sealing		1	0.50	0.50	1.00

4.1.3 Program-Level Free Ridership

Next, the evaluation team combined the measure-level FR scores into a program-level FR score. Table 4-14 shows the savings weights used to calculate the program-level FR score. Savings weights were calculated as follows:

$$Savings\ Weight = \frac{Population\ N * Verified\ Savings}{Gross\ Program\ Savings}$$

Table 4-14: Measure-Level Free Ridership Scores (n=71)

Measure		Population N	Verified Savings (kWh)	Savings Share (weight)	Mean FR Score
Central air conditioner		2,518	366	39%	0.58
Heat pump	*Air Source*	988	749	31%	0.58
	Geothermal	91	3,809	15%	0.65
Attic insulation and air sealing		140	1,065	6%	0.38
Variable speed pool pump		118	1,427	7%	0.08
Heat pump water heater		21	1,763	2%	0.38
Duct sealing		3	238	0%	1.00

The resulting program-level free ridership is 0.54.

4.2 Spillover

Spillover estimates energy savings from non-rebated energy improvements made outside of the program that are influenced by the program, and is used to adjust gross savings by the additional energy savings garnered and the level of attribution the program is able to claim for these non-rebated measures. Spillover ranges from 0 to infinity, with 0 being no spillover and values greater than 0 demonstrating the existence and magnitude of spillover.[4] The evaluation

[4] Spillover values can be interpreted as percentages, where 1=100%. Thus, a spillover value of .5 demonstrates a savings value of 50% of gross program savings.

team used participant survey data and trade ally interview and survey data to estimate spillover: participants to inform participant spillover (PSO) and trade allies to inform nonparticipant spillover (NPSO). These two estimates are summed to calculate total program spillover (SO):

$$SO = PSO + NPSO$$

4.2.1 Participant Spillover

The evaluation team asked participant survey respondents to indicate what energy saving measures or services they had implemented since participating in the program to identify potential spillover (see the Participant Survey in Appendix D for the spillover battery). The evaluation team then asked participants to use a 1 to 10 scale, where 1 means "not at all influential" and 10 means "extremely influential," to indicate how much influence Smart $aver had on their decision to purchase these energy saving measures. This question was repeated for each non-rebated measure category a respondent reported implementing. Table 4-15 exhibits how much program influence, ranging from 0% to 100%, is associated with each scale response to the spillover influence question.

Table 4-15: Participant Spillover Program Influence Values

Reported Smart $aver Influence	Influence Value
1	0.00
2	0.11
3	0.22
4	0.33
5	0.44
6	0.56
7	0.67
8	0.78
9	0.89
10	1.00
Don't know / Refused	0.00

The evaluation team used the measure-specific influence value to calculate the participant measure spillover (PMSO) for each measure that each participant reported. Participant measure spillover is calculated as follows:[5]

$$PMSO = Deemed\ Measure\ Savings * Number\ Installed * Influence\ Value$$

[5] Deemed savings for non-program spillover measures were referenced from the 2010 Ohio TRM and the 2015 Illinois TRM.

The evaluation team then summed all PMSO values and divided them by the participant sample's gross program savings to calculate the participant spillover estimate:

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

This calculation resulted in a Participant SO (PSO) value of 0.04.

4.2.2 Nonparticipant Spillover

Nonparticipant spillover refers to non-rebated program measures implemented by nonparticipants that were directly or indirectly influenced by the program. The evaluation team surveyed 41 trade allies to identify and measure nonparticipant spillover. The evaluation team back-calculated how many non-rebated measures trade allies installed in program territory in 2016 using trade ally estimates of the proportion of qualified units they applied for rebates in 2016 and program data on how many units they installed through the program in 2016. The program savings attributed to these non-rebated measures is discounted by trade ally's reported level of program influence on their practice of recommending these measures (Table 4-16), and the proportion of their clients with non-rebated measures that were not influenced by their recommendations. Nonparticipant spillover was calculated individually for each of the top three program-qualified measures that each surveyed trade ally installed in 2016.

Table 4-16: Trade Ally Influence Values

Program Influence Rating	Influence Value
0	0.0
1	0.1
2	0.2
3	0.3
4	0.4
5	0.5
6	0.6
7	0.7
8	0.8
9	0.9
10	1.0
Don't know / Refused	Measure level average

Thus, nonparticipant measure spillover is calculated as follows:[6]

$$NP\ Measure\ SO = *\ Program\ Influence$$

The evaluation team then summed all nonparticipant measure spillover values and divided them by the trade ally sample's gross program savings to calculate the program-level nonparticipant spillover estimate:

$$NPSO = \frac{\sum NP\ Measure\ SO}{Sample\ Program\ Savings}$$

This calculation resulted in a NPSO value of 0.07.

4.2.3 Program-Level Spillover

The evaluation team summed the PSO and NPSO values to calculate the program-level SO value. This calculation resulted in program-level SO of 0.11.

4.3 Net-to-Gross

After combining all FR and SO estimates, NTG for the program is 0.575 (Table 4-17). The evaluation team applied the NTG ratio of 0.575 to program-wide verified gross savings to calculate DEO Smart $aver net savings.

Table 4-17: Net-to-Gross Results

Free Ridership	Spillover	NTG
0.54	0.11	57.5%

6 NP Measure SO = nonparticipant spillover for a given measure type for a given trade ally. NRMC = non-rebated measure count installed in DEO territory in 2016. %NRM = percent of non-rebated measures.

5 Process Evaluation

5.1 Summary of Data Collection Activities

The process evaluation is based on telephone interviews and surveys with program and implementer staff, trade allies, and participants (Table 5-1).

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

Target Group	Method	Sample Size	Confidence/Precision
Program and implementer staff	Phone in-depth interview	2	N/A
High volume trade allies[a]	Phone in-depth interview	5	N/A
Trade allies (various rebate volumes)	Phone survey	41	90/8.5
Participants	Phone survey	71	90/9.6

[a] High volume trade allies are companies in the top 20% of trade allies in terms of number of rebated measures, for a given campaign, in 2016.

5.1.1 Program and Implementer Staff

The evaluation team conducted interviews with the Smart $aver Program Manager and a senior manager from the implementation staff in order to understand how the program was working and to capture their insights about the program's operations, challenges, expectations, and interactions with market actors (trade allies and customers).

5.1.2 Trade Allies

Participating contractors – called "trade allies" – are the primary program delivery channel for Smart $aver. In December of 2016, the evaluation team conducted five in-depth interviews with high volume Smart $aver trade allies. The in-depth interviews primarily served to pre-test some questions designed for the subsequent trade ally surveys and to see if any additional unforeseen topics emerged that warranted inclusion in participant or trade ally surveys. After interviewing five trade allies and making some corresponding adjustments to the survey guide, the evaluation team surveyed 41 trade allies in February 2017, asking them about various program topics such as satisfaction with the program and program-related challenges (Table 5-2).

Table 5-2: Trade Ally Research Objectives

Research Objectives
Assess Trade Ally engagement with the program and how they and their customers heard of the program
Assess program satisfaction

Research Objectives
Document Trade Ally program experience, including any challenges and opportunities for improving the program
Document Trade Ally perspective about the code changes and the future of the program
Gather data for Net-to-Gross spillover
Ask about Trade Ally firmographics and customer characteristics
Document program influence

The evaluation team contends that trade ally specializations (such as insulation, for example) can significantly shape trade ally experience with the program. The evaluation team monitored the measures that surveyed trade allies had experience with to ensure that the sample was diverse and representative in terms of measure experience. The distribution of the trade ally sample's measure experience generally reflects that of the larger trade ally population (Table 5-3).

Table 5-3: Trade Ally Experience with Smart $aver Measures in 2016

Measure		Number installed in evaluation timeframe	Number installed by TA survey sample	Number TA installers in survey sample
Central Air Conditioner		2,518	808	33
Heat Pump	*Air Source*	988	297	32
	Geothermal	91	14	3
Attic Insulation and Air Sealing		140	31	3
Variable Speed Pool Pump		118	1	1
Heat Pump Water Heater		21	2	2
Duct Sealing		3	0	0

5.1.3 Participants

In February 2017, the evaluation team surveyed a stratified random sample of 71 Smart $aver participants. The purpose of this data collection activity was to obtain a more detailed understanding of the customer experience with the program, identify potential areas for program improvement, and collect data to inform NTG estimates. Table 5-4 documents the specific research objectives of the participant survey.

Table 5-4: Participant Research Objectives

Research Objectives
Assess program outreach and marketing
Document customer experience with the program
Document reasons for participation and program influence

Research Objectives
Gather feedback needed to estimate Net-to-Gross ratio
Assess population segments the program is reaching

To ensure the results were applicable to the larger participant population, the evaluation team stratified the sample by measure type, thus ensuring that sampled participants were representative of the measures in the population.

Table 5-5: Measures Installed by Participant Sample (n=71)

Measure Installed		Sample %	Participant Population %
Central Air Conditioner		64%	65%
Heat Pump	*Air Source*	25%	25%
	Geothermal	3%	2%
Attic Insulation & Air Sealing		3%	4%
Pool Pump		3%	3%
Heat Pump Water Heater		1%	1%
Duct Sealing		1%	<1%

5.2 Process Evaluation Findings

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

5.2.1 Trade Ally Perspective

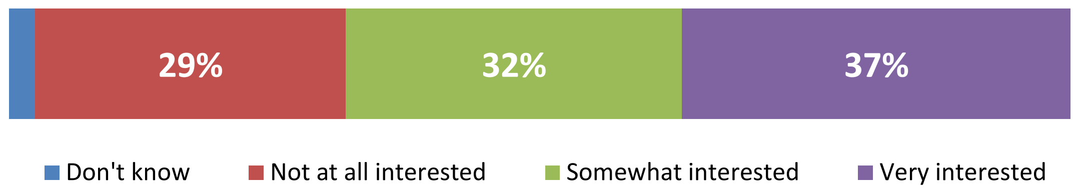
This section reports the results from trade ally surveys regarding their experience participating in the Smart $aver program in the Duke Energy Ohio jurisdiction.

5.2.1.1 Training

We asked trade allies about their satisfaction with program training, as well as their suggestions for future training opportunities. Overall, trade allies were largely dissatisfied with program training opportunities (see Figure 5-9), with trade allies indicating they dissatisfied because they had not received any program training.

When asked an open-ended question about what other training types they would be interested in, less than half of surveyed trade allies reported they would be interested in additional training opportunities. Specific training requests varied widely. However, when specifically asked to use a 0 to 10 scale to demonstrate their interest in a training course on how to more effectively sell high efficiency equipment, the majority (68%) expressed at least minor interest in sales training (Figure 5-1).

Figure 5-1: Interest in Sales Training (n=41)*

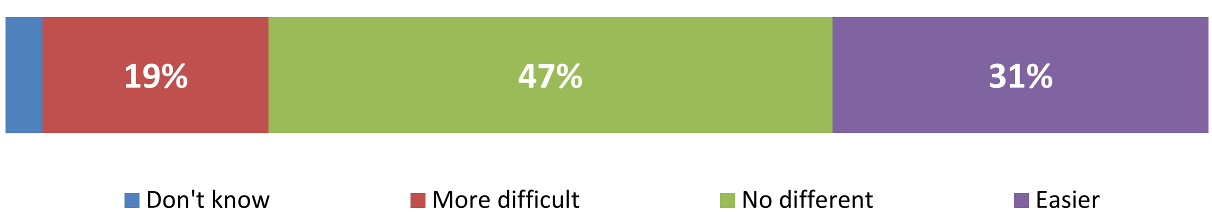


* Respondents used a 0 to 10 scale, where 0 meant “Not at all interested” and 10 meant “Extremely interested.” In the figure above, “Not at all interested” represents those selecting “0,” “Somewhat interested” represents those selecting “3” through “7,” and “Very interested” represents those selecting “8” through “10.”

5.2.1.2 Code Changes

The U.S. Department of Energy revised the efficiency standard for air source heat pumps applicable to specific regions including Ohio. The new standard requires split system air source heat pumps to achieve a 14 SEER and 8.2 HSPF minimum for systems manufactured after January 1st, 2015. The revised standard does not appear to have made a significant impact on costs to the consumer, as most (71%) trade allies that installed air source heat pumps through the program (n=32) reported that the incremental cost between 14 and 15 SEER air source heat pumps has not changed between 2014 and 2016. Further, about half (47%) of surveyed trade allies that installed air source heat pumps through the program said that it is no easier or more difficult to sell 15 SEER air source heat pumps following this code change (Figure 5-2). Additional analysis revealed that there was no significant relationship between number of rebated air source heat pumps installed and trade ally answers to these code change survey questions.

