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INFORMATION SHEET

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VOLUME:

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EXHIBITS

Duke Energy Carolinas, LLC, Application & Amended Application (A)

Barnes Direct Exhibits 1 – 11 (I/A)	Barnes Supplemental Exhibits 1 – 4 (I/A)
Miller Exhibits 1 – 7 (I/A)	Miller Supplemental Exhibits 1 – 7 (I/A)
Ham Exhibits 1 – 2 (I/A)	Ham Exhibits ~~A – I~~ (I/A) F - I
Allred Exhibits 1 – 2 (I/A)	Maness Exhibit 1 (I/A)
NCSEA Exhibits 1 – 2 (I/A)	

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DATE TRANSCRIBED: June 12, 2015

TRANSCRIPT PAGES: 21
PREFILED PAGES: 132

IVA

Ham Exhibit F

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Final Report

Evaluation of the Residential Smart $aver® Additional Measures Program in the Carolina System

Prepared for
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December 10, 2014

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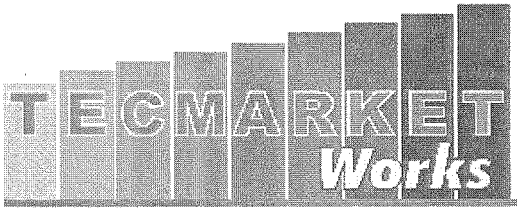

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Executive Summary

Key Findings and Recommendations

An overview of the key findings identified through this evaluation is presented in this section.

Significant Evaluation Findings

1. The attic insulation and whole house infiltration sealing measure provided more than 83% of the savings for the Insulate and Seal component of the program.
2. The duct leakage and sealing measure is most effective in ductwork installed in unconditioned spaces such as attics, where summer temperature, humidity and solar heat gains create conditions that maximize savings. The majority of customers had ducts sealed and insulated in unconditioned basements or crawlspaces, where the impacts are smaller. A small number of customers had ducts sealed and insulated in a conditioned basement. Insulating and sealing ductwork located in conditioned spaces provides no savings.
3. Overall, the energy savings for the Health Check component of the program were estimated at about 4% of compressor energy consumption, compared to the program ex-ante assumption of 10%. Eliminating units with identical test-in/test-out data increased the savings fraction to about 6.3%.
4. Based on the Health Check diagnostics report, about 15% of the work requests brought into the Health Check component of the program did not require any apparent service. The test-in report indicated the unit passed all relevant tests. About 30% of the work requests did not require refrigerant charge or air flow adjustments.
5. Results of the Health Check diagnostics were compared to an independent diagnostic protocol. The results were directionally similar, but the program protocol "passed" more systems than the independent protocol.
6. Quality control checks conducted by this evaluation revealed some potential data quality issues. A small number of measurements provided by the contractors were not physically possible. Identical test-in/test-out data were provided for about 30% of the units, which is unlikely given the program requirement for some level of service as a condition of participation. A large fraction (63%) of the units recorded a time difference of less than 10 minutes between test-in and test-out results. Generally, an HVAC unit should run for at least 10 minutes to attain stable operation. These observations indicate a need to increase quality control on the input data and contractor procedures.
7. The contents of the Health Check diagnostics report were not consistent across all units. The results were inconclusive in about 10% of the reports.

Recommendations

1. To maximize per job energy savings, the program should consider limiting duct leakage and sealing measures to duct systems located in unconditioned spaces. Duct systems located in attics have the greatest potential for energy savings.
2. The program collects valuable information on measure quantities and the results of whole house infiltration and duct leakage tests conducted by participating contractors. Some of these data were not entered into the program tracking database supplied to Duke Energy

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by the program administrator, requiring a supplemental data request. Duke Energy should consider establishing additional data requirements on the program tracking database.

3. Duke Energy should consider revising ex-ante assumptions for the Health Check program to account for customers entering the program with systems that do not require airflow or refrigerant charge adjustments.
4. Duke Energy should consider conducting on-site measurement and verification activities to verify the Health Check efficiency improvements calculated in this evaluation. The results are based on contractor-supplied measurements which may be subject to measurement or data entry errors.
5. Duke Energy should follow up with the Health Check program vendor to investigate physically impossible measurement results and review data entry quality control procedures, and standardize output reporting to unambiguously state the final condition of the unit.
6. Duke Energy should investigate potential performance issues with contractors who provided identical test-in/test-out data or who did not appear to allow sufficient time between test-in and test-out readings.

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Description of Program

The Duke Energy Residential Smart $aver Additional Measures program has two components: 1) Insulation and Seal (IS) offers insulation and sealing services and includes attic insulation, air leakage sealing, duct insulation, and duct leakage sealing; and 2) the Health Check (HC) component provides HVAC system tune-ups, focusing on refrigerant charge and air flow (RCA) adjustments.

Program Participation

This evaluation utilized data from participants in the program from August, 2012 through May, 2014. The number of customers participating in each component is shown below.

Program	Participation Count for August 2012 through May 2014
Residential Smart $aver: Insulate and Seal	346
Residential Smart $aver: Health Check	137

There may be some overlap, as customers in Insulate and Seal may have also participated in Health Check. Individual measure counts are higher, since customers may have participated in more than one aspect of each program and/or had multiple HVAC units serviced at their home.

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Methodology

Participant Surveys

TecMarket Works fielded a telephone survey with randomly selected participants in order to measure freeridership and spillover. Eighty (80) surveys were completed with program participants in the Carolina System whose insulation, sealing, and/or tune-up services were performed between October 17, 2012 and August 25, 2014 according to program records. Roughly half of the participants surveyed live in North Carolina (52.5% or 42 out of 80) and roughly half live in South Carolina (47.5% or 38 out of 80).

Trade Ally Surveys

TecMarket Works fielded a telephone survey with trade allies who participated in the program in order to assess freeridership and spillover. Eighteen (18) surveys were completed with trade allies in the Carolina System who currently participate in this program performing insulation, sealing, and/or tune-up services.

Engineering Analysis

A desk review of the measures installed under the Residential Smart $aver Additional Measures program was conducted. The Insulate and Seal (IS) component included attic insulation, air leakage sealing, duct insulation, and duct leakage sealing. The Health Check (HC) component provided HVAC system tune-ups, focusing on refrigerant charge and air flow (RCA) adjustments. For IS, DOE-2 simulations of prototypical single family residential buildings were conducted to provide unit energy savings estimates for each of the measures installed under the program. The unit energy savings were applied to the measure quantity and type recorded in the program tracking database. For HC, HVAC technician reports were reviewed for each of the participating customers, and the fault detection and diagnostic (FDD) information was reviewed to determine how many customers required RCA service, whether the service was conducted by the technician, whether the system was successfully tuned-up, and how much the efficiency improved as a result of the service. The energy savings were calculated using DOE-2 simulations of prototypical single family residential buildings, based on the incremental improvements in unit efficiency calculated from the FDD information.

Data collection methods, sample sizes, and sampling methodology

Participant Surveys

Duke Energy provided TecMarket Works with a list of 986 records of Additional Measure services performed in the Carolina System (516 in North Carolina and 470 in South Carolina). After aggregating measures by customer account number and removing records with missing contact information or duplicate records, "do not contact" numbers and customers who have recently been surveyed about other programs, the sample list consisted of 699 contactable customers. The survey was conducted by telephone by TecMarket Works staff from the list of 699 participant customers, and 80 respondents completed the survey (42 from North Carolina and 38 from South Carolina). The survey instrument can be found in *Appendix A: Participant Survey Instrument.*

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Trade Ally Surveys

Duke Energy provided TecMarket Works with records for 35 trade allies currently offering Additional Measures services through the Smart $aver program (29 companies based in North Carolina and 6 based in South Carolina). The survey was conducted by telephone by TecMarket Works staff from the list of 35 participating trade allies, and 18 trade allies completed the survey (16 companies from North Carolina and 2 companies from South Carolina). The survey instrument can be found in *Appendix B: Trade Ally Survey Instrument.*

Engineering Analysis

The engineering analysis was conducted on a census of participants. No surveying was required. Data were compiled from the program tracking database and program application information provided by Duke Energy.

Number of completes and sample disposition for each data collection effort

Participant Surveys

From the sample list of 699 participating customers, 383 were called between September 23 and 26, 2014, and a total of 80 usable telephone surveys were completed, yielding a response rate of 20.9% (80 out of 383) and a sample rate of 11.4% (80 out of 699).

Trade Ally Surveys

From the sample list of 35 participating trade allies, all 35 were called between September 24 and October 2, 2014, and a total of 18 usable telephone surveys were completed, yielding a response rate of 51.4% (18 out of 35).

Table 1. Summary of Data Collection Efforts

Smart $aver Additional Measures Program (Insulate & Seal, Health Check)					
Data Collection Effort	**Size of Population in Sample for Surveys**	**# of Attempted Contacts**	**# of Successful Contacts**	**Response Rate (surveyed out of attempted)**	**Sample Rate (surveyed out of population)**
Participant Surveys	699	383	80	20.9%	11.4%
Trade Ally Surveys	35	35	18	51.4%	51.4%

Engineering Analysis

No surveying was done as part of the gross engineering analysis. Participant surveys described above were used to identify spillover measures and calculate spillover savings in the participant survey sample.

Expected and achieved precision

Participant Surveys

The survey sample methodology had an expected precision of 90% +/- 8.7% and an achieved precision of 90% +/- 8.7%.

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Trade Ally Surveys
The survey sample methodology had a targeted precision of 90% +/- 9.5% and an achieved precision of 90% +/- 13.7%.

Engineering Analysis
No surveying was done as part of the gross engineering analysis. Participant surveys described above were used to calculate spillover savings.

Description of baseline assumptions, methods and data sources

Engineering Estimates
The existing or "as-found" condition of the home or the HVAC system defines the baseline. The as-found condition was documented by the installing contractor and submitted on the rebate application. Key data from the applications were provided with the program tracking data. Images of the applications and supplemental site reports on HVAC system tune-ups were also provided and were used to establish the as-found conditions.

Description of measures and selection of methods by measure(s) or market(s)

Engineering Estimates
DOE-2.2 simulations were used to develop unit energy savings estimates for all measures. Engineering calculations based on contractor data from the HVAC system tune-ups were also used to estimate HVAC system efficiency changes resulting from tune-ups. The unit energy savings were applied to measure quantity data from the program tracking database to estimate savings at the customer and program level.

Threats to validity, sources of bias and how those were addressed

Engineering Estimates
Any potential for bias in the engineering estimates is minimized through the use of building energy simulation models, which are considered to be state of the art for building shell and HVAC system analysis. Seasonality in heating and cooling energy use, and the use of natural ventilation during mild weather in the cooling season is incorporated to reduce upward bias in the engineering estimates. The evaluation is a desk review based on data supplied by the installing contractor; no on-site data collection was performed. Independent checks on the data for internal consistency were done to identify potentially erroneous data. The gross analysis was conducted for all participants, eliminating sampling bias or error. Spillover savings were estimated from a random sample of customers to minimize sampling bias in the spillover savings calculations. Engineering biases in the spillover calculations are difficult to quantify, but are expected to be minimal.

Snapback and Persistence
The theoretical additional energy and capacity used by customers that may occur from implementing an energy efficiency product, often called "snapback" if it occurs, was not addressed in this analysis. However, the level of savings resulting from these measures are not expected to encourage snapback. The measures are permanently installed, so removal is unlikely.

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The persistence of savings in HVAC tune-ups however, is not well-known at this time. Impact evaluations tend to focus on first year savings. Longer term studies required to establish persistence have not been conducted for HVAC tune-up measures.

Use of TRM values and explanation if TRM values not used

This evaluation did not rely on a Technical Reference Manual (TRM) to inform the calculation estimating the energy impact. Instead, a more reliable approach using DOE-2 simulations and fundamental engineering equations were used to estimate the savings. Spillover measures were analyzed using a combination of deemed savings estimates from the Duke ex-ante savings database, or calculations using equations from the Ohio TRM.

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Impact Evaluation Results

The impact evaluation used a desk review approach to estimate gross savings. Desk reviews involve reviews of program tracking data and program ex-ante assumptions, accompanied by engineering analysis to estimate energy impacts. On-site surveys and site measurement and verification (M&V) was not conducted; all of the data collection and analysis was done without leaving the desk. Desk reviews are conducted on programs with relatively small expected energy savings, where the costs of more involved primary data collection and M&V are not justified.

The desk review results are presented for the Insulate and Seal (IS) component and the HVAC system Health Check (HC) component separately. The HC program contractors collected extensive HVAC system performance data during the course of HVAC system diagnosis and tune-up, which provided a rich data resource for the evaluation team.

Insulate and Seal

The Insulate and Seal (IS) component included attic insulation, air leakage sealing, duct insulation, and duct leakage sealing. DOE-2 simulations of prototypical single family residential buildings were conducted to provide unit energy savings estimates for each of the measures installed under the program. The prototypical simulation models were derived from the residential building prototypes used in the California Database for Energy Efficiency Resources (DEER) study (Itron 2005), with adjustments made for local building practices and climate. The prototype "model" contains four separate residential buildings; 2 one-story and 2 two-story buildings. Each version of the one story and two story buildings are identical except for the orientation, which is shifted by 90 degrees. A sketch of the residential prototype buildings is shown in Figure 1.

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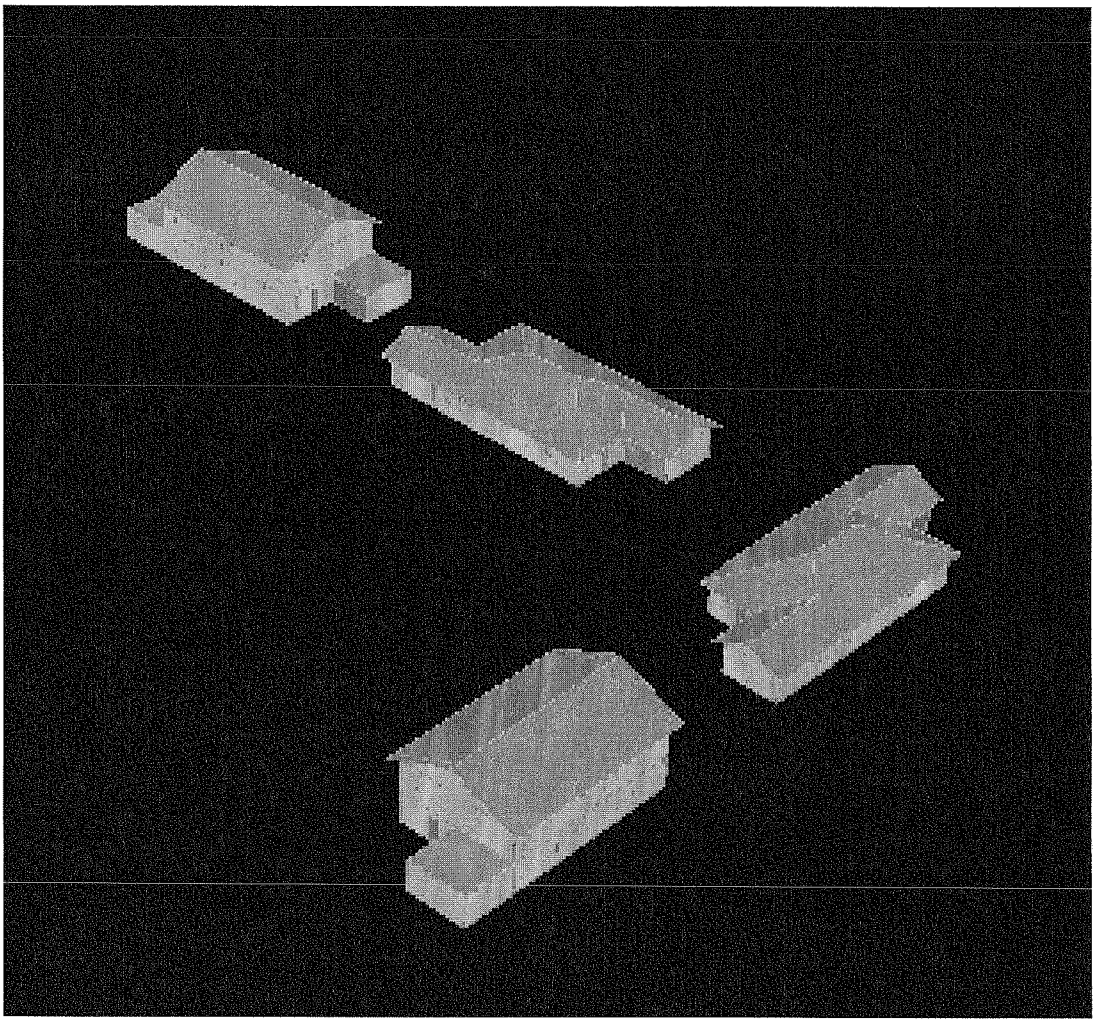

Figure 1. Residential Prototypical DOE-2 Model

The general characteristics of the residential building prototype model are summarized in Table 2.

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Table 2. Residential Building Characteristics

Characteristic	Value
Conditioned floor area	1 story house: 1465 SF (not including basement) 2 story house: 2930 SF (not including basement)
Wall construction and R-value	Wood frame with siding, R-11
Roof construction and R-value	Wood frame with asphalt shingles, R-value varies for each run
Glazing type	Properties vary by vintage
Lighting and appliance power density	0.51 W/SF average
HVAC system types	Packaged single zone AC with gas heat Air source heat pump
HVAC system size	Based on design day sizing run with 20% oversizing.
HVAC system efficiency	SEER = 10 Furnace efficiency = 0.78 AFUE
Thermostat setpoints	Heating setpoint/setback: 70/65 Cooling setpoint/setback: 75/80
Duct location	Buildings without basement: Unconditioned attic Buildings with basement: Basement
Duct surface area	Single story house: 390 SF supply, 72 SF return Two story house: 505 SF supply, 290 SF return
Duct leakage	Varies according to each run, evenly distributed between supply and return
Cooling season	Asheville, NC: Mar 25 - Sep 29 Charlotte, NC: Mar 17 – Oct 6 Greenville, SC: Mar 23 – Oct 7
Natural ventilation	Allowed during cooling season when cooling setpoint exceeded and outdoor temperature < 65°F. 3 air changes per hour

Attic and Duct Insulation

The prototypical simulations provided unit energy savings (UES) kWh/unit and kW/unit estimates for attic insulation, air leakage sealing, duct insulation, and duct leakage sealing measures as a function of HVAC system type. For the attic and duct insulation measures, UES values were developed at a series of discrete pre- and post-installation R-values. A matrix of simulation results is shown in Appendix D: DOE-2 Simulation Results. Pre- and post-installation R-value information were obtained from the program tracking data, and the energy savings were interpolated between the discrete values in the savings tables to estimate the unit energy savings for the specific pre- and post-installation R-values reported in the program tracking database.

Duct Leakage Sealing

The program tracking database contained duct leakage information from the IS contractors. The pre- and post-sealing leakage data were obtained from "duct blaster[1]" tests of the duct system. The leakage data were converted leakage as a percent of total system flow-rate. The DOE-2 simulations provided energy savings estimates at discrete levels of pre- and post-sealing leakage percentages. A matrix of simulation results is shown in *Appendix D: DOE-2 Simulation Results.* These leakage levels were interpolated between the discrete values in the savings tables to

[1] Most, but not all contractors used duct blaster tests to measure pre and post total duct leakage. A few tests were done using a pressure pan method. These test results were converted to % leakage.

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estimate the unit energy savings for the specific pre- and post-installation leakage percentages reported in the program tracking database.

Air Leakage Sealing

The program tracking database contained test-in and test-out information from blower door tests conducted by the IS contractors. The blower door information was converted to natural infiltration rates using the "LBL" method documented in the Energy Conservatory blower door user manual[2]. Reductions in natural infiltration rates were applied to UES values for infiltration reductions from the prototypical building simulations. UES tables for infiltration measures are shown in *Appendix D: DOE-2 Simulation Results*.

Results for Insulate and Seal

The results of the Insulate and Seal measure analysis are shown in Table 3.

Table 3. Insulate and Seal Savings Results

Measure	No. Of Jobs	Savings		Savings per job	
		kWh	kW	kWh	kW
Attic Insulation and Air Sealing	278	323,200	56.2	1,163	0.202
Duct Sealing	147	37,437	9.7	255	0.066
Duct Insulation	53	27,529	5.0	519	0.094
Total		388,165	70.9		

The attic insulation and air leakage sealing measure accounted for about 83% of the savings in the IS component of the program. The duct leakage and sealing measure was applied to homes with ductwork located in basements, crawlspaces and attics. The distribution of duct locations is shown in Table 4.

[2] Energy Conservatory, Minneapolis Blower Door Operation Manual for Model 3 and Model 4 Systems, May, 2004.

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Table 4. Duct System Location for Duct Leakage and Sealing Participants

Measure	Duct location	Number of Jobs
Duct Sealing	Attic	26
	Conditioned Basement	2
	Closed Crawlspace	13
	Uncon bsmt/ Open crawlspace	68
	Missing data	38
	Total	147
Duct Insulation	Attic	5
	Conditioned Basement	1
	Closed Crawlspace	14
	Uncon bsmt/ Open crawlspace	21
	Missing data	12
	Total	53

Note: energy savings from duct leakage sealing and insulation measures were calculated for ducts located in unconditioned spaces only. Sealing and insulating ducts located in the conditioned basements were assigned zero savings in Table 3, since duct losses contribute to meeting heating and cooling loads. Customers with missing data were also assigned zero savings in Table 3. The per customer results with all zero savings jobs removed are shown in Table 5. The number of jobs includes customers with ducts located in conditioned space and only those customers with sufficient data to perform the calculation. Table 5 represents the potential savings from the program if quality control procedures are put in place to reject applications with incomplete data or duct systems located in conditioned spaces.

Table 5. Duct Leakage and Sealing Savings per Job with Ducts in Unconditioned Spaces

Duct Location	Measure	No. of Jobs	Savings		Savings per job	
			kWh	kW	kWh	kW
Attic	Duct Leakage Sealing	26	19,854	5.3	764	0.205
	Duct Insulation	5	7,287	2.0	1,457	0.394
Closed and Open Crawlspace / Unconditioned Basement	Duct Leakage Sealing	81	17,582	4.4	217	0.054
	Duct Insulation	35	20,242	3.0	578	0.086
All Unconditioned Space	Duct Leakage Sealing	107	37,436	9.7	350	0.091
	Duct Insulation	40	27,529	5	688	0.125

Note: No. of jobs includes only those jobs with sufficient data for the calculation.

Health Check

The Health Check (HC) component provided HVAC system tune-ups, focusing on refrigerant charge and air flow (RCA) adjustments. HVAC technician reports were reviewed for each of the

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participating customers, and the fault detection and diagnostic (FDD) information was reviewed to determine how many customers required RCA service, whether the service was conducted by the technician, whether the system was successfully tuned-up, and how much the efficiency improved as a result of the service. The energy savings were calculated using DOE-2 simulations of prototypical single family residential buildings, based on the incremental improvements in unit efficiency calculated from the FDD information. FDD information collected by the technicians included:

- Suction (low side) temperature and pressure
- Liquid (high side) temperature and pressure
- Outdoor drybulb temperature
- Return air drybulb and wetbulb temperatures
- Supply air drybulb temperature
- Outdoor unit current (amps)
- Outdoor unit nominal voltage
- Refrigerant type (R-22 or R-410a)
- Expansion device type (fixed or thermal expansion valve (TXV))

A typical FDD report is shown in *Appendix E: Heath Check Diagnostic Report.*

Air Flow Diagnostics

The unit air flow was assessed by the program contractors using a "T-split" method. The T-split method calculates the difference between the return air and supply air drybulb temperatures (the T-split), and compares the measured T-split to target values established as a function of test conditions. If the T-split is too high, low air flow is the suspected cause. If the T-split is too low, excessive airflow or low cooling capacity is the suspected cause. Two sets of tests are generally run: "test-in" records the results prior to service and is used to diagnose airflow faults. "Test-out" records the condition of the system after airflow adjustments are made, and documents that the airflow is correct. The customer FDD report provided by the program contractor shows the results of the T-split test, the air flow fault diagnosis, and any actions taken by the contractor to correct suspected air flow faults.

The measured T-split values were independently compared to target values, using the T-split diagnostic tables contained in the California Energy Commission (CEC) Title 24 energy efficiency standards documentation[3]. The diagnosis of the system as reported by the contractor was compared to the CEC targets, and an independent diagnosis of air flow faults was developed. The results of this comparison are shown in Table 6.

[3] California Energy Commission Title 24 Joint Appendices, Appendix RA-3, 2008.

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Table 6. Comparison of Vendor and CEC Airflow FDD Protocol Results

FDD Test Result	Vendor		Evaluation	
	Test-In	Test-Out	Test-In	Test-Out
PASS	56	151	53	76
FAIL	69	5	56	32
NO DATA	50	19	66	67
TOTAL	175	175	175	175

Approximately 32% of the jobs passed the Vendor airflow FDD protocol during test-in. Eight-six percent (86%) of the jobs were shown to pass the Vendor FDD protocols at the conclusion of the service. Only 3% of the jobs were recorded as not passing the FDD protocol at the conclusion of the service. The Vendor FDD report was either not available or was inconclusive for the remaining 11% of the jobs.

A similar fraction of the jobs (30%) were shown to pass the CEC FDD protocol at test-in. A smaller fraction (43%) of jobs were shown to pass the CEC protocol at test-out, while 18% of the jobs failed the CEC protocol at test-out. About 38% of tests were conducted outside the allowable test conditions for the CEC protocol, so no FDD information is available for those projects.

The number of jobs passing the vendor FDD protocol at test-out is surprisingly high. It is generally difficult to correct all airflow problems without some ductwork modifications, which are generally outside the scope of tune-up activities. The number of jobs tested outside of the conditions allowed by the CEC protocol indicates the vendor protocol is capable of providing FDD analysis over a wider range of temperature and humidity conditions.

Note, 52 of the 175 jobs (30%) had identical test-in / test-out data. This is highly unlikely, given the program requirement for rendering service on all claimed units and the dynamic nature of HVAC operation. It is possible some contractors may have "gamed" the system by simply copying the test-in data into the test-out field. Also, 110 of the 175 jobs (63%) had test-out data recorded less than 10 minutes after the test-in data were recorded. Generally, an HVAC unit must operate for at least 10 minutes to attain stable operation. It is possible that the contractors were not allowing the units to fully stabilize during the FDD process.

Refrigerant Charge Diagnostics

Refrigerant charge FDD activities were conducted using the vendor FDD tool. The vendor tool uses low side and high side pressure and temperature measurements to calculate the suction (low-side) refrigerant superheat[4] or the liquid (high-side) subcooling[5]. Units with fixed metering devices are diagnosed using the superheat method, while units with TXV metering devices are diagnosed using the subcooling method. Target values for superheat or subcooling are developed

[4] Superheat is defined as the difference between refrigerant gas temperature and the saturation temperature at the measured low-side pressure.
[5] Subcooling is defined as the difference between the saturation temperature at the measured high-side pressure, and the refrigerant liquid temperature.

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as a function of outdoor drybulb temperature and return air wetbulb temperature. Two sets of tests are generally run: "test-in" records the condition of the system prior to service and is used to diagnose refrigerant charge faults. "Test-out" records the condition of the system after service is completed, and documents that the refrigerant charge is correct.

The FDD system uses the difference between the measured and target values to diagnose refrigerant charge faults. Systems with superheat values exceeding the target are generally undercharged, while systems with superheat values under the target are generally overcharged. Conversely, systems with subcooling values exceeding the target are generally overcharged while systems with subcooling values under the target are generally undercharged. Technicians are trained to add or remove refrigerant until the target value is reached. Note: target values are generally expressed as a range, where the target value is the midpoint of the range, and an acceptable deviation (e.g. +/- 5 deg F) is established.

The refrigerant charge FDD information recorded by the contractors was reviewed, and the number of systems requiring service and the results of the service were tabulated. The refrigerant charge diagnostics were independently assessed, using the CEC tables for superheat and a fixed 10 deg subcooling target for all TXV systems. The results of this comparison are shown Table 7.

Table 7. Comparison of Vendor and CEC Refrigerant Charge FDD Protocol Results

FDD Test Result	Vendor		Evaluation	
	Test-In	Test-Out	Test-In	Test-Out
PASS	56	147	77	107
FAIL	85	5	81	53
NO DATA	34	23	17	15
TOTAL	175	175	175	175

Approximately 32% of the jobs passed the Vendor charge FDD protocol during test-in. Eighty-four percent (84%) of the jobs were shown to pass the Vendor FDD protocols at the conclusion of the service. Only 3% of the jobs were recorded as not passing the FDD protocol at the conclusion of the service. These values are nearly identical to the airflow FDD results. The Vendor FDD report was either not available or was inconclusive for the remaining 13% of the jobs.

A slightly higher fraction of the jobs (44%) were shown to pass the CEC FDD protocol at test-in. A smaller fraction (61%) of jobs were shown to pass the CEC protocol at test-out, while 30% of the jobs failed the CEC protocol at test-out. About 9% of tests were either conducted outside the allowable test conditions for the CEC protocol or had insufficient information to conduct the FDD.

The number of jobs passing the vendor FDD protocol at test-out is very high. Although results for about 10% of the jobs were inconclusive, this indicates the contractors were able to complete the charge service for most of the customers. A smaller fraction (61%) of the jobs passed the

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CEC protocol at test-out. This is not surprising, since different protocols can produce different FDD results[6]. The CEC protocol expects the technicians to meet target values within +/- 5 degrees F. Loosening the tolerance on the test data will increase the number of jobs that pass. The subcooling criterion used in this desk review is a nominal value of 10 degrees F. Target subcooling values recommended by the manufacturer are on a label in the unit and are generally available to the technicians during service. Using the actual subcooling criteria from the manufacturer may result in more systems passing the FDD test at test-out than the typical value assumed in this desk review.

System Efficiency Improvements

The FDD data collected by the contractors was used to estimate changes in system efficiency as a result of the HC tune-up. The unit efficiency was defined as:

Efficiency = cooling delivered / input power

A refrigerant-side analysis was used to estimate delivered cooling. The refrigerant enthalpy (in Btu/lb) entering and leaving the evaporator was estimated from the refrigerant temperature and pressure measurements. The evaporator entering enthalpy was estimated from the liquid side temperature and pressure, assuming an isentropic (constant enthalpy) expansion process across the expansion device. The evaporator leaving enthalpy was calculated directly from the low side temperature and pressure measurements. Refrigerant mass flow rate (lb/hr) was estimated using a typical compressor curve and the compressor entering and leaving pressures[7]. Input power was estimated from the outdoor unit current and nominal voltage; and a constant power factor assumption of 0.9. The details of the efficiency analysis are shown in *Appendix F: Compressor Energy Savings Analysis*.

The results of the efficiency improvement analysis are shown in Table 8.

Table 8. Efficiency Improvement Analysis Results

Parameter	Number of Observations[8]	Average Change	Relative Precision	Confidence Interval
Compressor efficiency	149	4.1%	+/- 56%	1.7% - 6.5%

Note, the coefficient of variation[9] in the results was on the order of 4.3; thus the relative precision in the mean savings is fairly poor, even with a fairly large number of sites in the analysis.

An additional calculation of efficiency change was conducted, where sites that tested in OK or had identical test-in/test-out data were eliminated. The purpose of this calculation is to estimate

[6] Yuill, D and J Braun. Evaluating Fault Detection and Diagnostics Protocols Applied to Air-Cooled Vapor Compression Air Conditioners. Purdue University, West Lafayette, IN. 2012.
[7] Compressor discharge pressure was estimated to be 15 psig above the liquid line pressure to account for condenser pressure drop.
[8] Units with missing or physically impossible data were removed from the analysis.
[9] The coefficient of variation (CV) is defined as the sample standard deviation divided by the mean. A CV of 0.5 to 1.0 is typically assumed in sample design calculations.

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the potential savings after jobs not meeting the program criteria were eliminated. The results are shown in Table 9.

Table 9. Efficiency Improvement Analysis Results with Ineligible Units Removed.

Parameter	Number of Observations	Average Change	Relative Precision	Confidence Interval
Compressor efficiency	81	6.3%	+/- 52%	3.0% - 9.6%

Results from Health Check

The average efficiency change was projected into the annual compressor energy consumption from the DOE-2 simulations to estimate the overall energy and peak demand impacts. The results are shown in Table 10.

Table 10. Estimated Energy Savings Resulting from the Health Check Component

System	kWh/ton	kWh/unit	Units	Total
AC Tune-Up	23.4	70.2	83	5,827
Heat Pump Tune-Up	79.1	237.2	92	21,823
Totals			175	27,650

Projecting the potential savings from Table 9 into the DOE-2 simulation results gives the following per-unit savings estimates:

Table 11. Unit Savings Estimates with Ineligible Units Removed

System	kWh/ton	kWh/unit
AC Tune-Up	28.2	84.5
Heat Pump Tune-Up	148.1	444.2

In the analysis above, compressor efficiency changes were estimated during tests with the unit in cooling mode. The same incremental change in efficiency is assumed to apply to heat pump compressor operation in heating mode. Although approximately 15% of the units passed the vendor FDD protocol at test-in and did not require service, savings were claimed in the program tracking database for all jobs. According to the analysis described above, HC activities improved the efficiency of the units by about 4% across all participants. When units that tested in OK or units with identical test-in/test-out data were removed from the analysis, the savings percentage went up to about 6.3%. These savings fractions are lower than the program ex-ante assumption of 10% savings across all units. Based on these results, the program can be expected to achieve about a 6.3% savings in compressor energy once enhanced quality control procedures designed to eliminate ineligible units or screen out erroneous data are implemented.

The vendor and CEC FDD protocols returned different results, with the vendor protocol providing more "PASS" results than the CEC protocol in all cases. It is expected that two protocols will return different results, but the systematic differences in the results may warrant some field investigation. We did note some of the test-in and test-out values were identical except for the date/time stamps which seems unlikely. We also noticed some "non-physical" data in the reports, meaning temperature and pressure values recorded in the reports for liquid

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refrigerant turned out to describe refrigerant in a gaseous state, and vice versa. Presumably, the vendor FDD system has internal checks to identify potentially erroneous data, but these checks were not effective in all cases.

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Net-to-Gross Analysis for Impact Estimates

Freeridership

TecMarket Works utilized three sets of questions from the participant survey to estimate freeridership.

For the first set of calculations, the primary "gateway" question asks whether they would have had the rebated services performed without the Smart $aver program. Follow-up questions ask those who say they would have delayed these services to estimate how long they would have delayed the purchase, and ask those who say they would have had a different service performed instead what service would have been performed without the program.

The gateway question asked survey respondents what their behavior would have been if the Smart $aver rebate program had not been available. The four categories of response are:

a.) exact same service at the same time

b.) exact same service at a later time

c.) would have had a different service performed

d.) no service would have been performed

The breakdown of responses to the gateway question can be seen in Table 12 and Table 13. Participants who indicated that they would have bought the same unit at the same time were assigned a gateway freeridership score of 100%. Participants answering that they would not have any service performed without the program are assigned 0% gateway freeridership.

Freeridership for participants who indicated that they would have had a different service, or the same service performed at a later time, are assigned gateway freeridership scores higher than 0% and less than 100% based on the alternative service and/or the length of delay.

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Table 12. Gateway Freeridership Responses for Insulation and Sealing Measures

Gateway question response and gateway freerider score	Attic Insulation & Sealing (N=32)	Duct Insulation (N=10)	Duct Sealing (N=19)
Exact same service at same time (100% freerider)	56.3%	90.0%	68.4%
Exact same service within 6 months (75% freerider)	0.0%	0.0%	0.0%
Exact same service 6-12 months later (50% freerider)	6.3%	0.0%	0.0%
Exact same service 12-24 months later (25% freerider)	0.0%	0.0%	0.0%
Exact same service than 24 months later (0% freerider)	3.1%	0.0%	0.0%
Exact same service, not sure when (mean % freerider of the five rows above)	6.3%	0.0%	10.5%
Different service performed without the program (0% to 75% freerider, depending on the alternate service considered)	12.5%	0.0%	0.0%
No service performed without the program (0% freerider)	12.5%	10.0%	21.1%
Not sure what would have happened without the program (withhold from freeridership calculations)	3.1%	0.0%	0.0%

Table 13. Gateway Freeridership Responses for HVAC Health Check Measures

Gateway question response and gateway freerider score	Heat pump tune-ups (N=16)	AC tune-ups (N=21)
Exact same service at same time (100% freerider)	75.0%	76.2%
Exact same service within 6 months (75% freerider)	12.5%	0.0%
Exact same service 6-12 months later (50% freerider)	0.0%	4.8%
Exact same service 12-24 months later (25% freerider)	0.0%	0.0%
Exact same service than 24 months later (0% freerider)	0.0%	0.0%
Exact same service, not sure when (mean % freerider of the five rows above)	6.3%	4.8%
Different service performed without the program (0% to 75% freerider, depending on the alternate service considered)	0.0%	9.5%
No service performed without the program (0% freerider)	6.3%	4.8%
Not sure what would have happened without the program (withhold from freeridership calculations)	0.0%	0.0%

The responses to the gateway question indicate that a significant number of people were to some degree considering taking the same or similar action before their exposure to the program.