Figure 5-2: Difference in Ease or Difficulty in Selling 15 SEER air source heat pumps since Code Change (n=32)

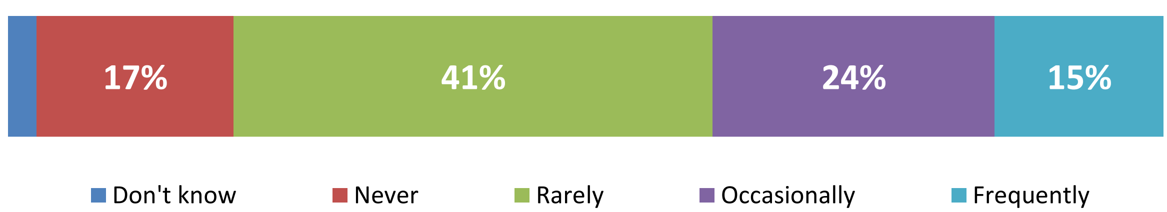


5.2.1.3 Recruiting Customers into Smart $aver

We asked trade allies about the primary reasons as to why their customers replace HVAC or water heating equipment or add attic insulation. While insulation trade allies reported that their customers add insulation to save money on energy bills and to improve comfort, HVAC and water heat trade allies reported that most new HVAC or water heat units are replacing broken or aging systems, and that few customers replace fully functional standard efficiency HVAC units with high efficiency units just for the energy savings. Participant findings (see section 5.2.2.2) corroborate these trade ally reports, as only 9% of HVAC replacement participants reported replacing a HVAC unit that was in good working condition.

Trade ally survey data – which is further corroborated by participant survey data (see section 5.2.2.1) – reveals that trade allies are largely responsible for recruiting customers into the program. As seen in Figure 5-3, over half (59%) of surveyed trade allies said that their customers "rarely" or "never" ask about Smart $aver rebates and about one-quarter (25%) said their customers occasionally ask about the program. Instead, trade allies typically introduce their customers to Smart $aver rebate opportunities.

Figure 5-3: How Often Customers Ask About Smart $aver Rebates (n=41)

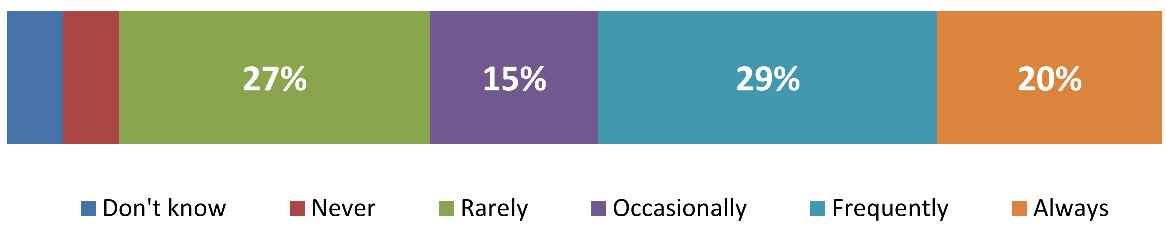


Further, a minority (30% of surveyed trade allies) expressed dissatisfaction with DEO's marketing of the program, with dissatisfied survey respondents noting that the marketing is not visible enough and the great majority of their customers are not familiar with Smart $aver. Participant survey results support these trade ally reports, as no survey respondents explicitly mentioned Duke Energy marketing materials as their source of program awareness. Thus, trade allies often need to educate their customers on the benefits of energy efficiency and the availability of Smart $aver rebates to bring new households into the program.

5.2.1.4 Rebate Application Process

Smart $aver transitioned to an online application system (called the "trade ally portal") in April 2016. We asked trade allies how frequently they have experienced problems or frustrations using the new portal (Figure 5-4). Although most (90%) reported experiencing problems or frustrations with the rebate application process, only about half (49%) said this was frequent or "always."

Figure 5-4: Frequency of Experiencing Problems or Frustrations with Online Rebate Application Process (n=41)



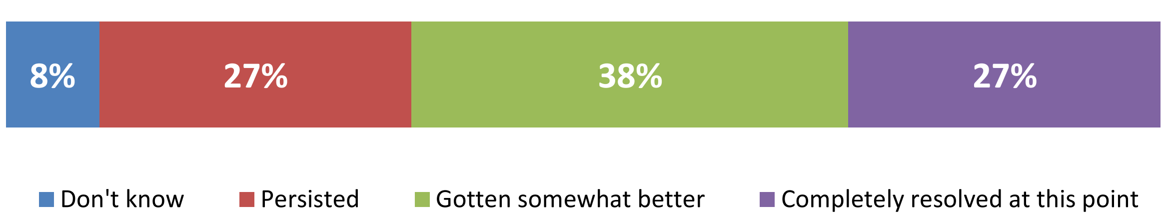
Trade allies that reported experiencing problems or frustrations with the rebate application process typically mentioned struggles with uploading to the portal (be it applications or documentation) which can result in needing to resubmit, or said that the application process is overly burdensome due to a “cumbersome” and “time-consuming” process (Table 5-6).

Table 5-6: Problems and Frustrations with the Rebate Application Process (Multiple Responses Allowed)

Responses	n=37
Data entry and form upload problems / having to resubmit forms	49%
Process is cumbersome	19%
Process takes too much time	11%
Not enough tracking info available	8%
Misc. other	24%
Don't know / no response	11%

Despite the prevalence of these problems and frustrations, the rebate application submission process was the highest rated item in the trade ally satisfaction battery (Figure 5-9). Further, most (65%) of trade allies indicated that these problems have gotten at least somewhat better since the rollout of the new portal system (Figure 5-5).

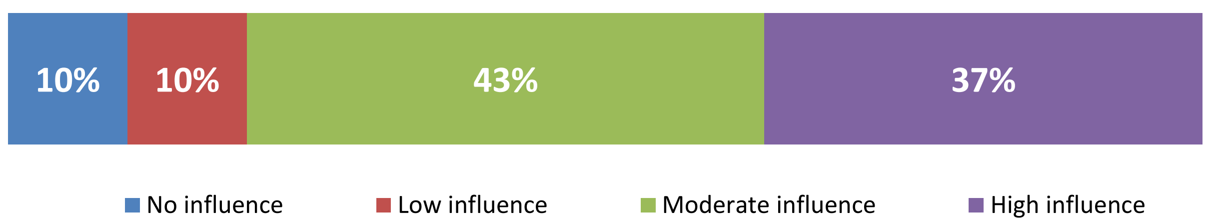
Figure 5-5: Trade Ally Perception of Portal Problems: Persisting vs. Improving (n=37)



5.2.1.5 Program Influence on Trade Allies

Trade ally survey results reveal that the program is influencing energy efficiency contracting services offered by contractors in the trade ally network. Most (73%, or 30 of 41) surveyed trade allies reported their knowledge of energy efficient products and services had increased since they became involved with Smart $aver, 37% of which said the program was highly influential on their increased knowledge (Figure 5-6).

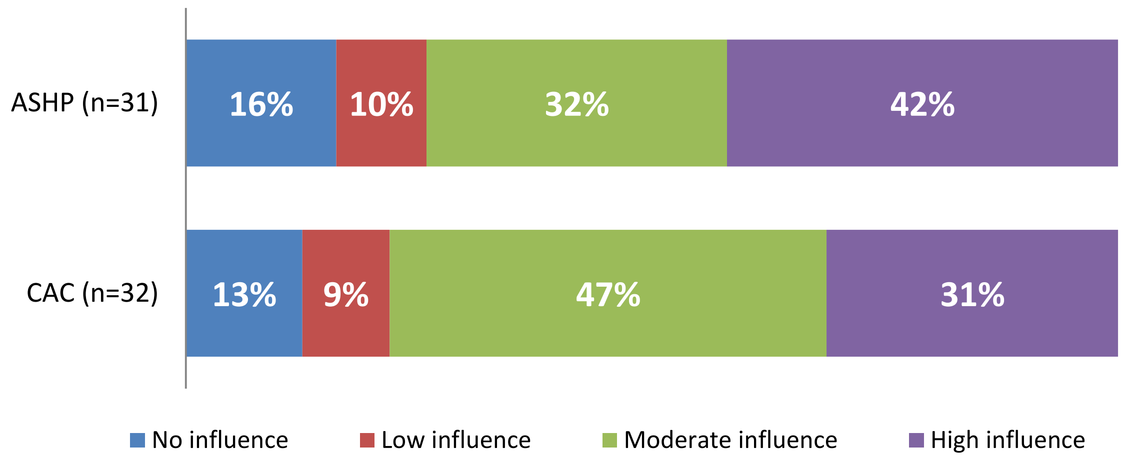
Figure 5-6: Smart $aver Influence on Increased Trade Ally Knowledge of Energy Efficient Products and Services (n=30)*



* Asked on a 0-10 scale, where 0 is “not at all influential” and 10 is “extremely influential.” “No influence” represents trade allies that reported “0,” low influence represents responses ranging from 1 to 3, moderate influence represents responses ranging from 4 to 7, and high influence represents responses ranging from 8 to 10.

Most HVAC trade allies reported that Smart $aver has at least partially influenced their practice of recommending qualifying HVAC measures, with about one-third or more – depending on the measure – indicating Smart $aver was highly influential (Figure 5-7).

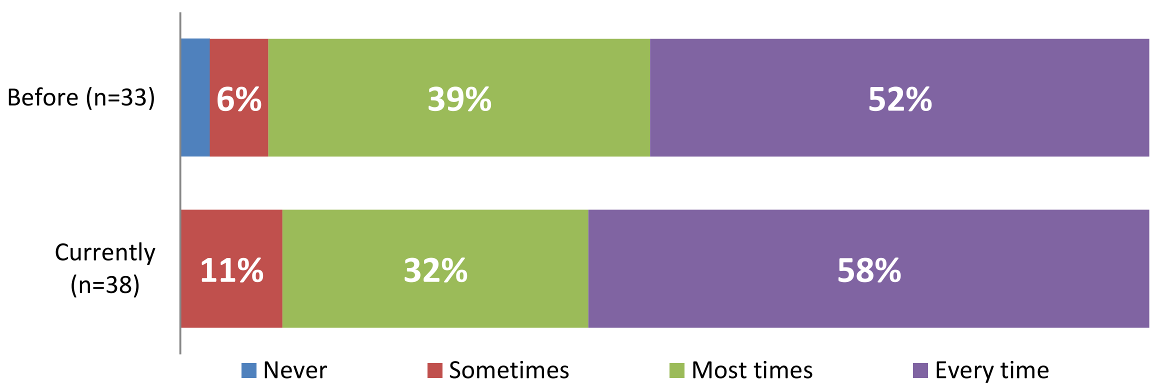
Figure 5-7: Program Influence on Trade Ally Practice of Recommending Program Qualified Measure*



* Asked on a 0-10 scale, where 0 is "not at all influential" and 10 is "extremely influential." "No influence" represents trade allies that reported "0," low influence represents responses ranging from 1 to 3, moderate influence represents responses ranging from 4 to 7, and high influence represents responses ranging from 8 to 10. Figure excludes "don't know" responses. Each row only includes trade allies who had experience with the measure.

Further, survey data reveals that contractors recommend high efficiency equipment more frequently now compared to before they were a participating trade ally in Smart $aver (Figure 5-8). Ultimately, about half of their central air conditioners (47%) or air source heat pumps (51%) installed in 2016 – on average – qualify for Smart $aver rebates (per trade ally self-reports).

Figure 5-8: Trade Ally Frequency of Recommending High Efficiency Equipment*



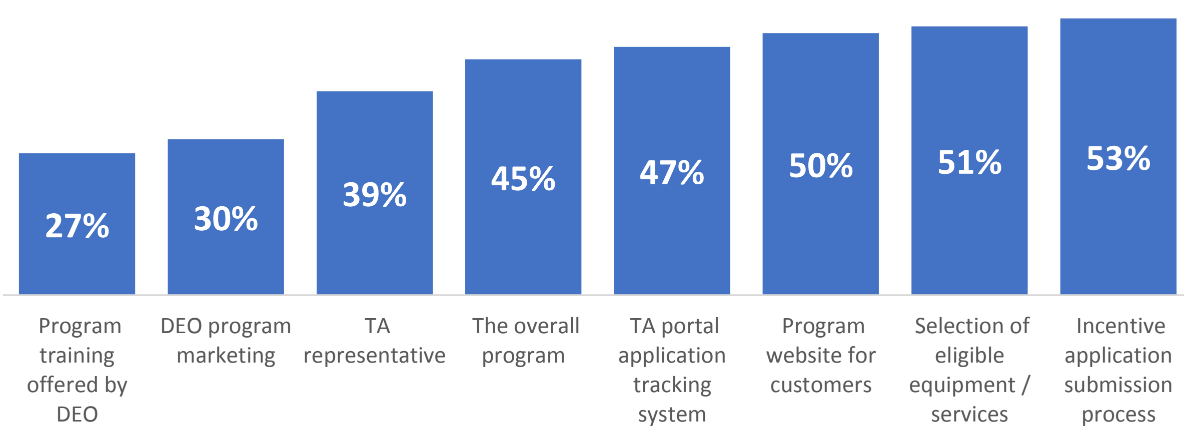
* Figure excludes "don't know" and "not applicable" responses. Only trade allies that install equipment measures (HVAC, water heat, and pool pumps) were asked these questions.

However, Smart $aver has limited influence on stocking of energy efficient equipment, as few (16%, or 6 of 38) trade allies who install equipment measures through the program reported keeping equipment in stock in the first place. Instead, most (84%, or 32 of 38) purchase equipment on an as-needed basis. Three of the six trade allies that reported stocking equipment said they keep more efficient equipment in stock now that they are participating in Smart $aver, all of which attributed at least minor influence to the program for their increased stocking of energy efficient equipment.

5.2.1.6 Satisfaction

Surveyed trade allies reported low satisfaction with several program elements (Figure 5-9). Program training, DEO marketing, and trade ally representatives received the lowest satisfaction ratings; dissatisfied trade allies elaborated they were dissatisfied with these items because they were not aware of their presence (that is, they felt program marketing, training opportunities, and contact from their trade ally representative was lacking). Additional analysis revealed that there was no significant relationship between the number of rebated measures installed and trade ally survey satisfaction ratings. However, unlike surveyed trade allies, interviewed trade allies – who were some of the most active trade allies in the program – were overwhelmingly satisfied with their trade ally representative. Our research reveals that interaction with a trade ally representative is commensurate with a trade ally's activity in the program, and that the disparity in frequency of communication explains why high volume trade allies were considerably more satisfied with their trade ally representative than less active trade allies.

Figure 5-9: Percent of Trade Allies Reporting High Satisfaction with Program Elements*



* Asked on a 0-10 scale, where 0 is "very dissatisfied," 5 is "neither satisfied nor dissatisfied," and 10 is "very satisfied." Figure exhibits percent with "high influence" ratings that range from 8 to 10. "Don't know" and "not applicable" responses were excluded when calculating the percentages in the figure; n values ranges from 34 to 40.

5.2.1.7 Suggestions for Improvement

Despite their low satisfaction ratings, trade allies had few suggestions for program improvement, including:

- Expand rebate offerings. Trade allies most commonly mentioned that gas furnaces (39%), tankless water heaters (7%), or humidifiers (5%) should be added to the Smart $aver program.

- Continue improving trade ally portal and incentive application process. Less than half (37%) of trade allies offered specific suggestions on how to improve the portal. These trade allies offered various unique suggestions, such as improving rebate turnaround times, eliminating duplicate names in the system, and other general usability suggestions.

- Expedite project inspection process. Only three trade allies offered suggestions for improving the project inspection process, two of which suggested that the process could be expedited (with one explicitly suggesting DEO should hire more inspectors as to reduce time between project inspections).

5.2.2 Participant Experience

In February of 2017, the evaluation team surveyed 71 Smart $aver participants who received rebates through the program between March and November 2016. All surveyed participants reported owning their home, with the exception of two participants who did not answer the question. Nearly all (93%) reported living in a single-family detached home, followed by 7% living in a condominium, and 1% living in a factory manufactured single-family home (Table 5-7). Additionally, nearly all (97%) reported living at the residence where the work was performed.

Table 5-7: Housing Type (n=71)

Housing Type	Percent
Single-family detached home	93%
Condominium	7%
Factory manufactured single-family home	1%
Total	**100%**

The evaluation team collected a participant sample that reflected the distribution of measures installed through the program during the evaluation timeframe (Table 5-8).[1] Central air conditioners and air-source heat pumps were the most commonly installed measures, accounting for nearly all (90%) installations in the program. Only one survey respondent received rebates for more than one measure; this respondent received rebates for attic insulation/air sealing and duct insulation/sealing (and was asked any measure-specific questions for both measures).

[1] While surveyed respondents received rebates between March and November 2016, the evaluation time frame – as well as the population proportions reported in Table 5-8 – are participants who received rebates between March and December 2016.

Table 5-8: Measure Type (n=71)

Measure Installed		Sample Size	Proportion of Sample	Proportion of Population
Central Air Conditioner		45	64%	65%
Heat Pump	*Air Source*	18	25%	25%
	Geothermal	2	3%	2%
Attic Insulation & Air Sealing		2	3%	4%
Pool Pump		2	3%	3%
Heat Pump Water Heater		1	1%	1%
Duct Sealing		1	1%	<1%

5.2.2.1 Participant Awareness

Trade allies are the primary way consumers learn about the program, as evidenced by nearly three-quarters (73%) of participants citing their contractor as their source of program awareness (Table 5-9). A minority of participants may have heard about Smart $aver via Duke Energy's marketing efforts, as several participants said they learned about the program from the internet (14%), a mailer (4%), or an advertisement (4%). However, none of the respondents reporting those sources explicitly mentioned Duke Energy or Smart $aver collateral (website, etc.), so it is unclear what proportion learned about the program via DEO's program marketing.

Table 5-9: Source of $mart Saver Program Awareness (Multiple Response, n=71)

Source of Program Awareness	Percent
Trade ally	73%
Online	14%
Mailer	4%
Advertisement, news, or social media	4%
Neighbor, friend, or family	4%
Other	4%

Respondents typically reported learning about energy efficient technologies from the internet, with more than half (56%) of surveyed participants reporting going online to search for information regarding energy savings (Table 5-10). However, nearly one-quarter of participants reported they do not typically search for information on how to save energy in their home.

Table 5-10: Source of Energy Savings Information (Multiple Response, n=71)

Source of Energy Savings Information	Percent
Online sources	56%
Go to utility website	10%
Read utility information on how to save money	9%
In-store salespeople	7%
Other	7%
Not applicable – don't typically search for information on how to save energy	24%

Source of Energy Savings Information	Percent
Don't know	1%
Refused	1%

5.2.2.2 Motivation to Participate

The evaluation team asked participants a series of questions to determine why they selected qualifying Smart $aver measures. For those participants who installed equipment measures, the evaluation team asked about the primary reason they installed the new equipment, and then asked why they chose an energy efficient version of that equipment.

Overall, a slight majority (56%) of participants reported replacing their equipment because it was "getting old" (Table 5-11). More than two-fifths (44%) replaced their equipment because it was broken or not working properly, and 9% did so even though it was in good working condition.

Table 5-11: Condition of Previous Equipment*

Condition of Previous System	Geothermal heat pump (n=2)	Central air conditioner (n=45)	Air-source heat pump (n=18)	Heat pump water heater (n=1)	Total (n=66)
Broken & old	1	4	1	0	6 (9%)
Old & working	1	0	0	0	1 (2%)
Working [only response]	0	6	0	0	6 (9%)
Old [only response]	0	21	9	1	31 (47%)
Broken [only response]	0	14	7	0	21 (32%)
No response	0	0	1	0	1 (2%)

*n=66 includes participants that installed the following: air source heat pump, geothermal heat pump, central air conditioner, or heat pump water heater.

The most commonly reported motivation for selecting highly efficient equipment over standard efficiency equipment for all participants was some form of monetary savings (31%), followed by wanting to take advantage of the cost savings and return on investment (29%) and a desire to consume less energy (22%) (Table 5-12).

Table 5-12: Motivation for Installing Energy Efficient Equipment (Multiple Response, n=66)

Motivations	Percent
Monetary savings*	31%
ROI & savings on energy bill	29%
To use less energy / make home more energy efficient	22%
To help the environment	15%
Wanted a quality system with low maintenance	8%
Interested in incentive / helped justify increased cost	6%
Contractor recommendation	5%
Other	15%

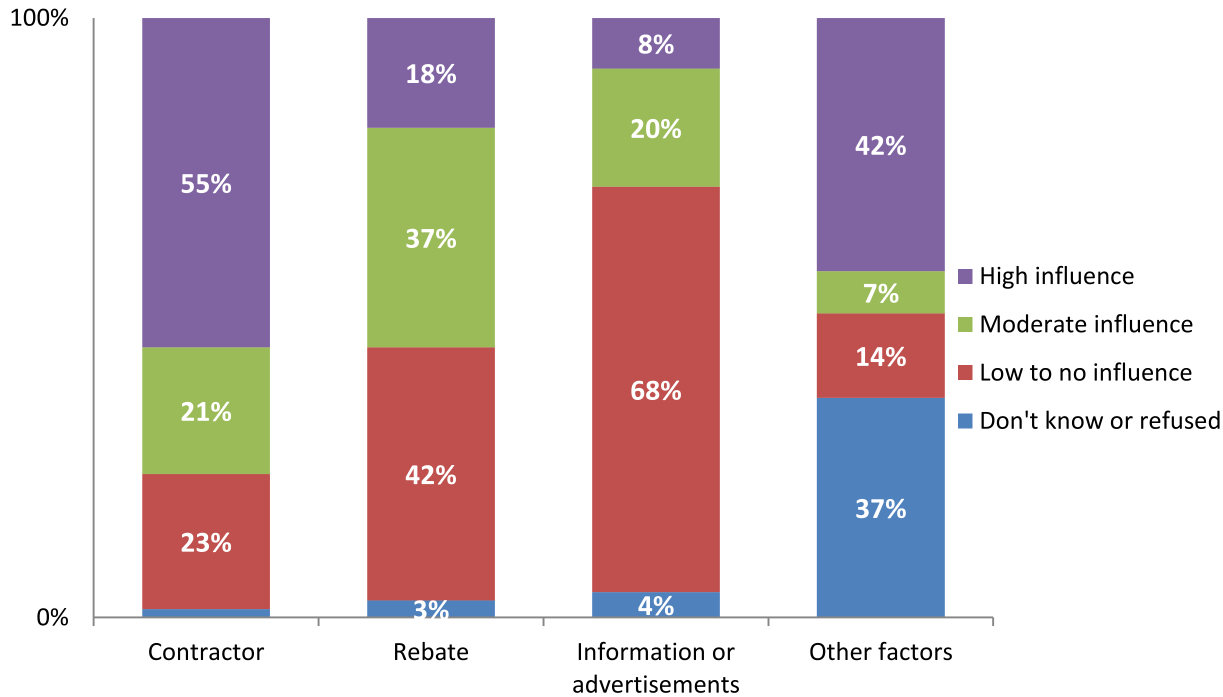
*Unclear if respondent is citing long term or upfront savings.

5.2.2.3 Program Influence

More than half (55%) of participants who purchased energy efficient equipment reported that recommendations from their contractor were highly influential in their decision to participate in the program (Figure 5-10).

Contractors were much more influential than the Smart $aver rebate, information, or advertisements. Other influential factors included recommendations from friends or family, increasing value of home for sale, or federal tax credits.

Figure 5-10: Influential Factors in Decision to Purchase Efficient Measures (n=71)[a]



a Participants were asked to rate each factor using a 0 to 10 scale where 0 meant "not at all influential," and 10 meant "extremely influential." Low influence represents responses ranging from 0 to 3, moderate influence represents responses ranging from 4 to 7, and high influence represents responses ranging from 8 to 10.

Nearly one-fifth (17%, or 12 of 71) of participants reported being familiar with other DEO energy efficiency programs (Table 5-13). Participants were most aware of the heat pump water heater and attic insulation/air sealing rebates (5 and 4 mentions, respectively). Among the 12 respondents that were aware of other DEO rebates, five reported receiving one or more of them. None of these respondents reported participating in these additional programs after their surveyed Smart $aver project.