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However, self-reported intent alone is not a predictor of actions; a set of adjustment questions are asked to assess the degree to which a participant might take a specific action in the absence of program. Net to gross (freerider) analysis is based on the participant's responses to a series of questions which together allow the evaluation expert to predict the degree to which the program played a role in causing a specific event or action to occur.

The first set of adjustments to the gateway freeridership question is based on questions which ask how participants found out about the Additional Measures program.

The four main categories of responses to these questions are:

a.) customer contacted trade ally about something other than the services performed through the Additional Measures program, and this program was recommended

b.) a trade ally recommended the Additional Measures program to the customer during a routine maintenance or service call

c.) a trade ally contacted the customer to solicit their participation the Additional Measures program (including via advertising)

d.) customer found out about the Additional Measures program from somewhere other than a trade ally and then sought out a participating trade ally (including Duke Energy website and flyers)

The breakdown of responses to the first adjustment factor can be seen in Table 14 and Table 15. Participants who indicated that they contacted a trade ally about something other than the services offered by this program and had Additional Measures recommended to them receive a multiplier adjustment of 1.0 (no change), since this behavior indicates that they had an intention to do something relating to the program-rebated services before learning about the program (otherwise they would not have contacted an HVAC or insulation contractor on their own initiative).

Customers who first found out about the program from a trade ally who had already come to their home for some type of maintenance or repairs receive a multiplier adjustment of 0.5 (gateway freeridership reduced by 50%), since this behavior is less indicative that they had intended to do something similar to the rebated services before the program (these customers could have declined the Additional Measures that were recommended, or chosen to do something else instead, such as HVAC replacement).

Customers who were contacted by a trade ally soliciting their program participation, and customers who found out about the program from somewhere other than a trade ally (usually from Duke Energy program marketing), receive a multiplier adjustment of 0.25 (gateway freeridership reduced by 75%). Responding to program information and vendor solicitations is less indicative of freeridership, and more indicative of the program having a direct influence on customer's decision-making.

Three surveyed participants who had attic insulation and air sealing performed (9.4% of 32) reported that they found out about the program when their property manager or condo

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association told them that arrangements had been made for their building to participate. These three participants are withheld from freerider calculations for this measure, since they did not make the decision to participate. For the other four measures in this program, all surveyed participants were the decision makers.

Table 14. Freeridership Adjustments for Insulation and Sealing Measures Based on How Customers Found Out About the Program

Gateway question response and gateway freerider score	Attic Insulation & Sealing (N=32)	Duct Insulation (N=10)	Duct Sealing (N=19)
Customer contacted the trade ally about something other than the program and this program was recommended (adjustment multiplier: 1.0)	18.8%	10.0%	10.5%
Trade ally suggested during routine maintenance or service call (adjustment multiplier: 0.5)	12.5%	40.0%	10.5%
Trade ally contacted customer to solicit participation (adjustment multiplier: 0.25)	0.0%	0.0%	0.0%
Customer found out about the program somewhere else and sought a participating trade ally (adjustment multiplier: 0.25)	56.3%	40.0%	68.4%
Not sure / don't recall (adjustment multiplier: mean adjustment multiplier for customers who gave the same response to the gateway question)	3.1%	10.0%	10.5%
Property manager / condo association made arrangements (withhold from freeridership calculations)	9.4%	0.0%	0.0%

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Table 15. Freeridership Adjustments for HVAC Health Check Measures Based on How Customers Found Out About the Program

Gateway question response and gateway freerider score	Heat pump tune-ups (N=16)	AC tune-ups (N=21)
Customer contacted the trade ally about something other than the program and this program was recommended (adjustment multiplier: 1.0)	0.0%	14.3%
Trade ally suggested during routine maintenance or service call (adjustment multiplier: 0.5)	50.0%	57.1%
Trade ally contacted customer to solicit participation (adjustment multiplier: 0.25)	12.5%	0.0%
Customer found out about the program somewhere else and sought a participating trade ally (adjustment multiplier: 0.25)	37.5%	28.6%
Not sure / don't recall (adjustment multiplier: mean adjustment multiplier for customers who gave the same response to the gateway question)	0.0%	0.0%
Property manager / condo association made arrangements (withhold from freeridership calculations)	0.0%	0.0%

The second and final set of adjustments to gateway freeridership is based on questions which ask participants to rate the influence of the Smart $aver incentive and the Smart $aver program information and technical assistance. Influence ratings were provided for both the program incentive and information, using a ten-point scale where "1" indicates minimal influence and "10" indicates maximum influence.

Participants were also asked if they were aware of the incentive rebate at the time they made the decision to participate in the program. If the participant was not aware of the incentive, then their rating for the influence of the program information and technical assistance is used to assign their adjustment multiplier (since the incentive rebate could not have influenced their decision if they did not know they were getting a rebate when they made this decision). If the participant was aware that they would receive an incentive, then the higher of their two influence scores is used.

The adjustment multipliers associated with participants' influence ratings are shown in Table 16. A high influence rating ("10") receives a .05 multiplier (reduces freeridership score by 95%) while a low influence score ("1") receives a 2.0 multiplier (doubles freeridership score) and moderate scores of "5" and "6" receive 1.0 multipliers (no change to freeridership score).

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Table 16. Freeridership Adjustment Multipliers Assigned for Influence Ratings

Influence rating	Freeridership Adjustment Multiplier
10 (most influence)	0.05
9	0.25
8	0.50
7	0.75
6	1.00
5	1.00
4	1.25
3	1.50
2	1.75
1 (least influence)	2.00

The average influence ratings given by participants are presented in Figure 3 on page 37. The algorithm described above (using the higher of two ratings unless they were not aware of the rebate when they decided to participate) produces average program influence ratings of 7.94 for attic insulation, 7.10 for duct insulation, 8.11 for duct sealing, 7.38 for heat pump tune-ups and 7.19 for AC tune-ups.

The final step is to multiply the baseline freeridership scores by the two adjustment factors for every participant with valid responses, which produces a freeridership score for each measure received by each participant. Measure-level freeridership is the average freerider score among surveyed participants who received that measure: duct sealing has the lowest level of freeridership at 11.6% and AC tune-ups have the highest at 29.9%, as seen in Table 17.

Program-level freeridership is calculated by weighting the measure-level freerider scores according to the distribution of measures in the participant population. Thus, program-level freeridership for the Smart $aver Additional Measures program is estimated at 19.6%.

Table 17. Freeridership by Measure and at the Program Level

Program measure	Average freeridership score for measure	Valid surveys used to calculate freeriders	Measure count in participant population	Measure percent in participant population	Weighted contribution to program freeridership (FR X % in population)
Attic insulation and air sealing	**14.6%**	29	343	34.8%	.0509
Duct insulation	**24.8%**	10	75	7.6%	.0189
Duct sealing	**11.6%**	19	192	19.5%	.0225
Heat pump tune-up	**23.7%**	16	170	17.2%	.0408
Air conditioner tune-up	**29.9%**	21	206	20.9%	.0625
				Program-level freeridership:	**19.6%**

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Validity and Reliability of the Freerider Estimation Approach

The field of freeridership assessment as specified in the California Evaluation Protocols basic estimation approach requires the construction of questions that allow the evaluation contractor to estimate the level of freeridership. The basic approach used in this evaluation is based on the results of a set of freerider questions incorporated into participant survey instruments that meets the reliability standards for freerider questions. The approach used in this assessment examines the various ways in which the program influences the customer's decision to have incented measures performed as part of the Residential Smart $aver Additional Measures program, and allocates a freeridership factor for each of the types of responses contained in the survey questions. The allocation approach assigns high freeridership values to participants who would have acquired the same services on their own, and that factor is influenced by their stated intentions regarding the timing and efficiency level of this acquisition. The scoring approach is proportional to the degree to which the participant would have acquired equivalent services on their own.

Spillover

In order to estimate the spillover savings attributed to the program several questions were added to the participant questionnaire aimed at determining the extent to which the program's information and incentives caused additional non-incented spillover actions to be taken by the participants. All 80 survey participants answered the net to gross question battery.

Respondents that had taken additional measures were asked about the type of equipment and when it was installed. No spillover was assigned to those respondents that took additional actions unless they also indicated that their experience with the program influenced them, to some degree, to take additional actions. Influence of the program was rated on a scale from one to ten, with ten being the most influential.

This rating is referred to as the participant's attribution score. Spillover savings was adjusted based on the strength of their attribution score. For example, if the respondent indicated an attribution score of seven out of ten, then their spillover savings were multiplied by 0.7 to estimate their spillover contribution to the program net to gross ratio.

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Table 18. Participant Spillover Savings and Attribution

Measure	kWh Savings	Attribution Score	Spillover kWh Savings
14.5 SEER AC	525	10	525
Weatherstripping doors, fireplace, and windows, water heater wrap	426	10	426
Water heater	277	10	277
Outlet gaskets	20	10	20
Setback Thermostat, window and door sealing	602	8	482
Cool roof	83	8	66
Geothermal heat pump, new windows	8,578	7	6,005
Outlet gaskets	20	6	12
Setback Thermostat	531	5	266
New windows, new door	462	5	231
Water heater	277	4	111
Window sealing	63	4	25
TOTAL	11,866		8,446

There were 12 survey participants who took additional actions for which enough information was provided to calculate energy savings. Their savings, attribution scores, and spillover contributions are shown in Table 18.

Spillover energy savings were estimated from the customer description of the measure taken and ex-ante savings estimates from the Duke Energy Midwest Master Database for that measure, or in the case of the infiltration measures, using the ASHRAE tables, equations, and calculation methods described in the 2005 ASHRAE Fundamentals Handbook, Chapter 27, "Ventilation and Infiltration." Tables S3.1, S3.2, S3.3, and S3.4.

The spillover savings were not subject to ex-post evaluation. Actions taken by respondents that provided insufficient data to estimate impact, or whose attribution score was one out of ten, received zero spillover credit. Table 19 shows the spillover percentage for the program of 12.4%.

Table 19. Spillover Percentage

Survey Respondent kWh Savings Excluding Spillover	Survey Respondent Spillover kWh savings	Spillover Percentage
68,297	8,446	12.4%

Program Net to Gross Adjustment

The combination of the reduction in energy savings attributed to freeriders plus the adjustment attributed to spillover provides a net to gross ratio of 90.4%.

The net to gross ratio is calculated as follows:

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Program Freeridership = 19.6%
Program Spillover = 12.4%
NTGR = (1 + spillover) * (1 – freeridership)
= 1.124 * 0.804
= 0.904

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Participant Survey Results

Program Participation

TecMarket Works surveyed 80 program participants in the Carolina System who received rebates for insulation and sealing and/or HVAC tune-ups through the Duke Energy Residential HVAC Energy Efficiency Program, also referred to as the Smart $aver Additional Measures program. The distributions of measures among surveyed participants and among the entire population of participants are shown in Table 20. All surveyed customers confirmed the receipt of the measures that were shown in program records.

Four out of five program participants only received one rebated measure from the program (82.5% of surveyed customers and 81.0% of the program population), and none received more than three different measures from the program. The most common measure received from this program is attic insulation and air sealing (performed for 40.0% of surveyed customers and 42.7% of the program population), and the least common is duct insulation (performed for 12.5% of surveyed customers and 9.3% of the program population).

Table 20. Measures Received by Program Participants

	Surveyed Participants (N=80)		Total Program Participation (N=804)	
Measures installed:	**Count**	**Percent**	**Count**	**Percent**
Attic insulation & air sealing	32	40.0%	343	42.7%
Duct insulation	10	12.5%	75	9.3%
Duct sealing	19	23.8%	192	23.9%
Heat pump tune-up	16	20.0%	170	21.1%
Central air conditioner tune-up	21	26.3%	206	25.6%
Number of measures installed per participant:				
One measure	66	82.5%	651	81.0%
Two measures	10	12.5%	124	15.4%
Three measures	4	5.0%	29	3.6%

Percentages total to more than 100% because participants can receive multiple measures.

More than a third of surveyed customers (36.3% or 29 out of 80) report that they have participated in other Duke Energy programs, as seen in Table 21. The most-mentioned programs are Residential Smart $aver: Free CFLs (20.0% or 16 out of 80) and Power Manager (10.0% or 8 out of 80). Five surveyed participants (6.3% of 80) have also received rebates for installing new heat pumps or central air conditioners through the Residential Smart $aver HVAC program.

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Table 21. Participation in Other Duke Energy Programs

	Surveyed Participants (N=80)	
	Count	Percent
Participated in other Duke Energy programs	**29**	**36.3%**
Free CFLs	16	20.0%
Power Manager	8	10.0%
Residential Smart $aver HVAC	5	6.3%
Home Energy House Call	4	5.0%
My Home Energy Report	3	3.8%
Appliance Recycling	1	1.3%
Savings Store (specialty bulbs)	1	1.3%
Other, listed below	3	3.8%
Have not participated in other Duke Energy programs	**48**	**60.0%**
Don't know / can't recall	**3**	**3.8%**

Percentages total to more than 100% because participants can participate in multiple programs.

Three participants mentioned participating in other Duke Energy programs, which are listed below.

- *I think I participated in a rebate program after having a new roof and windows installed.*[10]
- *I made an appliance purchase through Duke in the 1980s.*
- *I pay the all-electric e-rate.*

Only about a third of surveyed program participants had previously hired the vendor or contractor who performed their Smart $aver-rebated services, as seen in Table 22.

Table 22. Participant Relationship with Trade Allies

	Surveyed Participants (N=80)	
	Count	Percent
Had hired this contractor/vendor before participating in the Additional Measures program	27	33.8%
Never hired this contractor/vendor before participating in the Additional Measures program	52	65.0%
Don't know / can't recall	1	1.3%

Figure 2 shows how customers found out about the Additional Measures program, which differs by the measures that were performed. Participants who had heat pump (50.0% or 8 out of 16) and AC tune-ups (57.1% or 12 out of 21) were most likely to have learned about the program from a trade ally during a service call or routine maintenance visit. A majority of customers who had duct sealing (52.6% or 10 out of 19) and pluralities of those who had duct insulation (40.0%

[10] This customer is mistaken, as Duke Energy does not offer rebates for these measures.

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or 4 out of 10) and attic insulation (34.4% or 11 out of 32) learned about the program through communications from Duke Energy. Heat pump tune-ups were the only measures for which customers said trade allies had solicited them directly about participation (25.0% or 4 out of 16). Attic insulation and air sealing was the only measure for which customers said they were informed by their landlords (9.4% or 3 out of 32).

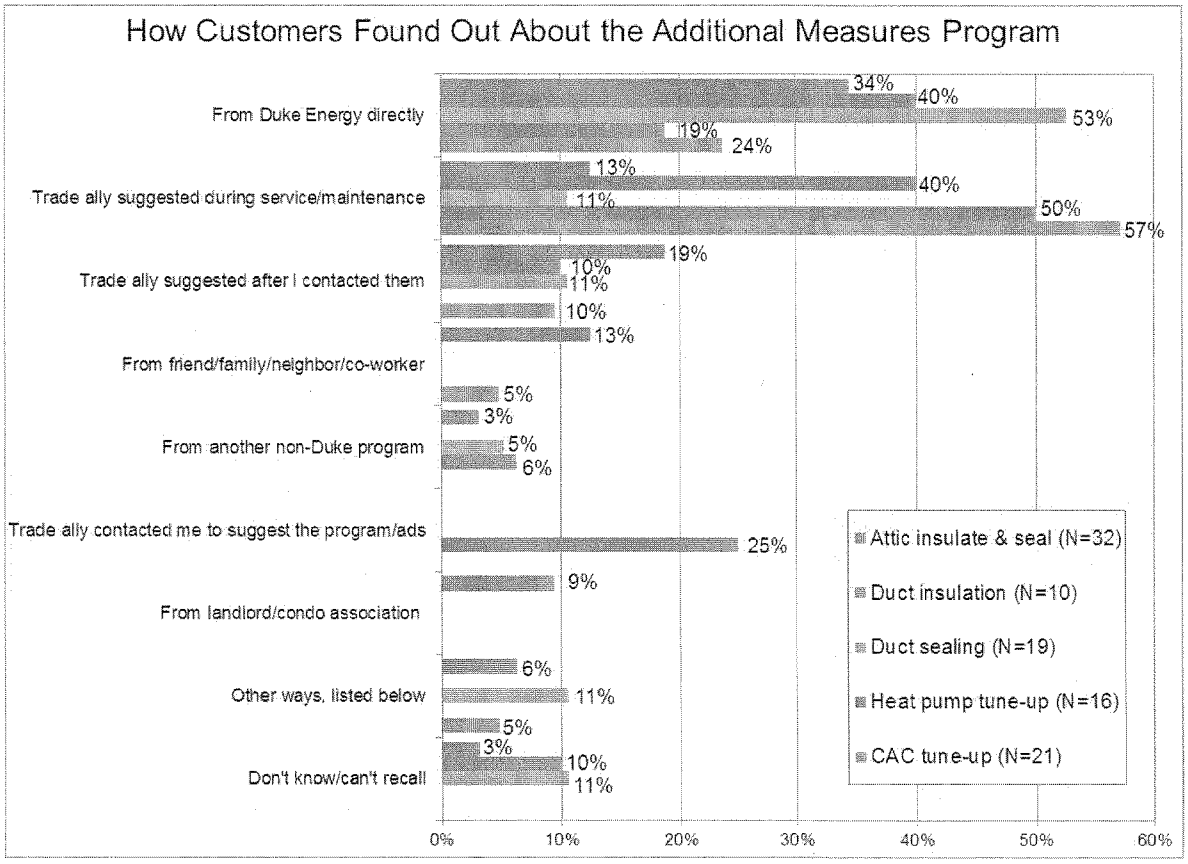

Figure 2. Source of Program Awareness by Measure Received

Three participants (accounting for five measures) learned about the program in "other ways", which are listed below.

- *I had gotten a mailing from Duke Energy about the program and the contractor we went with was also a participating vendor. So we heard about the program twice.* (Attic insulation and duct sealing)
- *I learned about the program in a newspaper article, which led me to then contact the city government representative that is coordinating the program for the City of Greensboro Accounting Division/Planning and Community Development.* (Attic insulation and duct sealing)
- *I was researching online for a company to give me a second opinion on whether I needed a service recommended by my home warranty company and I found the program listed on Carolina Heating's website.* (Air conditioner tune-up)

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Three participants (accounting for three measures) learned about the program from other non-Duke Energy programs, which are listed below.

- *I participated in the Worthwhile Investments Save Energy (WISE) program. They informed me about the Smart $aver program.* (Attic insulation)
- *The Chapel Hill Wise Homes and Buildings Program, who offered to pay 60% of the costs for these additional energy efficiency measures, must have signed us up for the program. I was otherwise unaware of the rebate program until a check from Duke Energy was sent to me.* (Duct sealing)
- *Saint Paul Catholic School sent us some information about the program by giving our kids pamphlets to take home.* (Heat pump tune-up)

Many customers learned about the Additional Measures program directly from Duke Energy; the channels they received these communications through are listed in Table 23. Most customers who heard about the program from Duke Energy first heard about it from Duke Energy mailings; this is true for all specific measures except for heat pump tune-ups, where two of the three participants who learned about the program from Duke Energy found out about it at the website.

Table 23. Channels for Participants Who Found Out About the Program from Duke Energy

Base: customers who heard about the program from Duke Energy	Attic insulate & air sealing (N=11)	Duct insulation (N=4)	Duct sealing (N=10)	Heat pump tune-up (N=3)	CAC tune-up (N=5)
Mailings or bill inserts	54.5%	75.0%	80.0%	33.3%	80.0%
Duke Energy website	18.2%	25.0%	10.0%	66.7%	0.0%
Duke Energy representative or another Duke Energy program	18.2%	0.0%	10.0%	0.0%	20.0%
Not specified	9.1%	0.0%	0.0%	0.0%	0.0%

Four customers mentioned that they heard about this program from a Duke Energy representative or through participation in another Duke Energy program: Two participants who received attic insulation found out about this program through participation in Home Energy House Call, one participant who received duct sealing heard about it while participating in the Appliance Recycling program, and one participant who received an AC tune-up reported that "*a Duke representative told me about it at an event in Greenville; I can't remember what the event was.*"

Participants were asked if they were aware that they would be receiving a rebate from the program when they made their decision to participate. As seen in Table 24, a clear majority of participants were aware of the rebate for every measure in the program; awareness of the rebate ranges from 68.4% (13 out of 19) for duct sealing up to 81.3% (13 out of 16) for heat pump tune-ups.

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Table 24. Customers' Awareness of the Program Rebate When Deciding To Participate

Percent of customers who were aware of the rebate when they made their decision to participate	Surveyed Participants	
	Measures installed	Percent aware of rebate
Attic insulation & air sealing	32	71.9%
Duct insulation	10	70.0%
Duct sealing	19	68.4%
Heat pump tune-up	16	81.3%
Central air conditioner tune-up	21	71.4%

Measures Received

The Additional Measures program provides three insulation and sealing measures: attic insulation and air sealing, duct insulation, and duct sealing. Participants who received these measures were asked what they would have done if the Duke Energy Additional Measures program had not been available to them. Table 25 shows that most participants believe they would have done the same thing at the same time without the Duke Energy program.

Table 25. Insulation and Sealing Measures: What Would Have Happened in the Absence of the Program

	Attic Insulation & Air Sealing (N=32)	Duct Insulation (N=10)	Duct Sealing (N=19)
Exact same service at same time	56.3%	90.0%	68.4%
Exact same service at a later time	15.6%	0.0%	10.5%
Would have had a different service performed	9.4%	0.0%	0.0%
Would not have had any service performed	12.5%	10.0%	21.1%
Would have done something else (none of the above)	3.1%	0.0%	0.0%
Don't know / can't recall	3.1%	0.0%	0.0%

Customers who said they would have had different services performed (or done "something else" instead of the services performed by the program) were asked what they would have done instead; these responses are listed below. None of the participants who received duct sealing or duct installation measures reported that they would have had a different service without the program.

Attic insulation & air sealing (N=4)

- *I would have had the attic insulation and air sealing done, but I would have gone with a different contractor who quoted me with a cheaper price and the quality of the rating of the insulation was not as good as what I eventually went with.*
- *We would have chosen a similar yet less expensive service.*
- *I would have only had the garage insulated.*

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- *I've been having breathing problems and was trying to figure out what I should have done. This was suggested to me and it worked out very well.*

The Additional Measures program also provides two HVAC "Health Check" measures: heat pump tune-ups and central air conditioner tune-ups. As seen in Table 26, most participants who received these measures also report that they believe they would have done the same thing at the same time without the Duke Energy program.

Table 26. Health Check Measures: What Would Have Happened in the Absence of the Program

	Heat Pump Tune-Up (N=16)	Central AC Tune-Up (N=21)
Exact same service at same time	75.0%	76.2%
Exact same service at a later time	18.8%	9.5%
Would have had a different service performed	0.0%	0.0%
Would not have had any service performed	6.3%	4.8%
Would have done something else (none of the above)	0.0%	9.5%
Don't know / can't recall	0.0%	0.0%

Customers who said they would have had different services performed (or done "something else" instead of the services performed by the program) were asked what they would have done instead; these responses are listed below. None of the participants who received heat pump tune-ups reported that they would have had a different service without the program.

Central AC tune-up (N=2)

- *Either way, I still had to have AC service work performed so that it would properly cool.*
- *I was contacting the vendor, Carolina Heating, for a second opinion on whether my coils needed to be acid washed, so I would have had that service done either by Carolina Heating or my home warranty-covered company. The PSI was set too high for a couple years and they found that the relay was just on the borderline of being out of spec; these were the reasons my air conditioner was not performing well. My coils weren't so dirty they needed a $400 procedure. He said I could wash those off with a garden hose.*

Participants were asked to rate the influence of the program rebate, program information and technical assistance on a ten-point scale where "10" indicates the highest possible influence. Average influence ratings are shown in Figure 3 and range from 5.8 to 7.5 which indicates moderate to high levels of influence. For all measures in this program, customers report that the information and technical assistance had a greater influence on participation than the rebate.

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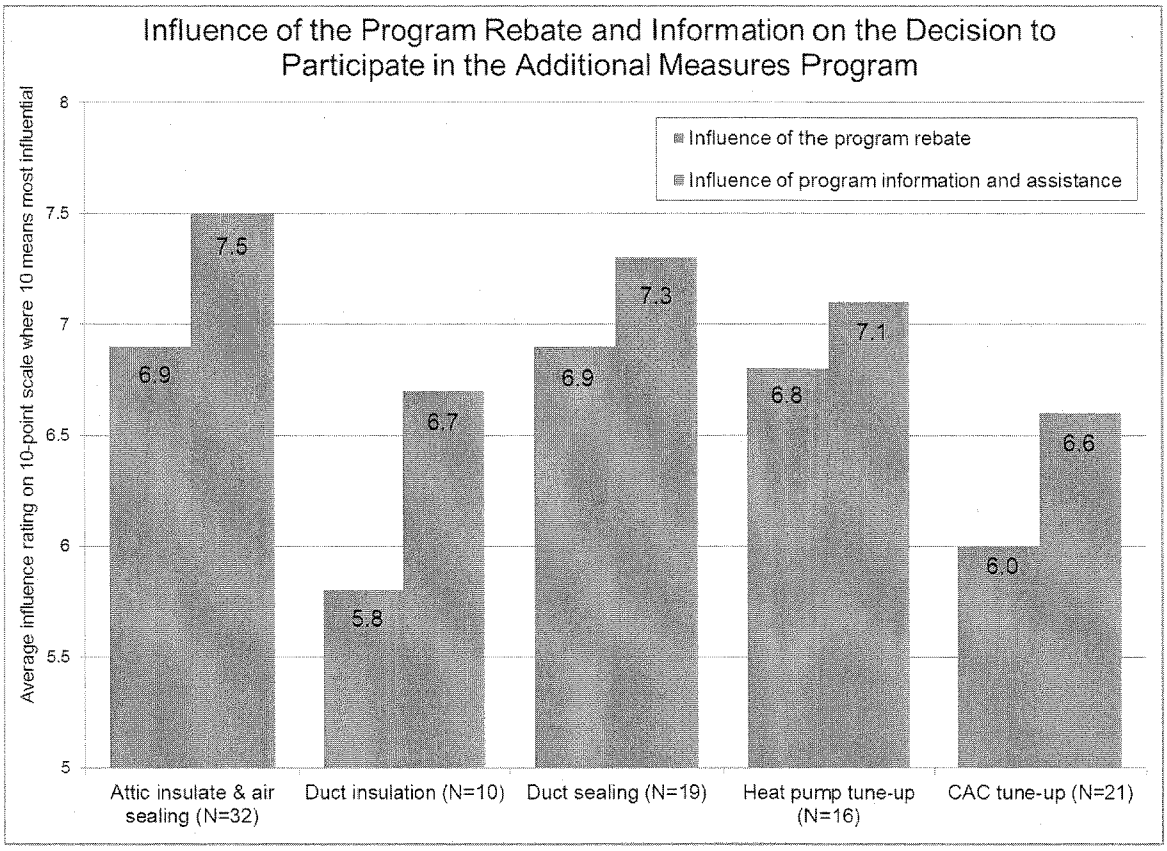

Figure 3. Influence of the Rebate and Information on Program Participation

Participants were asked if they had anything else done at the same time that they had their program-rebated services performed. Table 27 indicates that most duct sealing (80.0%) and duct insulation (68.4%) measures were accompanied by other repairs and services, as were about half of attic insulation and air sealing measures (53.1%). However, only a minority of heat pump (31.3%) and AC tune-ups (33.3%) involved other repairs or services being performed.

Table 27. Other Repairs and Services Performed at the Same Time as Program Measures

	Surveyed Participants	
	Measures installed	**Percent with other repairs and services at the same time**
Attic insulation & air sealing	32	53.1%
Duct insulation	10	80.0%
Duct sealing	19	68.4%
Heat pump tune-up	16	31.3%
Central air conditioner tune-up	21	33.3%

Participants were also asked to rate the influence of the Additional Measures program on their decision to have other work done at the same time. Table 28 through Table 32 list all actions reported by customers who gave the program an influence rating of at least "2 out of 10" on a ten-point scale where "10" means most influential. The simultaneous actions inspired by each

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measure are listed in a separate table; some actions are included in more than one table for customers who received more than one program measure.

Table 28. Other Repairs and Services Performed at About the Same Time as Attic Insulation and Air Sealing (N=13)

Actions taken at about the same time as program participation that have influence ratings of "2 out of 10" or higher	Rating of program influence on actions (10-point scale)
We installed a new central AC.	10
Duct Sealing (two measures from this program at once)	10
Duct sealing; vector support; insulation on two water heaters, sealing in the furnace closet, weatherstripping and air sealing around three exterior doorframes, around the fireplace mantel, and around windows; air sealing around skylights in the attic; and improvements to the vapor barrier underneath the house.	10
I had the garage attic space insulated as well.	10
I put in a solar attic fan as well.	8
I had a new high-efficiency roof put on.	8
We installed an insulated blanket above the access door in our attic.	7
We had geothermal done, new duct work and new windows installed.	7
I also got a new heat pump.	7
We encapsulated the crawl space at the same time as well. We also changed out the panes of glass in a large bay window to low-E. We also replaced an old door with a more substantial, new, solid wood door. The energy audit (HEHC) we had before the attic insulation was installed was the most influential aspect of making all these improvements.	5
I had a new air handler and heat pump installed.	5
Duct sealing; they also did work for drainage issues and a wet crawlspace.	4
I had my windows sealed, vacuum testing, I switched out many CFLs to LEDs, and I had my heat pump tested for amount of flow.	4

Table 29. Other Repairs and Services Performed at About the Same Time as Duct Insulation (N=6)

Actions taken at about the same time as program participation that have influence ratings of "2 out of 10" or higher	Rating of program influence on actions (10-point scale)
I had a new furnace, whole-house humidifier, and water heater installed at the same time.	10
We installed a new central AC.	10
I had a new air handler and heat pump installed.	5
They installed a new heat pump and new thermostats.	5
I had a 3 or 4 inch media filter installed on the system as well.	3
He also installed a new gas pack insulation heater.	2

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Table 30. Other Repairs and Services Performed at About the Same Time as Duct Sealing (N=9)

Actions taken at about the same time as program participation that have influence ratings of "2 out of 10" or higher	Rating of program influence on actions (10-point scale)
We installed a new central AC.	10
Attic insulation and air sealing (two measures from this program at once).	10
Attic insulation and sealing; vector support; insulation on two water heaters, sealing in the furnace closet, weatherstripping and air sealing around three exterior doorframes, around the fireplace mantel, and around windows; air sealing around skylights in the attic; and improvements to the vapor barrier underneath the house.	10
I had a new furnace, whole-house humidifier, and water heater installed at the same time.	10
I had the whole house air sealing and went up to R-38 insulation in the attic.	10
We had our crawlspace sealed, and a new forced air furnace & air conditioner installed.	7
New heat pump.	7
I had a new air handler and heat pump installed.	5
Attic insulation and air sealing; they also did work for drainage issues and a wet crawlspace.	4

Table 31. Other Repairs and Services Performed at About the Same Time as Heat Pump Tune-Up (N=3)

Actions taken at about the same time as program participation that have influence ratings of "2 out of 10" or higher	Rating of program influence on actions (10-point scale)
The contractor also replaced the air flow regulator on the heat pump.	10
I don't technically know what it's called, but it was what Freon used to be called; they added that.	9
I had a new heat pump installed.	6

Table 32. Other Repairs and Services Performed at About the Same Time as Central Air Conditioner Tune-Up (N=2)

Actions taken at about the same time as program participation that have influence ratings of "2 out of 10" or higher	Rating of program influence on actions (10-point scale)
I had the relay or capacitor replaced. If they hadn't done the diagnostic tests during the tune-up, I would have never known this needed replacing. The home warranty-covered company didn't catch this.	10
As suggested by the contractor who performed the central air conditioner tune-up, they removed Freon from my air conditioning unit.	9

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Additional Actions to Save Energy

Three surveyed participants (3.8% of 80) have installed new HVAC equipment since participating in the Additional Measures program (as opposed to installing new HVAC equipment at about the same time that they participated in the program, which is reported in the previous section of this document). These customers installed one new heat pump and two new central air conditioners.

Table 33. New HVAC Units Installed Since Participating in the Program

	Surveyed Participants (N=80)	
	Count	Percent
New heat pump installed since program	1	1.3%
New furnace installed since program	0	0.0%
New central AC installed since program	2	2.5%
No new HVAC units installed since program	76	95.0%
Don't know / can't recall	1	1.3%

Percentages total to more than 100% because participants can install multiple units.

Customers who installed new HVAC units since the program were asked if their participation in the Additional Measures program caused them to make these purchases any sooner or later than they would have otherwise. All three customers who purchased new HVAC units after participating in the Additional Measures program report that they would have had these units installed at the same time with or without the program. Details about additional HVAC installations are listed below in Table 34.

Table 34. Influence of the Program on New HVAC Units Installed Since Participating in the Program

New HVAC units installed (N=11)	Rating of program influence on new HVAC installation (10-point scale)
New AC installed, high efficiency rated 15 SEER	Not rated
New AC installed, not sure of efficiency rating	1
New heat pump installed, standard efficiency	8

Surveyed participants were also asked if they have done anything else to save energy in their home since participating in the Additional Measures program; about a third of participants report taking additional actions since the program, as seen in Table 35.

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Table 35. Additional Energy-Saving Actions Taken Since Participating in the Program

	Surveyed Participants (N=80)	
	Count	Percent
Additional action(s) taken to save energy since participating in the program	25	31.3%
No additional actions taken	53	66.3%
Don't know / can't recall	2	2.5%

Percentages total to more than 100% because participants can install multiple units.

Participants who took additional actions to save energy were asked to rate the influence of the Additional Measures program on these actions. Among the 25 surveyed customers who took additional actions, the average influence rating for the program was 3.20 on a ten-point scale where ten is highest, and the median rating is one out of ten; this indicates a low level of influence of the program on these additional actions. Actions taken by the twelve customers who gave the influence of the program a "2 out of 10" or higher rating are listed in Table 36.

Table 36. Energy-Saving Actions Influenced by Participation in the Program

Additional actions with influence ratings of "2 out of 10" or higher (N=12)	Rating of program influence on actions (10-point scale)
I sealed up air leaks behind and around sockets.	10
I changed the type of air conditioner filters to the ones our contractor recommended during the tune-up. We disconnected the foot warmers in our bed, which were pretty much on all the time.	8
We have adjusted our heating and cooling settings, instead of keeping the cooling at 73 degrees, we now keep it at about 76 degrees. We also installed some new seals on the windows and doors.	8
I have installed CFLs throughout the house.	7
I insulated behind sockets.	6
I had the air handler replaced soon after.	6
Our repair man came to our home and found that the breakers from the old radiant heaters which were in the ceiling had not been turned off. The breakers were still on and consuming energy! For over 10 years 18% of the Kilowatt Hours used in this old house were from those old, unused radiant heaters. We had always wondered why our energy usage was above average according to the My Home Energy Report. Part of the reason we decided to have the Heat Pump tune-up was to make sure it was running efficiently and hopefully figure out why our energy usage was so high. Fortunately our repair man realized where the excessive power draw was coming from. Besides this incident, we save energy in our home by drying the laundry outside on the clothesline and we keep the air conditioner set at 78 degrees in the summer.	6
We had new ductwork and new insulation put in.	4
I got some insulation for the attic area.	4
We installed a new water heater.	4
We've been changing over to LED bulbs.	2
We switched to CFLs when someone from Duke Energy brought them to the house.	2

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Customer Satisfaction

Surveyed participants were asked to rate their satisfaction with the Additional Measures program and Duke Energy on a ten-point scale where "10" means most satisfied. As seen in Table 37, the average overall satisfaction rating for this program is high at 8.96 out of 10. Satisfaction with specific aspects of the program and Duke Energy overall are slightly lower, ranging from 8.39 for the information provided by vendors and contractors up to 8.68 for the variety of services covered by the program.

Table 37. Satisfaction with the Program and with Duke Energy (N=80)

	Average Rating on 10-point scale
Satisfaction with the rebate amount offered by the program	8.47
Satisfaction with the variety of services covered by the program	8.68
Satisfaction with the information provided by your vendor or contractor about this program	8.39
Overall satisfaction with Additional Measures program	8.96
Overall satisfaction with Duke Energy	8.46

Percentages total to more than 100% because participants can install multiple units.

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Trade Ally Survey Results

Measures Offered through the Program

TecMarket Works surveyed 18 trade allies in the Carolina System who currently perform insulation, sealing, and/or HVAC tune-ups which are rebated through the Duke Energy Smart $aver Additional Measures program. The distributions of services performed by trade allies are shown in Table 38.

Duke Energy provided program records which indicated the services performed (or measures installed) by participating trade allies through May 31, 2014. When TecMarket Works surveyed these trade allies in September of 2014, respondents were asked which measures their company offered through the Smart $aver program. These responses do not correspond exactly for a couple of reasons: first, trade allies continued to perform services for customers during the four months between the time program records were provided and the time of the trade ally survey, and second, it is possible that a trade ally's measure offerings and services performed may change over time (for example, a company may have offered duct sealing before May 31, 2014 but did not have any completed duct sealing installations in the program records at that time).

A larger number of surveyed trade allies confirmed offering three, four, or five different measures (61.1% or 11 out of 18 surveyed trade allies), compared to the numbers of trade allies shown as having performed this many types of services (28.6% or 10 out of 35 participating trade allies had completed measures in three or more categories according to program records as of May 31, 2014). In particular, surveyed trade allies are more likely to report that they offer duct insulation (61.1% or 11 out of 18) compared to program records, which show that 37.1% or 13 out of 35 participating trade allies had completed measures in this category during the evaluation's timeframe.

Table 38. Type of Measures Offered by Trade Allies

	Services Offered by Surveyed Trade Allies (from survey; N=18)		Services Performed by All Participating Trade Allies (from program records; N=35)	
Measure Type:	**Trade Ally Count**	**Percent**	**Trade Ally Count**	**Percent**
Attic insulation & air sealing	13	72.2%	24	68.6%
Duct insulation	11	61.1%	13	37.1%
Duct sealing	15	83.3%	22	62.9%
Heat pump tune-up	7	38.9%	9	25.7%
Central air conditioner tune-up	7	38.9%	8	22.9%
Number of Measures:				
One measure	1	5.6%	6	17.1%
Two measures	6	33.3%	19	54.3%
Three measures	6	33.3%	8	22.9%
Four measures	3	16.7%	2	5.7%
Five measures	2	11.1%	0	0.0%

Percentages total to more than 100% because trade allies can offer multiple measures.

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Table 39 compares the services performed by surveyed trade allies with the services performed by the population of trade allies from the sample list. The attic insulation and air sealing measure is somewhat under-represented in the survey compared to the sample population, while duct sealing and HVAC tune-up measures are somewhat over-represented in the survey. Overall, the surveyed trade allies account for more than half of the total services performed according to program records (from 57.0% or 81 out of 142 duct insulations up to 90.0% or 54 out of 60 for AC tune-ups), except for attic insulation where surveyed trade allies account for only 45.6% (124 out of 272) of the measures installed in program records. Overall, according to program records, 59.1% (355 out of 601) of all measures installed during the evaluation timeframe were installed by trade allies who participated in this survey.

Table 39. Quantity of Measures Installed/Services Performed by Trade Allies

	Surveyed Trade Allies (N=355 measures)		All Participating Trade Allies (N=601 measures)	
Measures Installed:	**Measure Count**	**Percent**	**Measure Count**	**Percent**
Attic insulation & air sealing	124	34.9%	272	45.3%
Duct insulation	81	22.8%	142	23.6%
Duct sealing	40	11.3%	49	8.2%
Heat pump tune-up	56	15.8%	78	13.0%
Central air conditioner tune-up	54	15.2%	60	10.0%

Trade allies were asked if they market, sell or present program measures any differently from the non-rebated measures that they offer. Although a substantial minority of trade allies offering insulation and sealing do present these measures differently (ranging from 26.7% up to 45.5% by measure), none of the surveyed trade allies who offer HVAC tune-ups present these services differently from their non-rebated measures.

Table 40 shows what trade allies believe about the effect of program measures on HVAC replacement. The results for duct sealing and HVAC tune-ups are very similar, with about 30% believing that these measures have a net effect of causing customers to delay HVAC replacement while about 70% believe there is no net effect and none (0%) believe that replacements are occurring earlier than otherwise due to offering these measures. Duct insulation is believed to have less impact on delaying HVAC replacement, with only 9.1% (1 out of 11) saying that offering this service causes delays while 81.8% (9 out of 11) say it has no net effect on replacement timing. However, attic insulation is deemed by these trade allies to be the measure that is most likely to cause customers to delay HVAC replacement (38.5% or 5 out of 13), nearly as many as the percentage of trade allies saying this measure has no net effect (46.2% or 6 out of 13). One trade ally (7.7% of 13) believes that attic insulation and air sealing encourages earlier HVAC replacement, the only survey respondent to say this about any of the program measures.

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Table 40. Presentation of Rebated Measures and Effect of Measures on HVAC Replacement

	Measures Offered				
	Attic insulate & air seal (N=13)	Duct insulation (N=11)	Duct sealing (N=15)	Heat pump tune-up (N=7)	Air conditioner tune-up (N=7)
Market, sell or present this measure differently to customers than non-rebated measures	30.8%	45.5%	26.7%	0.0%	0.0%
Offering this measure encourages more customers to:					
Replace HVAC units sooner	7.7%	0.0%	0.0%	0.0%	0.0%
Replace HVAC units later	38.5%	9.1%	26.7%	28.6%	28.6%
No net effect on replacements	46.2%	81.8%	66.7%	71.4%	71.4%
Not sure	7.7%	9.1%	6.7%	0.0%	0.0%

Respondents that offer more than one measure are included in the column for every measure they offer (thus column N's total to 53 though there are only 18 survey respondents).

Trade allies who said they market, sell or present their rebated program measures differently than their non-rebated services and equipment were asked what is different. These responses are listed below by measure; some comments are repeated for more than one measure. None of the surveyed trade allies said that they offer HVAC tune-ups differently than their non-rebated measures.

Attic insulation and air sealing (N=4)

- *If we find the folks who are R-19 or less, we will let them know there is an opportunity to do both under the program. We usually market and price them as separate services.*
- *When they call us about the program, we focus primarily on the rebated items, but offer our services that we think they need.*
- *I ask first if they are a Duke Energy customer; if they're not, I go no further. Whatever the rebates, I offer them to all of my customers who are with Duke Energy. Not all are eligible, though.*
- *I wouldn't say we market Attic Insulation & Air Sealing any differently than our other services. We send direct mailers, advertise on television, have a company website, and our service technicians can provide informative handouts.*

Duct insulation (N=5)

- *We don't advertise the service the same way as we do with the manufacturer rebates.*
- *When they call us about the program, we focus primarily on the rebated items, but offer our services that we think they need.*
- *We use the Smart $aver rebate as a selling point when marketing duct insulation services.*

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- *That one's not flying too well. If they've got the old metal ductwork, I don't recommend they insulate it. I recommend flex duct. I'm just not a big fan of trying to insulate old metal ductwork: with holes, coming apart at the seams, dirty, often 30-years-old . . . It's just a band aid at that point. Also, the rebate is only about 10% percent of the total cost. The two I did were feasible. I do this work on metal ductwork about ten percent of the time, when it's feasible.*
- *We don't do it because it requires us to run duct blasters and we usually use a pressure pan because it takes a quarter of the time to do and we get the same results. With duct insulation, it's mighty expensive, and $75 is nothing and only covers about 5%. So, it's not even worth talking about.*

Duct sealing (N=4)

- *We don't advertise the service the same way as we do with the manufacturer rebates.*
- *When they call us about the program, we focus primarily on the rebated items, but offer our services that we think they need.*
- *I ask first if they are a Duke Energy customer; if they're not, I go no further. Whatever the rebates, I offer them to all of my customers who are with Duke Energy. Not all are eligible, though.*
- *We don't do it because it requires us to run duct blasters and we usually use a pressure pan because it takes a quarter of the time to do and we get the same results. With duct insulation, it's mighty expensive, and $75 is nothing and only covers about 5%. So, it's not even worth talking about.*

Estimates of the Program's Effect on Customers

Trade allies were asked to estimate what percentage of the measures covered by the program that they performed for Duke Energy customers received rebates through the program. Table 41 indicates there is again a wide range of estimates, from 0% to 100% for each measure. Mean estimates range from 29.5% to 51.5% by measure, though median estimates range from 1% to 50% by measure; the large difference between means and medians for HVAC tune-ups reflects a bipolar distribution (a majority of these trade allies estimated low numbers close to zero, while a minority gave estimates closer to 100%, without many estimates in between the extreme values).

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Table 41. Trade Ally Estimate of What Percentage of Measures They Performed for Duke Energy Customers were Rebated through the Program

N's shown are the number of trade allies who provided estimates for this question	Measures Offered				
	Attic insulate & air seal (N=12)	Duct insulation (N=9)	Duct sealing (N=14)	Heat pump tune-up (N=7)	Air conditioner tune-up (N=7)
Lowest estimate	6%	0%	0%	0%	0%
Highest estimate	95%	100%	100%	95%	95%
Mean estimate	31.7%	48.2%	51.5%	29.5%	29.5%
Median estimate	25.0%	50.0%	50.0%	1.0%	1.0%

Respondents that offer more than one measure are included in the column for every measure they offer (thus column N's total to 49 though there are only 18 survey respondents).

Trade allies were asked to estimate what percentage of their customers that receive Smart $aver-rebated measures would have had exactly the same services performed if the Duke Energy program had not been available. Table 42 indicates a very wide range of estimates, ranging from 0% to 100% for most measures, with average estimates ranging from 46.7% to 77.5% by measure, and median estimates ranging from 60.0% to 85.0%.

Table 42. Trade Ally Estimate of How Many Customers Would Have Done Exactly the Same Thing without the Program

N's shown are the number of trade allies who provided estimates for this question	Measures Offered				
	Attic insulate & air seal (N=10)	Duct insulation (N=10)	Duct sealing (N=12)	Heat pump tune-up (N=5)	Air conditioner tune-up (N=6)
Lowest estimate	25%	0%	0%	5%	0%
Highest estimate	100%	100%	100%	100%	75%
Mean estimate	77.5%	62.0%	66.7%	58.0%	46.7%
Median estimate	85.0%	67.5%	70.0%	60.0%	67.5%

Respondents that offer more than one measure are included in the column for every measure they offer (thus column N's total to 42 though there are only 18 survey respondents).

Trade allies were also asked to rate the influence of the program incentive and information on their customers' purchases of rebated measures through the program on a ten-point scale where "10" means most influential. Table 43 shows moderate influence ratings, ranging from 4.30 to 6.43 depending on the measure. Though the sample sizes are too small for significance testing, influence ratings for the incentive are consistent (ranging from 5.29 to 5.73 by measure), while there is more variation in the influence ratings for the information and technical assistance. Trade allies rated the influence of program information on duct-related measures (4.30 to 4.50) lower than the influence of the incentive for these measures, while for HVAC tune-ups the program information received a higher rating (6.00 to 6.43) than the incentive. The two influence ratings are similar for attic insulation and air sealing measures (5.69 for incentive and 5.92 for program information).

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Table 43. Trade Ally Ratings of Program Influence for Customers

N's shown are the number of trade allies who provided ratings	Measures Offered				
	Attic insulate & air seal (N=8)	Duct insulation (N=11)	Duct sealing (N=15)	Heat pump tune-up (N=7)	Air conditioner tune-up (N=7)
Influence of incentive on customer's purchase	5.69	5.73	5.53	5.50	5.29
Influence of program information and technical assistance on customer's purchase	5.92	4.30	4.50	6.43	6.00

Respondents that offer more than one measure are included in the column for every measure they offer (thus column N's total to 42 though there are only 18 survey respondents).

Trade allies were also asked to estimate what percentage of their customers who participated in the Duke Energy program came to the program through various acquisition channels. Table 44 shows the mean estimated percentages for several common methods separately for each measure offered; since these channels may overlap, and respondents were not required to give responses totaling 100%, these estimates should be considered directional indicators and not precise measurements.

For HVAC tune-ups, the most common method of recruiting participant customers is through recommendations made during maintenance or service calls (mean estimates are 48.6% for heat pump tune-up customers and 57.1% for air conditioning). For the insulation and sealing measures, the most common method is customers contacting trade allies about participation in the program (mean estimates range from 38.8% to 47.2% by measure), followed by trade allies contacting customers for other reasons and the trade allies recommend the program (mean estimates range from 34.8% to 46.1%). Trade allies soliciting customers is estimated to be the least frequent method of recruiting customers, especially soliciting among customers who have previously done business with the trade ally before (mean estimates range from 3.5% to 18.9%).

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Table 44. Estimated Distribution of Methods Trade Allies Use to Recruit Customers for the Additional Measures Program

Percentages in this table are the means of estimated percentages. N's shown are the number of trade allies who provided estimates for these questions	Measures Offered				
	Attic insulate & air seal (N=12)	Duct insulation (N=9)	Duct sealing (N=13)	Heat pump tune-up (N=7)	Air conditioner tune-up (N=7)
Recommend during maintenance / service calls	23.9%	31.7%	28.8%	48.6%	57.1%
Solicit participation from customers they have done business with before	3.5%	18.9%	16.5%	10.7%	17.9%
Solicit participation from potential new customers (have not done business with this company before)	22.5%	22.8%	28.1%	17.1%	15.7%
Customers contact trade ally specifically about participating in the Duke Energy program	38.8%	47.2%	46.5%	33.6%	26.4%
Customers contact trade ally about another issue and the program is recommended to them	34.8%	46.1%	37.3%	32.1%	32.1%
Other methods, specified below	2.1%	2.8%	1.9%	NA	NA

Columns do not total to 100% because respondents gave estimated percentages and their estimates were not required to add up to 100%.[11] *Respondents that offer more than one measure are included in the column for every measure they offer (thus column N's total to 48 though there are only 18 survey respondents).*

Three trade allies who volunteered that they have "other methods" of recruiting program participation were asked to describe those methods. These responses are listed below by the measures these trade allies were referring to. The trade ally who placed ads on Craigslist and Homeadvisor.com estimates that 25% of their program participants come to them through this channel, while the other two trade allies could not estimate how many participants they get through the channels they mentioned.

- For attic insulation and duct insulation: *I put an ad on Craigslist and HomeAdvisor.com that I'm a Duke Energy Trade Ally.*
- For attic insulation and duct insulation: *We put Smart $aver brochures out at a trade show or any event where we have a booth and are promoting our business.*
- For all three insulate and seal measures: *We put the Duke rebates on our website.*

[11] Aside from the survey instrument not requiring these responses to add up to 100%, the categories can overlap and may not be exhaustive, so percentages may total to more or less than 100%. For example, a customer could be solicited by the trade ally (via advertising) and then that same customer contacts the trade ally about participating in the program.

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Effect of the Program on Participating Trade Allies

Table 45 shows the percentage of trade allies that agree with several statements about the effect of the program on their business. Trade allies were asked if they thought the incentive levels were appropriate for the measures in this program; a majority of those offering HVAC tune-ups do find them appropriate (71.4% or 5 out of 7 for both heat pumps and air conditioners), though a minority of those offering insulation and sealing agreed (from 36.4% to 40.0%) by measure offered).

Every surveyed trade ally (100.0%) agreed that if the Smart $aver program did not offer incentives for these measures, that they would still offer these services to their customers. Allies who offer HVAC tune-ups were also asked if they would offer the exact same level of service without the program incentive, and all agreed that they would (100.0%). However, some trade allies did report that their approach to offering these measures would change in some way without the program incentive, from only 14.3% (1 out of 7) among trade allies that offer HVAC tune-ups up to 45.5% (5 out of 11) of trade allies offering duct insulation.

Although only about a quarter of surveyed trade allies (from 20.0% to 28.6% by measure offered) agreed that the program has influenced them to sell more efficient equipment and services than they would have otherwise, a majority (from 53.8% to 71.4% by measure offered) do report that offering the measures covered by the program has increased the number of customers they serve.

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Table 45. Trade Allies' Agreement with Statements about the Effects of the Program on Their Businesses

	Measures Offered				
	Attic insulate & air seal (N=13)	Duct insulation (N=11)	Duct sealing (N=15)	Heat pump tune-up (N=7)	Air conditioner tune-up (N=7)
Agree that program's incentive levels are appropriate	38.5%	36.4%	40.0%	71.4%	71.4%
Agree that if program did not offer customers incentive that they would still offer these measures	100.0%	100.0%	100.0%	100.0%	100.0%
Agree that if program did not offer customers incentives that they would change their approach to offering these measures	38.5%	45.5%	33.3%	14.3%	14.3%
Agree that if program did not offer customers incentives that they would offer the exact same level of HVAC tune-up	NA	NA	NA	100.0%	100.0%
Agree that program influenced them to market or sell higher volumes of efficiency-related services and equipment than otherwise	23.1%	27.3%	20.0%	28.6%	28.6%
Agree that offering program measures has increased number of customers served	53.8%	63.6%	60.0%	71.4%	71.4%

Respondents that offer more than one measure are included in the column for every measure they offer (thus column N's total to 53 though there are only 18 survey respondents).

The ten trade allies who did not agree that the program's incentive levels are appropriate were asked why not. Their verbatim comments are listed below according to the measures offered by the respondent company.

- Offers all three insulate and seal measures: *I used to do a lot more of them when I would do an energy audit of the houses. I would have all the pretesting all done. To get my rebate, I would have to do all the testing before and after, which cost a lot more than the $100. Blower door and combustion safety testing before and after cost money. Stop doing the $25 audits and have them pay for a full audit. They're not doing a full audit for things and things are being missed.*
- Offers all three insulate and seal measures: *They could actually be a little bit more. If they were a little more, it might change a few people's minds. I think for the attic insulation and air sealing, $350 instead $250. Reverse the insulation being the higher rebate between duct sealing and insulation; $175 is not a big incentive to do both those things either.*
- Offers all three insulate and seal measures: *They need to be significantly higher to get a better response rate. They should offer rebates for 50% of the cost up to $1,000.*

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- Offers all three insulate and seal measures: *They're minimal. I don't think the incentives have gotten any business for us. Everything you're doing to market the program is encouraging customers to have us come out, but the rebates haven't been a deal breaker.*
- Offers all three insulate and seal measures: *We had federal tax credits available of $1,500 and the Greensboro Better Buildings Program provided up to $2,000, or 50 percent on the dollar. I think that people have been somewhat spoiled by these programs. What it's forced us to do is we're matching the Smart Saver rebate for whatever they qualify for. So, if they qualify for $350, we match $350 to make it a true rebate. The Smart Saver Rebate isn't anything for most people.*
- Offers attic insulation and duct sealing: *Air sealing is much more beneficial and should be done before anything. Insulation rebates give a false sense that there's going to be improvement. But, customers only care about getting their insulation and their rebate with the program. They don't get a proper assessment.*
- Offers attic insulation and duct sealing: *I am in favor of the testing requirements but the incentive levels are insufficient. As of now, there is very little incentive for the homeowner to have these tests performed. Duke could provide a separate $200-300 rebate for just the testing itself.*
- Offers duct insulation and duct sealing: *I think they're low. The repairs can be very high for the consumer. They are too low across the board.*
- Offers HVAC tune-ups: *The incentive levels are insufficient. We charge $150 for a 'health check', which takes an average of four hours. The learning curve needed to operate the equipment is steep. A $50 incentive isn't enough to justify the expense, especially if the customer does not end up qualifying for the incentive or if their repairs amount to hundreds of dollars more.*
- Offers all five measures: *I think they're low, in my opinion, for all the services.*

The five trade allies who agreed that the program has influenced them to market and sell more energy efficient equipment and services were asked what changed due to this influence. Their verbatim comments are listed below according to the measures offered by the respondent company.

- Offers all three insulate and seal measures: *It's been a very good lead generation tool for me and they have provided a number of customer leads that I wouldn't have gotten otherwise.*
- Offers duct insulation and duct sealing: *Everybody likes to get a little bit of money back in their pocket.*
- Offers attic insulation: *It is giving us something to offer people to try to get them to purchase the service. It is helping us get more full house audits. And, when people hear they're getting money back, they get very excited. I've had two or three people said they did it to get that rebate. I've even had people say to me, 'You mean I'm getting something back from Duke?'*
- Offers HVAC tune-ups: *Customers are enticed by the rebate. They are more likely to employ our services or have equipment installed if a rebate is involved.*

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- Offers all five measures: *The program hasn't influenced the types of services we provide but it does help market them more effectively. Rebates are an added bonus, i.e. the cherry on top.*

The ten trade allies who reported that the program has increased the number of customers they serve were asked to estimate the amount of the increase. In percentage terms, these ten trade allies' estimated increases range from 1% to 50% with an average increase of 16.3% and a median increase of 10%. In absolute terms, estimates ranged from two to 100 additional customers, with an average estimate of 47 additional customers and median estimate of 34 additional customers. One customer volunteered additional comments, which are listed below.

- Offers all three insulate and seal measures: *Our increase in customers has been about 10%, but that's starting to change. We're matching the rebate, and we're getting a lot more interest from out of our pocket; $125 just doesn't excite people. But, I always tell our customers you don't buy a service because of the rebate, you buy because of the service. But you'll still have those people that will do it just because there's a rebate.*

The six surveyed trade allies who said that they would change how they market or offer these services if they were no longer rebated through the program were asked what would change. These responses are listed below.

- Offers all three insulate and seal measures: *I would look at other strategic partners to help market my services with.*
- Offers all three insulate and seal measures: *I wouldn't ask if they're a Duke Energy customer or not.*
- Offers all three insulate and seal measures: *If you need it, you need it, but I wouldn't go into whether they qualify or not before assessing the services they need.*
- Offers duct insulation and duct sealing: *As I said, everybody likes to get a little money back. If you can put that in your sales pitch, it definitely helps.*
- Offers attic insulation: *I'm not sure.*
- Offers all five measures: *We would continue to offer the same services but remove that tool from our toolbox.*

Trade allies were asked to estimate the percentage of their Smart $aver Additional Measures customers that purchase additional *non-rebated* energy efficiency equipment or services from them at the same time. The range of estimates is wide, ranging from 0% to 100% for every measure. Mean estimates for insulation and sealing measures range from 49.1% to 59.4% purchasing additional non-rebated services or equipment, which is higher than the 35.7% to 37.1% range estimated for HVAC tune-ups.

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Table 46. Trade Allies' Estimates for the Percentage of Participating Customers who Purchase Additional Non-Rebated Energy Efficiency Equipment and Services at About the Same Time

N's shown are the number of trade allies who provided estimates for this question	Measures Offered				
	Attic insulate & air seal (N=13)	Duct insulation (N=11)	Duct sealing (N=15)	Heat pump tune-up (N=7)	Air conditioner tune-up (N=7)
Lowest estimate	0%	0%	0%	0%	0%
Highest estimate	100%	100%	100%	90%	90%
Mean estimate	59.4%	49.1%	56.3%	37.1%	35.7%
Median estimate	70.0%	50.0%	50.0%	20.0%	20.0%

Respondents that offer more than one measure are included in the column for every measure they offer (thus column N's total to 53 though there are only 18 survey respondents).

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Appendix A: Participant Survey Instrument

Enter Month and Year
Installation Date _____

for answering machine 1st through penultimate attempts:
Hello, my name is [*full name*] and I am calling from TecMarket Works on behalf of Duke Energy to conduct a customer survey about the Smart $aver energy-efficiency program in which you participated. This program provided your household with <*insert service performed here*>. I'm sorry I missed you. I'll try again another time.

for answering machine - Final Attempt:
Hello, my name is [*full name]* and I am calling from TecMarket Works on behalf of Duke Energy to conduct a customer survey about the Smart $aver energy efficiency program in which you participated. This program provided your household with <*insert service performed here*>. This is my last attempt at reaching you, my apologies for any inconvenience.

if person answers
Hello, my name is [*full name].* I am calling from TecMarket Works on behalf of Duke Energy to conduct a customer survey about the Smart $aver energy efficiency program in which you participated. This program provided your household with <*insert service performed here*>. May I speak with _____ please?

If person talking, proceed. If person is called to the phone reintroduce. If not home, ask when would be a good time to call and schedule the call-back:

We are conducting this survey to obtain your opinions about Duke Energy's Smart $aver program in which you participated. We are not selling anything. For your time and feedback, you will receive a $10 check for completing this survey. The survey will take about 10 to 15 minutes to complete. Your answers will be kept confidential, and will help us to make improvements to the program to better serve others. May we begin the survey?

1a. Do you recall participating in the Smart $aver program?
( ) Yes
( ) No
( ) DK/NS

If No or DK/NS, read statement then ask Q1b:
This program was provided through Duke Energy in conjunction with local HVAC and insulation vendors. In this program, Duke Energy provides customers a rebate for the purchase and installation of efficient heat pumps and air conditioning, as well as attic and duct insulation, duct and air sealing, and heat pump and air conditioner tune-ups.

1b. Do you remember participating in this program?
( ) Yes
( ) No

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( ) DK/NS

If No or DK/NS, thank them, terminate interview and go to next participant.

2. According to our records, you had [*LIST ALL MEASURES RECEIVED***] performed in your home. Is this correct?** (*CHECK ALL MEASURES CONFIRMED BY PARTICIPANT, OR ELSE CHECK "DO NOT RECALL" IF THEY CANNOT CONFIRM ANY MEASURES*)

( ) Attic Insulation & Air Sealing
( ) Duct Insulation
( ) Duct Sealing
( ) Heat Pump Tune-Up
( ) Central Air Tune-Up
( ) Do not recall any of the above - *THANK AND TERMINATE*

3a. Have you participated in any other energy efficiency programs offered by Duke Energy, either in the past or since your [*insert response from Q2***] was performed?**
( ) Yes
( ) No
( ) DK/NS

If Yes, ask:
3b. Which other energy efficiency programs offered by Duke Energy have you participated in? About when was that?
(*Interviewer: do not record any Additional Measures reported in Q2 here.***)**

Record response:

REPEAT Q4a THROUGH Q9c ONCE FOR EACH MEASURE CHECKED IN Q2

4a. Next I am going to ask you some questions specifically about [*insert response from Q2***]. Which of the following statements best describes how you found out about this program?**

( ) **A contractor or vendor suggested the program during a service call or routine maintenance visit**
( ) **A participating contractor or vendor contacted me to suggest the program without me contacting them first**
( ) **I contacted the contractor or vendor about something else, and they suggested this program**
( ) **I learned about the program from somewhere other than the contractor or vendor and then sought out a participating contractor or vendor, or**
( ) **I learned about the program some other way** (in other words, none of the above)
( ) DK/NS (do not read)

If "learned about the program somewhere else" OR "some other way (none of the above)" checked for Q4a, then ask 4b:

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4b. Where did you learn about the [*insert response from Q2*] service offered through Duke Energy's Smart $aver program?
Record: _____

Everyone gets asked Q4c-d:
4c. When you made the decision to have [*insert response from Q2*] performed through the Smart $aver program, were you aware that you would receive a rebate from the program for this service?
( ) Yes
( ) No
( ) DK/NS

4d. Please indicate from the following choices what you would have done if the Duke Energy rebate program had not been available to you at the time you participated?
( ) **I would not have had the [*insert response from Q2*] performed.**
( ) **I would have had the exact same [*insert response from Q2*] performed at the same time.**
( ) **I would have had the exact same [*insert response from Q2*] performed, but at a different time.**
( ) **I would have had a somewhat different service performed instead of [*insert response from Q2*].**
( ) **Or, I would have done something different than what I did, but not any of the options mentioned above.**
( ) DK/NS (do not read)

If "different time" checked for Q4d, then ask Q5a-d before skipping to Q8a:
5a. Would you have had the [*insert response from Q2*] service performed sooner or later than you did if Duke Energy's Smart $aver rebate program had not been available?
( ) Sooner, *ask:* 5b. **How many months sooner?** _____
( ) Later, *ask:* 5c. **How many months later?** _____
( ) Other response, *record*: 5d. _____
( ) DK/NS

If "different service" checked for Q4d, then ask Q6a-b (and possibly Q6c-f) before skipping to Q8a:
6a. What would have been different if the Smart $aver [*insert response from Q2*] program had not been available?
Record response: _____

6b. If the Smart $aver program had not been available, would you have done this service at about the same time that you had your [*insert response from Q2*] performed?
( ) Yes
( ) No
( ) DK/NS

If "No" checked for Q6b, then ask Q6c-f before skipping to Q8a:
6c. Would you have had this alternate service performed sooner or later than you had the [*insert response from Q2*] performed?

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( ) Sooner, *ask:* 6d. **How many months sooner?** _____
( ) Later, *ask:* 6e. **How many months later?** _____
( ) Other response, *record*: 6f. _____
( ) DK/NS

If "done something different" checked for Q4d, then ask Q7a-b (and possibly Q7c-f) before continuing from Q8a:

7a. What would you have done instead of [*insert response from Q2***] if the Smart $aver program had not been available?**
Record response: _____

7b. If the Smart $aver program had not been available, would you have done this at about the same time that you had your [*insert response from Q2***] performed?**
( ) Yes
( ) No
( ) DK/NS

If "No" checked for Q7b, then ask Q7c-f before continuing from Q8a:

7c. Would you have had this alternate service performed sooner or later than you had the [*insert response from Q2***] performed?**
( ) Sooner, *ask:* 7d. **How many months sooner?** _____
( ) Later, *ask:* 7e. **How many months later?** _____
( ) Other response, *record*: 7f. _____
( ) DK/NS

8a. Thinking about the program rebate, on a scale of 1 to 10, where 1 means that the rebate had zero influence and a 10 means that the rebate had a major influence, please rate the level of influence the program rebate had on your decision to participate in the Smart Saver program [*insert response from Q2***].**

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) DK/NS

8b. Aside from the financial rebate, Duke Energy also provides information about energy efficiency and technical assistance with energy efficiency services. Some of this information and assistance is provided directly to customers, and some of it reaches customers indirectly through vendors and contractors who participate in the program. Using the same scale, where a 1 means the information and assistance provided had zero influence and a 10 means the information and assistance provided had a major influence, please rate the level of influence the program information and technical assistance had on your decision to participate in the Smart Saver program [*insert response from Q2***].**
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) DK/NS

9a. When your [*insert response from Q2***] was performed, did you have any repairs or other services performed, or new equipment installed, at about the same time?**
( ) Yes
( ) No
( ) DK/NS

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If "Yes" checked for Q9a, then ask Q9b and Q9c:

9b. What other repairs or services were performed and/or what new equipment was installed?

record: _____

9c. On a scale of 1 to 10, where 1 means zero influence and 10 means a major influence, please rate the level of influence your participation in the Smart $aver [*insert response from Q2*] program had on your decision to have these additional repairs or services performed and/or new equipment installed at the same time.

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) DK/NS

AFTER ASKING Q4a THROUGH Q9c SEPARATELY FOR EACH MEASURE CHECKED IN Q2, THEN CONTINUE FROM Q10a

10a. Have you had a new furnace, heat pump or central air conditioner installed since you participated in this Smart $aver program? (*check all that apply*)

( ) Yes, new heat pump
( ) Yes, new furnace
( ) Yes, new central air conditioner
( ) No, none of the above - *skip to Q11a*
( ) DK/NS - *skip to Q11a*

If any "Yes" is checked in Q10, then ask Q10b:

10b. Did your participation in the Smart $aver program lead you to have this new equipment installed any sooner or later than you would have otherwise?

(Interviewer: if there are multiple outcomes for multiple units, record details in Q10e)

( ) No, would have done it at the same time regardless
( ) Yes, got new unit(s) sooner than otherwise, *ask:* 10c. **How many months sooner?**

_____

( ) Yes, got new unit(s) later than otherwise, *ask:* 10d. **How many months later?**

_____

( ) Other response, *record*: 10e. _____
( ) DK/NS

If "Yes, sooner" is checked in Q10b, then ask Q10f:

10f. Did you receive a rebate from Duke Energy for your new [*insert all "yes" items from Q10a***]?**

(Interviewer: if there are multiple outcomes for multiple units, record details in Q10e)

( ) Yes, received rebate(s) from Duke Energy (for all new units)
( ) No, did not receive any rebate(s) from Duke Energy
( ) Received rebates for some units but not others, *specify*: **10g.**_____
( ) DK/NS

If "Yes, sooner" is checked in Q10b, then ask Q10h-j once for each item checked "yes" in Q10a:

10h. On a scale of 1 to 10, where 1 means that participating in the Smart $aver program had zero influence and a 10 means that this program had a major influence, please rate the level of influence that participating in this program had on your decision to install a new [*insert "yes" items from Q10a***].**

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( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) DK/NS

10i. Is your new [*insert "yes" items from Q10a*] a high-efficiency model or a standard-efficiency model?
( ) High efficiency - *continue with Q10j*
( ) Standard efficiency - *skip to Q11a*
( ) DK/NS - *skip to Q11a*

10j. What is the efficiency rating of your new [*insert "yes" items from Q10a*]?
( ) Know rating, *record*: _____
( ) DK/NS

11a. Have you done anything else to save energy in your home since your [*insert all responses from Q2*] was/were completed?
( ) Yes
( ) No
( ) DK/NS

If "Yes" checked for Q11a, then ask Q11b and Q11c:
11b. What else have you done?
record: _____

11c. On a scale of 1 to 10, where 1 means zero influence and 10 means a major influence, please rate the level of influence your participation in the Smart $aver program had on your decision to take these additional measures to save energy in your home?

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) DK/NS

We would like to ask you a few questions about your satisfaction with various aspects of the program. For these questions we would like you to rate your satisfaction using a 1 to 10 scale where a 1 means that you are very dissatisfied with that aspect and a 10 means that you are very satisfied.

How would you rate your satisfaction with:

12. The amount of the rebate provided by the program
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

13. The variety of services covered by the program
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

14. The information provided by your vendor or contractor about the Smart $aver Program
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

15. Before participating in this program, had you ever hired the contractor who provided your [*insert all responses from Q2*] services before?

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( ) Yes, had hired this contractor before participating in the program
( ) No, had not hired this contractor before participating in the program
( ) Other response, *record*: 15b. _____
( ) DK/NS

16. Now, considering all aspects of the program, how would you rate your overall satisfaction with the Smart $aver program on a scale from 1 to 10 where 1 means very dissatisfied and 10 means very satisfied?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) DK/NS

17. Using the same 1 to 10 scale, how would you rate your overall satisfaction with Duke Energy?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) DK/NS

18. We have reached the end of the survey. Do you have any comments that you would like for me to pass on to Duke Energy?

_____

That's all the questions I have for you today. Thank you for your time!
(politely end call)

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Appendix B: Trade Ally Survey Instrument

Name: _____

Title: _____

Position description and general responsibilities:

_____

_____

_____

for answering machine 1st through penultimate attempts:
My name is _____ and I am calling from TecMarket Works on behalf of Duke Energy to conduct an interview regarding Duke Energy's Residential Smart Saver Program under which your business has offered energy efficiency services. I'm sorry to have missed you. I will try you again another time, or I may be reached at <*give phone number*>. Thank you for considering helping us.

for answering machine - Final Attempt:
My name is _____ and I am calling from TecMarket Works on behalf of Duke Energy to conduct an interview regarding Duke Energy's Residential Smart Saver Program under which your business has offered energy efficiency services. This is my final attempt to reach you. I may be reached at <*give phone number*> if you are able to help us with this 15-minute survey by <*give final day and time*>. Thank you for considering helping us.

if person answers
My name is _____ and I am calling from TecMarket Works on behalf of Duke Energy. We are conducting this interview to obtain your opinions about, and experiences with, services you offered through Duke Energy's Residential Smart $aver Program. The opinions we are looking for are specific to service-related actions, such as air and duct sealing services, as well as heat pump or A/C tune-ups. We would like to know your thoughts on how this program is affecting customers' purchasing decisions and how it is affecting your business. This interview will take about 15 minutes to complete. Your responses will be kept confidential and will help to make improvements to the program. May we begin?