Table 5-13: Awareness and Participation in Other Duke Energy Programs (Multiple Response; n=71)

	Count aware	Participation	
		Count that participated	Participated before or after surveyed Smart $aver project
Familiar with Other Duke Energy Rebates	12	5	-
Other Smart $aver Rebates	-	-	-
Heat pump water heater	5	*1*	*Before*
Attic insulation and air seal	*4*	*2*	*Before*
HVAC	*1*	*0*	-
Duct sealing and insulation	*1*	*0*	-
Other Duke Energy Rebates	4	-	-
Discounted efficient lighting	*2*	*1*	*Before*
Window/door air sealing	*2*	*0*	-
Exhaust units	*1*	*1*	*At the same time*
Refrigerator upgrade	*1*	*0*	-
In-home energy audit	*1*	*0*	-

Around one-quarter (23%) of all respondents cited the program in influencing their decision to take further energy saving actions (a phenomenon known as “spillover”). Of those who cited the program in influencing their decision, respondents most commonly reported buying LEDs, installing other energy efficient appliances, and installing efficient windows (Table 5-14).

Table 5-14: Products or Services Purchased Since Receiving $mart Saver Rebate (Multiple Response, n=71)*

Products or Services Purchased	Count	Percent
Reported spillover actions	16	23%
LED lights	6	8%
Energy efficient appliances	6	8%
Efficient windows	4	6%
Efficient heating or cooling equipment	2	3%
Attic insulation	1	1%
Efficient water heater	1	1%
CFL lights	1	1%

*Excludes respondents who reported no influence from the program in their decision to purchase items.

5.2.2.4 Participant Experience with the Program

About one-sixth (15%, or 11 of 71) of surveyed participants reported they contacted program staff with questions during the course of participating in the program. Of the 11 participants that contacted program staff, most (7 of 11) contacted them just once. Furthermore, of those participants who contacted staff, the majority (10 of 11) reported doing so via phone (Table 5-15).

Table 5-15: Contact with Program Staff

Contact with Program Staff	Count	Percent
Frequency of Contact		
Never	58	82%
Once	7	10%
Two or three times	3	4%
Four times or more	1	1%
Don't know	2	3%
Total	**71**	**100%**
Contact Type (Multiple Response; n=11)*		
Phone	10	91%
Email	3	27%

*Includes those that indicated they contacted program staff at least once.

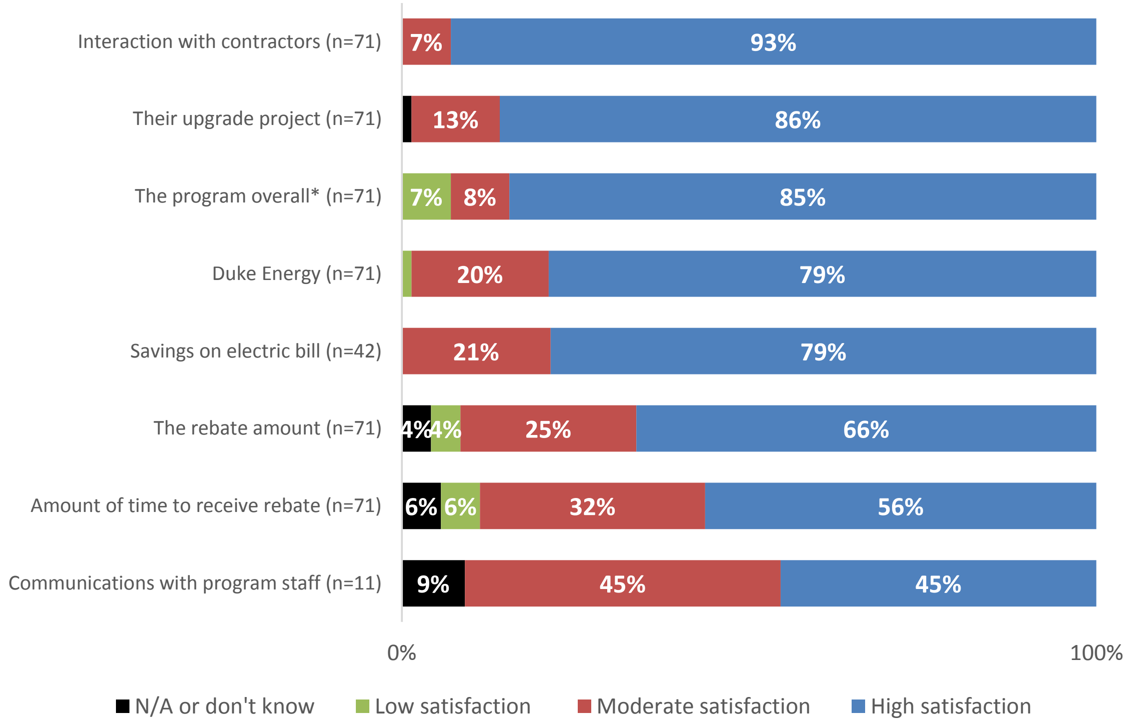
Most participants (83%) reported that their contractor submitted the rebate application for their Smart $aver project (Table 5-16).

Table 5-16: Person Who Submitted Rebate Application (n=71)

Person who Submitted Application	Percent
Contractor	83%
Respondent, or someone else in their home/house	10%
Don't know	7%
Total	**100%**

The majority of participants reported high satisfaction levels with most program elements (Figure 5-11). Nearly all (93%) reported being highly satisfied with their interaction with contractor. Furthermore, most participants reported being highly satisfied with their overall experience (85%) and results of their upgrade project (86%). Participants were comparably less satisfied with the rebate amount, the amount of time to receive their rebate, and communications with program staff.

Figure 5-11: Participant Satisfaction with Program Elements[a]



a Participants were asked to rate each factor using a 0 to 10 scale where 0 meant "not at all satisfied," 5 meant "neither satisfied nor dissatisfied," and 10 meant "very satisfied." Low satisfaction represents responses ranging from 0 to 3, moderate satisfaction represents responses ranging from 4 to 7, and high satisfaction represents responses ranging from 8 to 10.

* For this item, participants were asked to rate their overall satisfaction on a five-point scale, from "very dissatisfied" to "very satisfied." The Evaluation Team recoded responses to be comparable with other items in the series.

To determine which elements of the program are working well and what could be strengthened, the evaluation team asked participants to explain their reasoning behind the rating they gave for the program overall (Table 5-17). Of the 46 respondents that gave a reason for their rating, nearly all (96%) had something positive to say, reflecting the high level of satisfaction with the program. The most common explanation of positive ratings was simply the fact that they received a rebate or resulting benefit (33%). Respondents also reported experiencing good customer service or commented on the program staff's professionalism (28%). Few (15%) respondents had any negative comments regarding the program.

Table 5-17: Reason for Overall Program Rating (Multiple Response, n=46)

Reason for Satisfaction Rating	Count	Percent
Positive	**44**	**96%**
Received benefit / rebate	*15*	33%
Good customer service & professionalism	*13*	28%
Saved money on bill	*4*	9%
Liked the energy efficiency info they received	*4*	9%
Likes saving energy	*3*	7%
Good experience with the contractor	*3*	7%
The installed measure works well	*2*	4%
Negative	**7**	**15%**
Rebate did not motivate them	*3*	7%
Rebate was not big enough	*2*	4%
Did not receive gift card	*1*	2%
Not experiencing energy savings	*1*	2%
Other	6	13%

To further understand Smart $aver's effect on participants attitudes towards Duke Energy, the evaluation team asked whether their participation in the program had a positive, neutral, or negative effect on their overall satisfaction with Duke Energy. Overall, participation was beneficial, with three-quarters of respondents reporting a positive effect, and just 3% reporting a negative effect (Table 5-18).

Table 5-18: Effect of $mart Saver Program on Participants Satisfaction with Duke Energy (n=71)

Effect of Program on Satisfaction with Duke Energy	Percent
Positive effect	75%
No effect	23%
Negative effect	3%
Total	**100%**

Although savings were not a driving factor for participants' program satisfaction, the majority (59%) reported noticing savings on their electric bill since their last project was completed (Table 5-19).

Table 5-19: Resulting Energy Savings on Electric Bill (n=71)

Experienced Savings on Electric Bill	Percent
Yes, they noticed savings	59%
No - They looked but did not notice any savings	20%
No - They looked but it is too soon to tell	6%
They didn't look	4%
Don't know	11%

Experienced Savings on Electric Bill	Percent
Total	**100%**

The evaluation team asked all respondents if they had any suggestions to improve the program. Among the 30 participants who provided a response, around one-third (9 of 30) reported wanting more customer outreach to increase awareness of the program (Table 5-20). An additional eight respondents suggested improving the program description and instructions around how to receive the rebate.

Table 5-20: Suggestions for Improving $mart Saver Program (Multiple Response, n=30)

Suggestions for Improving the Program	Count
Raise awareness, perform more outreach	9
Improve program description/Instructions on how to get rebate	8
Expand rebates / offerings	4
Improve customer service	3
Use a check for rebates rather than gift card	3
Other	6

6 Conclusions and Recommendations

6.1 Impact

Data collected as part of the impact evaluation has informed the following conclusions and recommendations:

Conclusion 1: Revised federal efficiency standards for split system heat pumps affects minimum efficiency requirements in the state of Ohio. On January 1, 2015, new federal standards raised the required SEER rating for split system heat pumps to 14 and the HSPF to 8.2 across the northern region of the United States, including Ohio. This change impacts the minimum efficiency level heat pump systems offered in the Smart $aver program, and therefore also impacts the savings.

- **Recommendation:** Ensure ex ante savings for air source heat pumps reflect the federal efficiency standard for the next program cycle. Because the evaluation period spanned the sell-through period for the updated federal standard, the verified energy savings for air source and geothermal heat pumps is representative a mixed code baseline (i.e., SEER 13 and 14 and HSPF 8.0 and 8.2). However, the program should base future program savings on the new federal standard baseline. The estimated gross savings impacts for air source heat pumps using the new federal standard as baseline is presented in Table 3-15.

Conclusion 2: Over 90% of program participation occurred between rebated air source heat pumps and central air conditioners. However, the per unit savings for these programs are less than all other rebated measures with the exception of duct sealing.

- **Recommendation:** Investigate options to reallocate program resources to other program measures, as these measures have potential to increase the program's overall savings. Higher participation for other measures may be obtainable through more concerted marketing and outreach toward targeted customer segments.

6.2 Process

Based on evaluation findings, the evaluation team concluded the following and provides several suggestions on how to improve the program:

Conclusion 1: Duke Energy's marketing efforts appear to have limited impact on participation. There is little evidence that participants learned of Smart $aver via DEO marketing efforts, instead most found out after hiring a contractor affiliated with the program. Further, no participants reported subsequently participating in other DEO energy efficiency programs.

- **Recommendation 1:** Re-visit ongoing marketing efforts (paid Google ads, direct mail and email campaigns, etc.) to assess if those could be improved to be more effective within the constraints of the marketing budget. Even though trade allies are chiefly instrumental in generating consumer awareness, effective marketing via other channels could further increase customer awareness and ultimately participation in the program.

- **Recommendation 2:** Continue working with trade allies to cross promote other DEO programs, incentives, or campaigns. To measure the effectiveness of cross promotion efforts, create measurements or indicators to ascertain whether cross promotional efforts are generating any effect. For example, track the percentage of customers that participate in multiple DEO programs.

Conclusion 2: Trade allies need additional support to be more effective. Trade allies are the primary mechanism for bringing participants into the program, yet trade ally satisfaction with certain program elements is relatively low.

- **Recommendation 1:**
  - Continue to improve portal experience – trade allies want smoother submission processes and better tracking information.
  - Provide additional training opportunities – trade allies are dissatisfied with amount of training offered by DEO and many expressed interest in sales training.
  - Continue investigating opportunities to leverage the online portal to better communicate with and engage less active trade allies – due to comparatively increased direct communication with their trade ally representatives, high volume trade allies were considerably more satisfied with their trade ally representative than less active trade allies.[1] Leveraging the online portal to enhance communication with less active trade allies – which make up the majority of trade ally firms registered in the program but less than 30% of program participation – may improve overall contractor satisfaction with the program. Consider establishing metrics that monitor effects of portal-based communication with less active trade allies (ex: are less active trade allies becoming more active over time following increased communication?).

Conclusion 3: Freeridership is higher for replacement upon burnout scenarios. Participants replacing broken HVAC systems tend to have higher FR scores, which is likely tied to emergency replacement conditions and thus may explain why these respondents were more likely to report they would have taken the same action even if the incentive did not exist. Specifically, we found that free ridership for air source heat pumps and central air conditioners decreased by 7% when replacement upon burnout participants were removed from the analysis.

- **Recommendation 1:** Continue investigating innovative program approaches to encourage early replacement. Incentives specifically targeted at encouraging early equipment replacement may bring more early replacement participants into the program

[1] High volume trade allies constitute a minority of firms registered in the program, yet do the bulk of rebated projects: about 35 trade allies represent about 70% of program participation.

which can thus increase gross and net savings. Other utilities such as Ameren Illinois and Dayton Power & Light currently offer incentives for early HVAC replacements; consult program administrators of these or other early replacement programs to gather insights on effective strategies for encouraging early replacement.[2]

- **Recommendation 2:** Continue offering rebates for replacement upon burnout though, as these cases constitute a significant source of participation in the current market.

[2] See the following program websites for current examples of early replacement incentives:

http://actonenergy.com/for-my-home/explore-incentives/heating-and-air-conditioning-rebates

https://www.dpandl.com/save-money/residential/heating-cooling-rebates-for-your-home/heating-rebates/

https://www.kcpl.com/-/media/indexedmedia/save_energy_and_money/home/mo_energy_efficiency/kcpl_rebateincentivechart_0314_2017v43.pdf?la=en

https://www.xcelenergy.com/programs_and_rebates/residential_programs_and_rebates/heating_and_cooling/cooling

Appendix A Summary Form

Smart $aver Program
Completed EMV Fact Sheet

Description of program

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

Date	September 1, 2015 – May 1 2017	Measure	Verified Net Savings (kWh)
Region(s)	Ohio	Central Air Conditioner	210
Evaluation Period	January 1 – December 31, 2016	Air Source Heat Pump	430
Annual kWh Net Savings	1,358,406 kWh	Geothermal Heat Pump	2,190
Coincident kW Impact - Summer	469 kW	Attic Insulation & Air Seal	612
Coincident kW Impact - Winter	149 kW	Variable Speed Pool Pump	820
Net-to-Gross Ratio	57.5%	Heat Pump Water Heater	1,014
Process Evaluation	Yes	Duct Sealing	137
Previous Evaluation(s)	2012 -2013 – The Cadmus Group		

Evaluation Methodology

Impact Evaluation Activities

- *45 on-site verifications; 37 metered systems*
- *71 telephone surveys of participating households.*

Impact Evaluation Findings

- *Realization rate = 68% for energy impacts; 47% for summer demand impacts; 39% for winter demand impacts*
- *Net-to-gross ratio = 0.57*

Process Evaluation Activities

- *Trade Allies; 5 interviews with high volume contractors and 41 surveys with additional contractors.*
- *Participants; 71 telephone surveys of participating households.*

Process Evaluation Findings

- *Participants are highly satisfied with Smart $aver.*
- *Smart $aver influences energy efficiency contracting services.*
- *Trade allies are Smart $aver's most successful marketing channel.*
- *Consumer awareness of Smart $aver appears to be low.*
- *The transition to the online portal has been challenging for trade allies.*

Appendix B Measure Impact Results

Table B-1 Program Year 2016 Verified Impacts by Measure

Measure	Gross Energy Savings per unit (kWh)	Gross Summer Coincident Demand per unit (kW)	Gross Winter Coincident Demand per unit (kW)	Free Ridership	Spillover	Net to Gross Ratio	M&V Factor (Energy) (RR x NTG)	Measure Life
Central Air Conditioner	366	0.214	0.026					18
Heat Pump	1,007	0.158	0.158					18
Attic Insulation & Air Seal	1,065	0.338	0.127	0.54	0.11	0.58	0.39	20
Variable Speed Pool Pump	1,427	0.476	0.000					10
Heat Pump Water Heater	1,763	0.135	0.199					10
Duct Sealing	238	0.079	0.028					18

Appendix C Senate Bill 310 Legislation on Energy Efficiency Accounting

130th General Assembly Senate Bill Number 310

Sec. 4928.662. For the purpose of measuring and determining compliance with the energy efficiency and peak demand reduction requirements under section 4928.66 of the Revised Code, the public utilities commission shall count and recognize compliance as follows:

(A) Energy efficiency savings and peak demand reduction achieved through actions taken by customers or through electric distribution utility programs that comply with federal standards for either or both energy efficiency and peak demand reduction requirements, including resources associated with such savings or reduction that are recognized as capacity resources by the regional transmission organization operating in Ohio in compliance with section 4928.12 of the Revised Code, shall count toward compliance with the energy efficiency and peak demand reduction requirements.

(B) Energy efficiency savings and peak demand reduction achieved on and after the effective date of S.B. 310 of the 130th general assembly shall be measured on the higher of an as found or deemed basis, except that, solely at the option of the electric distribution utility, such savings and reduction achieved since 2006 may also be measured using this method. For new construction, the energy efficiency savings and peak demand reduction shall be counted based on 2008 federal standards, provided that when new construction replaces an existing facility, the difference in energy consumed, energy intensity, and peak demand between the new and replaced facility shall be counted toward meeting the energy efficiency and peak demand reduction requirements.

(C) The commission shall count both the energy efficiency savings and peak demand reduction on an annualized basis.

(D) The commission shall count both the energy efficiency savings and peak demand reduction on a gross savings basis.

(E) The commission shall count energy efficiency savings and peak demand reductions associated with transmission and distribution infrastructure improvements that reduce line losses. No energy efficiency or peak demand reduction achieved under division (E) of this section shall qualify for shared savings.

(F) Energy efficiency savings and peak demand reduction amounts approved by the commission shall continue to be counted toward achieving the energy efficiency and peak demand reduction requirements as long as the requirements remain in effect.

(G) Any energy efficiency savings or peak demand reduction amount achieved in excess of the requirements may, at the discretion of the electric distribution utility, be banked and applied toward achieving the energy efficiency or peak demand reduction requirements in future years.

Appendix D Survey Instruments

Trade Ally In Depth Interview

Introduction

Hi, I'm ____ calling from Research Into Action on behalf of Duke Energy Ohio. We are evaluating the SMART $AVER program and we are looking to speak with contractors like 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 Ohio's SMART $AVER program, is that correct? And are you knowledgeable about those incented 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 Ohio – this is your chance to tell us what is working well, what isn't, and how Duke Energy Ohio can improve the program to better serve you and your customers. Do you have time to speak on the phone with me today 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 just so I can go back and clean up my notes after we are done talking, as to ensure I accurately captured everything you said.]

Background

Q2. My records show your company provides [PIPE IN SERVICES OFFERED: HVAC, plumbing, shell] services through SMART $AVER. Is that correct?

Q3. Have you completed any **new construction** projects that received incentives from the Smart Saver program?

Awareness and Engagement

Q4. How do you explain the value of energy efficiency upgrades to your customers? What are some successful strategies?

Q5. [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?

Q6. How did your company learn about the SMART $AVER program?

Q7. 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?]

Q8. 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?

Q9. How do you think Duke Energy Ohio could improve their marketing and outreach efforts?

Q10. What does your company do to market the SMART $AVER program?

Q11. How can Duke better support your SMART $AVER marketing efforts?

Q12. Have you attended any orientations or training events from Duke Energy Ohio? 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?

Q13. Would you like additional training opportunities to help your team more effectively sell rebated equipment? [*Probe: what type of training: sales/marketing training*]

Q14. Tell me about your thoughts and experiences with the new online application system. (How has it improved or worsened the application process?)

Q15. Do you ever use the program's online portal for contractors for reasons other than submitting rebate applications? If so, for what? Is it helpful? Could it use improvement?

Q16. A new company, Blackhawk Engagement Solutions, is implementing the program now (they take care of rebate application processing, fulfillment and the program call center). How has this affected your experience in the program, if at all?

Q17. How satisfied are you with your Duke Energy Trade Ally Representative? (IF NEEDED: Please explain why you said that)

Trade Ally Program Experience

Q18. What are the challenges you've experienced in the program?

Probes:

- QA audit process (common fails? QA process is cumbersome?)
- Variety of measures offered
- Customer participation rates
- Rebate application process
- Delays
- Communications with Duke Energy and implementer

- Other

Q19. Do you have any suggestions on how to improve the program process?

Program Satisfaction

Q20. What do you like best about the program?

Q21. What do you like least about the program?

Market Changes

Q22. [ASK IF INSTALLED HVAC MEASURES] The Department of Energy set new Seasonal Energy Efficiency Ratio (SEER) codes for air conditioners and heat pumps manufactured or distributed on or after January 1, 2015. How has this change affected the work you do through the program? (Has the code change made it easier to sell qualifying equipment?)

Q23. How might this code change affect the wider HVAC market?

Q24. How has the cost difference between 14 and 15 SEER heat pumps changed now that 14 SEER is code?

Q25. How has the cost difference between 14 and 15 SEER single package ACs changed now that 14 SEER is code?

Q26. What new energy efficient technologies do you see taking off in the near future? What are your customers asking for? Are there any energy efficient technologies you think would sell better if Duke offered incentives for them? If so, what?

Program Influence

Q27. 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?

Q28. And what about now?

Q29. 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?

Q30. Why do you say that?

Q31. Do you keep the equipment you install in stock, or do you mostly purchase equipment on an as-needed basis?

Q32. [IF THEY KEEP STOCK] Would you say the energy efficiency of your stock has increased, decreased, or stayed about the same since you joined the program?

Q33. [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?

Q34. Why do you say that?

Q35. Would you say your knowledge of energy efficiency [contractor specialty] 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 Duke’s SMART $AVER program had on your increased knowledge of energy efficiency [contractor specialty]?

Q37. Why do you say that?

Q38. 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 if the rebates were not available?

Firmographics

Q39. Including yourself, how many employees work at your location?

Q40. How many locations does your organization have?

Q41. [IF MORE THAN ONE LOCATION] Including yourself, how many employees work at your organization across all locations?

Q42. And about how many residential HVAC installation jobs do you all do each year?

Closing

Q43. Thanks so much for your time today. Are there any other comments you would like to provide?

Trade Ally Survey

Introduction

Hi, I'm ____ calling from Nexant on behalf of Duke Energy Ohio. May I speak with whomever is most knowledgeable about the rebated [MEASURE LIST] that your firm has installed through the Duke Energy Ohio Smart Saver 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 sales person]

[ONCE APPROPRIATE CONTACT IS ON PHONE]

We want to get some feedback on how the program is working for your firm - this is your chance to tell us what is working well, what isn't, and how Duke Energy Ohio can improve the program to better serve you and your customers. Is this a good time to talk?

IF NEEDED:

The survey takes about 15 minutes, depending on how much you have to say.

If now isn't a good time, when could I call you back?

Great. Rest assured, your answers will be confidential and not tied to you or your firm. Is it okay if I record our conversation? This is just so I accurately capture everything you say.

Screening [ASK ALL]

[Base: All respondents]

How many locations does your company have?

One

Two

Three

Four

Five

More than five [Interviewer, make sure to record the exact number of locations if this option is checked:] ______________

98. Don't Know

99. Refusal

[ASK IF 0>1] We would like to talk today about jobs associated with the [PIPE IN ADDRESS] location. Are you able to speak to the work associated with that location?

YES [CONTINUE]

NO [ASK TO SPEAK WITH ALTERNATIVE APPROPRIATE PERSON]

98. Don't know [ASK TO SPEAK WITH ALTERNATIVE APPROPRIATE PERSON]

99. Refused [THANK AND TERMINATE, RECORD]

Does your firm primarily focus on new construction or existing home projects?

New construction projects [THANK AND TERMINATE]

Existing homes

Both

98. Don't know [ASK TO SPEAK WITH ALTERNATIVE APPROPRIATE PERSON]

99. Refused [THANK AND TERMINATE, RECORD]

[READ PREFACE TO ALL]

In my questions today, when I mention Duke I am referring only to Duke Energy Ohio.

[IF NEEDED: Duke Energy Ohio serves the Cincinnati metro]

Sources of Program Awareness

[BASE: ALL RESPONDENTS]

How did you first hear about Duke Energy Ohio Smart $aver rebate offers?

Word-of-mouth (co-worker, another contractor)

Duke Energy website

Duke Energy program representative

TV/Radio/Newspaper/Billboard Ad

Event (home show, workshop, etc.)