V1. Which of the following services has your company provided to customers that have been associated with the Residential Smart $aver program? (*READ LIST, CHECK ALL THAT APPLY*)

( ) **Attic Insulation & Air Sealing**
( ) **Duct Insulation**

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( ) **Duct Sealing**
( ) **Heat Pump Tune-Up**
( ) **Central Air Tune-Up**

V2a. In your opinion, are the incentive levels offered by Duke Energy appropriate for this program?

( ) Yes - SKIP TO V3a
( ) No - ASK V2b THEN CONTINUE
( ) DK/NS - ASK V2b THEN CONTINUE

V2b. Why do you say that?
Record response:

REPEAT V3a THROUGH V8e ONCE FOR EACH MEASURE CHECKED IN V1

V3a. Do you market, sell or present the Smart $aver rebated <*INSERT RESPONSE FROM V1*> to your customers any differently than your non-rebated services and equipment?

( ) Yes - ASK V3b THEN CONTINUE
( ) No - SKIP TO V4a
( ) DK/NS - SKIP TO V4a

V3b. What is different about the way you market, sell or present <*INSERT RESPONSE FROM V1*> compared to other services and equipment?

Record response:

V4a. Thinking only about customers who purchased the Smart $aver-rebated <*INSERT RESPONSE FROM V1*>, what percent of those customers do you think would have still had the exact same service performed if the Duke Energy program had not been available?

Record response (try to get a <u>percentage number</u> if possible; record verbal response if they won't give a number):

V4b. Using a scale of 1 to 10, where 1 means not at all influential and 10 means very influential, how important would you say the <u>incentive rebate</u> is to your customers' decision to purchase these services from your company?

Circle one:

1	2	3	4	5	6	7	8	9	10	DK/NS
Not at all influential									Very influential	

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V5b. Using a scale of 1 to 10, where 1 means not at all influential and 10 means very influential, how important would you say the program information and technical assistance is to your customers' decision to purchase these services from your company?

Circle one:

1	2	3	4	5	6	7	8	9	10	DK/NS
Not at all influential									Very influential	

V6. What percentage of <*INSERT RESPONSE FROM V1*> services that you performed for Duke Energy customers last year were rebated through the Smart $aver program?

Record response (try to get a percentage number if possible; record verbal response if they won't give a number):

_____

Next I am going to read you a list of five ways in which customers might join this program. After I read the list to you once, please estimate what percentage of your customers who have participated in Duke Energy's Smart $aver <*INSERT RESPONSE FROM V1*> program joined the program through each of these methods.

Read V7a through V7e once, then read a second time recording responses for each. Responses do not need to total to 100%.

V7a. **One: You recommend the/a <*INSERT RESPONSE FROM V1*> to customers during your maintenance or service calls**, *record percent:* _____

V7b. **Two: You reach out to solicit participation from customers with whom you have done business before, but not as part of your maintenance or service calls**, *record percent:*

_____

V7c. **Three: You reach out to solicit participation by contacting potential new customers who you have not done business with before**, *record percent:* _____

V7d. **Four: Customers who contact you specifically about participating in the <*INSERT RESPONSE FROM V1*> program**, *record percent:* _____

V7e. **Five: Customers who contact you about other issues or services and you recommend <*INSERT RESPONSE FROM V1*> to them**, *record percent:* _____

V8. Are there any other methods you use to sign customers up for Smart $aver <*INSERT RESPONSE FROM V1*> that I have not mentioned yet?

( ) Yes
( ) No
( ) DK/NS

If "yes" in V8, then ask V8b and V8c:

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V8b. What else does your company do to get your customers to participate in the <*INSERT RESPONSE FROM V1*> program (that I have not already mentioned?)

Record response:

_____

V8c. What percentage of your customers who have participated in the Smart $aver <*INSERT RESPONSE FROM V1*> program joined through this method/these methods?

Record percent (record multiple percents if multiple methods are mentioned in V8b):

_____

V8d. About what percentage of your customers who receive rebates for <*INSERT RESPONSE FROM V1*> purchase additional *non-rebated* energy efficient equipment or efficiency-related services from you at about the same time?

Enter a percentage if possible; if they cannot provide a number record their verbal response ("just a few", etc.):

Record: _____

V8e. Next I am going to read three statements. Please tell me which of these three statements you think best describes the situation at your company.

( ) One: Offering <*INSERT RESPONSE FROM V1*> encourages more customers to replace their old HVAC units sooner.

( ) Two: Offering <*INSERT RESPONSE FROM V1*> encourages more customers to delay replacing their old HVAC.

( ) Three: Offering <*INSERT RESPONSE FROM V1*> has no net effect on the timing of old HVAC unit replacement.

( ) DK/NS (do not read)

AFTER ASKING V3a THROUGH V8e SEPARATELY FOR EACH MEASURE CHECKED IN Q1, THEN CONTINUE FROM Q9a

V9a. Has this program influenced your decision to push, market or sell higher volumes of efficiency-related services and equipment than you would have without the program?

( ) Yes - ASK V9b THEN CONTINUE
( ) No - SKIP TO V10a
( ) DK/NS - SKIP TO V10a

V9b. Why do you say that? (What has changed due to the influence of the program?)

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Record response:

V10a. Has offering Smart $aver-rebated <*INSERT RESPONSES FROM V1*> increased the number of customers your company serves?

( ) Yes - ASK V10b and V10c
( ) No - SKIP TO V11a
( ) DK/NS - SKIP TO V11a

V10b. Please estimate the percentage increase in your customer base due to offering Smart $aver-rebated <*INSERT RESPONSES FROM V1*> .
Enter a percentage if possible; if they cannot provide a number record their verbal response ("just a few", etc.):

Record: _____

V10c. About how many customers per year is that?
Enter a number if possible; if they cannot provide a number record their verbal response ("a couple dozen", etc.):

Record: _____

V11a. There are no plans to terminate this program, but we would like to know how the program affects contractors. If the Residential Smart $aver program did not offer customers incentives for these specific services, would you still market or sell <*INSERT RESPONSES FROM V1*> to your customers?

( ) Yes - CONTINUE WITH V11b
( ) No - SKIP TO Q11f
( ) DK/NS - SKIP TO Q11f

V11b. Would your approach to offering these services change in any way?
( ) Yes - ASK V11c-e THEN SKIP TO V12
( ) No - SKIP TO V12
( ) DK/NS - SKIP TO V12

V11c. What would be different without the program?

Record response:

Ask V11d-e only if they have "heat pump tune-up" or "AC tune-up" checked in V1.
V11d. In the absence of the program, would you continue to offer the exact same level of HVAC tune-up service to your customers?
( ) Yes - SKIP TO V12
( ) No - ASK V11e THEN SKIP TO V12
( ) DK/NS - SKIP TO V12

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V11e. What would be different about the level of HVAC tune-up services your company offers without the program?
Record response:

V11f. Why do you say that? (What would be different without the program?)

Record response:

V12. We have reached the end of the survey. Do you have any comments that you would like for me to pass on to Duke Energy?

Record response (if any):

Thank you for your time today!
(politely end call)

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Appendix C: Participant and Trade Ally Suggestions for Duke Energy

At the end of the survey, interviewers asked participants if they had any comments to pass on to Duke Energy. Thirty-six out of 80 surveyed participants made comments, which are categorized and listed below; many of these comments do not relate to the Additional Measures program.

Comments about the Smart $aver Additional Measures program

- *I thought the $50 rebate was off the price of the central air conditioner tune-up, I guess it was unclear to me that you really only got the $50 off if additional services were performed, which is why I went along with the additional services. The rebate and required qualifications were unclear to me. Another thing is that the company who performed the services suggested having the Freon removed from the air conditioning unit, which I've never heard of doing, but they went ahead and removed the Freon and charged that as an additional service. I don't think it was the right thing to have done to the unit. Also during the time of the services that the vendor or contractor was at my house I had questions that they were unable to answer and I could not find any additional contact information from Duke Energy to ask those questions about the services, the program, or the rebate qualifications. I suggest this program offer a follow-up from Duke Energy so if customers had questions they could be dealt with. Oh, and another thing, I have two units, and it turned out that this particular contractor charged separately for each tune-up, they had problems with the second unit and said they were going to come back to fix the second unit, and they didn't come back. After I called them about when they were coming to service the second unit, they said they were no longer part of the Smart $aver program and were unable to help me. I paid over $200 for additional services to have the Freon removed, an additional service I thought I really did not need, but was convinced by the contractor that I needed to get the additional services in order to get the Smart $aver rebate. I am still quite unclear about how the Smart $aver program was supposed to work. I would really appreciate if Duke Energy could do a follow up with me about my participation and the services that were performed.*
- *The one thing that frustrated me a little bit was, when the contractor was done, they conducted all the testing that they were certified to do. Then, someone from Duke Energy had to come out do the exact same testing. I wish they'd accepted the results from the contractor and not had to come back out. It was very inconvenient for us.*
- *As a result of participating of the program, we became an Energy Star certified home. This program should offer information on the reduced rates for Energy Star certified homes. If I'd known about this earlier, I would have applied to Duke Energy for these reduced rates months ago.*
- *Having the ducts sealed and adding insulation to the attic and our crawlspace has cut the house's energy consumption in half. I knew that getting these things done would help the efficiency so I was planning on doing them even without the rebate. The rebate did help ease the financial burden of having the work done and we're reinvesting the savings in new windows, which will be installed next month.*

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- *I did appreciate and enjoy participating in the program, however I did not see the results in the reduction of my bill. It appears to be about the same. I have the equal payment plan. Maybe it'll go down when I get re-evaluated. I did notice improved comfort, though.*
- *Well, I was told that by investing in having the attic insulation and air sealing performed on my house it was supposed to make a huge difference with my heating and cooling costs and efficiency. I really have not seen or noticed an improvement, so I am slightly disappointed with the lack of those results. Besides that, I thought the contractor who performed the work was very helpful and very professional.*
- *I think this is a great program. It saved me money and the people were very informative.*
- *They could send us some more bulbs, if they want to. We're 100% satisfied with the rebates and we're well satisfied with the unit we got.*
- *The initial rebate was great and the results are still coming in over time. The coal ash spill has not reflected well on their ability to control things, and as a stockholder I don't want the pay for the spill. The spill has affected my satisfaction with Duke Energy. I'm enthusiastic about trying to clean up the environment and moving to renewable sources of energy, like solar panels.*
- *There were problems with submitting the whole house air sealing and attic insulation. I believed ERS had submitted for the attic insulation and air sealing. When my rebate for the duct sealing came, but the insulation rebate didn't come, I called ERS to ask what happened. Apparently, it was a processing error on Duke's part where they didn't separate the applications. I got busy with work and by the time I figured out what was going on, the 90-day window had passed. I would have liked if they'd let me know prior that there was a time period for processing the rebate, so that I could have had an indication that there was an issue with the attic insulation rebate. I would have liked that money.*
- *I wondered why the rebate took two to three months; I feel this should have been a little shorter in time.*
- *It took me a long time to get my rebate check. I even had to call a few times. I also didn't understand a lot about what they actually did with this program. It wasn't explained to me very well.*
- *Duke Energy could provide rebates for attic fans. Our fan has lowered our energy bill approximately 20%.*
- *I think it's good when Duke Energy has incentives to benefit the customer for doing home improvements. I hope they continue to offer these incentives and offer even more in the future.*
- *I have some confusion about how we got our name on your list of people who participated in this Smart $aver program, it must have been the company who did the work on my home who applied us for the program. I really did not receive any information about the program, but I did get the rebate check for $100, so I guess we qualified for the Smart $aver.*
- *I was very disappointed to hear that this program was ending*[12] *and I was very disappointed to hear that it was timeboxed. I don't think they're investing enough with*

[12] TMW does not know the source of this misinformation.

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alternative energy and they don't seem to care about safety, especially with this coal ash spill. And, it's continuing. They're not interested in finding innovative solutions for our safety and sustainable energy sources. To be energy efficient, I bought an electric car, so my electric use went up. The government gave me a rebate, but Duke Energy didn't offer anything. They're a stodgy, stodgy company. I wouldn't buy stock in them. When I invest my money, that's my ultimate test. I will never buy stock in Duke.

Comments that are not about the Smart $aver Additional Measures program

- *Your power service and stuff is good, but your ability to communicate with the disabled community sucks. I am blind and your website is horrific. It's not encoded for the disabled community, as it should be by law. And, you are required by law to give me a bill in braille, which I only get it if I ask for it each time. I have to truck the bill to my mom's house and she has to pay the bill for me. If I did not have my mom, then I'm in a world of hurt. I'd have to pay somebody to pay my Duke Energy bill for me. I think she finally set up online bill paying, so she didn't have to write checks for me. Other than my one complaint of all of your program opportunities, energy-efficiency information, and billing information being entirely inaccessible to me without my mom's help, I have no other complaints about Duke's service. My power seems to stay on while everyone around me has outages when we have storms.*
- *I think the rates are high and that Duke Energy should take responsibility for their coal ash spill. They're the ones who didn't keep the ash contained well enough so they should have to clean it up.*
- *I am upset about the coal ash spill and Duke's anti-solar lobbying efforts. Duke Energy should support renewable energies.*
- *I am pleased with their services; they've always been very helpful with anything I've ever needed.*
- *I am very grateful that Duke Energy is always communicating with their customers and trying to improve their services.*
- *I love their automatic billing. I hate writing checks.*
- *Duke Energy could bury power lines.*
- *Duke Energy could monitor customers' daily usage and notify them via email in cases of uncharacteristic spikes. This would be akin to a service formally provided by the now defunct Piedmont Energy.*
- *Our 'My Home Energy Report' might be inaccurate. We have added onto our house and have made changes. I have called customer service and was unable to get an answer to our question. I want to know if the report is based on our original house or our renovated house.*
- *Duke Energy could improve customer service. I dislike the convoluted phone menu options. Please make it easier for me to speak to a helpful customer service representative straight away when I call.*
- *They could make their website easier to get around on. Specifically what kind of heat pump do I buy in order to receive a rebate? There needs to be a better way to search for information.*

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- *I would like to encourage Duke Energy to use those solar funds, and continue to encourage alternative clean energies. I want more alternatives; I'd like to see a decline in the use of coal power and to completely stop using nuclear power.*
- *I would like to encourage Duke Energy to explore renewable energy resources, especially with solar energy. I'd like them to support a program which would help customers with installation of solar panels for their properties, or even have renting opportunities of the renewable systems. Why is Duke not doing this? It only makes sense for a region that has a surplus of sun to harvest that energy. Also, especially for customers with older homes, somehow have Duke Energy check to make sure those old radiant heat sources have their breakers turned off, or have that be a 'double-check suggestion' on the My Home Energy Report so more people are aware of that energy wasting potential.*
- *A long time ago, and they did correct it, but when they were putting lines underground, they caused a blockage in my sewer line. They did pay what the plumber costs me, but I kind of feel like I should have been better compensated. I mean, I had sewage in my house. Maybe their customer service is better now. That's the reason I didn't rate my satisfaction as high.*
- *I was somehow removed from the even billing payment plan, which I had never approved. We somehow got a $300 bill which we couldn't pay for because we're on a fixed income. I had paid the bills every month so I was surprised by the $300 bill and I couldn't figure out when we used that energy because I keep all of our bills. When I called Duke Energy about the bill, no one could tell me when we used that power.*
- *Duke Energy could be less profit-driven and reduce rates for customers.*
- *I am less than satisfied with Duke Energy because the rates keep going up.*
- *I'd like to see Duke Energy lower the cost of their rates. I'd like to see Duke Energy offer me a military discount on my utility services.*
- *Don't raise their rates anymore.*
- *Give back more money. They got plenty and they can afford to give back to their customers and less to their stockholders. They need to reduce their stockholder percentage by 10%. I mean, how many stocks do you know of where you're guaranteed 20%?*

At the end of trade ally interviews, trade allies were also asked if they had any comments about to share with Duke Energy. Twelve trade allies offered comments about the Additional Measures program, which are listed below.

- Offers all five measures: *Replacing an HVAC unit leads customers to participate in other Smart $aver services at the same time. The program application form is a bit cumbersome. Building Performance Institute (BPI) standards are not the ultimate qualifier here in the Carolinas. There are other factors to consider.*
- Offers all five measures: *Sometimes, we get a call from customers who had the Duke Energy audit done only to find out they just had a walkthrough. People become confused because they actually didn't know that what they had was only a walkthrough and they don't understand why they have to have another audit. If you don't check something like the backdraft, it's unsafe for the customers. It goes to logic to do a full energy audit*

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before doing the work. We follow BPI protocol. It's going to take a bigger tax credit to offer full audits to people. Duke needs to have clear language with people who have the free walkthrough done.

- Offers all three insulate and seal measures: *I would love to see them put larger rebates into this program to make it more effective.*
- Offers all three insulate and seal measures: *The one thing that has probably got me out to more houses for energy audits was the comparison report Duke sends out. That's a very good marketing tool and it really helps us out. People trust you guys that say they have high power bills because you'd be the ones least likely to say that unless it were true.*
- Offers all three insulate and seal measures: *I would absolutely love for Duke Energy to let me know how I'm doing. I've heard some good comments on audits. But, what I'd love is to hear back from Duke Energy about how the customers in this program are doing energy-wise, how much they're saving.*
- Offers all three insulate and seal measures: *I noticed on the website, when I went to the program, that my company was at the bottom of the list and that there was no link to my website. My company is a longtime participant in this program, probably as long as the program has been available.*
- Offers all three insulate and seal measures: *I just encourage you to keep the program and increase the value on the rebates. Big thumbs up on the program!*
- Offers all three insulate and seal measures: *I just spoke with my Duke rep yesterday about these concerns with this program. Duke Energy is doing a major disservice to their customers by offering walkthrough efficiency audits through a third party. It's actually harming the homeowner. There's no accountability in the process with these third party auditors. All they care about is getting their $50 and moving on to eight other homes that day. When we get to the home, nothing coincides on the paperwork provided by these auditors with what's actually going on in the house. An example is we had a lady in a 1936 house who was told she needed attic insulation and sealing and that was it. The third party audit had checked off on air leaks and other things. When we got there, there was no insulation and sealing anywhere the auditor checked off on. Attic Insulation and sealing was only about one tenth of what this lady needed and she thought she only needed attic insulation. They completely BS'd her. The people that Duke Energy is contracting out to do these audits suck and they're dumber than a stick horse. These audits are doing more harm than providing benefit. These audits are designed to bring people to the Smart Saver Program website. The third party auditor, through [redacted], is [redacted]. Another example is we had a call from a lady in a 1932 house that had such a terrible audit conducted that she called us. She said she showed the auditor a place where air was leaking under her cabinetry and the auditor said, 'You know that mismatched sock from the dryer? The one where you can't find the other one? Stuff that in there and it'll stop the leak.' That suggestion was beyond absurd. Our company is trying to lend creditability to the industry as a whole, but things like this damage the industry. I have recommendations for the program. First, Duke Energy should turn over the energy audits that are being done by third parties to the contractors participating in the Smart $aver Program. We are properly certified and we have a vested interest in doing the work properly, regardless of rebate costs. We do a free field site seeing survey for all of our customers. Then we do diagnostics. We never charge our customers for walkthrough audits. Second, if they do not turn over the walkthrough audits to program*

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contractors, they need greater accountability measures and they need to require that the third party auditors go into the home with a list of program contractors and program information. You don't save kilowatts by audits, but by doing the work. Third, they need to add a small incentive for windows because that's what people think will save them energy. And, fourth, there has to be some kind of educational aspect to this program. Have Duke Energy give a quarterly, or bi-annual, public presentation on exactly what services promote efficiency. These presentations will raise awareness of the program and methods to save energy, and will go a long way toward the longevity and level of success of this program.

- Offers attic insulation and duct sealing: *Duke Energy and Duke Energy Progress could merge their incentive programs or clarify the differences between them. Duke could market the health & safety aspects of the program, and also show customers how it could lower their energy bills. Provide more training about proper duct & attic sealing techniques.*
- Offers attic insulation and duct sealing: *I don't think this is a good program at all. The first step needs to be a comprehensive energy assessment, not a Duke Energy pitiful assessment. I think this program gives people a false sense of improvement, and is not a good use of customers' finances.*
- Offers duct insulation, duct sealing and HVAC tune-ups: *I would suggest providing customers with two different rebate options: a smaller rebate if their system passes the initial test, or a larger rebate if it fails. Customers don't like the idea of their system needing to fail the test in order to qualify for the incentive.*
- Offers HVAC tune-ups: *I don't know how many people truly look at the program postcards Duke sends out. We gave them a list of customers and we probably only got back one percent from that. Get the word out that there's rebate programs out there.*

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Appendix D: DOE-2 Simulation Results

Table 47. Infiltration (Air Leakage Sealing) Unit Energy Savings

City	Duct location	HVAC System	kWh/cfm	kW/cfm
Asheville	Attic	AC Gas Heat	1.3	0.0000
Asheville	Basement	AC Gas Heat	1.2	0.0043
Asheville	Attic	Heat Pump	20.1	0.0000
Asheville	Basement	Heat Pump	17.1	0.0022
Charlotte	Attic	AC Gas Heat	2.3	0.0000
Charlotte	Basement	AC Gas Heat	2.2	0.0012
Charlotte	Attic	Heat Pump	12.1	0.0000
Charlotte	Basement	Heat Pump	10.9	0.0012
Greenville	Attic	AC Gas Heat	2.7	0.0000
Greenville	Basement	AC Gas Heat	2.2	0.0013
Greenville	Attic	Heat Pump	16.7	0.0000
Greenville	Basement	Heat Pump	15.0	0.0013

Table 48. Cooling System Size

City	Duct location	SF/ton 2 story prototype	SF/ton Single Story Prototype	SF/ton avg
Asheville	Attic	709	634	671
Asheville	Basement	705	496	600
Charlotte	Attic	593	495	544
Charlotte	Basement	693	598	646
Greenville	Attic	598	507	553
Greenville	Basement	703	615	659

Table 49. Annual HVAC Compressor Energy Consumption

City	HVAC type	Cooling (kWh/ton)	Compressor heating (kWh/ton)	Total compressor (kWh/ton)
Asheville	AC with gas heat	344	0	344
Asheville	Air source heat pump	483	2,248	2,731
Charlotte	AC with gas heat	643	0	643
Charlotte	Air source heat pump	771	962	1,734
Greenville	AC with gas heat	530	0	530
Greenville	Air source heat pump	635	1,338	1,973

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Table 50. Attic Insulation Measure Unit Energy Savings

City	Duct location	HVAC System	Rbase	Rmeasure	kWh/kSF	kW/kSF
Asheville	Attic	AC Gas Heat	0	11	305.6	0.000
Asheville	Attic	AC Gas Heat	0	19	346.8	0.000
Asheville	Attic	AC Gas Heat	0	30	373.2	0.000
Asheville	Attic	AC Gas Heat	0	38	380.0	0.000
Asheville	Attic	AC Gas Heat	0	49	387.0	0.000
Asheville	Attic	AC Gas Heat	0	60	392.7	0.000
Asheville	Attic	AC Gas Heat	11	19	41.1	0.000
Asheville	Attic	AC Gas Heat	11	30	67.6	0.000
Asheville	Attic	AC Gas Heat	11	38	74.4	0.000
Asheville	Attic	AC Gas Heat	11	49	81.4	0.000
Asheville	Attic	AC Gas Heat	11	60	87.0	0.000
Asheville	Attic	AC Gas Heat	19	30	26.5	0.000
Asheville	Attic	AC Gas Heat	19	38	33.3	0.000
Asheville	Attic	AC Gas Heat	19	49	40.3	0.000
Asheville	Attic	AC Gas Heat	19	60	45.9	0.000
Asheville	Attic	AC Gas Heat	30	38	6.8	0.000
Asheville	Attic	AC Gas Heat	30	49	13.8	0.000
Asheville	Attic	AC Gas Heat	30	60	19.5	0.000
Asheville	Attic	AC Gas Heat	38	49	7.0	0.000
Asheville	Attic	AC Gas Heat	38	60	12.6	0.000
Asheville	Basement	AC Gas Heat	0	11	315.7	0.290
Asheville	Basement	AC Gas Heat	0	19	357.3	0.341
Asheville	Basement	AC Gas Heat	0	30	376.5	0.375
Asheville	Basement	AC Gas Heat	0	38	384.0	0.375
Asheville	Basement	AC Gas Heat	0	49	391.8	0.392
Asheville	Basement	AC Gas Heat	0	60	397.6	0.410
Asheville	Basement	AC Gas Heat	11	19	41.6	0.051
Asheville	Basement	AC Gas Heat	11	30	60.8	0.085
Asheville	Basement	AC Gas Heat	11	38	68.3	0.085
Asheville	Basement	AC Gas Heat	11	49	76.1	0.102
Asheville	Basement	AC Gas Heat	11	60	81.9	0.119
Asheville	Basement	AC Gas Heat	19	30	19.1	0.034
Asheville	Basement	AC Gas Heat	19	38	26.6	0.034
Asheville	Basement	AC Gas Heat	19	49	34.5	0.051
Asheville	Basement	AC Gas Heat	19	60	40.3	0.068
Asheville	Basement	AC Gas Heat	30	38	7.5	0.000
Asheville	Basement	AC Gas Heat	30	49	15.4	0.017
Asheville	Basement	AC Gas Heat	30	60	21.2	0.034
Asheville	Basement	AC Gas Heat	38	49	7.8	0.017
Asheville	Basement	AC Gas Heat	38	60	13.7	0.034

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City	Duct location	HVAC System	Rbase	Rmeasure	kWh/kSF	kW/kSF
Asheville	Attic	Heat Pump	0	11	3214.8	0.324
Asheville	Attic	Heat Pump	0	19	3587.0	0.392
Asheville	Attic	Heat Pump	0	30	3806.7	0.444
Asheville	Attic	Heat Pump	0	38	3894.9	0.461
Asheville	Attic	Heat Pump	0	49	3966.4	0.478
Asheville	Attic	Heat Pump	0	60	4014.3	0.495
Asheville	Attic	Heat Pump	11	19	372.2	0.068
Asheville	Attic	Heat Pump	11	30	591.8	0.119
Asheville	Attic	Heat Pump	11	38	680.0	0.137
Asheville	Attic	Heat Pump	11	49	751.5	0.154
Asheville	Attic	Heat Pump	11	60	799.5	0.171
Asheville	Attic	Heat Pump	19	30	219.6	0.051
Asheville	Attic	Heat Pump	19	38	307.8	0.068
Asheville	Attic	Heat Pump	19	49	379.4	0.085
Asheville	Attic	Heat Pump	19	60	427.3	0.102
Asheville	Attic	Heat Pump	30	38	88.2	0.000
Asheville	Attic	Heat Pump	30	49	159.7	0.000
Asheville	Attic	Heat Pump	30	60	207.7	0.000
Asheville	Attic	Heat Pump	38	49	71.5	0.017
Asheville	Attic	Heat Pump	38	60	119.5	0.034
Asheville	Basement	Heat Pump	0	11	2755.1	0.461
Asheville	Basement	Heat Pump	0	19	3067.7	0.546
Asheville	Basement	Heat Pump	0	30	3252.0	0.580
Asheville	Basement	Heat Pump	0	38	3322.0	0.597
Asheville	Basement	Heat Pump	0	49	3383.1	0.614
Asheville	Basement	Heat Pump	0	60	3423.4	0.631
Asheville	Basement	Heat Pump	11	19	312.6	0.085
Asheville	Basement	Heat Pump	11	30	496.9	0.119
Asheville	Basement	Heat Pump	11	38	566.9	0.137
Asheville	Basement	Heat Pump	11	49	628.0	0.154
Asheville	Basement	Heat Pump	11	60	668.3	0.171
Asheville	Basement	Heat Pump	19	30	184.3	0.034
Asheville	Basement	Heat Pump	19	38	254.3	0.051
Asheville	Basement	Heat Pump	19	49	315.4	0.068
Asheville	Basement	Heat Pump	19	60	355.6	0.085
Asheville	Basement	Heat Pump	30	38	70.0	0.000
Asheville	Basement	Heat Pump	30	49	131.1	0.000
Asheville	Basement	Heat Pump	30	60	171.3	0.000
Asheville	Basement	Heat Pump	38	49	61.1	0.017
Asheville	Basement	Heat Pump	38	60	101.4	0.034
Charlotte	Attic	AC Gas Heat	0	11	497.3	0.137

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City	Duct location	HVAC System	Rbase	Rmeasure	kWh/kSF	kW/kSF
Charlotte	Attic	AC Gas Heat	0	19	557.0	0.154
Charlotte	Attic	AC Gas Heat	0	30	590.1	0.171
Charlotte	Attic	AC Gas Heat	0	38	603.8	0.171
Charlotte	Attic	AC Gas Heat	0	49	612.8	0.171
Charlotte	Attic	AC Gas Heat	0	60	622.9	0.171
Charlotte	Attic	AC Gas Heat	11	19	59.7	0.017
Charlotte	Attic	AC Gas Heat	11	30	92.8	0.034
Charlotte	Attic	AC Gas Heat	11	38	106.5	0.034
Charlotte	Attic	AC Gas Heat	11	49	115.5	0.034
Charlotte	Attic	AC Gas Heat	11	60	125.6	0.034
Charlotte	Attic	AC Gas Heat	19	30	33.1	0.017
Charlotte	Attic	AC Gas Heat	19	38	46.8	0.017
Charlotte	Attic	AC Gas Heat	19	49	55.8	0.017
Charlotte	Attic	AC Gas Heat	19	60	65.9	0.017
Charlotte	Attic	AC Gas Heat	30	38	13.7	0.000
Charlotte	Attic	AC Gas Heat	30	49	22.7	0.000
Charlotte	Attic	AC Gas Heat	30	60	32.8	0.000
Charlotte	Attic	AC Gas Heat	38	49	9.0	0.000
Charlotte	Attic	AC Gas Heat	38	60	19.1	0.000
Charlotte	Basement	AC Gas Heat	0	11	499.1	0.239
Charlotte	Basement	AC Gas Heat	0	19	556.3	0.290
Charlotte	Basement	AC Gas Heat	0	30	588.9	0.341
Charlotte	Basement	AC Gas Heat	0	38	600.0	0.358
Charlotte	Basement	AC Gas Heat	0	49	612.8	0.375
Charlotte	Basement	AC Gas Heat	0	60	620.8	0.375
Charlotte	Basement	AC Gas Heat	11	19	57.2	0.051
Charlotte	Basement	AC Gas Heat	11	30	89.8	0.102
Charlotte	Basement	AC Gas Heat	11	38	100.9	0.119
Charlotte	Basement	AC Gas Heat	11	49	113.7	0.137
Charlotte	Basement	AC Gas Heat	11	60	121.7	0.137
Charlotte	Basement	AC Gas Heat	19	30	32.6	0.051
Charlotte	Basement	AC Gas Heat	19	38	43.7	0.068
Charlotte	Basement	AC Gas Heat	19	49	56.5	0.085
Charlotte	Basement	AC Gas Heat	19	60	64.5	0.085
Charlotte	Basement	AC Gas Heat	30	38	11.1	0.017
Charlotte	Basement	AC Gas Heat	30	49	23.9	0.034
Charlotte	Basement	AC Gas Heat	30	60	31.9	0.034
Charlotte	Basement	AC Gas Heat	38	49	12.8	0.017
Charlotte	Basement	AC Gas Heat	38	60	20.8	0.017
Charlotte	Attic	Heat Pump	0	11	2229.9	0.529
Charlotte	Attic	Heat Pump	0	19	2491.8	0.614

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City	Duct location	HVAC System	Rbase	Rmeasure	kWh/kSF	kW/kSF
Charlotte	Attic	Heat Pump	0	30	2646.4	0.666
Charlotte	Attic	Heat Pump	0	38	2703.9	0.683
Charlotte	Attic	Heat Pump	0	49	2755.1	0.700
Charlotte	Attic	Heat Pump	0	60	2788.7	0.717
Charlotte	Attic	Heat Pump	11	19	261.9	0.085
Charlotte	Attic	Heat Pump	11	30	416.6	0.137
Charlotte	Attic	Heat Pump	11	38	474.1	0.154
Charlotte	Attic	Heat Pump	11	49	525.3	0.171
Charlotte	Attic	Heat Pump	11	60	558.9	0.188
Charlotte	Attic	Heat Pump	19	30	154.6	0.051
Charlotte	Attic	Heat Pump	19	38	212.1	0.068
Charlotte	Attic	Heat Pump	19	49	263.3	0.085
Charlotte	Attic	Heat Pump	19	60	296.9	0.102
Charlotte	Attic	Heat Pump	30	38	57.5	0.000
Charlotte	Attic	Heat Pump	30	49	108.7	0.000
Charlotte	Attic	Heat Pump	30	60	142.3	0.000
Charlotte	Attic	Heat Pump	38	49	51.2	0.017
Charlotte	Attic	Heat Pump	38	60	84.8	0.034
Charlotte	Basement	Heat Pump	0	11	2044.4	0.427
Charlotte	Basement	Heat Pump	0	19	2283.3	0.495
Charlotte	Basement	Heat Pump	0	30	2420.6	0.546
Charlotte	Basement	Heat Pump	0	38	2474.4	0.563
Charlotte	Basement	Heat Pump	0	49	2521.0	0.580
Charlotte	Basement	Heat Pump	0	60	2551.5	0.597
Charlotte	Basement	Heat Pump	11	19	238.9	0.068
Charlotte	Basement	Heat Pump	11	30	376.3	0.119
Charlotte	Basement	Heat Pump	11	38	430.0	0.137
Charlotte	Basement	Heat Pump	11	49	476.6	0.154
Charlotte	Basement	Heat Pump	11	60	507.2	0.171
Charlotte	Basement	Heat Pump	19	30	137.4	0.051
Charlotte	Basement	Heat Pump	19	38	191.1	0.068
Charlotte	Basement	Heat Pump	19	49	237.7	0.085
Charlotte	Basement	Heat Pump	19	60	268.3	0.102
Charlotte	Basement	Heat Pump	30	38	53.8	0.000
Charlotte	Basement	Heat Pump	30	49	100.3	0.000
Charlotte	Basement	Heat Pump	30	60	130.9	0.000
Charlotte	Basement	Heat Pump	38	49	46.6	0.017
Charlotte	Basement	Heat Pump	38	60	77.1	0.034
Greenville	Attic	AC Gas Heat	0	11	380.4	0.034
Greenville	Attic	AC Gas Heat	0	19	429.7	0.034
Greenville	Attic	AC Gas Heat	0	30	456.3	0.051