Other, please specify:______________

98. Don't know

99. Refused

[BASE: ALL RESPONDENTS]

How many times per year do you visit the Duke Energy Ohio website to locate information about the Smart $aver rebates? [Single response. Do not read]

1-2 times a year

3-5 times a year

5-10 times a year

More than 10 times a year

98. Don't know

99. Refused

[IF INSTALLED HVAC EQUIPMENT]

What are the primary reasons your customers install new HVAC equipment? [Open-ended response. Record response verbatim]

[IF INSTALLED POOL PUMP]

What are the primary reasons your customers install new pool pumps? [Open-ended response. Record response verbatim]

[IF INSTALLED WATER HEATER]

What are the primary reasons your customers replace their water heaters? [Open-ended response. Record response verbatim]

[IF DID DUCTWORK]

What are the primary reasons your customers insulate and seal their ductwork? [Open-ended response. Record response verbatim]

[IF DID ATTIC INSULATION]

What are the primary reasons your customers insulate and seal their attic? [Open-ended response. Record response verbatim]

Nonparticipant Spillover

[READ PREFACE TO ALL:]

Now we are going to ask you some questions about the work for homeowners your company did last year in Duke Energy Ohio Territory. When answering these questions, please only consider your work in Duke Energy Ohio Territory, which includes the greater Cincinnati metro area.

[IF 0>1, READ] Remember, please only consider jobs associated with the [PIPE IN ADDRESS] location when answering questions.

[START LOOP – LOOP THROUGH TOP THREE MOST INSTALLED MEASURE TYPES THAT TA INSTALLED IN 2016]

[Base: All respondents]

About what proportion of the [MEASURE] jobs that your company did in Duke territory in 2016 would have qualified for a Duke rebate? Your best estimate is fine. [*Interviewers: Record a number. if they give a range, record a mid-point of that range. For example, if they say 80 to 90%, input 85%*.]

[Record response]

[Do not read:]

-98. Don't Know

-99. Refusal

[BASE: ALL RESPONDENTS]

And since April 2016, what percent of all your Duke rebate qualified [MEASURE] projects did you actually apply for a rebate? [If needed: Your best estimate is fine.] [*Interviewers: Record a number. if they give a range, record a mid-point of that range. For example, if they say 80 to 90%, input 85%*.]

[Record response]

[Do not read:]

-98. Don't Know

-99. Refusal

About what proportion of your rebate qualifying [MEASURE] customers specifically requested the [MEASURE] on their own and were not influenced by your recommendation? [If needed: Your best estimate is fine.]

1. . [Record percent]

[Do not read:]

-98. Don't Know

-99. Refusal

Using a 0 to 10 scale, where 0 is "not at all influential" and 10 is "extremely influential," how much influence has the Duke program had on your business practice of recommending rebate qualifying [MEASURE] to your customers?
[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.	Don't Know
99.	Refused

[END LOOP]

Program Influence and Effects on TAs

[BASE: TRADE ALLIES THAT INSTALLED EQUIPMENT MEASURES]

Thinking back to before you were involved in the Duke Energy Ohio 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]

None of the time

Some of the time

Most of the time

Every time

97. Not applicable – I've been involved with the Duke program since starting in the industry/this company

98. Don't know

99. Refused

[BASE: TRADE ALLIES THAT INSTALLED EQUIPMENT MEASURES]

And what about now? [*If needed:* Currently, how often do 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. DO NOT READ]

None of the time

Some of the time

Most of the time

Every time

98. Don't know

99. Refused

[Base: IF INSTALLED EQUIPMENT]

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

[SINGLE RESPONSE. DO NOT READ]

Keep stock

Don’t keep stock - purchase equipment on an as-needed basis

Both - some products we keep in stock and other are purchased on an as-needed basis

98. Don't know

99. Refused

[ASK IF Q31=1 OR 3] Would you say your stock of energy efficient equipment has increased, decreased, or stayed about the same since you joined the program?

Increased

Decreased

Stayed about the same

98. Don't know

99. Refused

[ASK IF Q32=1] Using a 0 to 10 scale, where 0 is “not at all influential” and 10 is “extremely influential,” how much influence has Duke Energy Ohio’ program had on your increased stocking of energy efficient equipment?

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.	Don’t Know
99.	Refused

[Base: All respondents]

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 program?

Increased

Decreased

Stayed about the same

98. Don't know

99. Refused

[ASK IF Q35=1] Using a 0 to 10 scale, where 0 is “not at all influential” and 10 is “extremely influential,” how much influence has Duke Energy Ohio’ program had on your increased knowledge of energy efficient products and services?

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.	Don’t Know
99.	Refused

Code Changes

IF CENTRAL AIR CONDITIONER FLAG = 1

IF AIR SOURCE HEAT PUMP FLAG = 1

[READ PREFACE IF CONTRACTOR INSTALLED CENTRAL AIR CONDITIONERS OR AIR SOURCE HEAT PUMPS]

As you may know, a new code for single package air conditioners and air source heat pumps was enforced last year – the minimum SEER went from 13 to 14.

[Base: IF CONTRACTOR INSTALLED CENTRAL AIR CONDITIONERS]

IF CENTRAL AIR CONDITIONER FLAG = 1

How much more difficult or easier is it to sell 15 SEER central air conditioners now that the code is 14 SEER? Would you say it is: [READ FIRST FIVE RESPONSE OPTIONS]

Much more difficult

Somewhat more difficult

No different

Somewhat easier

Much easier

[Do not read:]

97. Do not sell SEER 15

98. Don't know

99. Refused

[Base: IF CONTRACTOR INSTALLED CENTRAL AIR CONDITIONERS]

Now we want to better understand how energy efficiency codes affect the price of central air conditioners and how this has changed over the last couple of years. About two years ago, what was the average price difference between a 14 SEER central air conditioner and a similarly sized 15 SEER unit? [IF NEEDED: We're interested to know how much more a 15 SEER unit cost compared to a 14 SEER unit, as of two years ago]

[OPEN-ENDED RESPONSE]

[*Do not read:*]

98. Don't know

99. Refused

[Base: IF CONTRACTOR INSTALLED CENTRAL AIR CONDITIONERS]

And what is the average price difference between a 14 SEER central air conditioner and a similarly sized 15 SEER unit in today's market? [IF NEEDED: We're interested to know how much more a 15 SEER unit cost compared to a 14 SEER unit, as of today]

[OPEN-ENDED RESPONSE]

[*Do not read:*]

98. Don't know

99. Refused

[Base: IF CONTRACTOR INSTALLED AIR SOURCE HEAT PUMPS]

IF AIR SOURCE HEAT PUMP FLAG = 1

How much more difficult or easier is it to sell 15 SEER air source heat pumps now that the code is 14 SEER? Would you say it is: [READ FIRST FIVE RESPONSE OPTIONS]

Much more difficult

Somewhat more difficult

No different

Somewhat easier

Much easier

[Do not read:]

97. Do not sell SEER 15

98. Don't know

99. Refused

[Base: IF CONTRACTOR INSTALLED AIR SOURCE HEAT PUMPS]

Now we want to better understand how energy efficiency codes affect the price of air source heat pumps and how this has changed over the last couple of years. About two years ago, what was the average price difference between a 14 SEER air source heat pumps and a similarly sized 15 SEER unit? [IF NEEDED: We're interested to know how much more a 15 SEER unit cost compared to a 14 SEER unit, as of two years ago]

[OPEN-ENDED RESPONSE]

[*Do not read:*]

98. Don't know

99. Refused

[Base: IF CONTRACTOR INSTALLED AIR SOURCE HEAT PUMPS]

And what is the average price difference between a 14 SEER air source heat pumps and a similarly sized 15 SEER unit in today's market? [IF NEEDED: We're interested to know how much more a 15 SEER unit cost compared to a 14 SEER unit, as of today]

[OPEN-ENDED RESPONSE]

[*Do not read:*]

98. Don't know

99. Refused

Challenges and Suggestions for Improvement

[Base: All respondents]

What energy efficient products, technologies, or services should be added to the Duke Energy Progress rebate program? [DO NOT READ: Choose all that apply]

Modulating furnaces

Heat recovery ventilation (HRV) systems

Boilers

Electronically commutated motor (ECM) furnaces

Tankless water heaters

Web enabled or smart thermostats

Humidifiers

Air handlers

No others should be added

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

98. Don't know

99. Refused

[Base: All respondents]

What types of training, if any, would you be interested in receiving from Duke Energy or a third party hired by Duke Energy?

[OPEN-ENDED RESPONSE]

[*Do not read:*]

98. Don't know

99. Refused

[Base: All respondents]

On a scale from 0 to 10, where 0 is “not at all interested” and 10 is “extremely interested,” how interested would you be in a training course on how to more effectively sell high efficiency equipment to your customers if it was offered by the program?

0.	0. Not all interested
1.	1.
2.	2
3.	3
4.	4
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10. Extremely interested
98.	Don’t Know
99.	Refused

[Base: All respondents]

How often do your customers ask about the Duke Energy Ohio rebates before you've had the chance to bring them up? Would you say…[READ FIRST FIVE RESPONSE OPTIONS]

Never

Rarely

Occasionally

Frequently, or

Always

[*Do not read:*]

98. Don't know

99. Refused

[Base: All respondents]

Since Duke transitioned to the online application system in April 2016, how frequently have you experienced problems or frustrations with the rebate application process? Would you say…[READ FIRST FIVE RESPONSE OPTIONS]

Never

Rarely

Occasionally

Frequently, or

Always

[*Do not read:*]

98. Don't know

99. Refused

[ASK IF 0=2-5] What types of problems or frustrations did you experience?

[Record response]

[Do not read:]

98. Don't know

99. Refused

[ASK IF 0=2-5]

Overall, have these problems persisted or gotten better over time? Would you say these problems have:

[Read:]

Persisted

Gotten somewhat better, or

Have been completely resolved at this point

[*Do not read:*]

98. Don't know

99. Refused

[Base: All respondents]

Do you have any suggestions on how Duke Energy Ohio could improve the rebate application process?

[Record response]

[Do not read:]

98. Don't know

99. Refused

[Base: All respondents]

Duke Energy Ohio routinely inspects contractors' jobs. Have you ever had a project that failed Duke Energy's inspection of the work?

Yes – I've had a project fail inspection

No– I've never had a project fail inspection

I'm not familiar with what you are talking about

Not sure if any of my projects have failed or not

I’ve never had a project inspected

98. Don't know

99. Refused

[Base: If Q35<>5]

Do you have any suggestions on how Duke Energy Ohio could improve the project inspection process?

[Record response]

[Do not read:]

98. Don't know

99. Refused

Satisfaction

[Preamble:]

Thanks for your feedback so far, next I have some questions about your satisfaction with the program.

[Base: All respondents]

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]

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

[Base: Ask If 0 =1|2]

[Programmer’s Note: Repeat 0 for each statement from 0 where 0<5]

Please explain why you were dissatisfied with [INSERT STATEMENT FROM 0 A-H]:

[Record response]

[Do not read:]

98. Don't know

99. Refused

Firmographics

Thanks for all of your feedback today. We are almost done. We just need some basic info about your company.

[Base: All respondents]

Including yourself, about how many employees work at ADDRESS?

[Record response]

[Do not read:]

98. Don't know

99. Refused

[ASK IF 0>1] Including yourself, about how many employees work at your organization across all locations?

[Record response]

[Do not read:]

98. Don't know

99. Refused

Closing

[Base: All respondents]

Thanks so much for your time today. Are there any other comments you would like to provide?

[Record response]

Participant Survey

Overview of Data Collection Activity

Descriptor	This Instrument
Instrument Type	Phone survey
Estimated Time to Complete	10-15 minutes
Population Description	Duke Energy Ohio Smart $aver Participants
Population Size	TBD
Contact List Size	TBD
Completion Goal(s)	68
Contact List Source and Date	TBD
Type of Sampling	Random
Contact Sought	Ohio households who received Smart $aver incentives after January 2016
Fielding Firm	Nexant

Research Objectives and Associated Questions

Research Topics from the work plan	Associated Questions
Source of program awareness and how customers typically learn of energy efficient technologies	0 through 0 and 0
Net-to-gross	0 through 0
Reasons for installing the equipment, air-sealing (ducts), or upgrading insulation	0 through 0
Experience with the program (rebate paperwork, turnaround, quality of installation, etc.), including	0 through 0 and 0 through 0

contractor satisfaction and whether program influenced them to engage in other Duke energy efficiency programs	
Program satisfaction, including satisfaction with Duke Energy	Q37 through Q53
Demographics	0 and Q56 through 0

Programmer and Interviewer Information

Programming note style conventions in this document:

[PROGRAMMING] Programming instructions are in bracketed CAPS.

[*Interviewer notes*] Onscreen interviewer instructions are in *italics*.

[**Piped value**] Database inputs or question response inputs are in **bold**.