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City	Duct location	HVAC System	Rbase	Rmeasure	kWh/kSF	kW/kSF
Greenville	Attic	AC Gas Heat	0	38	470.8	0.051
Greenville	Attic	AC Gas Heat	0	49	480.5	0.051
Greenville	Attic	AC Gas Heat	0	60	486.5	0.051
Greenville	Attic	AC Gas Heat	11	19	49.3	0.000
Greenville	Attic	AC Gas Heat	11	30	75.9	0.017
Greenville	Attic	AC Gas Heat	11	38	90.4	0.017
Greenville	Attic	AC Gas Heat	11	49	100.2	0.017
Greenville	Attic	AC Gas Heat	11	60	106.1	0.017
Greenville	Attic	AC Gas Heat	19	30	26.6	0.017
Greenville	Attic	AC Gas Heat	19	38	41.1	0.017
Greenville	Attic	AC Gas Heat	19	49	50.9	0.017
Greenville	Attic	AC Gas Heat	19	60	56.8	0.017
Greenville	Attic	AC Gas Heat	30	38	14.5	0.000
Greenville	Attic	AC Gas Heat	30	49	24.2	0.000
Greenville	Attic	AC Gas Heat	30	60	30.2	0.000
Greenville	Attic	AC Gas Heat	38	49	9.7	0.000
Greenville	Attic	AC Gas Heat	38	60	15.7	0.000
Greenville	Basement	AC Gas Heat	0	11	386.7	0.068
Greenville	Basement	AC Gas Heat	0	19	438.4	0.102
Greenville	Basement	AC Gas Heat	0	30	461.4	0.119
Greenville	Basement	AC Gas Heat	0	38	473.4	0.137
Greenville	Basement	AC Gas Heat	0	49	481.9	0.137
Greenville	Basement	AC Gas Heat	0	60	488.1	0.137
Greenville	Basement	AC Gas Heat	11	19	51.7	0.034
Greenville	Basement	AC Gas Heat	11	30	74.7	0.051
Greenville	Basement	AC Gas Heat	11	38	86.7	0.068
Greenville	Basement	AC Gas Heat	11	49	95.2	0.068
Greenville	Basement	AC Gas Heat	11	60	101.4	0.068
Greenville	Basement	AC Gas Heat	19	30	23.0	0.017
Greenville	Basement	AC Gas Heat	19	38	35.0	0.034
Greenville	Basement	AC Gas Heat	19	49	43.5	0.034
Greenville	Basement	AC Gas Heat	19	60	49.7	0.034
Greenville	Basement	AC Gas Heat	30	38	11.9	0.017
Greenville	Basement	AC Gas Heat	30	49	20.5	0.017
Greenville	Basement	AC Gas Heat	30	60	26.6	0.017
Greenville	Basement	AC Gas Heat	38	49	8.5	0.000
Greenville	Basement	AC Gas Heat	38	60	14.7	0.000
Greenville	Attic	Heat Pump	0	11	2459.0	0.324
Greenville	Attic	Heat Pump	0	19	2748.8	0.375
Greenville	Attic	Heat Pump	0	30	2924.1	0.427
Greenville	Attic	Heat Pump	0	38	2993.0	0.427

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City	Duct location	HVAC System	Rbase	Rmeasure	kWh/kSF	kW/kSF
Greenville	Attic	Heat Pump	0	49	3052.2	0.444
Greenville	Attic	Heat Pump	0	60	3091.0	0.461
Greenville	Attic	Heat Pump	11	19	289.8	0.051
Greenville	Attic	Heat Pump	11	30	465.0	0.102
Greenville	Attic	Heat Pump	11	38	534.0	0.102
Greenville	Attic	Heat Pump	11	49	593.2	0.119
Greenville	Attic	Heat Pump	11	60	631.9	0.137
Greenville	Attic	Heat Pump	19	30	175.3	0.051
Greenville	Attic	Heat Pump	19	38	244.2	0.051
Greenville	Attic	Heat Pump	19	49	303.4	0.068
Greenville	Attic	Heat Pump	19	60	342.2	0.085
Greenville	Attic	Heat Pump	30	38	68.9	0.000
Greenville	Attic	Heat Pump	30	49	128.2	0.000
Greenville	Attic	Heat Pump	30	60	166.9	0.000
Greenville	Attic	Heat Pump	38	49	59.2	0.017
Greenville	Attic	Heat Pump	38	60	98.0	0.034
Greenville	Basement	Heat Pump	0	11	2255.3	0.239
Greenville	Basement	Heat Pump	0	19	2519.1	0.290
Greenville	Basement	Heat Pump	0	30	2676.3	0.324
Greenville	Basement	Heat Pump	0	38	2738.1	0.341
Greenville	Basement	Heat Pump	0	49	2790.3	0.358
Greenville	Basement	Heat Pump	0	60	2825.1	0.358
Greenville	Basement	Heat Pump	11	19	263.8	0.051
Greenville	Basement	Heat Pump	11	30	421.0	0.085
Greenville	Basement	Heat Pump	11	38	482.8	0.102
Greenville	Basement	Heat Pump	11	49	535.0	0.119
Greenville	Basement	Heat Pump	11	60	569.8	0.119
Greenville	Basement	Heat Pump	19	30	157.2	0.034
Greenville	Basement	Heat Pump	19	38	218.9	0.051
Greenville	Basement	Heat Pump	19	49	271.2	0.068
Greenville	Basement	Heat Pump	19	60	306.0	0.068
Greenville	Basement	Heat Pump	30	38	61.8	0.000
Greenville	Basement	Heat Pump	30	49	114.0	0.000
Greenville	Basement	Heat Pump	30	60	148.8	0.000
Greenville	Basement	Heat Pump	38	49	52.2	0.017
Greenville	Basement	Heat Pump	38	60	87.0	0.017

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Table 51. Duct Insulation and Sealing Measure Unit Energy Savings

City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	AC Gas Heat	0	0	8	5	12	0.008
Asheville	Attic	AC Gas Heat	0	4	8	5	497	0.186
Asheville	Attic	AC Gas Heat	0	4	8	8	483	0.171
Asheville	Attic	AC Gas Heat	0	6	8	5	522	0.209
Asheville	Attic	AC Gas Heat	0	6	8	8	506	0.202
Asheville	Attic	AC Gas Heat	0	19	8	5	561	0.279
Asheville	Attic	AC Gas Heat	0	19	8	8	546	0.264
Asheville	Attic	AC Gas Heat	0	0	10	5	19	0.008
Asheville	Attic	AC Gas Heat	0	0	10	8	8	0.000
Asheville	Attic	AC Gas Heat	0	4	10	5	505	0.186
Asheville	Attic	AC Gas Heat	0	4	10	8	490	0.171
Asheville	Attic	AC Gas Heat	0	4	10	10	481	0.163
Asheville	Attic	AC Gas Heat	0	6	10	5	529	0.209
Asheville	Attic	AC Gas Heat	0	6	10	8	513	0.202
Asheville	Attic	AC Gas Heat	0	6	10	10	503	0.194
Asheville	Attic	AC Gas Heat	0	19	10	5	568	0.279
Asheville	Attic	AC Gas Heat	0	19	10	8	554	0.264
Asheville	Attic	AC Gas Heat	0	19	10	10	544	0.248
Asheville	Attic	AC Gas Heat	0	0	20	5	57	0.016
Asheville	Attic	AC Gas Heat	0	0	20	8	45	0.008
Asheville	Attic	AC Gas Heat	0	0	20	10	37	0.008
Asheville	Attic	AC Gas Heat	0	4	20	5	542	0.194
Asheville	Attic	AC Gas Heat	0	4	20	8	527	0.178
Asheville	Attic	AC Gas Heat	0	4	20	10	518	0.171
Asheville	Attic	AC Gas Heat	0	4	20	20	465	0.109
Asheville	Attic	AC Gas Heat	0	6	20	5	567	0.217
Asheville	Attic	AC Gas Heat	0	6	20	8	551	0.209
Asheville	Attic	AC Gas Heat	0	6	20	10	541	0.202
Asheville	Attic	AC Gas Heat	0	6	20	20	488	0.132
Asheville	Attic	AC Gas Heat	0	19	20	5	606	0.287
Asheville	Attic	AC Gas Heat	0	19	20	8	591	0.271
Asheville	Attic	AC Gas Heat	0	19	20	10	581	0.256
Asheville	Attic	AC Gas Heat	0	19	20	20	527	0.178
Asheville	Attic	AC Gas Heat	0	0	23	5	64	0.016
Asheville	Attic	AC Gas Heat	0	0	23	8	53	0.008
Asheville	Attic	AC Gas Heat	0	0	23	10	45	0.008
Asheville	Attic	AC Gas Heat	0	0	23	20	8	0.000
Asheville	Attic	AC Gas Heat	0	4	23	5	550	0.194
Asheville	Attic	AC Gas Heat	0	4	23	8	535	0.178
Asheville	Attic	AC Gas Heat	0	4	23	10	526	0.171
Asheville	Attic	AC Gas Heat	0	4	23	20	472	0.109
Asheville	Attic	AC Gas Heat	0	4	23	23	454	0.093
Asheville	Attic	AC Gas Heat	0	6	23	5	574	0.217
Asheville	Attic	AC Gas Heat	0	6	23	8	559	0.209
Asheville	Attic	AC Gas Heat	0	6	23	10	548	0.202
Asheville	Attic	AC Gas Heat	0	6	23	20	496	0.132
Asheville	Attic	AC Gas Heat	0	6	23	23	478	0.109
Asheville	Attic	AC Gas Heat	0	19	23	5	613	0.287
Asheville	Attic	AC Gas Heat	0	19	23	8	599	0.271
Asheville	Attic	AC Gas Heat	0	19	23	10	589	0.256
Asheville	Attic	AC Gas Heat	0	19	23	20	535	0.178

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	AC Gas Heat	0	19	23	23	518	0.155
Asheville	Attic	AC Gas Heat	0	0	25	5	73	0.016
Asheville	Attic	AC Gas Heat	0	0	25	8	62	0.008
Asheville	Attic	AC Gas Heat	0	0	25	10	54	0.008
Asheville	Attic	AC Gas Heat	0	0	25	20	17	0.000
Asheville	Attic	AC Gas Heat	0	0	25	23	9	0.000
Asheville	Attic	AC Gas Heat	0	4	25	5	559	0.194
Asheville	Attic	AC Gas Heat	0	4	25	8	544	0.178
Asheville	Attic	AC Gas Heat	0	4	25	10	535	0.171
Asheville	Attic	AC Gas Heat	0	4	25	20	481	0.109
Asheville	Attic	AC Gas Heat	0	4	25	23	463	0.093
Asheville	Attic	AC Gas Heat	0	4	25	25	452	0.078
Asheville	Attic	AC Gas Heat	0	6	25	5	583	0.217
Asheville	Attic	AC Gas Heat	0	6	25	8	568	0.209
Asheville	Attic	AC Gas Heat	0	6	25	10	557	0.202
Asheville	Attic	AC Gas Heat	0	6	25	20	505	0.132
Asheville	Attic	AC Gas Heat	0	6	25	23	487	0.109
Asheville	Attic	AC Gas Heat	0	6	25	25	475	0.101
Asheville	Attic	AC Gas Heat	0	19	25	5	622	0.287
Asheville	Attic	AC Gas Heat	0	19	25	8	608	0.271
Asheville	Attic	AC Gas Heat	0	19	25	10	598	0.256
Asheville	Attic	AC Gas Heat	0	19	25	20	544	0.178
Asheville	Attic	AC Gas Heat	0	19	25	23	527	0.155
Asheville	Attic	AC Gas Heat	0	19	25	25	516	0.140
Asheville	Attic	AC Gas Heat	0	0	35	5	113	0.023
Asheville	Attic	AC Gas Heat	0	0	35	8	101	0.016
Asheville	Attic	AC Gas Heat	0	0	35	10	93	0.016
Asheville	Attic	AC Gas Heat	0	0	35	20	56	0.008
Asheville	Attic	AC Gas Heat	0	0	35	23	48	0.008
Asheville	Attic	AC Gas Heat	0	0	35	25	39	0.008
Asheville	Attic	AC Gas Heat	0	4	35	5	598	0.202
Asheville	Attic	AC Gas Heat	0	4	35	8	583	0.186
Asheville	Attic	AC Gas Heat	0	4	35	10	574	0.178
Asheville	Attic	AC Gas Heat	0	4	35	20	521	0.116
Asheville	Attic	AC Gas Heat	0	4	35	23	503	0.101
Asheville	Attic	AC Gas Heat	0	4	35	25	491	0.085
Asheville	Attic	AC Gas Heat	0	4	35	35	433	0.031
Asheville	Attic	AC Gas Heat	0	6	35	5	622	0.225
Asheville	Attic	AC Gas Heat	0	6	35	8	607	0.217
Asheville	Attic	AC Gas Heat	0	6	35	10	596	0.209
Asheville	Attic	AC Gas Heat	0	6	35	20	544	0.140
Asheville	Attic	AC Gas Heat	0	6	35	23	527	0.116
Asheville	Attic	AC Gas Heat	0	6	35	25	514	0.109
Asheville	Attic	AC Gas Heat	0	6	35	35	455	0.047
Asheville	Attic	AC Gas Heat	0	19	35	5	647	0.279
Asheville	Attic	AC Gas Heat	0	19	35	8	637	0.264
Asheville	Attic	AC Gas Heat	0	19	35	10	583	0.186
Asheville	Attic	AC Gas Heat	0	19	35	20	566	0.163
Asheville	Attic	AC Gas Heat	0	19	35	23	555	0.147
Asheville	Attic	AC Gas Heat	0	19	35	25	493	0.078
Asheville	Attic	AC Gas Heat	0	19	35	35	622	0.225
Asheville	Attic	AC Gas Heat	4	4	8	5	15	0.016
Asheville	Attic	AC Gas Heat	4	6	8	5	39	0.039

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	AC Gas Heat	4	6	8	8	23	0.031
Asheville	Attic	AC Gas Heat	4	19	8	5	78	0.109
Asheville	Attic	AC Gas Heat	4	19	8	8	64	0.093
Asheville	Attic	AC Gas Heat	4	4	10	5	24	0.023
Asheville	Attic	AC Gas Heat	4	4	10	8	9	0.008
Asheville	Attic	AC Gas Heat	4	6	10	5	48	0.047
Asheville	Attic	AC Gas Heat	4	6	10	8	33	0.039
Asheville	Attic	AC Gas Heat	4	6	10	10	22	0.031
Asheville	Attic	AC Gas Heat	4	19	10	5	87	0.116
Asheville	Attic	AC Gas Heat	4	19	10	8	73	0.101
Asheville	Attic	AC Gas Heat	4	19	10	10	63	0.085
Asheville	Attic	AC Gas Heat	4	4	20	5	77	0.085
Asheville	Attic	AC Gas Heat	4	4	20	8	63	0.070
Asheville	Attic	AC Gas Heat	4	4	20	10	53	0.062
Asheville	Attic	AC Gas Heat	4	6	20	5	102	0.109
Asheville	Attic	AC Gas Heat	4	6	20	8	86	0.101
Asheville	Attic	AC Gas Heat	4	6	20	10	76	0.093
Asheville	Attic	AC Gas Heat	4	6	20	20	23	0.023
Asheville	Attic	AC Gas Heat	4	19	20	5	141	0.178
Asheville	Attic	AC Gas Heat	4	19	20	8	126	0.163
Asheville	Attic	AC Gas Heat	4	19	20	10	116	0.147
Asheville	Attic	AC Gas Heat	4	19	20	20	63	0.070
Asheville	Attic	AC Gas Heat	4	4	23	5	96	0.101
Asheville	Attic	AC Gas Heat	4	4	23	8	81	0.085
Asheville	Attic	AC Gas Heat	4	4	23	10	71	0.078
Asheville	Attic	AC Gas Heat	4	4	23	20	18	0.016
Asheville	Attic	AC Gas Heat	4	6	23	5	120	0.124
Asheville	Attic	AC Gas Heat	4	6	23	8	104	0.116
Asheville	Attic	AC Gas Heat	4	6	23	10	94	0.109
Asheville	Attic	AC Gas Heat	4	6	23	20	41	0.039
Asheville	Attic	AC Gas Heat	4	6	23	23	24	0.016
Asheville	Attic	AC Gas Heat	4	19	23	5	159	0.194
Asheville	Attic	AC Gas Heat	4	19	23	8	144	0.178
Asheville	Attic	AC Gas Heat	4	19	23	10	134	0.163
Asheville	Attic	AC Gas Heat	4	19	23	20	81	0.085
Asheville	Attic	AC Gas Heat	4	19	23	23	64	0.062
Asheville	Attic	AC Gas Heat	4	4	25	5	107	0.116
Asheville	Attic	AC Gas Heat	4	4	25	8	92	0.101
Asheville	Attic	AC Gas Heat	4	4	25	10	83	0.093
Asheville	Attic	AC Gas Heat	4	4	25	20	30	0.031
Asheville	Attic	AC Gas Heat	4	4	25	23	12	0.016
Asheville	Attic	AC Gas Heat	4	6	25	5	131	0.140
Asheville	Attic	AC Gas Heat	4	6	25	8	116	0.132
Asheville	Attic	AC Gas Heat	4	6	25	10	105	0.124
Asheville	Attic	AC Gas Heat	4	6	25	20	53	0.054
Asheville	Attic	AC Gas Heat	4	6	25	23	36	0.031
Asheville	Attic	AC Gas Heat	4	6	25	25	23	0.023
Asheville	Attic	AC Gas Heat	4	19	25	5	171	0.209
Asheville	Attic	AC Gas Heat	4	19	25	8	156	0.194
Asheville	Attic	AC Gas Heat	4	19	25	10	146	0.178
Asheville	Attic	AC Gas Heat	4	19	25	20	92	0.101
Asheville	Attic	AC Gas Heat	4	19	25	23	75	0.078
Asheville	Attic	AC Gas Heat	4	19	25	25	64	0.062

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	AC Gas Heat	4	4	35	5	165	0.171
Asheville	Attic	AC Gas Heat	4	4	35	8	151	0.155
Asheville	Attic	AC Gas Heat	4	4	35	10	141	0.147
Asheville	Attic	AC Gas Heat	4	4	35	20	88	0.085
Asheville	Attic	AC Gas Heat	4	4	35	23	70	0.070
Asheville	Attic	AC Gas Heat	4	4	35	25	58	0.054
Asheville	Attic	AC Gas Heat	4	6	35	5	190	0.194
Asheville	Attic	AC Gas Heat	4	6	35	8	174	0.186
Asheville	Attic	AC Gas Heat	4	6	35	10	164	0.178
Asheville	Attic	AC Gas Heat	4	6	35	20	111	0.109
Asheville	Attic	AC Gas Heat	4	6	35	23	94	0.085
Asheville	Attic	AC Gas Heat	4	6	35	25	81	0.078
Asheville	Attic	AC Gas Heat	4	6	35	35	22	0.016
Asheville	Attic	AC Gas Heat	4	19	35	5	229	0.264
Asheville	Attic	AC Gas Heat	4	19	35	8	214	0.248
Asheville	Attic	AC Gas Heat	4	19	35	10	204	0.233
Asheville	Attic	AC Gas Heat	4	19	35	20	150	0.155
Asheville	Attic	AC Gas Heat	4	19	35	23	133	0.132
Asheville	Attic	AC Gas Heat	4	19	35	25	122	0.116
Asheville	Attic	AC Gas Heat	4	19	35	35	60	0.047
Asheville	Attic	AC Gas Heat	6	6	8	5	16	0.008
Asheville	Attic	AC Gas Heat	6	19	8	5	55	0.078
Asheville	Attic	AC Gas Heat	6	19	8	8	40	0.062
Asheville	Attic	AC Gas Heat	6	6	10	5	26	0.016
Asheville	Attic	AC Gas Heat	6	6	10	8	10	0.008
Asheville	Attic	AC Gas Heat	6	19	10	5	65	0.085
Asheville	Attic	AC Gas Heat	6	19	10	8	50	0.070
Asheville	Attic	AC Gas Heat	6	19	10	10	40	0.054
Asheville	Attic	AC Gas Heat	6	6	20	5	78	0.085
Asheville	Attic	AC Gas Heat	6	6	20	8	63	0.078
Asheville	Attic	AC Gas Heat	6	6	20	10	52	0.070
Asheville	Attic	AC Gas Heat	6	19	20	5	118	0.155
Asheville	Attic	AC Gas Heat	6	19	20	8	103	0.140
Asheville	Attic	AC Gas Heat	6	19	20	10	93	0.124
Asheville	Attic	AC Gas Heat	6	19	20	20	39	0.047
Asheville	Attic	AC Gas Heat	6	6	23	5	96	0.109
Asheville	Attic	AC Gas Heat	6	6	23	8	80	0.101
Asheville	Attic	AC Gas Heat	6	6	23	10	70	0.093
Asheville	Attic	AC Gas Heat	6	6	23	20	17	0.023
Asheville	Attic	AC Gas Heat	6	19	23	5	135	0.178
Asheville	Attic	AC Gas Heat	6	19	23	8	120	0.163
Asheville	Attic	AC Gas Heat	6	19	23	10	110	0.147
Asheville	Attic	AC Gas Heat	6	19	23	20	57	0.070
Asheville	Attic	AC Gas Heat	6	19	23	23	40	0.047
Asheville	Attic	AC Gas Heat	6	6	25	5	108	0.116
Asheville	Attic	AC Gas Heat	6	6	25	8	92	0.109
Asheville	Attic	AC Gas Heat	6	6	25	10	82	0.101
Asheville	Attic	AC Gas Heat	6	6	25	20	30	0.031
Asheville	Attic	AC Gas Heat	6	6	25	23	12	0.008
Asheville	Attic	AC Gas Heat	6	19	25	5	147	0.186
Asheville	Attic	AC Gas Heat	6	19	25	8	133	0.171
Asheville	Attic	AC Gas Heat	6	19	25	10	123	0.155
Asheville	Attic	AC Gas Heat	6	19	25	20	69	0.078

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	AC Gas Heat	6	19	25	23	52	0.054
Asheville	Attic	AC Gas Heat	6	19	25	25	41	0.039
Asheville	Attic	AC Gas Heat	6	6	35	5	167	0.178
Asheville	Attic	AC Gas Heat	6	6	35	8	152	0.171
Asheville	Attic	AC Gas Heat	6	6	35	10	141	0.163
Asheville	Attic	AC Gas Heat	6	6	35	20	89	0.093
Asheville	Attic	AC Gas Heat	6	6	35	23	71	0.070
Asheville	Attic	AC Gas Heat	6	6	35	25	59	0.062
Asheville	Attic	AC Gas Heat	6	19	35	5	206	0.248
Asheville	Attic	AC Gas Heat	6	19	35	8	192	0.233
Asheville	Attic	AC Gas Heat	6	19	35	10	182	0.217
Asheville	Attic	AC Gas Heat	6	19	35	20	128	0.140
Asheville	Attic	AC Gas Heat	6	19	35	23	111	0.116
Asheville	Attic	AC Gas Heat	6	19	35	25	100	0.101
Asheville	Attic	AC Gas Heat	6	19	35	35	38	0.031
Asheville	Attic	AC Gas Heat	19	19	8	5	15	0.016
Asheville	Attic	AC Gas Heat	19	19	10	5	25	0.031
Asheville	Attic	AC Gas Heat	19	19	10	8	10	0.016
Asheville	Attic	AC Gas Heat	19	19	20	5	78	0.109
Asheville	Attic	AC Gas Heat	19	19	20	8	64	0.093
Asheville	Attic	AC Gas Heat	19	19	20	10	54	0.078
Asheville	Attic	AC Gas Heat	19	19	23	5	95	0.132
Asheville	Attic	AC Gas Heat	19	19	23	8	81	0.116
Asheville	Attic	AC Gas Heat	19	19	23	10	71	0.101
Asheville	Attic	AC Gas Heat	19	19	23	20	17	0.023
Asheville	Attic	AC Gas Heat	19	19	25	5	106	0.147
Asheville	Attic	AC Gas Heat	19	19	25	8	92	0.132
Asheville	Attic	AC Gas Heat	19	19	25	10	82	0.116
Asheville	Attic	AC Gas Heat	19	19	25	20	28	0.039
Asheville	Attic	AC Gas Heat	19	19	25	23	11	0.016
Asheville	Attic	AC Gas Heat	19	19	35	5	169	0.217
Asheville	Attic	AC Gas Heat	19	19	35	8	154	0.202
Asheville	Attic	AC Gas Heat	19	19	35	10	144	0.186
Asheville	Attic	AC Gas Heat	19	19	35	20	90	0.109
Asheville	Attic	AC Gas Heat	19	19	35	23	73	0.085
Asheville	Attic	AC Gas Heat	19	19	35	25	62	0.070
Asheville	Attic	Heat Pump	0	0	8	5	89	0.008
Asheville	Attic	Heat Pump	0	4	8	5	3800	0.171
Asheville	Attic	Heat Pump	0	4	8	8	3706	0.163
Asheville	Attic	Heat Pump	0	6	8	5	3945	0.202
Asheville	Attic	Heat Pump	0	6	8	8	3851	0.186
Asheville	Attic	Heat Pump	0	19	8	5	4190	0.248
Asheville	Attic	Heat Pump	0	19	8	8	4102	0.240
Asheville	Attic	Heat Pump	0	0	10	5	150	0.008
Asheville	Attic	Heat Pump	0	0	10	8	60	0.000
Asheville	Attic	Heat Pump	0	4	10	5	3860	0.171
Asheville	Attic	Heat Pump	0	4	10	8	3766	0.163
Asheville	Attic	Heat Pump	0	4	10	10	3702	0.155
Asheville	Attic	Heat Pump	0	6	10	5	4005	0.202
Asheville	Attic	Heat Pump	0	6	10	8	3911	0.186
Asheville	Attic	Heat Pump	0	6	10	10	3848	0.178
Asheville	Attic	Heat Pump	0	19	10	5	4250	0.248
Asheville	Attic	Heat Pump	0	19	10	8	4162	0.240

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	Heat Pump	0	19	10	10	4101	0.233
Asheville	Attic	Heat Pump	0	0	20	5	452	0.008
Asheville	Attic	Heat Pump	0	0	20	8	362	0.000
Asheville	Attic	Heat Pump	0	0	20	10	302	0.000
Asheville	Attic	Heat Pump	0	4	20	5	4162	0.171
Asheville	Attic	Heat Pump	0	4	20	8	4068	0.163
Asheville	Attic	Heat Pump	0	4	20	10	4004	0.155
Asheville	Attic	Heat Pump	0	4	20	20	3670	0.116
Asheville	Attic	Heat Pump	0	6	20	5	4307	0.202
Asheville	Attic	Heat Pump	0	6	20	8	4214	0.186
Asheville	Attic	Heat Pump	0	6	20	10	4151	0.178
Asheville	Attic	Heat Pump	0	6	20	20	3822	0.140
Asheville	Attic	Heat Pump	0	19	20	5	4553	0.248
Asheville	Attic	Heat Pump	0	19	20	8	4464	0.240
Asheville	Attic	Heat Pump	0	19	20	10	4404	0.233
Asheville	Attic	Heat Pump	0	19	20	20	4085	0.178
Asheville	Attic	Heat Pump	0	0	23	5	544	0.016
Asheville	Attic	Heat Pump	0	0	23	8	455	0.008
Asheville	Attic	Heat Pump	0	0	23	10	395	0.008
Asheville	Attic	Heat Pump	0	0	23	20	93	0.008
Asheville	Attic	Heat Pump	0	4	23	5	4255	0.178
Asheville	Attic	Heat Pump	0	4	23	8	4161	0.171
Asheville	Attic	Heat Pump	0	4	23	10	4097	0.163
Asheville	Attic	Heat Pump	0	4	23	20	3763	0.124
Asheville	Attic	Heat Pump	0	4	23	23	3657	0.116
Asheville	Attic	Heat Pump	0	6	23	5	4399	0.209
Asheville	Attic	Heat Pump	0	6	23	8	4306	0.194
Asheville	Attic	Heat Pump	0	6	23	10	4243	0.186
Asheville	Attic	Heat Pump	0	6	23	20	3915	0.147
Asheville	Attic	Heat Pump	0	6	23	23	3811	0.140
Asheville	Attic	Heat Pump	0	19	23	5	4645	0.256
Asheville	Attic	Heat Pump	0	19	23	8	4557	0.248
Asheville	Attic	Heat Pump	0	19	23	10	4496	0.240
Asheville	Attic	Heat Pump	0	19	23	20	4178	0.186
Asheville	Attic	Heat Pump	0	19	23	23	4078	0.178
Asheville	Attic	Heat Pump	0	0	25	5	606	0.016
Asheville	Attic	Heat Pump	0	0	25	8	516	0.008
Asheville	Attic	Heat Pump	0	0	25	10	456	0.008
Asheville	Attic	Heat Pump	0	0	25	20	154	0.008
Asheville	Attic	Heat Pump	0	0	25	23	61	0.000
Asheville	Attic	Heat Pump	0	4	25	5	4316	0.178
Asheville	Attic	Heat Pump	0	4	25	8	4222	0.171
Asheville	Attic	Heat Pump	0	4	25	10	4158	0.163
Asheville	Attic	Heat Pump	0	4	25	20	3824	0.124
Asheville	Attic	Heat Pump	0	4	25	23	3719	0.116
Asheville	Attic	Heat Pump	0	4	25	25	3647	0.109
Asheville	Attic	Heat Pump	0	6	25	5	4461	0.209
Asheville	Attic	Heat Pump	0	6	25	8	4367	0.194
Asheville	Attic	Heat Pump	0	6	25	10	4304	0.186
Asheville	Attic	Heat Pump	0	6	25	20	3976	0.147
Asheville	Attic	Heat Pump	0	6	25	23	3873	0.140
Asheville	Attic	Heat Pump	0	6	25	25	3802	0.124
Asheville	Attic	Heat Pump	0	19	25	5	4706	0.256

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	Heat Pump	0	19	25	8	4618	0.248
Asheville	Attic	Heat Pump	0	19	25	10	4557	0.240
Asheville	Attic	Heat Pump	0	19	25	20	4239	0.186
Asheville	Attic	Heat Pump	0	19	25	23	4139	0.178
Asheville	Attic	Heat Pump	0	19	25	25	4070	0.171
Asheville	Attic	Heat Pump	0	0	35	5	919	0.016
Asheville	Attic	Heat Pump	0	0	35	8	830	0.008
Asheville	Attic	Heat Pump	0	0	35	10	770	0.008
Asheville	Attic	Heat Pump	0	0	35	20	467	0.008
Asheville	Attic	Heat Pump	0	0	35	23	375	0.000
Asheville	Attic	Heat Pump	0	0	35	25	314	0.000
Asheville	Attic	Heat Pump	0	4	35	5	4630	0.178
Asheville	Attic	Heat Pump	0	4	35	8	4536	0.171
Asheville	Attic	Heat Pump	0	4	35	10	4472	0.163
Asheville	Attic	Heat Pump	0	4	35	20	4138	0.124
Asheville	Attic	Heat Pump	0	4	35	23	4032	0.116
Asheville	Attic	Heat Pump	0	4	35	25	3961	0.109
Asheville	Attic	Heat Pump	0	4	35	35	3593	0.070
Asheville	Attic	Heat Pump	0	6	35	5	4774	0.209
Asheville	Attic	Heat Pump	0	6	35	8	4681	0.194
Asheville	Attic	Heat Pump	0	6	35	10	4618	0.186
Asheville	Attic	Heat Pump	0	6	35	20	4290	0.147
Asheville	Attic	Heat Pump	0	6	35	23	4186	0.140
Asheville	Attic	Heat Pump	0	6	35	25	4115	0.124
Asheville	Attic	Heat Pump	0	6	35	35	3748	0.085
Asheville	Attic	Heat Pump	0	19	35	5	4932	0.248
Asheville	Attic	Heat Pump	0	19	35	8	4871	0.240
Asheville	Attic	Heat Pump	0	19	35	10	4553	0.186
Asheville	Attic	Heat Pump	0	19	35	20	4452	0.178
Asheville	Attic	Heat Pump	0	19	35	23	4384	0.171
Asheville	Attic	Heat Pump	0	19	35	25	4026	0.116
Asheville	Attic	Heat Pump	0	19	35	35	4774	0.209
Asheville	Attic	Heat Pump	4	4	8	5	94	0.008
Asheville	Attic	Heat Pump	4	6	8	5	239	0.039
Asheville	Attic	Heat Pump	4	6	8	8	145	0.023
Asheville	Attic	Heat Pump	4	19	8	5	484	0.085
Asheville	Attic	Heat Pump	4	19	8	8	396	0.078
Asheville	Attic	Heat Pump	4	4	10	5	158	0.016
Asheville	Attic	Heat Pump	4	4	10	8	64	0.008
Asheville	Attic	Heat Pump	4	6	10	5	302	0.047
Asheville	Attic	Heat Pump	4	6	10	8	209	0.031
Asheville	Attic	Heat Pump	4	6	10	10	146	0.023
Asheville	Attic	Heat Pump	4	19	10	5	548	0.093
Asheville	Attic	Heat Pump	4	19	10	8	460	0.085
Asheville	Attic	Heat Pump	4	19	10	10	399	0.078
Asheville	Attic	Heat Pump	4	4	20	5	492	0.054
Asheville	Attic	Heat Pump	4	4	20	8	398	0.047
Asheville	Attic	Heat Pump	4	4	20	10	334	0.039
Asheville	Attic	Heat Pump	4	6	20	5	637	0.085
Asheville	Attic	Heat Pump	4	6	20	8	543	0.070
Asheville	Attic	Heat Pump	4	6	20	10	480	0.062
Asheville	Attic	Heat Pump	4	6	20	20	152	0.023
Asheville	Attic	Heat Pump	4	19	20	5	882	0.132

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	Heat Pump	4	19	20	8	794	0.124
Asheville	Attic	Heat Pump	4	19	20	10	733	0.116
Asheville	Attic	Heat Pump	4	19	20	20	415	0.062
Asheville	Attic	Heat Pump	4	4	23	5	598	0.062
Asheville	Attic	Heat Pump	4	4	23	8	503	0.054
Asheville	Attic	Heat Pump	4	4	23	10	440	0.047
Asheville	Attic	Heat Pump	4	4	23	20	105	0.008
Asheville	Attic	Heat Pump	4	6	23	5	742	0.093
Asheville	Attic	Heat Pump	4	6	23	8	649	0.078
Asheville	Attic	Heat Pump	4	6	23	10	586	0.070
Asheville	Attic	Heat Pump	4	6	23	20	258	0.031
Asheville	Attic	Heat Pump	4	6	23	23	154	0.023
Asheville	Attic	Heat Pump	4	19	23	5	988	0.140
Asheville	Attic	Heat Pump	4	19	23	8	899	0.132
Asheville	Attic	Heat Pump	4	19	23	10	839	0.124
Asheville	Attic	Heat Pump	4	19	23	20	521	0.070
Asheville	Attic	Heat Pump	4	19	23	23	420	0.062
Asheville	Attic	Heat Pump	4	4	25	5	669	0.070
Asheville	Attic	Heat Pump	4	4	25	8	575	0.062
Asheville	Attic	Heat Pump	4	4	25	10	511	0.054
Asheville	Attic	Heat Pump	4	4	25	20	177	0.016
Asheville	Attic	Heat Pump	4	4	25	23	71	0.008
Asheville	Attic	Heat Pump	4	6	25	5	813	0.101
Asheville	Attic	Heat Pump	4	6	25	8	720	0.085
Asheville	Attic	Heat Pump	4	6	25	10	657	0.078
Asheville	Attic	Heat Pump	4	6	25	20	329	0.039
Asheville	Attic	Heat Pump	4	6	25	23	225	0.031
Asheville	Attic	Heat Pump	4	6	25	25	155	0.016
Asheville	Attic	Heat Pump	4	19	25	5	1059	0.147
Asheville	Attic	Heat Pump	4	19	25	8	971	0.140
Asheville	Attic	Heat Pump	4	19	25	10	910	0.132
Asheville	Attic	Heat Pump	4	19	25	20	592	0.078
Asheville	Attic	Heat Pump	4	19	25	23	492	0.070
Asheville	Attic	Heat Pump	4	19	25	25	423	0.062
Asheville	Attic	Heat Pump	4	4	35	5	1037	0.109
Asheville	Attic	Heat Pump	4	4	35	8	943	0.101
Asheville	Attic	Heat Pump	4	4	35	10	879	0.093
Asheville	Attic	Heat Pump	4	4	35	20	545	0.054
Asheville	Attic	Heat Pump	4	4	35	23	440	0.047
Asheville	Attic	Heat Pump	4	4	35	25	368	0.039
Asheville	Attic	Heat Pump	4	6	35	5	1182	0.140
Asheville	Attic	Heat Pump	4	6	35	8	1088	0.124
Asheville	Attic	Heat Pump	4	6	35	10	1026	0.116
Asheville	Attic	Heat Pump	4	6	35	20	697	0.078
Asheville	Attic	Heat Pump	4	6	35	23	594	0.070
Asheville	Attic	Heat Pump	4	6	35	25	523	0.054
Asheville	Attic	Heat Pump	4	6	35	35	155	0.016
Asheville	Attic	Heat Pump	4	19	35	5	1427	0.186
Asheville	Attic	Heat Pump	4	19	35	8	1339	0.178
Asheville	Attic	Heat Pump	4	19	35	10	1278	0.171
Asheville	Attic	Heat Pump	4	19	35	20	960	0.116
Asheville	Attic	Heat Pump	4	19	35	23	860	0.109
Asheville	Attic	Heat Pump	4	19	35	25	791	0.101

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	Heat Pump	4	19	35	35	434	0.047
Asheville	Attic	Heat Pump	6	6	8	5	93	0.016
Asheville	Attic	Heat Pump	6	19	8	5	339	0.062
Asheville	Attic	Heat Pump	6	19	8	8	251	0.054
Asheville	Attic	Heat Pump	6	6	10	5	156	0.023
Asheville	Attic	Heat Pump	6	6	10	8	63	0.008
Asheville	Attic	Heat Pump	6	19	10	5	402	0.070
Asheville	Attic	Heat Pump	6	19	10	8	313	0.062
Asheville	Attic	Heat Pump	6	19	10	10	253	0.054
Asheville	Attic	Heat Pump	6	6	20	5	484	0.062
Asheville	Attic	Heat Pump	6	6	20	8	391	0.047
Asheville	Attic	Heat Pump	6	6	20	10	328	0.039
Asheville	Attic	Heat Pump	6	19	20	5	730	0.109
Asheville	Attic	Heat Pump	6	19	20	8	642	0.101
Asheville	Attic	Heat Pump	6	19	20	10	581	0.093
Asheville	Attic	Heat Pump	6	19	20	20	263	0.039
Asheville	Attic	Heat Pump	6	6	23	5	588	0.070
Asheville	Attic	Heat Pump	6	6	23	8	495	0.054
Asheville	Attic	Heat Pump	6	6	23	10	432	0.047
Asheville	Attic	Heat Pump	6	6	23	20	104	0.008
Asheville	Attic	Heat Pump	6	19	23	5	834	0.116
Asheville	Attic	Heat Pump	6	19	23	8	745	0.109
Asheville	Attic	Heat Pump	6	19	23	10	685	0.101
Asheville	Attic	Heat Pump	6	19	23	20	367	0.047
Asheville	Attic	Heat Pump	6	19	23	23	266	0.039
Asheville	Attic	Heat Pump	6	6	25	5	659	0.085
Asheville	Attic	Heat Pump	6	6	25	8	565	0.070
Asheville	Attic	Heat Pump	6	6	25	10	503	0.062
Asheville	Attic	Heat Pump	6	6	25	20	174	0.023
Asheville	Attic	Heat Pump	6	6	25	23	71	0.016
Asheville	Attic	Heat Pump	6	19	25	5	904	0.132
Asheville	Attic	Heat Pump	6	19	25	8	816	0.124
Asheville	Attic	Heat Pump	6	19	25	10	756	0.116
Asheville	Attic	Heat Pump	6	19	25	20	437	0.062
Asheville	Attic	Heat Pump	6	19	25	23	337	0.054
Asheville	Attic	Heat Pump	6	19	25	25	269	0.047
Asheville	Attic	Heat Pump	6	6	35	5	1026	0.124
Asheville	Attic	Heat Pump	6	6	35	8	933	0.109
Asheville	Attic	Heat Pump	6	6	35	10	870	0.101
Asheville	Attic	Heat Pump	6	6	35	20	542	0.062
Asheville	Attic	Heat Pump	6	6	35	23	438	0.054
Asheville	Attic	Heat Pump	6	6	35	25	368	0.039
Asheville	Attic	Heat Pump	6	19	35	5	1272	0.171
Asheville	Attic	Heat Pump	6	19	35	8	1184	0.163
Asheville	Attic	Heat Pump	6	19	35	10	1123	0.155
Asheville	Attic	Heat Pump	6	19	35	20	805	0.101
Asheville	Attic	Heat Pump	6	19	35	23	705	0.093
Asheville	Attic	Heat Pump	6	19	35	25	636	0.085
Asheville	Attic	Heat Pump	6	19	35	35	278	0.031
Asheville	Attic	Heat Pump	19	19	8	5	88	0.008
Asheville	Attic	Heat Pump	19	19	10	5	149	0.016
Asheville	Attic	Heat Pump	19	19	10	8	61	0.008
Asheville	Attic	Heat Pump	19	19	20	5	467	0.070

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Asheville	Attic	Heat Pump	19	19	20	8	379	0.062
Asheville	Attic	Heat Pump	19	19	20	10	318	0.054
Asheville	Attic	Heat Pump	19	19	23	5	567	0.078
Asheville	Attic	Heat Pump	19	19	23	8	479	0.070
Asheville	Attic	Heat Pump	19	19	23	10	419	0.062
Asheville	Attic	Heat Pump	19	19	23	20	100	0.008
Asheville	Attic	Heat Pump	19	19	25	5	636	0.085
Asheville	Attic	Heat Pump	19	19	25	8	548	0.078
Asheville	Attic	Heat Pump	19	19	25	10	487	0.070
Asheville	Attic	Heat Pump	19	19	25	20	169	0.016
Asheville	Attic	Heat Pump	19	19	25	23	68	0.008
Asheville	Attic	Heat Pump	19	19	35	5	994	0.140
Asheville	Attic	Heat Pump	19	19	35	8	905	0.132
Asheville	Attic	Heat Pump	19	19	35	10	845	0.124
Asheville	Attic	Heat Pump	19	19	35	20	527	0.070
Asheville	Attic	Heat Pump	19	19	35	23	426	0.062
Asheville	Attic	Heat Pump	19	19	35	25	358	0.054
Charlotte	Attic	AC Gas Heat	0	0	8	5	20	0.006
Charlotte	Attic	AC Gas Heat	0	4	8	5	587	0.209
Charlotte	Attic	AC Gas Heat	0	4	8	8	560	0.196
Charlotte	Attic	AC Gas Heat	0	6	8	5	617	0.234
Charlotte	Attic	AC Gas Heat	0	6	8	8	590	0.222
Charlotte	Attic	AC Gas Heat	0	19	8	5	670	0.298
Charlotte	Attic	AC Gas Heat	0	19	8	8	643	0.279
Charlotte	Attic	AC Gas Heat	0	0	10	5	33	0.006
Charlotte	Attic	AC Gas Heat	0	0	10	8	13	0.000
Charlotte	Attic	AC Gas Heat	0	4	10	5	600	0.209
Charlotte	Attic	AC Gas Heat	0	4	10	8	573	0.196
Charlotte	Attic	AC Gas Heat	0	4	10	10	555	0.190
Charlotte	Attic	AC Gas Heat	0	6	10	5	630	0.234
Charlotte	Attic	AC Gas Heat	0	6	10	8	603	0.222
Charlotte	Attic	AC Gas Heat	0	6	10	10	585	0.215
Charlotte	Attic	AC Gas Heat	0	19	10	5	683	0.298
Charlotte	Attic	AC Gas Heat	0	19	10	8	656	0.279
Charlotte	Attic	AC Gas Heat	0	19	10	10	638	0.266
Charlotte	Attic	AC Gas Heat	0	0	20	5	96	0.019
Charlotte	Attic	AC Gas Heat	0	0	20	8	76	0.013
Charlotte	Attic	AC Gas Heat	0	0	20	10	63	0.013
Charlotte	Attic	AC Gas Heat	0	4	20	5	663	0.222
Charlotte	Attic	AC Gas Heat	0	4	20	8	636	0.209
Charlotte	Attic	AC Gas Heat	0	4	20	10	618	0.203
Charlotte	Attic	AC Gas Heat	0	4	20	20	517	0.133
Charlotte	Attic	AC Gas Heat	0	6	20	5	693	0.247
Charlotte	Attic	AC Gas Heat	0	6	20	8	666	0.234
Charlotte	Attic	AC Gas Heat	0	6	20	10	647	0.228
Charlotte	Attic	AC Gas Heat	0	6	20	20	547	0.152
Charlotte	Attic	AC Gas Heat	0	19	20	5	746	0.310
Charlotte	Attic	AC Gas Heat	0	19	20	8	719	0.291
Charlotte	Attic	AC Gas Heat	0	19	20	10	700	0.279
Charlotte	Attic	AC Gas Heat	0	19	20	20	601	0.190
Charlotte	Attic	AC Gas Heat	0	0	23	5	114	0.019
Charlotte	Attic	AC Gas Heat	0	0	23	8	94	0.013
Charlotte	Attic	AC Gas Heat	0	0	23	10	81	0.013

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	AC Gas Heat	0	0	23	20	18	0.000
Charlotte	Attic	AC Gas Heat	0	4	23	5	681	0.222
Charlotte	Attic	AC Gas Heat	0	4	23	8	654	0.209
Charlotte	Attic	AC Gas Heat	0	4	23	10	635	0.203
Charlotte	Attic	AC Gas Heat	0	4	23	20	535	0.133
Charlotte	Attic	AC Gas Heat	0	4	23	23	503	0.108
Charlotte	Attic	AC Gas Heat	0	6	23	5	711	0.247
Charlotte	Attic	AC Gas Heat	0	6	23	8	684	0.234
Charlotte	Attic	AC Gas Heat	0	6	23	10	665	0.228
Charlotte	Attic	AC Gas Heat	0	6	23	20	565	0.152
Charlotte	Attic	AC Gas Heat	0	6	23	23	533	0.127
Charlotte	Attic	AC Gas Heat	0	19	23	5	764	0.310
Charlotte	Attic	AC Gas Heat	0	19	23	8	737	0.291
Charlotte	Attic	AC Gas Heat	0	19	23	10	718	0.279
Charlotte	Attic	AC Gas Heat	0	19	23	20	619	0.190
Charlotte	Attic	AC Gas Heat	0	19	23	23	587	0.158
Charlotte	Attic	AC Gas Heat	0	0	25	5	126	0.025
Charlotte	Attic	AC Gas Heat	0	0	25	8	106	0.019
Charlotte	Attic	AC Gas Heat	0	0	25	10	93	0.019
Charlotte	Attic	AC Gas Heat	0	0	25	20	30	0.006
Charlotte	Attic	AC Gas Heat	0	0	25	23	12	0.006
Charlotte	Attic	AC Gas Heat	0	4	25	5	693	0.228
Charlotte	Attic	AC Gas Heat	0	4	25	8	666	0.215
Charlotte	Attic	AC Gas Heat	0	4	25	10	648	0.209
Charlotte	Attic	AC Gas Heat	0	4	25	20	547	0.139
Charlotte	Attic	AC Gas Heat	0	4	25	23	516	0.114
Charlotte	Attic	AC Gas Heat	0	4	25	25	495	0.101
Charlotte	Attic	AC Gas Heat	0	6	25	5	723	0.253
Charlotte	Attic	AC Gas Heat	0	6	25	8	696	0.241
Charlotte	Attic	AC Gas Heat	0	6	25	10	678	0.234
Charlotte	Attic	AC Gas Heat	0	6	25	20	577	0.158
Charlotte	Attic	AC Gas Heat	0	6	25	23	546	0.133
Charlotte	Attic	AC Gas Heat	0	6	25	25	525	0.120
Charlotte	Attic	AC Gas Heat	0	19	25	5	776	0.317
Charlotte	Attic	AC Gas Heat	0	19	25	8	749	0.298
Charlotte	Attic	AC Gas Heat	0	19	25	10	731	0.285
Charlotte	Attic	AC Gas Heat	0	19	25	20	631	0.196
Charlotte	Attic	AC Gas Heat	0	19	25	23	600	0.165
Charlotte	Attic	AC Gas Heat	0	19	25	25	578	0.152
Charlotte	Attic	AC Gas Heat	0	0	35	5	184	0.032
Charlotte	Attic	AC Gas Heat	0	0	35	8	164	0.025
Charlotte	Attic	AC Gas Heat	0	0	35	10	151	0.025
Charlotte	Attic	AC Gas Heat	0	0	35	20	88	0.013
Charlotte	Attic	AC Gas Heat	0	0	35	23	70	0.013
Charlotte	Attic	AC Gas Heat	0	0	35	25	58	0.006
Charlotte	Attic	AC Gas Heat	0	4	35	5	751	0.234
Charlotte	Attic	AC Gas Heat	0	4	35	8	724	0.222
Charlotte	Attic	AC Gas Heat	0	4	35	10	706	0.215
Charlotte	Attic	AC Gas Heat	0	4	35	20	605	0.146
Charlotte	Attic	AC Gas Heat	0	4	35	23	574	0.120
Charlotte	Attic	AC Gas Heat	0	4	35	25	553	0.108
Charlotte	Attic	AC Gas Heat	0	4	35	35	454	0.044
Charlotte	Attic	AC Gas Heat	0	6	35	5	781	0.260

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	AC Gas Heat	0	6	35	8	754	0.247
Charlotte	Attic	AC Gas Heat	0	6	35	10	736	0.241
Charlotte	Attic	AC Gas Heat	0	6	35	20	635	0.165
Charlotte	Attic	AC Gas Heat	0	6	35	23	604	0.139
Charlotte	Attic	AC Gas Heat	0	6	35	25	583	0.127
Charlotte	Attic	AC Gas Heat	0	6	35	35	481	0.051
Charlotte	Attic	AC Gas Heat	0	19	35	5	807	0.304
Charlotte	Attic	AC Gas Heat	0	19	35	8	789	0.291
Charlotte	Attic	AC Gas Heat	0	19	35	10	689	0.203
Charlotte	Attic	AC Gas Heat	0	19	35	20	658	0.171
Charlotte	Attic	AC Gas Heat	0	19	35	23	636	0.158
Charlotte	Attic	AC Gas Heat	0	19	35	25	533	0.082
Charlotte	Attic	AC Gas Heat	0	19	35	35	781	0.260
Charlotte	Attic	AC Gas Heat	4	4	8	5	27	0.013
Charlotte	Attic	AC Gas Heat	4	6	8	5	57	0.038
Charlotte	Attic	AC Gas Heat	4	6	8	8	30	0.025
Charlotte	Attic	AC Gas Heat	4	19	8	5	110	0.101
Charlotte	Attic	AC Gas Heat	4	19	8	8	83	0.082
Charlotte	Attic	AC Gas Heat	4	4	10	5	46	0.019
Charlotte	Attic	AC Gas Heat	4	4	10	8	19	0.006
Charlotte	Attic	AC Gas Heat	4	6	10	5	76	0.044
Charlotte	Attic	AC Gas Heat	4	6	10	8	48	0.032
Charlotte	Attic	AC Gas Heat	4	6	10	10	30	0.025
Charlotte	Attic	AC Gas Heat	4	19	10	5	128	0.108
Charlotte	Attic	AC Gas Heat	4	19	10	8	101	0.089
Charlotte	Attic	AC Gas Heat	4	19	10	10	83	0.076
Charlotte	Attic	AC Gas Heat	4	4	20	5	146	0.089
Charlotte	Attic	AC Gas Heat	4	4	20	8	119	0.076
Charlotte	Attic	AC Gas Heat	4	4	20	10	100	0.070
Charlotte	Attic	AC Gas Heat	4	6	20	5	176	0.114
Charlotte	Attic	AC Gas Heat	4	6	20	8	149	0.101
Charlotte	Attic	AC Gas Heat	4	6	20	10	130	0.095
Charlotte	Attic	AC Gas Heat	4	6	20	20	30	0.019
Charlotte	Attic	AC Gas Heat	4	19	20	5	229	0.177
Charlotte	Attic	AC Gas Heat	4	19	20	8	202	0.158
Charlotte	Attic	AC Gas Heat	4	19	20	10	183	0.146
Charlotte	Attic	AC Gas Heat	4	19	20	20	84	0.057
Charlotte	Attic	AC Gas Heat	4	4	23	5	177	0.114
Charlotte	Attic	AC Gas Heat	4	4	23	8	150	0.101
Charlotte	Attic	AC Gas Heat	4	4	23	10	132	0.095
Charlotte	Attic	AC Gas Heat	4	4	23	20	32	0.025
Charlotte	Attic	AC Gas Heat	4	6	23	5	207	0.139
Charlotte	Attic	AC Gas Heat	4	6	23	8	180	0.127
Charlotte	Attic	AC Gas Heat	4	6	23	10	162	0.120
Charlotte	Attic	AC Gas Heat	4	6	23	20	61	0.044
Charlotte	Attic	AC Gas Heat	4	6	23	23	30	0.019
Charlotte	Attic	AC Gas Heat	4	19	23	5	260	0.203
Charlotte	Attic	AC Gas Heat	4	19	23	8	233	0.184
Charlotte	Attic	AC Gas Heat	4	19	23	10	215	0.171
Charlotte	Attic	AC Gas Heat	4	19	23	20	115	0.082
Charlotte	Attic	AC Gas Heat	4	19	23	23	84	0.051
Charlotte	Attic	AC Gas Heat	4	4	25	5	198	0.127
Charlotte	Attic	AC Gas Heat	4	4	25	8	171	0.114

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	AC Gas Heat	4	4	25	10	153	0.108
Charlotte	Attic	AC Gas Heat	4	4	25	20	52	0.038
Charlotte	Attic	AC Gas Heat	4	4	25	23	21	0.013
Charlotte	Attic	AC Gas Heat	4	6	25	5	228	0.152
Charlotte	Attic	AC Gas Heat	4	6	25	8	201	0.139
Charlotte	Attic	AC Gas Heat	4	6	25	10	182	0.133
Charlotte	Attic	AC Gas Heat	4	6	25	20	82	0.057
Charlotte	Attic	AC Gas Heat	4	6	25	23	51	0.032
Charlotte	Attic	AC Gas Heat	4	6	25	25	30	0.019
Charlotte	Attic	AC Gas Heat	4	19	25	5	281	0.215
Charlotte	Attic	AC Gas Heat	4	19	25	8	254	0.196
Charlotte	Attic	AC Gas Heat	4	19	25	10	235	0.184
Charlotte	Attic	AC Gas Heat	4	19	25	20	136	0.095
Charlotte	Attic	AC Gas Heat	4	19	25	23	104	0.063
Charlotte	Attic	AC Gas Heat	4	19	25	25	83	0.051
Charlotte	Attic	AC Gas Heat	4	4	35	5	298	0.190
Charlotte	Attic	AC Gas Heat	4	4	35	8	271	0.177
Charlotte	Attic	AC Gas Heat	4	4	35	10	252	0.171
Charlotte	Attic	AC Gas Heat	4	4	35	20	152	0.101
Charlotte	Attic	AC Gas Heat	4	4	35	23	120	0.076
Charlotte	Attic	AC Gas Heat	4	4	35	25	100	0.063
Charlotte	Attic	AC Gas Heat	4	6	35	5	328	0.215
Charlotte	Attic	AC Gas Heat	4	6	35	8	301	0.203
Charlotte	Attic	AC Gas Heat	4	6	35	10	282	0.196
Charlotte	Attic	AC Gas Heat	4	6	35	20	182	0.120
Charlotte	Attic	AC Gas Heat	4	6	35	23	150	0.095
Charlotte	Attic	AC Gas Heat	4	6	35	25	129	0.082
Charlotte	Attic	AC Gas Heat	4	6	35	35	28	0.006
Charlotte	Attic	AC Gas Heat	4	19	35	5	380	0.279
Charlotte	Attic	AC Gas Heat	4	19	35	8	354	0.260
Charlotte	Attic	AC Gas Heat	4	19	35	10	335	0.247
Charlotte	Attic	AC Gas Heat	4	19	35	20	235	0.158
Charlotte	Attic	AC Gas Heat	4	19	35	23	204	0.127
Charlotte	Attic	AC Gas Heat	4	19	35	25	183	0.114
Charlotte	Attic	AC Gas Heat	4	19	35	35	79	0.038
Charlotte	Attic	AC Gas Heat	6	6	8	5	27	0.013
Charlotte	Attic	AC Gas Heat	6	19	8	5	80	0.076
Charlotte	Attic	AC Gas Heat	6	19	8	8	53	0.057
Charlotte	Attic	AC Gas Heat	6	6	10	5	46	0.019
Charlotte	Attic	AC Gas Heat	6	6	10	8	19	0.006
Charlotte	Attic	AC Gas Heat	6	19	10	5	98	0.082
Charlotte	Attic	AC Gas Heat	6	19	10	8	71	0.063
Charlotte	Attic	AC Gas Heat	6	19	10	10	53	0.051
Charlotte	Attic	AC Gas Heat	6	6	20	5	146	0.095
Charlotte	Attic	AC Gas Heat	6	6	20	8	119	0.082
Charlotte	Attic	AC Gas Heat	6	6	20	10	100	0.076
Charlotte	Attic	AC Gas Heat	6	19	20	5	199	0.158
Charlotte	Attic	AC Gas Heat	6	19	20	8	172	0.139
Charlotte	Attic	AC Gas Heat	6	19	20	10	153	0.127
Charlotte	Attic	AC Gas Heat	6	19	20	20	54	0.038
Charlotte	Attic	AC Gas Heat	6	6	23	5	178	0.120
Charlotte	Attic	AC Gas Heat	6	6	23	8	150	0.108
Charlotte	Attic	AC Gas Heat	6	6	23	10	132	0.101

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	AC Gas Heat	6	6	23	20	31	0.025
Charlotte	Attic	AC Gas Heat	6	19	23	5	230	0.184
Charlotte	Attic	AC Gas Heat	6	19	23	8	203	0.165
Charlotte	Attic	AC Gas Heat	6	19	23	10	185	0.152
Charlotte	Attic	AC Gas Heat	6	19	23	20	85	0.063
Charlotte	Attic	AC Gas Heat	6	19	23	23	54	0.032
Charlotte	Attic	AC Gas Heat	6	6	25	5	199	0.133
Charlotte	Attic	AC Gas Heat	6	6	25	8	171	0.120
Charlotte	Attic	AC Gas Heat	6	6	25	10	153	0.114
Charlotte	Attic	AC Gas Heat	6	6	25	20	52	0.038
Charlotte	Attic	AC Gas Heat	6	6	25	23	21	0.013
Charlotte	Attic	AC Gas Heat	6	19	25	5	251	0.196
Charlotte	Attic	AC Gas Heat	6	19	25	8	224	0.177
Charlotte	Attic	AC Gas Heat	6	19	25	10	206	0.165
Charlotte	Attic	AC Gas Heat	6	19	25	20	106	0.076
Charlotte	Attic	AC Gas Heat	6	19	25	23	75	0.044
Charlotte	Attic	AC Gas Heat	6	19	25	25	54	0.032
Charlotte	Attic	AC Gas Heat	6	6	35	5	300	0.209
Charlotte	Attic	AC Gas Heat	6	6	35	8	273	0.196
Charlotte	Attic	AC Gas Heat	6	6	35	10	255	0.190
Charlotte	Attic	AC Gas Heat	6	6	35	20	154	0.114
Charlotte	Attic	AC Gas Heat	6	6	35	23	123	0.089
Charlotte	Attic	AC Gas Heat	6	6	35	25	102	0.076
Charlotte	Attic	AC Gas Heat	6	19	35	5	353	0.272
Charlotte	Attic	AC Gas Heat	6	19	35	8	326	0.253
Charlotte	Attic	AC Gas Heat	6	19	35	10	308	0.241
Charlotte	Attic	AC Gas Heat	6	19	35	20	208	0.152
Charlotte	Attic	AC Gas Heat	6	19	35	23	176	0.120
Charlotte	Attic	AC Gas Heat	6	19	35	25	155	0.108
Charlotte	Attic	AC Gas Heat	6	19	35	35	52	0.032
Charlotte	Attic	AC Gas Heat	19	19	8	5	27	0.019
Charlotte	Attic	AC Gas Heat	19	19	10	5	45	0.032
Charlotte	Attic	AC Gas Heat	19	19	10	8	18	0.013
Charlotte	Attic	AC Gas Heat	19	19	20	5	145	0.120
Charlotte	Attic	AC Gas Heat	19	19	20	8	118	0.101
Charlotte	Attic	AC Gas Heat	19	19	20	10	100	0.089
Charlotte	Attic	AC Gas Heat	19	19	23	5	176	0.152
Charlotte	Attic	AC Gas Heat	19	19	23	8	150	0.133
Charlotte	Attic	AC Gas Heat	19	19	23	10	131	0.120
Charlotte	Attic	AC Gas Heat	19	19	23	20	31	0.032
Charlotte	Attic	AC Gas Heat	19	19	25	5	198	0.165
Charlotte	Attic	AC Gas Heat	19	19	25	8	171	0.146
Charlotte	Attic	AC Gas Heat	19	19	25	10	152	0.133
Charlotte	Attic	AC Gas Heat	19	19	25	20	53	0.044
Charlotte	Attic	AC Gas Heat	19	19	25	23	21	0.013
Charlotte	Attic	AC Gas Heat	19	19	35	5	301	0.241
Charlotte	Attic	AC Gas Heat	19	19	35	8	274	0.222
Charlotte	Attic	AC Gas Heat	19	19	35	10	256	0.209
Charlotte	Attic	AC Gas Heat	19	19	35	20	156	0.120
Charlotte	Attic	AC Gas Heat	19	19	35	23	125	0.089
Charlotte	Attic	AC Gas Heat	19	19	35	25	104	0.076
Charlotte	Attic	Heat Pump	0	0	8	5	57	0.000
Charlotte	Attic	Heat Pump	0	4	8	5	1658	0.190

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	Heat Pump	0	4	8	8	1605	0.184
Charlotte	Attic	Heat Pump	0	6	8	5	1721	0.215
Charlotte	Attic	Heat Pump	0	6	8	8	1668	0.203
Charlotte	Attic	Heat Pump	0	19	8	5	1828	0.266
Charlotte	Attic	Heat Pump	0	19	8	8	1777	0.253
Charlotte	Attic	Heat Pump	0	0	10	5	94	0.000
Charlotte	Attic	Heat Pump	0	0	10	8	37	0.000
Charlotte	Attic	Heat Pump	0	4	10	5	1695	0.190
Charlotte	Attic	Heat Pump	0	4	10	8	1641	0.184
Charlotte	Attic	Heat Pump	0	4	10	10	1605	0.177
Charlotte	Attic	Heat Pump	0	6	10	5	1757	0.215
Charlotte	Attic	Heat Pump	0	6	10	8	1704	0.203
Charlotte	Attic	Heat Pump	0	6	10	10	1668	0.196
Charlotte	Attic	Heat Pump	0	19	10	5	1865	0.266
Charlotte	Attic	Heat Pump	0	19	10	8	1813	0.253
Charlotte	Attic	Heat Pump	0	19	10	10	1779	0.241
Charlotte	Attic	Heat Pump	0	0	20	5	282	0.006
Charlotte	Attic	Heat Pump	0	0	20	8	224	0.006
Charlotte	Attic	Heat Pump	0	0	20	10	188	0.006
Charlotte	Attic	Heat Pump	0	4	20	5	1883	0.196
Charlotte	Attic	Heat Pump	0	4	20	8	1829	0.190
Charlotte	Attic	Heat Pump	0	4	20	10	1792	0.184
Charlotte	Attic	Heat Pump	0	4	20	20	1599	0.133
Charlotte	Attic	Heat Pump	0	6	20	5	1945	0.222
Charlotte	Attic	Heat Pump	0	6	20	8	1892	0.209
Charlotte	Attic	Heat Pump	0	6	20	10	1856	0.203
Charlotte	Attic	Heat Pump	0	6	20	20	1665	0.158
Charlotte	Attic	Heat Pump	0	19	20	5	2052	0.272
Charlotte	Attic	Heat Pump	0	19	20	8	2001	0.260
Charlotte	Attic	Heat Pump	0	19	20	10	1966	0.247
Charlotte	Attic	Heat Pump	0	19	20	20	1781	0.196
Charlotte	Attic	Heat Pump	0	0	23	5	339	0.006
Charlotte	Attic	Heat Pump	0	0	23	8	282	0.006
Charlotte	Attic	Heat Pump	0	0	23	10	245	0.006
Charlotte	Attic	Heat Pump	0	0	23	20	57	0.000
Charlotte	Attic	Heat Pump	0	4	23	5	1940	0.196
Charlotte	Attic	Heat Pump	0	4	23	8	1887	0.190
Charlotte	Attic	Heat Pump	0	4	23	10	1850	0.184
Charlotte	Attic	Heat Pump	0	4	23	20	1656	0.133
Charlotte	Attic	Heat Pump	0	4	23	23	1594	0.127
Charlotte	Attic	Heat Pump	0	6	23	5	2002	0.222
Charlotte	Attic	Heat Pump	0	6	23	8	1949	0.209
Charlotte	Attic	Heat Pump	0	6	23	10	1914	0.203
Charlotte	Attic	Heat Pump	0	6	23	20	1722	0.158
Charlotte	Attic	Heat Pump	0	6	23	23	1661	0.139
Charlotte	Attic	Heat Pump	0	19	23	5	2110	0.272
Charlotte	Attic	Heat Pump	0	19	23	8	2059	0.260
Charlotte	Attic	Heat Pump	0	19	23	10	2024	0.247
Charlotte	Attic	Heat Pump	0	19	23	20	1838	0.196
Charlotte	Attic	Heat Pump	0	19	23	23	1779	0.177
Charlotte	Attic	Heat Pump	0	0	25	5	378	0.013
Charlotte	Attic	Heat Pump	0	0	25	8	321	0.013
Charlotte	Attic	Heat Pump	0	0	25	10	284	0.013

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	Heat Pump	0	0	25	20	96	0.006
Charlotte	Attic	Heat Pump	0	0	25	23	39	0.006
Charlotte	Attic	Heat Pump	0	4	25	5	1979	0.203
Charlotte	Attic	Heat Pump	0	4	25	8	1925	0.196
Charlotte	Attic	Heat Pump	0	4	25	10	1889	0.190
Charlotte	Attic	Heat Pump	0	4	25	20	1695	0.139
Charlotte	Attic	Heat Pump	0	4	25	23	1633	0.133
Charlotte	Attic	Heat Pump	0	4	25	25	1591	0.127
Charlotte	Attic	Heat Pump	0	6	25	5	2041	0.228
Charlotte	Attic	Heat Pump	0	6	25	8	1988	0.215
Charlotte	Attic	Heat Pump	0	6	25	10	1952	0.209
Charlotte	Attic	Heat Pump	0	6	25	20	1761	0.165
Charlotte	Attic	Heat Pump	0	6	25	23	1700	0.146
Charlotte	Attic	Heat Pump	0	6	25	25	1658	0.139
Charlotte	Attic	Heat Pump	0	19	25	5	2149	0.279
Charlotte	Attic	Heat Pump	0	19	25	8	2097	0.266
Charlotte	Attic	Heat Pump	0	19	25	10	2063	0.253
Charlotte	Attic	Heat Pump	0	19	25	20	1877	0.203
Charlotte	Attic	Heat Pump	0	19	25	23	1817	0.184
Charlotte	Attic	Heat Pump	0	19	25	25	1776	0.171
Charlotte	Attic	Heat Pump	0	0	35	5	570	0.013
Charlotte	Attic	Heat Pump	0	0	35	8	513	0.013
Charlotte	Attic	Heat Pump	0	0	35	10	477	0.013
Charlotte	Attic	Heat Pump	0	0	35	20	289	0.006
Charlotte	Attic	Heat Pump	0	0	35	23	231	0.006
Charlotte	Attic	Heat Pump	0	0	35	25	193	0.000
Charlotte	Attic	Heat Pump	0	4	35	5	2171	0.203
Charlotte	Attic	Heat Pump	0	4	35	8	2118	0.196
Charlotte	Attic	Heat Pump	0	4	35	10	2081	0.190
Charlotte	Attic	Heat Pump	0	4	35	20	1887	0.139
Charlotte	Attic	Heat Pump	0	4	35	23	1825	0.133
Charlotte	Attic	Heat Pump	0	4	35	25	1783	0.127
Charlotte	Attic	Heat Pump	0	4	35	35	1567	0.082
Charlotte	Attic	Heat Pump	0	6	35	5	2234	0.228
Charlotte	Attic	Heat Pump	0	6	35	8	2181	0.215
Charlotte	Attic	Heat Pump	0	6	35	10	2145	0.209
Charlotte	Attic	Heat Pump	0	6	35	20	1954	0.165
Charlotte	Attic	Heat Pump	0	6	35	23	1892	0.146
Charlotte	Attic	Heat Pump	0	6	35	25	1851	0.139
Charlotte	Attic	Heat Pump	0	6	35	35	1635	0.101
Charlotte	Attic	Heat Pump	0	19	35	5	2290	0.266
Charlotte	Attic	Heat Pump	0	19	35	8	2255	0.253
Charlotte	Attic	Heat Pump	0	19	35	10	2069	0.203
Charlotte	Attic	Heat Pump	0	19	35	20	2010	0.184
Charlotte	Attic	Heat Pump	0	19	35	23	1969	0.171
Charlotte	Attic	Heat Pump	0	19	35	25	1757	0.120
Charlotte	Attic	Heat Pump	0	19	35	35	2234	0.228
Charlotte	Attic	Heat Pump	4	4	8	5	54	0.006
Charlotte	Attic	Heat Pump	4	6	8	5	116	0.032
Charlotte	Attic	Heat Pump	4	6	8	8	63	0.019
Charlotte	Attic	Heat Pump	4	19	8	5	223	0.082
Charlotte	Attic	Heat Pump	4	19	8	8	172	0.070
Charlotte	Attic	Heat Pump	4	4	10	5	90	0.013

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	Heat Pump	4	4	10	8	37	0.006
Charlotte	Attic	Heat Pump	4	6	10	5	152	0.038
Charlotte	Attic	Heat Pump	4	6	10	8	99	0.025
Charlotte	Attic	Heat Pump	4	6	10	10	64	0.019
Charlotte	Attic	Heat Pump	4	19	10	5	260	0.089
Charlotte	Attic	Heat Pump	4	19	10	8	209	0.076
Charlotte	Attic	Heat Pump	4	19	10	10	174	0.063
Charlotte	Attic	Heat Pump	4	4	20	5	284	0.063
Charlotte	Attic	Heat Pump	4	4	20	8	230	0.057
Charlotte	Attic	Heat Pump	4	4	20	10	194	0.051
Charlotte	Attic	Heat Pump	4	6	20	5	346	0.089
Charlotte	Attic	Heat Pump	4	6	20	8	293	0.076
Charlotte	Attic	Heat Pump	4	6	20	10	257	0.070
Charlotte	Attic	Heat Pump	4	6	20	20	66	0.025
Charlotte	Attic	Heat Pump	4	19	20	5	454	0.139
Charlotte	Attic	Heat Pump	4	19	20	8	403	0.127
Charlotte	Attic	Heat Pump	4	19	20	10	368	0.114
Charlotte	Attic	Heat Pump	4	19	20	20	182	0.063
Charlotte	Attic	Heat Pump	4	4	23	5	346	0.070
Charlotte	Attic	Heat Pump	4	4	23	8	293	0.063
Charlotte	Attic	Heat Pump	4	4	23	10	256	0.057
Charlotte	Attic	Heat Pump	4	4	23	20	62	0.006
Charlotte	Attic	Heat Pump	4	6	23	5	408	0.095
Charlotte	Attic	Heat Pump	4	6	23	8	355	0.082
Charlotte	Attic	Heat Pump	4	6	23	10	320	0.076
Charlotte	Attic	Heat Pump	4	6	23	20	128	0.032
Charlotte	Attic	Heat Pump	4	6	23	23	67	0.013
Charlotte	Attic	Heat Pump	4	19	23	5	516	0.146
Charlotte	Attic	Heat Pump	4	19	23	8	465	0.133
Charlotte	Attic	Heat Pump	4	19	23	10	430	0.120
Charlotte	Attic	Heat Pump	4	19	23	20	244	0.070
Charlotte	Attic	Heat Pump	4	19	23	23	184	0.051
Charlotte	Attic	Heat Pump	4	4	25	5	388	0.076
Charlotte	Attic	Heat Pump	4	4	25	8	335	0.070
Charlotte	Attic	Heat Pump	4	4	25	10	298	0.063
Charlotte	Attic	Heat Pump	4	4	25	20	104	0.013
Charlotte	Attic	Heat Pump	4	4	25	23	42	0.006
Charlotte	Attic	Heat Pump	4	6	25	5	450	0.101
Charlotte	Attic	Heat Pump	4	6	25	8	397	0.089
Charlotte	Attic	Heat Pump	4	6	25	10	362	0.082
Charlotte	Attic	Heat Pump	4	6	25	20	170	0.038
Charlotte	Attic	Heat Pump	4	6	25	23	109	0.019
Charlotte	Attic	Heat Pump	4	6	25	25	67	0.013
Charlotte	Attic	Heat Pump	4	19	25	5	558	0.152
Charlotte	Attic	Heat Pump	4	19	25	8	507	0.139
Charlotte	Attic	Heat Pump	4	19	25	10	472	0.127
Charlotte	Attic	Heat Pump	4	19	25	20	286	0.076
Charlotte	Attic	Heat Pump	4	19	25	23	227	0.057
Charlotte	Attic	Heat Pump	4	19	25	25	186	0.044
Charlotte	Attic	Heat Pump	4	4	35	5	605	0.120
Charlotte	Attic	Heat Pump	4	4	35	8	551	0.114
Charlotte	Attic	Heat Pump	4	4	35	10	515	0.108
Charlotte	Attic	Heat Pump	4	4	35	20	321	0.057