The Evaluation Team will pipe in measure data from the Smart $aver Ohio database in order to reference specific measures respondents have installed. Throughout this survey, pipe in fields are denoted by brackets and bolded capital letters: [**EXAMPLE**]. The table below explains the pipe in fields that will likely be used in this survey.

Please note that the pipe in fields may change once we receive and review the program database records.

Database Pipe In Field Descriptions

Pipe In Field	Description
PROJECT#1 LIST	List of all measures participant did at their property for their first project in January to December of 2016 (a "project" is defined as one measure or a group of measures with the same Measure Start Date value).
PROJECT#2 LIST	List of all measures participant did at their property in January to December of 2016 subsequent to their first project. This field is not populated if participant only did one measure or one multi-measure project.
PIPE IN WHICHEVER WAS INSTALLED:	Specifies which specific measure the participant installed from a specified list of measures.

LIST ALL MEASURES	List of all measures participant did at their property in 2016.
LAST PROJECT	List of all measures participant did at their property in their last (or only) project in 2016.
MEASURE	Pipe in a given measure from LIST OF ALL MEASURES (used in 0 loop)

Instrument

Introduction

[*READ IF CONTACT NAME IS KNOWN:*] Hello, may I speak with _____. [*READ IF NAME IS UNKNOWN*] Hi, my name is __________from Nexant. I'm calling on behalf of Duke Energy Ohio. Our records show that you received a rebate for [**LIST ALL MEASURES**] from the Duke Energy Ohio Smart $aver Program.

[*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 RENTER (AND/OR THEIR LANDLORD OR PROPERTY MANAGER WAS RESPONSIBLE FOR THE PROJECT), ASK FOR LANDLORD/PROPERTY MANAGER'S NAME AND PHONE NUMBER AND USE THAT AS THE NEW POINT OF CONTACT]

Duke Energy would like your feedback about the work that was done to the home/property through the program as well as feedback on your experience with the program. Is now a good time to talk?

[*IF NEEDED*]*:* The survey will take about 10 to 15 minutes, depending on how much you have to say.

[*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 Type Confirmation

[ASK ALL]

I'm going to read a list of building types. Please stop me when I mention the building type that best describes the residence where this work was done. [*READ LIST*]

[SINGLE RESPONSE]

Single-family detached home [*IF NEEDED*: *NOT A DUPLEX, TOWNHOME, OR APARTMENT; ATTACHED GARAGE IS OK*]

Factory manufactured single family home

Row house or town house

Duplex

Triplex [*IF NEEDED: BUILDING WITH THREE UNITS*]

Apartment or condo building with four or more units

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

98. Don't know

99. Refused

[PROGRAMMER: IF 0=1-2, BUILDING TYPE=SF. IF 0=3-6, BUILDING TYPE=OTHER. IF 0=96-99, USE PRE-CODED BUILDING TYPE FROM LIST]

Sources of Program Information

[ASK ALL]

How did you hear about the Duke Energy Ohio Smart $aver **rebate(s)** that you received*? [RECORD VERBATIM]*

[ASK ALL]

Are you familiar with other energy-efficiency rebates that Duke Energy Ohio offers, aside from the **[LIST ALL MEASURES THEY RECEIVED FROM SMART$SAVER PROGRAM] rebate(s)*?***

[SINGLE RESPONSE]

Yes

No

98. Don't know

99. Refused

[ASK IF 0= 1 (Yes)]

Which other rebates are you familiar with? *[Do not read list]* [PROGRAMMER: EXCLUDE THE REBATES THAT THEY RECEIVED FROM THE LIST BELOW]

[MULTIPLE RESPONSE]

Heat pump water heater rebate

Heating and cooling system rebate

Geothermal heat pump rebate

Attic Insulation and Air Seal rebate

Duct sealing and insulation rebate

In-home energy audit (also called Home Energy House Call)

Variable-speed Pool pump rebate

Power Manager bill discounts (for allowing Duke Energy to ramp down air-conditioning during peak usage events)

Discounted efficient lighting (CFLs, LEDs, and specialty bulbs)

Other – please specify: [OPEN-ENDED RESPONSE]

Don’t know

Refused

[ASK IF 0= 1 (Yes)]

Have you received any of these other rebates?

[SINGLE RESPONSE]

Yes

No

98. Don't know

99. Refused

[ASK IF 0= 1 (Yes) AND MORE THAN ONE ITEM SELECTED IN 0; IF ONLY ONE ITEM SELECTED IN 0 AND 0=1, AUTOCODE 0 RESPONSE FOR 0]

Which rebate(s) did you receive? *[Do not read list]*

[MULTIPLE RESPONSE]

Heat pump water heater rebate

Heating and cooling system rebate

Geothermal heat pump rebate

Attic Insulation and Air Seal rebate

Duct sealing and insulation rebate

In-home energy audit (also called Home Energy House Call)

Variable-speed Pool pump rebate

Power Manager bill discounts (for allowing Duke Energy to ramp down air-conditioning during peak usage events)

Discounted efficient lighting (CFLs, LEDs, and specialty bulbs)

Other – please specify: [OPEN-ENDED RESPONSE]

98. Don't know

99. Refused

Program Influence

[ASK IF 0= 1 (Yes)]

Did you receive the [**Insert rebated measures from 0**] before or after [**PROJECT#1 LIST**] work was done? [REPEAT THIS QUESTION FOR EACH REBATE OPTION SELECTED IN 0]

[SINGLE RESPONSE]

Before

After

Both before and after

At the same time

98. Don't know

99. Refused

[ASK IF 0= 2 or 3 (“After” or “Both before and after”)]

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 [**Insert response from 0**]? [REPEAT THIS QUESTION FOR EACH REBATE OPTION SELECTED IN 0 WHERE RESPONSE TO 0=2 ("After") OR 0=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.	Don't Know
99.	Refused

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

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.	Don’t Know
99.	Refused

Motivations

We’d like to know what motivated you to complete the work we’ve been talking about that was rebated through the Duke Energy Ohio Smart $aver Program.

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

[IF AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP WAS INSTALLED, READ:] 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, READ:] Which of the following best describes the condition of the previous air conditioner that you replaced?

[*READ* – MULTIPLE RESPONSE]

It was broken or malfunctioning

It was getting old, or

It was in good working condition

[*Do not read:*]

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

98. Don't know

99. Refused

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

What motivated you to install an **energy efficient** system rather than a less efficient one that would use more energy?

[RECORD VERBATIM]

[ASK IF HEAT PUMP WATER HEATER WAS INSTALLED]

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

[*READ* – MULTIPLE RESPONSE]

It was broken or malfunctioning

It was getting old, or

It was in good working condition

[*Do not read:*]

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

98. Don't know

99. Refused

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

What motivated you to [IF DUCT SEALING WAS PERFORMED, READ: repair your ductwork; IF ATTIC INSULATION WAS INSTALLED, READ: insulate your attic]?

[RECORD VERBATIM] [ASK IF POOL PUMP WAS INSTALLED]

What motivated you to install an ENERGY STAR pool pump?

[RECORD VERBATIM] **Free-ridership**

I'd like to ask a few questions about what you most likely would have done had you not received assistance from Duke Energy Ohio for the **[LIST ALL MEASURES]**.

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

Which of the following statements best describes the actions you would have taken if Duke Energy Ohio rebates and information were not available: [*READ LIST*]

[SINGLE RESPONSE]

Would not have installed the **[PIPE IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP]**

Would have postponed the purchase for at least one year

Would have bought a less expensive or less energy efficient **heating and cooling system**

Would have bought the exact same **[PIPE IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP]**, and paid the full cost yourself

[*Do not read:*]

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

98. Don't know

99. Refused

[ASK IF 0= 3]

You said you would have bought a/an [**PIPE IN WHICHEVER WAS INSTALLED: AIR SOURCE HEAT PUMP OR GEOTHERMAL HEAT PUMP**] that was less expensive or less energy efficient if you had not received the rebate or information from Duke Energy Ohio. Do you think it is more likely that you would have bought equipment that was…?

Almost as efficient as the one you bought, or

Significantly less efficient than the one you bought

[*Do not read:*]

98. Don’t know

99. Refused

[ASK IF THEY INSTALLED: CENTRAL AIR CONDITIONER]

Which of the following statements best describes the actions you would have taken if Duke Energy Ohio rebates and information were not available: [*READ LIST*]

[SINGLE RESPONSE]

Would not have installed the **CENTRAL AIR CONDITIONER**

Would have postponed the purchase for at least one year

Would have bought a less expensive or less energy efficient **cooling system**

Would have bought the exact same **CENTRAL AIR CONDITIONER**, and paid the full cost yourself

[*Do not read:*]

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

98. Don't know

99. Refused

[ASK IF 0= 3]

You said you would have bought a **CENTRAL AIR CONDITIONER** that was less expensive or less energy efficient if you had not received the rebate or information from Duke Energy Ohio. Do you think it is more likely that you would have bought equipment that was…?

Almost as efficient as the one you bought, or

Significantly less efficient than the one you bought

[*Do not read:*]

98. Don’t know

99. Refused

[ASK IF THEY INSTALLED: HEAT PUMP WATER HEATER]

Which of the following statements best describes the actions you would have taken if Duke Energy Ohio rebates and information were not available: [*READ LIST*]

[SINGLE RESPONSE]

Would not have installed the Heat Pump Water Heater

Would have postponed the purchase for at least one year

Would have bought a less expensive or less energy efficient Heat Pump Water Heater

Would have bought the exact same Heat Pump Water Heater, and paid the full cost yourself

[*Do not read:*]

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

98. Don't know

99. Refused

[ASK IF 0= 3]

You said you would have bought a Heat Pump Water Heater that was less expensive or less energy efficient if you had not received the rebate or information from Duke Energy Ohio. Do you think it is more likely that you would have bought equipment that was…?

Almost as efficient as the one you bought, or

Significantly less efficient than the one you bought

[*Do not read:*]

98. Don’t know

99. Refused

[ASK IF THEY UPGRADED: ATTIC INSULATION]

Which of the following statements best describes the actions you would have taken if Duke Energy Ohio rebates and information were not available: [*READ LIST*]

[SINGLE RESPONSE]

Would not have done the **attic insulation**

Put off doing attic insulation for at least one year

Would have added less insulation

Would have done the exact same **upgrade**, and paid the full cost yourself

[*Do not read:*]

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

98. Don't know

99. Refused

[ASK IF 0= 3]

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

[*RECORD VERBATIM*:] _______________

Don’t know

99. Refused

[ASK IF THEY DID DUCT SEALING]

Which of the following statements best describes the actions you would have taken if Duke Energy Ohio rebates and information were not available: [*READ LIST*]

[SINGLE RESPONSE]

Would not have had ducts sealed, repaired, or replaced

Would have postponed the work for at least one year

Would have had the exact same work done, and paid the full cost yourself

[*Do not read:*]

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

98. Don't know

99. Refused

[ASK IF THEY INSTALLED A VARIABLE SPEED POOL PUMP]

Which of the following statements best describes the actions you would have taken if Duke Energy Ohio rebates and information were not available: [*READ LIST*]

[SINGLE RESPONSE]

Would not have installed or replaced the pool pump

Would have postponed the installation of the pool pump for at least one year

Would have had the exact same pool pump installed, and paid the full cost yourself

[*Do not read:*]

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

98. Don't know

99. Refused

[ASK ALL]

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 Ohio, 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 0 FOR EACH MEASURE IN MEASURE LIST. WHEN REPEATING, CALLERS CAN USE ABBREVIATED LANGUAGE (E.G.: “AND FOR THE INSULATION, HOW INFLUENTIAL WAS…”]

Spillover

[ASK ALL]

Since receiving your rebate from Duke Energy Ohio for the **[LIST ALL MEASURES],** what other products or services have you purchased to help save energy in your home? [*PROBE: Did you do anything else?*]

[Do not read list] [MULTIPLE RESPONSE]

Installed energy efficient appliances

Moved into an ENERGY STAR home *[VERIFY:“Is Duke Energy still your gas or electricity utility?” Yes/No]*

Installed efficient heating or cooling equipment

Installed efficient windows

Added insulation

Sealed air leaks [NOT DUCT SEALING – PROBE TO CODE]

Sealed ducts

Bought LEDs

Bought CFLs

Installed an energy efficient tank-style water heater [PROBE TO CODE]

Installed a tankless water heater [PROBE TO CODE]

None – no other actions taken

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

98. Don't know

99. Refused

[ASK IF 0=5]

Did you add insulation to your attic, walls, or below the floor?