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	Heat Pump	4	4	35	23	259	0.051
Charlotte	Attic	Heat Pump	4	4	35	25	217	0.044
Charlotte	Attic	Heat Pump	4	6	35	5	667	0.146
Charlotte	Attic	Heat Pump	4	6	35	8	614	0.133
Charlotte	Attic	Heat Pump	4	6	35	10	578	0.127
Charlotte	Attic	Heat Pump	4	6	35	20	387	0.082
Charlotte	Attic	Heat Pump	4	6	35	23	326	0.063
Charlotte	Attic	Heat Pump	4	6	35	25	284	0.057
Charlotte	Attic	Heat Pump	4	6	35	35	69	0.019
Charlotte	Attic	Heat Pump	4	19	35	5	774	0.196
Charlotte	Attic	Heat Pump	4	19	35	8	723	0.184
Charlotte	Attic	Heat Pump	4	19	35	10	688	0.171
Charlotte	Attic	Heat Pump	4	19	35	20	503	0.120
Charlotte	Attic	Heat Pump	4	19	35	23	443	0.101
Charlotte	Attic	Heat Pump	4	19	35	25	402	0.089
Charlotte	Attic	Heat Pump	4	19	35	35	190	0.038
Charlotte	Attic	Heat Pump	6	6	8	5	53	0.013
Charlotte	Attic	Heat Pump	6	19	8	5	160	0.063
Charlotte	Attic	Heat Pump	6	19	8	8	109	0.051
Charlotte	Attic	Heat Pump	6	6	10	5	89	0.019
Charlotte	Attic	Heat Pump	6	6	10	8	36	0.006
Charlotte	Attic	Heat Pump	6	19	10	5	196	0.070
Charlotte	Attic	Heat Pump	6	19	10	8	145	0.057
Charlotte	Attic	Heat Pump	6	19	10	10	110	0.044
Charlotte	Attic	Heat Pump	6	6	20	5	280	0.063
Charlotte	Attic	Heat Pump	6	6	20	8	227	0.051
Charlotte	Attic	Heat Pump	6	6	20	10	191	0.044
Charlotte	Attic	Heat Pump	6	19	20	5	387	0.114
Charlotte	Attic	Heat Pump	6	19	20	8	336	0.101
Charlotte	Attic	Heat Pump	6	19	20	10	302	0.089
Charlotte	Attic	Heat Pump	6	19	20	20	116	0.038
Charlotte	Attic	Heat Pump	6	6	23	5	341	0.082
Charlotte	Attic	Heat Pump	6	6	23	8	288	0.070
Charlotte	Attic	Heat Pump	6	6	23	10	253	0.063
Charlotte	Attic	Heat Pump	6	6	23	20	61	0.019
Charlotte	Attic	Heat Pump	6	19	23	5	449	0.133
Charlotte	Attic	Heat Pump	6	19	23	8	398	0.120
Charlotte	Attic	Heat Pump	6	19	23	10	363	0.108
Charlotte	Attic	Heat Pump	6	19	23	20	177	0.057
Charlotte	Attic	Heat Pump	6	19	23	23	118	0.038
Charlotte	Attic	Heat Pump	6	6	25	5	383	0.089
Charlotte	Attic	Heat Pump	6	6	25	8	330	0.076
Charlotte	Attic	Heat Pump	6	6	25	10	294	0.070
Charlotte	Attic	Heat Pump	6	6	25	20	103	0.025
Charlotte	Attic	Heat Pump	6	6	25	23	42	0.006
Charlotte	Attic	Heat Pump	6	19	25	5	490	0.139
Charlotte	Attic	Heat Pump	6	19	25	8	439	0.127
Charlotte	Attic	Heat Pump	6	19	25	10	405	0.114
Charlotte	Attic	Heat Pump	6	19	25	20	219	0.063
Charlotte	Attic	Heat Pump	6	19	25	23	159	0.044
Charlotte	Attic	Heat Pump	6	19	25	25	118	0.032
Charlotte	Attic	Heat Pump	6	6	35	5	598	0.127
Charlotte	Attic	Heat Pump	6	6	35	8	545	0.114

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Charlotte	Attic	Heat Pump	6	6	35	10	510	0.108
Charlotte	Attic	Heat Pump	6	6	35	20	318	0.063
Charlotte	Attic	Heat Pump	6	6	35	23	257	0.044
Charlotte	Attic	Heat Pump	6	6	35	25	215	0.038
Charlotte	Attic	Heat Pump	6	19	35	5	706	0.177
Charlotte	Attic	Heat Pump	6	19	35	8	655	0.165
Charlotte	Attic	Heat Pump	6	19	35	10	620	0.152
Charlotte	Attic	Heat Pump	6	19	35	20	434	0.101
Charlotte	Attic	Heat Pump	6	19	35	23	375	0.082
Charlotte	Attic	Heat Pump	6	19	35	25	334	0.070
Charlotte	Attic	Heat Pump	6	19	35	35	121	0.019
Charlotte	Attic	Heat Pump	19	19	8	5	51	0.013
Charlotte	Attic	Heat Pump	19	19	10	5	86	0.025
Charlotte	Attic	Heat Pump	19	19	10	8	35	0.013
Charlotte	Attic	Heat Pump	19	19	20	5	272	0.076
Charlotte	Attic	Heat Pump	19	19	20	8	221	0.063
Charlotte	Attic	Heat Pump	19	19	20	10	186	0.051
Charlotte	Attic	Heat Pump	19	19	23	5	331	0.095
Charlotte	Attic	Heat Pump	19	19	23	8	280	0.082
Charlotte	Attic	Heat Pump	19	19	23	10	245	0.070
Charlotte	Attic	Heat Pump	19	19	23	20	60	0.019
Charlotte	Attic	Heat Pump	19	19	25	5	372	0.108
Charlotte	Attic	Heat Pump	19	19	25	8	321	0.095
Charlotte	Attic	Heat Pump	19	19	25	10	286	0.082
Charlotte	Attic	Heat Pump	19	19	25	20	101	0.032
Charlotte	Attic	Heat Pump	19	19	25	23	41	0.013
Charlotte	Attic	Heat Pump	19	19	35	5	584	0.158
Charlotte	Attic	Heat Pump	19	19	35	8	533	0.146
Charlotte	Attic	Heat Pump	19	19	35	10	499	0.133
Charlotte	Attic	Heat Pump	19	19	35	20	313	0.082
Charlotte	Attic	Heat Pump	19	19	35	23	253	0.063
Charlotte	Attic	Heat Pump	19	19	35	25	212	0.051
Greenville	Attic	AC Gas Heat	0	0	8	5	19	0.005
Greenville	Attic	AC Gas Heat	0	4	8	5	397	0.143
Greenville	Attic	AC Gas Heat	0	4	8	8	372	0.123
Greenville	Attic	AC Gas Heat	0	6	8	5	415	0.163
Greenville	Attic	AC Gas Heat	0	6	8	8	391	0.148
Greenville	Attic	AC Gas Heat	0	19	8	5	448	0.204
Greenville	Attic	AC Gas Heat	0	19	8	8	424	0.184
Greenville	Attic	AC Gas Heat	0	0	10	5	30	0.010
Greenville	Attic	AC Gas Heat	0	0	10	8	12	0.005
Greenville	Attic	AC Gas Heat	0	4	10	5	408	0.148
Greenville	Attic	AC Gas Heat	0	4	10	8	384	0.128
Greenville	Attic	AC Gas Heat	0	4	10	10	368	0.117
Greenville	Attic	AC Gas Heat	0	6	10	5	427	0.169
Greenville	Attic	AC Gas Heat	0	6	10	8	403	0.153
Greenville	Attic	AC Gas Heat	0	6	10	10	387	0.138
Greenville	Attic	AC Gas Heat	0	19	10	5	460	0.209
Greenville	Attic	AC Gas Heat	0	19	10	8	436	0.189
Greenville	Attic	AC Gas Heat	0	19	10	10	420	0.179
Greenville	Attic	AC Gas Heat	0	0	20	5	86	0.020
Greenville	Attic	AC Gas Heat	0	0	20	8	67	0.015
Greenville	Attic	AC Gas Heat	0	0	20	10	56	0.010

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	AC Gas Heat	0	4	20	5	464	0.158
Greenville	Attic	AC Gas Heat	0	4	20	8	440	0.138
Greenville	Attic	AC Gas Heat	0	4	20	10	423	0.128
Greenville	Attic	AC Gas Heat	0	4	20	20	346	0.066
Greenville	Attic	AC Gas Heat	0	6	20	5	483	0.179
Greenville	Attic	AC Gas Heat	0	6	20	8	458	0.163
Greenville	Attic	AC Gas Heat	0	6	20	10	442	0.148
Greenville	Attic	AC Gas Heat	0	6	20	20	364	0.082
Greenville	Attic	AC Gas Heat	0	19	20	5	516	0.220
Greenville	Attic	AC Gas Heat	0	19	20	8	492	0.199
Greenville	Attic	AC Gas Heat	0	19	20	10	476	0.189
Greenville	Attic	AC Gas Heat	0	19	20	20	397	0.102
Greenville	Attic	AC Gas Heat	0	0	23	5	101	0.026
Greenville	Attic	AC Gas Heat	0	0	23	8	83	0.020
Greenville	Attic	AC Gas Heat	0	0	23	10	71	0.015
Greenville	Attic	AC Gas Heat	0	0	23	20	15	0.005
Greenville	Attic	AC Gas Heat	0	4	23	5	479	0.163
Greenville	Attic	AC Gas Heat	0	4	23	8	455	0.143
Greenville	Attic	AC Gas Heat	0	4	23	10	439	0.133
Greenville	Attic	AC Gas Heat	0	4	23	20	361	0.072
Greenville	Attic	AC Gas Heat	0	4	23	23	338	0.056
Greenville	Attic	AC Gas Heat	0	6	23	5	498	0.184
Greenville	Attic	AC Gas Heat	0	6	23	8	474	0.169
Greenville	Attic	AC Gas Heat	0	6	23	10	458	0.153
Greenville	Attic	AC Gas Heat	0	6	23	20	379	0.087
Greenville	Attic	AC Gas Heat	0	6	23	23	356	0.066
Greenville	Attic	AC Gas Heat	0	19	23	5	531	0.225
Greenville	Attic	AC Gas Heat	0	19	23	8	507	0.204
Greenville	Attic	AC Gas Heat	0	19	23	10	491	0.194
Greenville	Attic	AC Gas Heat	0	19	23	20	412	0.107
Greenville	Attic	AC Gas Heat	0	19	23	23	389	0.092
Greenville	Attic	AC Gas Heat	0	0	25	5	111	0.026
Greenville	Attic	AC Gas Heat	0	0	25	8	93	0.020
Greenville	Attic	AC Gas Heat	0	0	25	10	81	0.015
Greenville	Attic	AC Gas Heat	0	0	25	20	25	0.005
Greenville	Attic	AC Gas Heat	0	0	25	23	10	0.000
Greenville	Attic	AC Gas Heat	0	4	25	5	489	0.163
Greenville	Attic	AC Gas Heat	0	4	25	8	465	0.143
Greenville	Attic	AC Gas Heat	0	4	25	10	449	0.133
Greenville	Attic	AC Gas Heat	0	4	25	20	371	0.072
Greenville	Attic	AC Gas Heat	0	4	25	23	348	0.056
Greenville	Attic	AC Gas Heat	0	4	25	25	333	0.046
Greenville	Attic	AC Gas Heat	0	6	25	5	508	0.184
Greenville	Attic	AC Gas Heat	0	6	25	8	484	0.169
Greenville	Attic	AC Gas Heat	0	6	25	10	468	0.153
Greenville	Attic	AC Gas Heat	0	6	25	20	390	0.087
Greenville	Attic	AC Gas Heat	0	6	25	23	366	0.066
Greenville	Attic	AC Gas Heat	0	6	25	25	351	0.056
Greenville	Attic	AC Gas Heat	0	19	25	5	541	0.225
Greenville	Attic	AC Gas Heat	0	19	25	8	517	0.204
Greenville	Attic	AC Gas Heat	0	19	25	10	501	0.194
Greenville	Attic	AC Gas Heat	0	19	25	20	423	0.107
Greenville	Attic	AC Gas Heat	0	19	25	23	399	0.092

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	AC Gas Heat	0	19	25	25	383	0.077
Greenville	Attic	AC Gas Heat	0	0	35	5	163	0.036
Greenville	Attic	AC Gas Heat	0	0	35	8	145	0.031
Greenville	Attic	AC Gas Heat	0	0	35	10	133	0.026
Greenville	Attic	AC Gas Heat	0	0	35	20	77	0.015
Greenville	Attic	AC Gas Heat	0	0	35	23	62	0.010
Greenville	Attic	AC Gas Heat	0	0	35	25	52	0.010
Greenville	Attic	AC Gas Heat	0	4	35	5	541	0.174
Greenville	Attic	AC Gas Heat	0	4	35	8	517	0.153
Greenville	Attic	AC Gas Heat	0	4	35	10	501	0.143
Greenville	Attic	AC Gas Heat	0	4	35	20	423	0.082
Greenville	Attic	AC Gas Heat	0	4	35	23	400	0.066
Greenville	Attic	AC Gas Heat	0	4	35	25	384	0.056
Greenville	Attic	AC Gas Heat	0	4	35	35	308	0.020
Greenville	Attic	AC Gas Heat	0	6	35	5	560	0.194
Greenville	Attic	AC Gas Heat	0	6	35	8	536	0.179
Greenville	Attic	AC Gas Heat	0	6	35	10	519	0.163
Greenville	Attic	AC Gas Heat	0	6	35	20	441	0.097
Greenville	Attic	AC Gas Heat	0	6	35	23	418	0.077
Greenville	Attic	AC Gas Heat	0	6	35	25	403	0.066
Greenville	Attic	AC Gas Heat	0	6	35	35	325	0.020
Greenville	Attic	AC Gas Heat	0	19	35	5	569	0.215
Greenville	Attic	AC Gas Heat	0	19	35	8	553	0.204
Greenville	Attic	AC Gas Heat	0	19	35	10	474	0.117
Greenville	Attic	AC Gas Heat	0	19	35	20	451	0.102
Greenville	Attic	AC Gas Heat	0	19	35	23	435	0.087
Greenville	Attic	AC Gas Heat	0	19	35	25	357	0.036
Greenville	Attic	AC Gas Heat	0	19	35	35	560	0.194
Greenville	Attic	AC Gas Heat	4	4	8	5	24	0.020
Greenville	Attic	AC Gas Heat	4	6	8	5	43	0.041
Greenville	Attic	AC Gas Heat	4	6	8	8	19	0.026
Greenville	Attic	AC Gas Heat	4	19	8	5	76	0.082
Greenville	Attic	AC Gas Heat	4	19	8	8	52	0.061
Greenville	Attic	AC Gas Heat	4	4	10	5	41	0.031
Greenville	Attic	AC Gas Heat	4	4	10	8	16	0.010
Greenville	Attic	AC Gas Heat	4	6	10	5	59	0.051
Greenville	Attic	AC Gas Heat	4	6	10	8	35	0.036
Greenville	Attic	AC Gas Heat	4	6	10	10	19	0.020
Greenville	Attic	AC Gas Heat	4	19	10	5	92	0.092
Greenville	Attic	AC Gas Heat	4	19	10	8	68	0.072
Greenville	Attic	AC Gas Heat	4	19	10	10	52	0.061
Greenville	Attic	AC Gas Heat	4	4	20	5	118	0.092
Greenville	Attic	AC Gas Heat	4	4	20	8	94	0.072
Greenville	Attic	AC Gas Heat	4	4	20	10	78	0.061
Greenville	Attic	AC Gas Heat	4	6	20	5	137	0.112
Greenville	Attic	AC Gas Heat	4	6	20	8	113	0.097
Greenville	Attic	AC Gas Heat	4	6	20	10	96	0.082
Greenville	Attic	AC Gas Heat	4	6	20	20	18	0.015
Greenville	Attic	AC Gas Heat	4	19	20	5	170	0.153
Greenville	Attic	AC Gas Heat	4	19	20	8	146	0.133
Greenville	Attic	AC Gas Heat	4	19	20	10	130	0.123
Greenville	Attic	AC Gas Heat	4	19	20	20	51	0.036
Greenville	Attic	AC Gas Heat	4	4	23	5	141	0.107

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	AC Gas Heat	4	4	23	8	117	0.087
Greenville	Attic	AC Gas Heat	4	4	23	10	101	0.077
Greenville	Attic	AC Gas Heat	4	4	23	20	23	0.015
Greenville	Attic	AC Gas Heat	4	6	23	5	160	0.128
Greenville	Attic	AC Gas Heat	4	6	23	8	136	0.112
Greenville	Attic	AC Gas Heat	4	6	23	10	120	0.097
Greenville	Attic	AC Gas Heat	4	6	23	20	42	0.031
Greenville	Attic	AC Gas Heat	4	6	23	23	18	0.010
Greenville	Attic	AC Gas Heat	4	19	23	5	193	0.169
Greenville	Attic	AC Gas Heat	4	19	23	8	169	0.148
Greenville	Attic	AC Gas Heat	4	19	23	10	153	0.138
Greenville	Attic	AC Gas Heat	4	19	23	20	75	0.051
Greenville	Attic	AC Gas Heat	4	19	23	23	51	0.036
Greenville	Attic	AC Gas Heat	4	4	25	5	157	0.117
Greenville	Attic	AC Gas Heat	4	4	25	8	133	0.097
Greenville	Attic	AC Gas Heat	4	4	25	10	116	0.087
Greenville	Attic	AC Gas Heat	4	4	25	20	39	0.026
Greenville	Attic	AC Gas Heat	4	4	25	23	15	0.010
Greenville	Attic	AC Gas Heat	4	6	25	5	175	0.138
Greenville	Attic	AC Gas Heat	4	6	25	8	151	0.123
Greenville	Attic	AC Gas Heat	4	6	25	10	135	0.107
Greenville	Attic	AC Gas Heat	4	6	25	20	57	0.041
Greenville	Attic	AC Gas Heat	4	6	25	23	34	0.020
Greenville	Attic	AC Gas Heat	4	6	25	25	18	0.010
Greenville	Attic	AC Gas Heat	4	19	25	5	209	0.179
Greenville	Attic	AC Gas Heat	4	19	25	8	185	0.158
Greenville	Attic	AC Gas Heat	4	19	25	10	169	0.148
Greenville	Attic	AC Gas Heat	4	19	25	20	90	0.061
Greenville	Attic	AC Gas Heat	4	19	25	23	67	0.046
Greenville	Attic	AC Gas Heat	4	19	25	25	51	0.031
Greenville	Attic	AC Gas Heat	4	4	35	5	233	0.153
Greenville	Attic	AC Gas Heat	4	4	35	8	209	0.133
Greenville	Attic	AC Gas Heat	4	4	35	10	192	0.123
Greenville	Attic	AC Gas Heat	4	4	35	20	115	0.061
Greenville	Attic	AC Gas Heat	4	4	35	23	91	0.046
Greenville	Attic	AC Gas Heat	4	4	35	25	76	0.036
Greenville	Attic	AC Gas Heat	4	6	35	5	251	0.174
Greenville	Attic	AC Gas Heat	4	6	35	8	227	0.158
Greenville	Attic	AC Gas Heat	4	6	35	10	211	0.143
Greenville	Attic	AC Gas Heat	4	6	35	20	133	0.077
Greenville	Attic	AC Gas Heat	4	6	35	23	110	0.056
Greenville	Attic	AC Gas Heat	4	6	35	25	94	0.046
Greenville	Attic	AC Gas Heat	4	6	35	35	17	0.000
Greenville	Attic	AC Gas Heat	4	19	35	5	285	0.215
Greenville	Attic	AC Gas Heat	4	19	35	8	261	0.194
Greenville	Attic	AC Gas Heat	4	19	35	10	245	0.184
Greenville	Attic	AC Gas Heat	4	19	35	20	166	0.097
Greenville	Attic	AC Gas Heat	4	19	35	23	143	0.082
Greenville	Attic	AC Gas Heat	4	19	35	25	127	0.066
Greenville	Attic	AC Gas Heat	4	19	35	35	49	0.015
Greenville	Attic	AC Gas Heat	6	6	8	5	24	0.015
Greenville	Attic	AC Gas Heat	6	19	8	5	57	0.056
Greenville	Attic	AC Gas Heat	6	19	8	8	33	0.036

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	AC Gas Heat	6	6	10	5	40	0.031
Greenville	Attic	AC Gas Heat	6	6	10	8	16	0.015
Greenville	Attic	AC Gas Heat	6	19	10	5	74	0.072
Greenville	Attic	AC Gas Heat	6	19	10	8	50	0.051
Greenville	Attic	AC Gas Heat	6	19	10	10	33	0.041
Greenville	Attic	AC Gas Heat	6	6	20	5	118	0.097
Greenville	Attic	AC Gas Heat	6	6	20	8	94	0.082
Greenville	Attic	AC Gas Heat	6	6	20	10	78	0.066
Greenville	Attic	AC Gas Heat	6	19	20	5	152	0.138
Greenville	Attic	AC Gas Heat	6	19	20	8	128	0.117
Greenville	Attic	AC Gas Heat	6	19	20	10	112	0.107
Greenville	Attic	AC Gas Heat	6	19	20	20	33	0.020
Greenville	Attic	AC Gas Heat	6	6	23	5	142	0.117
Greenville	Attic	AC Gas Heat	6	6	23	8	118	0.102
Greenville	Attic	AC Gas Heat	6	6	23	10	101	0.087
Greenville	Attic	AC Gas Heat	6	6	23	20	23	0.020
Greenville	Attic	AC Gas Heat	6	19	23	5	175	0.158
Greenville	Attic	AC Gas Heat	6	19	23	8	151	0.138
Greenville	Attic	AC Gas Heat	6	19	23	10	135	0.128
Greenville	Attic	AC Gas Heat	6	19	23	20	56	0.041
Greenville	Attic	AC Gas Heat	6	19	23	23	33	0.026
Greenville	Attic	AC Gas Heat	6	6	25	5	157	0.128
Greenville	Attic	AC Gas Heat	6	6	25	8	133	0.112
Greenville	Attic	AC Gas Heat	6	6	25	10	117	0.097
Greenville	Attic	AC Gas Heat	6	6	25	20	39	0.031
Greenville	Attic	AC Gas Heat	6	6	25	23	15	0.010
Greenville	Attic	AC Gas Heat	6	19	25	5	190	0.169
Greenville	Attic	AC Gas Heat	6	19	25	8	166	0.148
Greenville	Attic	AC Gas Heat	6	19	25	10	150	0.138
Greenville	Attic	AC Gas Heat	6	19	25	20	72	0.051
Greenville	Attic	AC Gas Heat	6	19	25	23	48	0.036
Greenville	Attic	AC Gas Heat	6	19	25	25	32	0.020
Greenville	Attic	AC Gas Heat	6	6	35	5	235	0.174
Greenville	Attic	AC Gas Heat	6	6	35	8	210	0.158
Greenville	Attic	AC Gas Heat	6	6	35	10	194	0.143
Greenville	Attic	AC Gas Heat	6	6	35	20	116	0.077
Greenville	Attic	AC Gas Heat	6	6	35	23	93	0.056
Greenville	Attic	AC Gas Heat	6	6	35	25	77	0.046
Greenville	Attic	AC Gas Heat	6	19	35	5	268	0.215
Greenville	Attic	AC Gas Heat	6	19	35	8	244	0.194
Greenville	Attic	AC Gas Heat	6	19	35	10	228	0.184
Greenville	Attic	AC Gas Heat	6	19	35	20	149	0.097
Greenville	Attic	AC Gas Heat	6	19	35	23	126	0.082
Greenville	Attic	AC Gas Heat	6	19	35	25	110	0.066
Greenville	Attic	AC Gas Heat	6	19	35	35	32	0.015
Greenville	Attic	AC Gas Heat	19	19	8	5	24	0.020
Greenville	Attic	AC Gas Heat	19	19	10	5	40	0.031
Greenville	Attic	AC Gas Heat	19	19	10	8	16	0.010
Greenville	Attic	AC Gas Heat	19	19	20	5	119	0.117
Greenville	Attic	AC Gas Heat	19	19	20	8	95	0.097
Greenville	Attic	AC Gas Heat	19	19	20	10	79	0.087
Greenville	Attic	AC Gas Heat	19	19	23	5	142	0.133
Greenville	Attic	AC Gas Heat	19	19	23	8	118	0.112

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	AC Gas Heat	19	19	23	10	102	0.102
Greenville	Attic	AC Gas Heat	19	19	23	20	23	0.015
Greenville	Attic	AC Gas Heat	19	19	25	5	158	0.148
Greenville	Attic	AC Gas Heat	19	19	25	8	134	0.128
Greenville	Attic	AC Gas Heat	19	19	25	10	118	0.117
Greenville	Attic	AC Gas Heat	19	19	25	20	39	0.031
Greenville	Attic	AC Gas Heat	19	19	25	23	16	0.015
Greenville	Attic	AC Gas Heat	19	19	35	5	236	0.199
Greenville	Attic	AC Gas Heat	19	19	35	8	212	0.179
Greenville	Attic	AC Gas Heat	19	19	35	10	196	0.169
Greenville	Attic	AC Gas Heat	19	19	35	20	117	0.082
Greenville	Attic	AC Gas Heat	19	19	35	23	94	0.066
Greenville	Attic	AC Gas Heat	19	19	35	25	78	0.051
Greenville	Attic	Heat Pump	0	0	8	5	79	0.000
Greenville	Attic	Heat Pump	0	4	8	5	1883	0.143
Greenville	Attic	Heat Pump	0	4	8	8	1802	0.133
Greenville	Attic	Heat Pump	0	6	8	5	1957	0.158
Greenville	Attic	Heat Pump	0	6	8	8	1876	0.148
Greenville	Attic	Heat Pump	0	19	8	5	2087	0.194
Greenville	Attic	Heat Pump	0	19	8	8	2008	0.179
Greenville	Attic	Heat Pump	0	0	10	5	132	0.000
Greenville	Attic	Heat Pump	0	0	10	8	53	0.000
Greenville	Attic	Heat Pump	0	4	10	5	1936	0.143
Greenville	Attic	Heat Pump	0	4	10	8	1855	0.133
Greenville	Attic	Heat Pump	0	4	10	10	1800	0.128
Greenville	Attic	Heat Pump	0	6	10	5	2010	0.158
Greenville	Attic	Heat Pump	0	6	10	8	1929	0.148
Greenville	Attic	Heat Pump	0	6	10	10	1875	0.143
Greenville	Attic	Heat Pump	0	19	10	5	2140	0.194
Greenville	Attic	Heat Pump	0	19	10	8	2061	0.179
Greenville	Attic	Heat Pump	0	19	10	10	2008	0.174
Greenville	Attic	Heat Pump	0	0	20	5	398	0.000
Greenville	Attic	Heat Pump	0	0	20	8	319	0.000
Greenville	Attic	Heat Pump	0	0	20	10	266	0.000
Greenville	Attic	Heat Pump	0	4	20	5	2202	0.143
Greenville	Attic	Heat Pump	0	4	20	8	2120	0.133
Greenville	Attic	Heat Pump	0	4	20	10	2066	0.128
Greenville	Attic	Heat Pump	0	4	20	20	1785	0.092
Greenville	Attic	Heat Pump	0	6	20	5	2276	0.158
Greenville	Attic	Heat Pump	0	6	20	8	2195	0.148
Greenville	Attic	Heat Pump	0	6	20	10	2141	0.143
Greenville	Attic	Heat Pump	0	6	20	20	1863	0.107
Greenville	Attic	Heat Pump	0	19	20	5	2406	0.194
Greenville	Attic	Heat Pump	0	19	20	8	2327	0.179
Greenville	Attic	Heat Pump	0	19	20	10	2274	0.174
Greenville	Attic	Heat Pump	0	19	20	20	2000	0.138
Greenville	Attic	Heat Pump	0	0	23	5	478	0.000
Greenville	Attic	Heat Pump	0	0	23	8	399	0.000
Greenville	Attic	Heat Pump	0	0	23	10	346	0.000
Greenville	Attic	Heat Pump	0	0	23	20	80	0.000
Greenville	Attic	Heat Pump	0	4	23	5	2282	0.143
Greenville	Attic	Heat Pump	0	4	23	8	2200	0.133
Greenville	Attic	Heat Pump	0	4	23	10	2146	0.128

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	Heat Pump	0	4	23	20	1866	0.092
Greenville	Attic	Heat Pump	0	4	23	23	1778	0.082
Greenville	Attic	Heat Pump	0	6	23	5	2356	0.158
Greenville	Attic	Heat Pump	0	6	23	8	2275	0.148
Greenville	Attic	Heat Pump	0	6	23	10	2221	0.143
Greenville	Attic	Heat Pump	0	6	23	20	1943	0.107
Greenville	Attic	Heat Pump	0	6	23	23	1856	0.097
Greenville	Attic	Heat Pump	0	19	23	5	2486	0.194
Greenville	Attic	Heat Pump	0	19	23	8	2407	0.179
Greenville	Attic	Heat Pump	0	19	23	10	2354	0.174
Greenville	Attic	Heat Pump	0	19	23	20	2080	0.138
Greenville	Attic	Heat Pump	0	19	23	23	1994	0.123
Greenville	Attic	Heat Pump	0	0	25	5	532	0.000
Greenville	Attic	Heat Pump	0	0	25	8	452	0.000
Greenville	Attic	Heat Pump	0	0	25	10	400	0.000
Greenville	Attic	Heat Pump	0	0	25	20	134	0.000
Greenville	Attic	Heat Pump	0	0	25	23	54	0.000
Greenville	Attic	Heat Pump	0	4	25	5	2335	0.143
Greenville	Attic	Heat Pump	0	4	25	8	2254	0.133
Greenville	Attic	Heat Pump	0	4	25	10	2200	0.128
Greenville	Attic	Heat Pump	0	4	25	20	1919	0.092
Greenville	Attic	Heat Pump	0	4	25	23	1831	0.082
Greenville	Attic	Heat Pump	0	4	25	25	1772	0.077
Greenville	Attic	Heat Pump	0	6	25	5	2410	0.158
Greenville	Attic	Heat Pump	0	6	25	8	2329	0.148
Greenville	Attic	Heat Pump	0	6	25	10	2275	0.143
Greenville	Attic	Heat Pump	0	6	25	20	1996	0.107
Greenville	Attic	Heat Pump	0	6	25	23	1910	0.097
Greenville	Attic	Heat Pump	0	6	25	25	1850	0.087
Greenville	Attic	Heat Pump	0	19	25	5	2539	0.194
Greenville	Attic	Heat Pump	0	19	25	8	2460	0.179
Greenville	Attic	Heat Pump	0	19	25	10	2407	0.174
Greenville	Attic	Heat Pump	0	19	25	20	2133	0.138
Greenville	Attic	Heat Pump	0	19	25	23	2047	0.123
Greenville	Attic	Heat Pump	0	19	25	25	1989	0.107
Greenville	Attic	Heat Pump	0	0	35	5	803	0.005
Greenville	Attic	Heat Pump	0	0	35	8	723	0.005
Greenville	Attic	Heat Pump	0	0	35	10	671	0.005
Greenville	Attic	Heat Pump	0	0	35	20	405	0.005
Greenville	Attic	Heat Pump	0	0	35	23	325	0.005
Greenville	Attic	Heat Pump	0	0	35	25	271	0.005
Greenville	Attic	Heat Pump	0	4	35	5	2606	0.148
Greenville	Attic	Heat Pump	0	4	35	8	2525	0.138
Greenville	Attic	Heat Pump	0	4	35	10	2471	0.133
Greenville	Attic	Heat Pump	0	4	35	20	2190	0.097
Greenville	Attic	Heat Pump	0	4	35	23	2102	0.087
Greenville	Attic	Heat Pump	0	4	35	25	2043	0.082
Greenville	Attic	Heat Pump	0	4	35	35	1738	0.046
Greenville	Attic	Heat Pump	0	6	35	5	2681	0.163
Greenville	Attic	Heat Pump	0	6	35	8	2600	0.153
Greenville	Attic	Heat Pump	0	6	35	10	2546	0.148
Greenville	Attic	Heat Pump	0	6	35	20	2267	0.112
Greenville	Attic	Heat Pump	0	6	35	23	2181	0.102

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	Heat Pump	0	6	35	25	2121	0.092
Greenville	Attic	Heat Pump	0	6	35	35	1817	0.056
Greenville	Attic	Heat Pump	0	19	35	5	2731	0.184
Greenville	Attic	Heat Pump	0	19	35	8	2678	0.179
Greenville	Attic	Heat Pump	0	19	35	10	2404	0.143
Greenville	Attic	Heat Pump	0	19	35	20	2318	0.128
Greenville	Attic	Heat Pump	0	19	35	23	2260	0.112
Greenville	Attic	Heat Pump	0	19	35	25	1958	0.072
Greenville	Attic	Heat Pump	0	19	35	35	2681	0.163
Greenville	Attic	Heat Pump	4	4	8	5	81	0.010
Greenville	Attic	Heat Pump	4	6	8	5	155	0.026
Greenville	Attic	Heat Pump	4	6	8	8	75	0.015
Greenville	Attic	Heat Pump	4	19	8	5	285	0.061
Greenville	Attic	Heat Pump	4	19	8	8	206	0.046
Greenville	Attic	Heat Pump	4	4	10	5	136	0.015
Greenville	Attic	Heat Pump	4	4	10	8	54	0.005
Greenville	Attic	Heat Pump	4	6	10	5	210	0.031
Greenville	Attic	Heat Pump	4	6	10	8	129	0.020
Greenville	Attic	Heat Pump	4	6	10	10	75	0.015
Greenville	Attic	Heat Pump	4	19	10	5	340	0.066
Greenville	Attic	Heat Pump	4	19	10	8	261	0.051
Greenville	Attic	Heat Pump	4	19	10	10	208	0.046
Greenville	Attic	Heat Pump	4	4	20	5	416	0.051
Greenville	Attic	Heat Pump	4	4	20	8	335	0.041
Greenville	Attic	Heat Pump	4	4	20	10	281	0.036
Greenville	Attic	Heat Pump	4	6	20	5	490	0.066
Greenville	Attic	Heat Pump	4	6	20	8	410	0.056
Greenville	Attic	Heat Pump	4	6	20	10	356	0.051
Greenville	Attic	Heat Pump	4	6	20	20	77	0.015
Greenville	Attic	Heat Pump	4	19	20	5	620	0.102
Greenville	Attic	Heat Pump	4	19	20	8	541	0.087
Greenville	Attic	Heat Pump	4	19	20	10	488	0.082
Greenville	Attic	Heat Pump	4	19	20	20	214	0.046
Greenville	Attic	Heat Pump	4	4	23	5	504	0.061
Greenville	Attic	Heat Pump	4	4	23	8	423	0.051
Greenville	Attic	Heat Pump	4	4	23	10	369	0.046
Greenville	Attic	Heat Pump	4	4	23	20	88	0.010
Greenville	Attic	Heat Pump	4	6	23	5	578	0.077
Greenville	Attic	Heat Pump	4	6	23	8	498	0.066
Greenville	Attic	Heat Pump	4	6	23	10	444	0.061
Greenville	Attic	Heat Pump	4	6	23	20	165	0.026
Greenville	Attic	Heat Pump	4	6	23	23	78	0.015
Greenville	Attic	Heat Pump	4	19	23	5	708	0.112
Greenville	Attic	Heat Pump	4	19	23	8	629	0.097
Greenville	Attic	Heat Pump	4	19	23	10	576	0.092
Greenville	Attic	Heat Pump	4	19	23	20	302	0.056
Greenville	Attic	Heat Pump	4	19	23	23	216	0.041
Greenville	Attic	Heat Pump	4	4	25	5	564	0.066
Greenville	Attic	Heat Pump	4	4	25	8	482	0.056
Greenville	Attic	Heat Pump	4	4	25	10	428	0.051
Greenville	Attic	Heat Pump	4	4	25	20	147	0.015
Greenville	Attic	Heat Pump	4	4	25	23	59	0.005
Greenville	Attic	Heat Pump	4	6	25	5	638	0.082