[Do not read list] [MULTIPLE RESPONSE]

Attic

Wall

Below the floor

98. Don't know

99. Refused

[ASK IF 0<>98-99]

[PROGRAMMER: REPEAT 0 FOR EACH ITEM MENTIONED IN 0]

Approximately what proportion of the [**ITEM MENTIONED IN 0**] SPACE DID YOU ADD INSULATION?

[*RECORD VERBATIM AS % - INPUT MID-POINT IF RANGE IS OFFERED*:] _______________[*IF NEEDED: Your best estimate is fine]*

Don’t know

99. Refused

[ASK IF 0=8]

How many of LEDs did you install in your home?

[*RECORD VERBATIM:*] _______________ [*IF NEEDED: Your best estimate is fine]*

98. Don’t know

99. Refused

[ASK IF 0 = 9]

How many of CFLs did you install in your home?

[*RECORD VERBATIM:*] _______________[*IF NEEDED: Your best estimate is fine]*

98. Don’t know

99. Refused

[ASK IF 0 = 1]

What kinds of appliance(s) did you buy?

[Do not read list] [MULTIPLE RESPONSE]

Refrigerator

Stand-alone Freezer

Dishwasher

Clothes washer

Clothes dryer

Oven

Microwave

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

98. Don’t know

99. Refused

[A*SK* IF 0 = 1-7]

Was the [**INSERT 0 RESPONSE**] an ENERGY STAR or high-efficiency model?

[SINGLE RESPONSE]

Yes

No

98. Don't know

99. Refused

[REPEAT THIS QUESTION FOR EACH ITEM MENTIONED IN 0]

[ASK IF 0 = 3]

What type of heating or cooling equipment did you buy?

[Do not read list] [MULTIPLE RESPONSE]

Central air conditioner

Window/room air conditioner unit

Wall air conditioner unit

Air source heat pump

Geothermal heat pump

Boiler

Furnace

Programmable thermostat

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

98. Don't know

99. Refused

[A*SK* IF 0= 1-96]

Was the [**INSERT 0 RESPONSE**] an ENERGY STAR or high-efficiency model?

[SINGLE RESPONSE]

Yes

No

98. Don't know

99. Refused

[REPEAT THIS QUESTION FOR EACH ITEM MENTIONED IN 0]

[ASK IF 0<> 12, 98, 99]

On a scale of 0 to 10, where 0 means “not at all influential” and 10 means “extremely influential”, how much influence did the Duke Energy Ohio rebate program have on your decision to…

[MATRIX QUESTION: SCALE]

[LOGIC] Item	1 – Not at all influential	2	3	4	5	6	7	8	9	10 – Extremely influential	98 DK	99 RF
[IF 0 = 1, ELSE SKIP] Install energy efficient appliances												
[IF 0 = 2, ELSE SKIP] Move into an ENERGY STAR home												
[IF 0 = 3, ELSE SKIP] Buy efficient heating or cooling equipment												
[IF 0 = 4, ELSE SKIP] Buy efficient windows												
[IF 0 = 5, ELSE SKIP] Buy additional insulation												
[IF 0 = 6, ELSE SKIP] Seal air leaks												
[IF 0 = 7, ELSE SKIP] Seal ducts												
[IF 0 = 8, ELSE SKIP] Buy LEDs												
[IF 0 = 9, ELSE SKIP] Buy CFLs												
IF 0 = 10, ELSE SKIP] Install an energy efficient tank-style water heater												
IF 0 = 11, ELSE SKIP] Install a tankless water heater												
[IF 0 = 96, ELSE SKIP] **[open ended response]**												

How They Search For EE Information

[ASK ALL]

Where do you typically search for information on how to save energy in your property?

[Do not read list] [MULTIPLE RESPONSE]

Online – read reviews about products

Go to utility website

Read my utility information – it has tips on how to save energy

Go to the store and talk to salespeople

Look for ENERGY STAR logo on products

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

97. Not applicable – I don't typically search for information on how to save energy in my home/property

98. Don't know

99. Refused

Program Satisfaction and Challenges

The next few questions are about your satisfaction with the program.

[ASK ALL]

Using a 0 to 10 scale where 0 means "very dissatisfied," 10 means "neither satisfied nor dissatisfied," and 10 means "very satisfied," how satisfied were you with the rebate amount for [**LAST PROJECT**]? [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
99.	Refused

[ASK ALL]

Who submitted the rebate application for the [**LAST PROJECT**] – was it you or your contractor?

[Do not read list] [SINGLE RESPONSE]

Me, or someone else in my home/business

Contractor

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

98. Don't know

99. Refused

[ASK IF 0 = 1 (CUSTOMER SUBMITTED REBATE APPLICATION)]

From the time you submitted the application, about how many weeks did it take to receive your rebate?

[*RECORD VERBATIM*:] _______________[*IF NEEDED: Your best estimate is fine]*

98. Don't know

99. Refused

[ASK ALL]

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,” 10 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
99.	Refused

[ASK IF 0<5 (Somewhat to Very Dissatisfied)]

Why did you give that rating? ________[RECORD VERBATIM]

[ASK ALL]

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]

Never

Once

2 or 3 times

4 times or more

98. Don't know

99. Refused

[ASK IF 0 = 2-4]

How did you contact them?

[Do not read list] [MULTIPLE RESPONSE]

Phone

Email

Fax

Letter

In person

98. Don't know

99. Refused

[ASK IF 0 =2-4]

Using that same scale, how satisfied were you with these communications? [*INTERVIEWER NOTE: REPEAT SCALE IF NECESSARY: Please use a 0 to 10 scale where 0 means "very dissatisfied," 10 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
99.	Refused

[ASK IF 0<5 (Somewhat to Very Dissatisfied)]

Why did you give that rating? ________________[RECORD VERBATIM]

[ASK ALL]

Have you noticed any savings on your electric bill since the [**LAST PROJECT**] project?

[SINGLE RESPONSE]

Yes, they noticed savings

No - They looked but **did not** notice any savings

No - They looked but it is too soon to tell

They didn’t look

98. Don't know

99. Refused

[ASK IF 0= Yes (if noticed savings)]

How satisfied are you with any savings you noticed on your electric bill since the [**LAST PROJECT**] project? [*INTERVIEWER NOTE: REPEAT SCALE IF NECESSARY: Please use a 0 to 10 scale where 0 means “very dissatisfied,” 10 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

[ASK ALL]

How satisfied are you with your [**LAST PROJECT**] project? [*INTERVIEWER NOTE: REPEAT SCALE IF NECESSARY: Please use a 0 to 10 scale where 0 means “very dissatisfied,” 10 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.	Don’t Know
99.	Refused

[ASK IF 0<5 (Somewhat to Very Dissatisfied)]

Why did you give that rating?

[*RECORD VERBATIM*] ________

98. Don't know

99. Refused

[ASK ALL]

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,” 10 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

[ASK IF 0< 5 (Somewhat to Very Dissatisfied)]

Why did you give that rating?

[*RECORD VERBATIM*] ________

98. Don't know

99. Refused

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," 10 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

Would you say that your participation in Duke Energy Ohio Smart $aver Rebate Program has had a positive effect, a negative effect, or no effect on your overall satisfaction with Duke Energy?

Negative effect

No effect

Positive effect

98. Don't know

99. Refused

[ASK ALL]

Finally, if you were rating your overall satisfaction with the Duke Energy Ohio 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 satisfied
2.	Somewhat satisfied
3.	3. Neither satisfied nor

	dissatisfied
4.	Somewhat dissatisfied
5.	Very dissatisfied
98.	Don’t Know
99.	Refused

[ASK IF 0 <> 98 or 99]

Why do you give that rating? _________

[ASK ALL]

Do you have any suggestions to improve Duke Energy’s Smart $aver Program?

[YES, *RECORD VERBATIM*] ________

No

98. Don't know

99. Refused

Demographics/Property Characteristics

Finally, I just need to ask you some questions about the residence where the rebated work was done.

[ASK ALL]

Do you live at this residence where the work was performed?

Yes

No

99. Refused

[ASK IF 0=2]

Are you a property manager or an owner of the residence where the work was performed?

Owner

Property manager

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

99. Refused

[ASK IF 0=1]

Do you own or rent this residence?

[SINGLE RESPONSE]

Own

Rent

98. Don't know

99. Refused

[ASK IF 0=Rent]

Do you pay your own electric bill or is it included in your rent? [*DO NOT READ*]

[Single RESPONSE]

Pay own bill

Included in rent

98. Don't know

99. Refused

[ASK ALL]

Approximately when was this residence first built? [*DO NOT READ*]

[SINGLE RESPONSE]

Before 1960

1960-1969

1970-1979

1980-1989

1990-1999

2000-2005

2006-2010

2011-2015

2016

98. Don't know

99. Refused

[ASK ALL]

Excluding unfinished basements, how many square feet is the residence?

NUMERICAL OPEN END [RANGE 0-99,999]_______

98. Don't know

99. Refused

[ASK IF 0=Don’t Know or Refused]

Would you estimate the residence is about: [*READ LIST*]

[SINGLE RESPONSE]

less than 1,000 sqft

1,001-2,000 sqft

2,001-3,000 sqft

3,001-4,000 sqft

4,001-5,000 sqft

Greater than 5,000 sqft

98. Don’t know

99. Refused

[ASK ALL]

Does the primary heating system at the residence run on… [*READ*]

[SINGLE RESPONSE]

Electricity

Natural Gas (not propane)

Liquid propane gas

Fuel Oil

Wood

Or something else, please specify: [OPEN-ENDED RESPONSE]

[Do not read list]

98. Don't know

99. Refused

[ASK ALL]

I’m going to read a list of income ranges. Please stop me when I reach the range that includes your annual household income. [*READ LIST*]

[SINGLE RESPONSE]

1. Less than $25,000
2. $25,000 to less than $50,000
3. $50,000 to less than $75,000
4. $75,000 to less than $100,000
5. $100,000 to less than $150,000
6. $150,000 or more

98. Don’t know

99. Refused

That is all of the questions I have for you today. Thank you very much for your time.

Appendix E Housing Characteristics and Demographics

The majority (81%) of participants' residences were constructed prior to the year 2000 (Table E-6-1).

Table E-6-1: Year of Residence Construction

Year of Construction	Count	Percent
Before 1960	14	20%
1960-1969	4	6%
1970-1979	11	15%
1980-1989	12	17%
1990-1999	16	23%
2000-2005	9	13%
2006-2010	3	4%
2011-2015	0	0%
2016+	1	1%
Don't know	1	1%
Total	**71**	**100%**

More than three-quarters (78%) of respondents live in homes smaller than 3,000 sq/ft (Table E-6-2).

Table E-6-2: Residence Square Footage

Square Footage	Count	Percent
1,000-1,499	10	14%
1,500-1,999	21	30%
2,000-2,499	17	24%
2,500-2,999	7	10%
3,000-3,499	4	6%
3,500-3,999	3	4%
4000+	8	11%
Don't know	1	1%
Total	**71**	**100%**

The majority (61%) of participants use natural gas to heat their home (Table E-6-3).

Table E-6-3: Primary Heating Fuel

Primary Heating Fuel	Count	Percent
Natural gas	43	61%
Electricity	25	35%
Liquid propane gas	1	1%
Don't know	2	3%
Total	**71**	**100%**

The evaluation team calculated the weighted average of the income distribution of homeowners across the Duke Energy Ohio service territory. Overall, participants had higher household incomes relative to the population in the five counties that Duke Energy serves in Ohio. More than three-fifths (63%) of the sample reported annual household incomes of $75,000 or greater, compared to just one-half of the population. About one-quarter of respondents declined to answer this question (Table E-6-4).

Table E-6-4: Annual Household Income

Annual Household Income	Sample Proportion		Census*
	Count	Percent [a]	Percent
Less than $25,000	1	2%	12%
$25,000 to less than $50,000	4	8%	20%
$50,000 to less than $75,000	14	27%	20%
$75,000 to less than $100,000	7	13%	15%
$100,000 to less than $150,000	13	25%	19%
$150,000 or more	13	25%	16%
Don’t know	2	-	-
Refused	17	-	-
Total	**71**	**100%**	**100%**

* Source: U.S. Census Bureau, 2011-2015 American Community Survey 5-Year Estimates. Annual household income of homeowners: weighted average distribution across Duke Energy Ohio service territory (Brown, Butler, Clermont, Hamilton, and Warren counties).

a Percent of respondents who provided a valid answer to this question, n=52.