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	Heat Pump	4	6	25	8	557	0.072
Greenville	Attic	Heat Pump	4	6	25	10	503	0.066
Greenville	Attic	Heat Pump	4	6	25	20	225	0.031
Greenville	Attic	Heat Pump	4	6	25	23	138	0.020
Greenville	Attic	Heat Pump	4	6	25	25	79	0.010
Greenville	Attic	Heat Pump	4	19	25	5	767	0.117
Greenville	Attic	Heat Pump	4	19	25	8	689	0.102
Greenville	Attic	Heat Pump	4	19	25	10	635	0.097
Greenville	Attic	Heat Pump	4	19	25	20	361	0.061
Greenville	Attic	Heat Pump	4	19	25	23	276	0.046
Greenville	Attic	Heat Pump	4	19	25	25	218	0.031
Greenville	Attic	Heat Pump	4	4	35	5	868	0.102
Greenville	Attic	Heat Pump	4	4	35	8	787	0.092
Greenville	Attic	Heat Pump	4	4	35	10	732	0.087
Greenville	Attic	Heat Pump	4	4	35	20	452	0.051
Greenville	Attic	Heat Pump	4	4	35	23	364	0.041
Greenville	Attic	Heat Pump	4	4	35	25	304	0.036
Greenville	Attic	Heat Pump	4	6	35	5	942	0.117
Greenville	Attic	Heat Pump	4	6	35	8	862	0.107
Greenville	Attic	Heat Pump	4	6	35	10	807	0.102
Greenville	Attic	Heat Pump	4	6	35	20	529	0.066
Greenville	Attic	Heat Pump	4	6	35	23	442	0.056
Greenville	Attic	Heat Pump	4	6	35	25	383	0.046
Greenville	Attic	Heat Pump	4	6	35	35	79	0.010
Greenville	Attic	Heat Pump	4	19	35	5	1072	0.153
Greenville	Attic	Heat Pump	4	19	35	8	993	0.138
Greenville	Attic	Heat Pump	4	19	35	10	940	0.133
Greenville	Attic	Heat Pump	4	19	35	20	666	0.097
Greenville	Attic	Heat Pump	4	19	35	23	580	0.082
Greenville	Attic	Heat Pump	4	19	35	25	522	0.066
Greenville	Attic	Heat Pump	4	19	35	35	220	0.026
Greenville	Attic	Heat Pump	6	6	8	5	81	0.010
Greenville	Attic	Heat Pump	6	19	8	5	210	0.046
Greenville	Attic	Heat Pump	6	19	8	8	131	0.031
Greenville	Attic	Heat Pump	6	6	10	5	135	0.015
Greenville	Attic	Heat Pump	6	6	10	8	54	0.005
Greenville	Attic	Heat Pump	6	19	10	5	264	0.051
Greenville	Attic	Heat Pump	6	19	10	8	186	0.036
Greenville	Attic	Heat Pump	6	19	10	10	132	0.031
Greenville	Attic	Heat Pump	6	6	20	5	413	0.051
Greenville	Attic	Heat Pump	6	6	20	8	332	0.041
Greenville	Attic	Heat Pump	6	6	20	10	278	0.036
Greenville	Attic	Heat Pump	6	19	20	5	543	0.087
Greenville	Attic	Heat Pump	6	19	20	8	464	0.072
Greenville	Attic	Heat Pump	6	19	20	10	411	0.066
Greenville	Attic	Heat Pump	6	19	20	20	137	0.031
Greenville	Attic	Heat Pump	6	6	23	5	500	0.061
Greenville	Attic	Heat Pump	6	6	23	8	419	0.051
Greenville	Attic	Heat Pump	6	6	23	10	365	0.046
Greenville	Attic	Heat Pump	6	6	23	20	87	0.010
Greenville	Attic	Heat Pump	6	19	23	5	630	0.097
Greenville	Attic	Heat Pump	6	19	23	8	551	0.082
Greenville	Attic	Heat Pump	6	19	23	10	498	0.077

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City	Duct Location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kwh /ton	Summer kw/ton
Greenville	Attic	Heat Pump	6	19	23	20	224	0.041
Greenville	Attic	Heat Pump	6	19	23	23	138	0.026
Greenville	Attic	Heat Pump	6	6	25	5	559	0.072
Greenville	Attic	Heat Pump	6	6	25	8	478	0.061
Greenville	Attic	Heat Pump	6	6	25	10	424	0.056
Greenville	Attic	Heat Pump	6	6	25	20	146	0.020
Greenville	Attic	Heat Pump	6	6	25	23	59	0.010
Greenville	Attic	Heat Pump	6	19	25	5	689	0.107
Greenville	Attic	Heat Pump	6	19	25	8	610	0.092
Greenville	Attic	Heat Pump	6	19	25	10	557	0.087
Greenville	Attic	Heat Pump	6	19	25	20	283	0.051
Greenville	Attic	Heat Pump	6	19	25	23	197	0.036
Greenville	Attic	Heat Pump	6	19	25	25	139	0.020
Greenville	Attic	Heat Pump	6	6	35	5	863	0.107
Greenville	Attic	Heat Pump	6	6	35	8	783	0.097
Greenville	Attic	Heat Pump	6	6	35	10	728	0.092
Greenville	Attic	Heat Pump	6	6	35	20	450	0.056
Greenville	Attic	Heat Pump	6	6	35	23	363	0.046
Greenville	Attic	Heat Pump	6	6	35	25	304	0.036
Greenville	Attic	Heat Pump	6	19	35	5	993	0.143
Greenville	Attic	Heat Pump	6	19	35	8	914	0.128
Greenville	Attic	Heat Pump	6	19	35	10	861	0.123
Greenville	Attic	Heat Pump	6	19	35	20	587	0.087
Greenville	Attic	Heat Pump	6	19	35	23	501	0.072
Greenville	Attic	Heat Pump	6	19	35	25	443	0.056
Greenville	Attic	Heat Pump	6	19	35	35	141	0.015
Greenville	Attic	Heat Pump	19	19	8	5	79	0.015
Greenville	Attic	Heat Pump	19	19	10	5	132	0.020
Greenville	Attic	Heat Pump	19	19	10	8	53	0.005
Greenville	Attic	Heat Pump	19	19	20	5	406	0.056
Greenville	Attic	Heat Pump	19	19	20	8	327	0.041
Greenville	Attic	Heat Pump	19	19	20	10	274	0.036
Greenville	Attic	Heat Pump	19	19	23	5	492	0.072
Greenville	Attic	Heat Pump	19	19	23	8	413	0.056
Greenville	Attic	Heat Pump	19	19	23	10	360	0.051
Greenville	Attic	Heat Pump	19	19	23	20	86	0.015
Greenville	Attic	Heat Pump	19	19	25	5	550	0.087
Greenville	Attic	Heat Pump	19	19	25	8	471	0.072
Greenville	Attic	Heat Pump	19	19	25	10	418	0.066
Greenville	Attic	Heat Pump	19	19	25	20	144	0.031
Greenville	Attic	Heat Pump	19	19	25	23	58	0.015
Greenville	Attic	Heat Pump	19	19	35	5	852	0.128
Greenville	Attic	Heat Pump	19	19	35	8	773	0.112
Greenville	Attic	Heat Pump	19	19	35	10	720	0.107
Greenville	Attic	Heat Pump	19	19	35	20	446	0.072
Greenville	Attic	Heat Pump	19	19	35	23	360	0.056
Greenville	Attic	Heat Pump	19	19	35	25	302	0.041

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	25	10	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	23	12	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	20	16	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	10	26	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	8	28	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	5	31	0.063
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	25	14	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	23	18	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	20	22	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	10	34	0.063
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	8	37	0.070
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	5	41	0.077
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	25	14	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	23	17	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	20	21	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	10	34	0.063
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	8	36	0.070
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	5	40	0.077
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	25	14	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	23	17	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	20	21	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	10	36	0.070
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	8	38	0.077
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	5	42	0.084
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	23	2	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	20	5	0.014

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	10	16	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	8	18	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	5	21	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	23	4	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	20	7	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	10	19	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	8	23	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	5	26	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	23	3	0.000
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	20	6	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	10	19	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	8	22	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	5	26	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	23	3	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	20	7	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	10	21	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	8	24	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	5	28	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	20	3	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	10	13	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	8	15	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	5	18	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	20	4	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	10	16	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	8	19	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	5	23	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	20	4	0.014

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	10	17	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	8	19	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	5	23	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	20	4	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	10	19	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	8	21	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	5	25	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	10	10	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	8	12	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	5	15	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	10	12	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	8	15	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	5	19	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	10	13	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	8	16	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	5	19	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	10	14	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	8	17	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	5	21	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	10	8	2	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	10	5	5	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	10	8	3	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	10	5	7	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	10	8	2	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	10	5	6	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	10	8	2	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	10	5	6	0.014

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	8	5	3	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	8	5	4	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	8	5	4	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	8	5	4	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	35	34	0.077
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	25	49	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	23	52	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	20	56	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	10	68	0.141
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	8	71	0.148
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	5	75	0.155
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	35	37	0.084
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	25	51	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	23	54	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	20	58	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	10	71	0.148
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	8	73	0.155
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	5	77	0.162
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	35	77	0.162
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	25	37	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	23	51	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	20	54	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	10	58	0.134
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	8	72	0.162
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	5	75	0.169
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	25	38	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	23	42	0.098

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	20	46	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	10	58	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	8	61	0.134
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	5	65	0.141
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	25	41	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	23	43	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	20	47	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	10	60	0.134
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	8	63	0.141
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	5	67	0.148
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	25	41	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	23	44	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	20	48	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	10	62	0.148
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	8	65	0.155
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	5	69	0.162
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	23	40	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	20	43	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	10	55	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	8	59	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	5	63	0.134
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	23	41	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	20	45	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	10	58	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	8	61	0.134
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	5	65	0.141
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	23	41	0.105

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	20	45	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	10	60	0.141
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	8	62	0.148
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	5	66	0.155
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	20	40	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	10	52	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	8	56	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	5	59	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	20	42	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	10	55	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	8	58	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	5	61	0.134
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	20	42	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	10	57	0.134
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	8	59	0.141
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	5	63	0.148
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	10	42	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	8	45	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	5	49	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	10	45	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	8	47	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	5	51	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	10	47	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	8	49	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	5	53	0.127
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	8	8	44	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	8	5	47	0.098

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	8	8	45	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	8	5	49	0.105
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	8	8	47	0.113
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	8	5	51	0.120
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	35	3	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	25	17	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	23	19	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	20	23	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	10	36	0.070
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	8	39	0.077
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	5	43	0.084
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	35	2	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	25	17	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	23	19	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	20	24	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	10	38	0.084
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	8	41	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	5	45	0.098
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	25	3	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	23	5	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	20	9	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	10	22	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	8	25	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	5	28	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	25	3	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	23	5	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	20	9	0.028

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	10	24	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	8	26	0.063
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	5	30	0.070
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	23	1	0.000
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	20	5	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	10	18	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	8	21	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	5	25	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	23	2	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	20	6	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	10	20	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	8	23	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	5	27	0.063
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	20	2	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	10	15	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	8	17	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	5	21	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	20	2	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	10	16	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	8	19	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	5	23	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	10	3	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	8	5	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	5	9	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	10	4	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	8	7	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	5	11	0.035

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	8	8	2	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	8	5	6	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	8	8	4	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	8	5	8	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	35	0	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	25	14	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	23	17	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	20	21	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	10	36	0.077
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	8	38	0.084
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	5	42	0.091
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	25	0	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	23	3	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	20	7	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	10	21	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	8	24	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	5	28	0.063
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	23	0	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	20	4	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	10	19	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	8	21	0.056
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	5	25	0.063
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	20	0	0.007
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	10	15	0.035
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	8	17	0.042
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	5	21	0.049
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	10	2	0.014

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	8	4	0.021
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	5	8	0.028
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	8	8	2	0.014
Asheville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	8	5	6	0.021
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	25	34	0.021
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	23	40	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	20	50	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	10	82	0.063
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	8	89	0.063
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	5	99	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	25	56	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	23	68	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	20	85	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	10	146	0.063
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	8	158	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	5	177	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	25	58	0.021
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	23	70	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	20	87	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	10	151	0.063
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	8	165	0.063
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	5	184	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	25	61	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	23	75	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	20	94	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	10	163	0.063
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	8	177	0.063

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	5	199	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	23	7	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	20	16	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	10	49	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	8	55	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	5	65	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	23	11	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	20	29	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	10	89	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	8	102	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	5	121	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	23	12	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	20	29	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	10	93	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	8	106	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	5	126	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	23	13	0.000
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	20	32	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	10	102	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	8	116	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	5	137	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	20	10	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	10	42	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	8	49	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	5	59	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	20	17	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	10	78	0.028

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	8	90	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	5	109	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	20	17	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	10	81	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	8	94	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	5	114	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	20	19	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	10	89	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	8	103	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	5	124	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	20	10	32	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	20	8	39	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	20	5	49	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	20	10	61	0.021
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	20	8	73	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	20	5	92	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	20	10	64	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	20	8	77	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	20	5	97	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	20	10	70	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	20	8	83	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	20	5	105	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	10	8	7	0.000
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	10	5	17	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	10	8	13	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	10	5	31	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	10	8	13	0.000

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	10	5	33	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	10	8	14	0.000
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	10	5	35	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	0	8	5	10	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	4	8	5	19	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	6	8	5	20	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	19	19	8	5	21	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	35	230	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	25	286	0.098
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	23	298	0.105
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	20	315	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	10	376	0.134
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	8	388	0.141
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	5	407	0.148
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	35	246	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	25	304	0.098
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	23	316	0.105
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	20	333	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	10	397	0.141
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	8	410	0.141
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	5	430	0.148
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	35	430	0.148
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	25	275	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	23	336	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	20	349	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	10	369	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	8	438	0.148

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	5	452	0.148
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	25	253	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	23	264	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	20	282	0.091
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	10	342	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	8	355	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	5	373	0.127
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	25	270	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	23	282	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	20	300	0.091
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	10	363	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	8	377	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	5	396	0.127
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	25	303	0.091
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	23	316	0.091
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	20	335	0.098
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	10	405	0.127
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	8	419	0.127
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	5	440	0.134
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	23	258	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	20	275	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	10	336	0.105
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	8	348	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	5	367	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	23	276	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	20	293	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	10	357	0.113

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	8	370	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	5	390	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	23	309	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	20	329	0.091
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	10	398	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	8	412	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	5	433	0.127
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	20	265	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	10	326	0.098
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	8	339	0.105
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	5	357	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	20	283	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	10	347	0.105
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	8	360	0.105
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	5	380	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	20	319	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	10	389	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	8	402	0.113
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	5	424	0.120
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	10	10	294	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	10	8	306	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	10	5	325	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	10	10	315	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	10	8	328	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	10	5	348	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	10	10	356	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	10	8	370	0.084

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	10	5	391	0.091
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	8	8	299	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	4	8	5	318	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	8	8	321	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	6	8	5	341	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	8	8	363	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	0	19	8	5	385	0.091
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	35	16	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	25	74	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	23	86	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	20	103	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	10	167	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	8	180	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	5	200	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	35	45	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	25	106	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	23	119	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	20	139	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	10	208	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	8	222	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	5	244	0.084
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	25	18	0.000
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	23	29	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	20	47	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	10	111	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	8	124	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	5	143	0.049

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	25	50	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	23	63	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	20	82	0.021
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	10	152	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	8	166	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	5	187	0.056
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	23	18	0.000
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	20	35	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	10	99	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	8	112	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	5	132	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	23	52	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	20	71	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	10	140	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	8	154	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	5	176	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	20	18	0.000
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	10	82	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	8	95	0.028
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	5	115	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	20	54	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	10	123	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	8	137	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	5	158	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	10	10	21	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	10	8	34	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	10	5	54	0.014

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	10	10	63	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	10	8	77	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	10	5	98	0.021
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	8	8	22	0.000
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	6	8	5	41	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	8	8	64	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	4	19	8	5	85	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	35	29	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	25	91	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	23	104	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	20	123	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	10	193	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	8	207	0.070
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	5	228	0.077
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	25	32	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	23	45	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	20	65	0.021
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	10	134	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	8	148	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	5	170	0.056
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	23	34	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	20	53	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	10	122	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	8	136	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	5	158	0.049
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	20	36	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	10	105	0.035

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	8	119	0.035
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	5	140	0.042
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	10	10	41	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	10	8	55	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	10	5	77	0.014
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	8	8	42	0.007
Asheville	Uncon bsmt/ crawl space	Heat Pump	6	19	8	5	63	0.014
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	25	19	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	23	22	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	20	27	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	10	45	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	8	49	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	5	54	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	25	29	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	23	35	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	20	44	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	10	75	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	8	81	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	5	91	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	25	30	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	23	36	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	20	46	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	10	78	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	8	84	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	5	94	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	25	32	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	23	39	0.007

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	20	49	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	10	82	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	8	89	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	5	99	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	23	3	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	20	9	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	10	27	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	8	30	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	5	36	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	23	6	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	20	15	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	10	46	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	8	52	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	5	61	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	23	6	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	20	16	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	10	47	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	8	54	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	5	63	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	23	7	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	20	16	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	10	50	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	8	57	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	5	67	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	20	6	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	10	23	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	8	27	0.000

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	5	33	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	20	9	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	10	40	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	8	46	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	5	55	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	20	10	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	10	41	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	8	48	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	5	57	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	20	10	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	10	43	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	8	50	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	5	60	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	10	18	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	8	21	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	5	27	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	10	30	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	8	37	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	5	46	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	10	32	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	8	38	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	5	48	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	10	34	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	8	40	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	5	50	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	10	8	4	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	10	5	9	0.000

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	10	8	6	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	10	5	16	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	10	8	7	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	10	5	16	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	10	8	7	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	10	5	17	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	0	8	5	6	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	4	8	5	9	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	6	8	5	9	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	19	19	8	5	10	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	35	70	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	25	99	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	23	105	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	20	114	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	10	144	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	8	151	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	5	160	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	35	74	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	25	104	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	23	111	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	20	120	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	10	152	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	8	159	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	5	168	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	35	168	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	25	83	-0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	23	116	0.000

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	20	122	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	10	132	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	8	166	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	5	172	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	25	80	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	23	86	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	20	95	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	10	126	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	8	132	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	5	142	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	25	86	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	23	92	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	20	102	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	10	133	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	8	140	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	5	149	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	25	97	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	23	104	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	20	113	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	10	147	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	8	154	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	5	164	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	23	83	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	20	92	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	10	123	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	8	129	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	5	138	0.022

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	23	89	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	20	98	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	10	130	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	8	137	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	5	146	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	23	100	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	20	110	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	10	144	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	8	150	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	5	161	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	20	87	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	10	117	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	8	123	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	5	133	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	20	93	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	10	124	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	8	131	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	5	140	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	20	105	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	10	138	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	8	145	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	5	155	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	10	99	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	8	106	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	5	115	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	10	107	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	8	113	0.022

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	5	123	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	10	121	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	8	127	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	5	137	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	8	8	102	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	4	8	5	111	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	8	8	110	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	6	8	5	119	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	8	8	124	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	0	19	8	5	134	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	35	5	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	25	35	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	23	41	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	20	51	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	10	82	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	8	89	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	5	98	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	35	14	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	25	46	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	23	53	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	20	63	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	10	96	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	8	103	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	5	113	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	25	6	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	23	12	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	20	21	0.007

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	10	53	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	8	60	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	5	69	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	25	17	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	23	23	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	20	33	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	10	67	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	8	74	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	5	84	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	23	6	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	20	15	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	10	47	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	8	54	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	5	63	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	23	17	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	20	27	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	10	61	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	8	67	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	5	78	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	20	6	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	10	38	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	8	44	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	5	54	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	20	18	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	10	52	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	8	58	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	5	68	0.030

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	10	7	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	8	14	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	5	23	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	10	21	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	8	28	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	5	38	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	8	8	8	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	6	8	5	17	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	8	8	22	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	4	19	8	5	32	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	35	9	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	25	41	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	23	48	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	20	58	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	10	91	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	8	98	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	5	108	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	25	11	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	23	18	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	20	28	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	10	61	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	8	68	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	5	78	0.037
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	23	12	0.000
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	20	21	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	10	55	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	8	62	0.030

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	5	72	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	20	12	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	10	45	0.022
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	8	52	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	5	62	0.030
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	10	14	0.007
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	8	21	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	5	31	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	8	8	14	0.015
Charlotte	Uncon bsmt/ crawl space	AC Gas Heat	6	19	8	5	24	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	35	25	40	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	35	23	48	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	35	20	60	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	35	10	99	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	35	8	107	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	35	5	119	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	35	25	66	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	35	23	80	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	35	20	100	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	35	10	171	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	35	8	186	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	35	5	207	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	35	25	68	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	35	23	82	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	35	20	104	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	35	10	177	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	35	8	192	0.037

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	35	5	215	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	35	25	73	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	35	23	88	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	35	20	111	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	35	10	189	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	35	8	205	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	35	5	229	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	25	23	8	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	25	20	20	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	25	10	59	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	25	8	67	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	25	5	79	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	25	23	14	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	25	20	34	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	25	10	105	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	25	8	119	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	25	5	141	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	25	23	14	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	25	20	35	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	25	10	109	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	25	8	124	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	25	5	146	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	25	23	15	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	25	20	38	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	25	10	116	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	25	8	132	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	25	5	156	0.037

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	23	20	12	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	23	10	51	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	23	8	59	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	23	5	71	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	23	20	20	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	23	10	91	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	23	8	106	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	23	5	128	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	23	20	21	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	23	10	95	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	23	8	110	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	23	5	132	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	23	20	22	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	23	10	101	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	23	8	117	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	23	5	141	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	20	10	39	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	20	8	47	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	20	5	59	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	20	10	71	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	20	8	85	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	20	5	107	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	20	10	73	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	20	8	88	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	20	5	111	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	20	10	78	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	20	8	94	0.022

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	20	5	118	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	10	8	8	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	10	5	20	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	10	8	14	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	10	5	36	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	10	8	15	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	10	5	37	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	10	8	16	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	10	5	40	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	0	8	5	12	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	4	8	5	22	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	6	8	5	23	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	19	19	8	5	24	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	35	35	234	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	35	25	300	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	35	23	314	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	35	20	334	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	35	10	405	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	35	8	419	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	35	5	441	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	35	35	250	-0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	35	25	318	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	35	23	332	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	35	20	353	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	35	10	427	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	35	8	442	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	35	5	464	0.037

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	35	35	464	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	35	25	279	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	35	23	353	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	35	20	368	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	35	10	390	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	35	8	468	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	35	5	484	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	25	25	260	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	25	23	273	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	25	20	294	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	25	10	364	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	25	8	379	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	25	5	401	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	25	25	278	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	25	23	292	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	25	20	313	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	25	10	386	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	25	8	401	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	25	5	424	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	25	25	312	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	25	23	327	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	25	20	350	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	25	10	428	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	25	8	444	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	25	5	468	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	23	23	265	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	23	20	286	0.007

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	23	10	357	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	23	8	371	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	23	5	393	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	23	23	284	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	23	20	305	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	23	10	379	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	23	8	393	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	23	5	416	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	23	23	319	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	23	20	342	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	23	10	420	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	23	8	436	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	23	5	460	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	20	20	274	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	20	10	345	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	20	8	359	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	20	5	381	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	20	20	293	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	20	10	367	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	20	8	382	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	20	5	404	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	20	20	330	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	20	10	408	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	20	8	424	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	20	5	449	0.052
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	10	10	305	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	10	8	320	0.037

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	10	5	342	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	10	10	327	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	10	8	342	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	10	5	365	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	10	10	369	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	10	8	385	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	10	5	409	0.052
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	8	8	312	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	4	8	5	334	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	8	8	335	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	6	8	5	357	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	8	8	377	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	0	19	8	5	401	0.052
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	35	35	16	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	35	25	84	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	35	23	98	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	35	20	120	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	35	10	193	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	35	8	208	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	35	5	231	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	35	35	46	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	35	25	119	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	35	23	134	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	35	20	156	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	35	10	235	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	35	8	251	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	35	5	275	0.052

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	25	25	18	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	25	23	32	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	25	20	53	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	25	10	127	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	25	8	142	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	25	5	164	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	25	25	53	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	25	23	68	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	25	20	90	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	25	10	168	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	25	8	184	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	25	5	209	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	23	23	18	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	23	20	40	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	23	10	113	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	23	8	128	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	23	5	151	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	23	23	54	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	23	20	77	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	23	10	155	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	23	8	171	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	23	5	195	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	20	20	19	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	20	10	93	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	20	8	108	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	20	5	130	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	20	20	56	0.007

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	20	10	134	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	20	8	150	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	20	5	174	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	10	10	22	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	10	8	37	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	10	5	59	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	10	10	64	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	10	8	79	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	10	5	104	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	8	8	22	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	6	8	5	45	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	8	8	65	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	4	19	8	5	89	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	35	35	30	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	35	25	103	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	35	23	118	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	35	20	141	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	35	10	219	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	35	8	235	0.045
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	35	5	259	0.052
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	25	25	35	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	25	23	50	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	25	20	72	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	25	10	150	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	25	8	166	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	25	5	191	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	23	23	36	0.007

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	23	20	58	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	23	10	136	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	23	8	152	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	23	5	177	0.037
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	20	20	37	0.000
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	20	10	115	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	20	8	131	0.022
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	20	5	155	0.030
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	10	10	42	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	10	8	58	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	10	5	82	0.015
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	8	8	43	0.007
Charlotte	Uncon bsmt/ crawl space	Heat Pump	6	19	8	5	67	0.015
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	25	19	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	23	23	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	20	28	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	10	46	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	8	50	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	35	5	55	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	25	26	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	23	30	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	20	38	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	10	61	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	8	66	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	35	5	73	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	25	26	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	23	31	0.023

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	20	37	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	10	62	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	8	67	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	35	5	75	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	25	27	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	23	32	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	20	40	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	10	64	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	8	69	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	35	5	77	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	23	4	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	20	9	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	10	28	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	8	31	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	25	5	37	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	23	4	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	20	12	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	10	35	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	8	40	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	25	5	47	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	23	5	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	20	11	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	10	36	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	8	41	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	25	5	49	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	23	6	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	20	13	0.006

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	10	38	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	8	43	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	25	5	50	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	20	5	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	10	24	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	8	27	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	23	5	33	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	20	7	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	10	31	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	8	36	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	23	5	42	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	20	6	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	10	31	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	8	36	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	23	5	44	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	20	7	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	10	32	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	8	37	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	23	5	45	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	10	18	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	8	22	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	20	5	28	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	10	23	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	8	28	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	20	5	35	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	10	25	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	8	30	0.023

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	20	5	37	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	10	25	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	8	30	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	20	5	37	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	10	8	4	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	10	5	9	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	10	8	5	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	10	5	11	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	10	8	5	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	10	5	12	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	10	8	5	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	10	5	12	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	0	8	5	5	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	4	8	5	7	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	6	8	5	8	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	19	19	8	5	7	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	35	48	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	25	74	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	23	78	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	20	86	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	10	109	0.087
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	8	114	0.093
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	35	5	121	0.099
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	35	51	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	25	76	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	23	82	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	20	88	0.070

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	10	113	0.093
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	8	118	0.093
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	35	5	125	0.105
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	35	125	0.105
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	25	56	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	23	82	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	20	88	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	10	95	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	8	120	0.099
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	35	5	125	0.105
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	25	55	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	23	60	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	20	67	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	10	90	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	8	95	0.081
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	25	5	102	0.087
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	25	58	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	23	63	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	20	69	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	10	94	0.081
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	8	99	0.081
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	25	5	107	0.093
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	25	64	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	23	69	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	20	77	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	10	102	0.087
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	8	107	0.093

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	25	5	114	0.099
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	23	56	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	20	63	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	10	86	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	8	91	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	23	5	98	0.081
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	23	59	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	20	65	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	10	90	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	8	95	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	23	5	103	0.087
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	23	65	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	20	73	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	10	98	0.081
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	8	103	0.087
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	23	5	110	0.093
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	20	58	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	10	81	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	8	86	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	20	5	93	0.081
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	20	60	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	10	85	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	8	90	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	20	5	97	0.087
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	20	67	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	10	92	0.081
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	8	97	0.087

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	20	5	105	0.093
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	10	63	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	8	68	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	10	5	74	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	10	66	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	8	71	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	10	5	79	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	10	74	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	8	79	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	10	5	86	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	8	8	64	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	4	8	5	71	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	8	8	68	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	6	8	5	75	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	8	8	75	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	0	19	8	5	83	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	35	3	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	25	28	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	23	34	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	20	40	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	10	65	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	8	70	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	35	5	77	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	35	8	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	25	34	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	23	40	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	20	47	0.041

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	10	72	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	8	77	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	35	5	85	0.076
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	25	3	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	23	8	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	20	14	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	10	39	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	8	44	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	25	5	51	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	25	8	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	23	14	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	20	22	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	10	46	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	8	51	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	25	5	59	0.052
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	23	3	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	20	10	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	10	34	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	8	39	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	23	5	47	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	23	10	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	20	17	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	10	42	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	8	47	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	23	5	54	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	20	2	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	10	27	0.023

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	8	32	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	20	5	40	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	20	10	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	10	35	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	8	40	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	20	5	47	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	10	4	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	8	9	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	10	5	16	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	10	11	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	8	16	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	10	5	24	0.023
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	8	8	4	0.000
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	6	8	5	11	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	8	8	11	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	4	19	8	5	19	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	35	5	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	25	32	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	23	37	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	20	45	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	10	70	0.058
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	8	75	0.064
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	35	5	82	0.070
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	25	6	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	23	11	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	20	19	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	10	44	0.035

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	8	49	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	25	5	56	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	23	6	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	20	14	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	10	39	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	8	44	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	23	5	51	0.046
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	20	7	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	10	32	0.029
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	8	37	0.035
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	20	5	45	0.041
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	10	7	0.006
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	8	12	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	10	5	20	0.017
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	8	8	8	0.012
Greenville	Uncon bsmt/ crawl space	AC Gas Heat	6	19	8	5	15	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	25	44	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	23	53	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	20	66	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	10	110	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	8	119	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	35	5	133	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	25	73	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	23	87	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	20	109	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	10	189	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	8	206	0.058

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	35	5	232	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	25	75	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	23	90	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	20	113	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	10	197	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	8	214	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	35	5	241	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	25	80	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	23	96	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	20	121	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	10	212	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	8	231	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	35	5	261	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	23	9	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	20	22	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	10	67	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	8	76	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	25	5	89	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	23	14	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	20	37	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	10	116	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	8	133	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	25	5	159	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	23	15	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	20	38	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	10	122	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	8	139	0.035

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	25	5	166	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	23	16	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	20	41	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	10	132	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	8	151	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	25	5	181	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	20	13	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	10	58	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	8	67	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	23	5	80	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	20	23	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	10	102	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	8	119	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	23	5	145	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	20	24	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	10	107	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	8	125	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	23	5	152	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	20	25	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	10	116	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	8	135	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	23	5	165	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	20	10	44	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	20	8	53	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	20	5	66	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	20	10	79	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	20	8	96	0.029

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	20	5	122	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	20	10	83	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	20	8	101	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	20	5	128	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	20	10	91	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	20	8	110	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	20	5	140	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	10	8	9	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	10	5	22	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	10	8	17	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	10	5	43	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	10	8	18	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	10	5	45	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	10	8	19	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	10	5	49	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	0	8	5	13	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	4	8	5	26	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	6	8	5	27	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	19	19	8	5	30	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	35	197	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	25	270	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	23	283	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	20	306	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	10	386	0.081
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	8	403	0.087
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	35	5	429	0.093
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	35	210	0.035

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	25	285	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	23	300	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	20	324	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	10	407	0.081
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	8	425	0.087
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	35	5	452	0.093
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	35	452	0.093
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	25	236	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	23	317	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	20	332	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	10	357	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	8	448	0.087
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	35	5	467	0.093
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	25	226	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	23	240	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	20	262	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	10	342	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	8	359	0.076
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	25	5	385	0.081
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	25	241	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	23	256	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	20	280	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	10	363	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	8	381	0.076
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	25	5	408	0.081
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	25	273	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	23	288	0.052

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	20	314	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	10	404	0.076
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	8	424	0.081
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	25	5	453	0.087
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	23	231	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	20	254	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	10	333	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	8	350	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	23	5	376	0.076
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	23	247	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	20	271	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	10	354	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	8	372	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	23	5	399	0.076
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	23	279	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	20	305	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	10	396	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	8	415	0.076
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	23	5	444	0.081
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	20	240	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	10	320	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	8	336	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	20	5	363	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	20	258	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	10	341	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	8	359	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	20	5	386	0.070

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	20	291	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	10	382	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	8	401	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	20	5	431	0.076
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	10	10	275	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	10	8	292	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	10	5	318	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	10	10	296	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	10	8	314	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	10	5	341	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	10	10	338	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	10	8	357	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	10	5	387	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	8	8	283	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	4	8	5	309	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	8	8	305	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	6	8	5	332	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	8	8	348	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	0	19	8	5	378	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	35	13	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	25	89	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	23	103	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	20	127	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	10	210	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	8	228	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	35	5	255	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	35	39	0.006

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	25	120	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	23	135	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	20	161	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	10	251	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	8	271	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	35	5	300	0.070
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	25	16	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	23	31	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	20	54	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	10	137	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	8	155	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	25	5	182	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	25	47	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	23	62	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	20	88	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	10	179	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	8	198	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	25	5	228	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	23	17	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	20	40	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	10	124	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	8	141	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	23	5	168	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	23	49	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	20	74	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	10	165	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	8	184	0.041

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	23	5	214	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	20	17	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	10	101	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	8	119	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	20	5	146	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	20	51	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	10	142	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	8	161	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	20	5	191	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	10	10	21	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	10	8	39	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	10	5	66	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	10	10	63	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	10	8	82	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	10	5	111	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	8	8	22	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	6	8	5	49	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	8	8	65	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	4	19	8	5	95	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	35	26	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	25	106	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	23	122	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	20	147	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	10	238	0.052
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	8	257	0.058
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	35	5	287	0.064
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	25	31	0.006

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City	Duct location	HVAC System	Rvalue pre	Rvalue post	Leak pre	Leak post	kWh/ton	Summer kW/ton
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	23	47	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	20	72	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	10	163	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	8	182	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	25	5	212	0.046
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	23	32	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	20	57	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	10	148	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	8	167	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	23	5	197	0.041
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	20	34	0.000
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	10	125	0.023
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	8	144	0.029
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	20	5	173	0.035
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	10	10	41	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	10	8	61	0.012
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	10	5	90	0.017
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	8	8	43	0.006
Greenville	Uncon bsmt/ crawl space	Heat Pump	6	19	8	5	72	0.012

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Appendix E: Heath Check Diagnostic Report

DUKE ENERGY. | Smart $aver®

North Carolina Residential Smart $aver Incentive Application – Health Check

Customer Information *(All information must match the information on the electric utility bill.)*

Duke Energy Electric Account #: [redacted]
Customer Email: [redacted]
Duke Energy Customer Name (as listed on account): [redacted]
Home Owner/Landlord Name (if different from above): _____ (Payee)

☑ The customer has been notified that an incentive is dependant upon the successful completion of the Health Check including any required repairs.

Service Address
Address 1: [redacted]
Address 2: _____
City: Charlotte
State, Zip Code: NC 28211
Phone: [redacted]

Mailing Address ☑ *(Same as Service Address)*
Address 1: _____
Address 2: _____
City: _____
State, Zip Code: _____
Alternate Phone: (___) _____

Trade Ally Information

Company Name: Kirkland A/C & Heating, Inc.
Mailing Address 1: 3734 Monroe Road
Mailing Address 2: _____
City, State, Zip: Charlotte, NC 28205
Contact Person: Connie
Telephone: (704) 332-9276
Fax: (704) 376-0244
Email: service@kirklandac.com

Application Checklist

☑ Pre & Post Tests ☑ Invoice Copy ☑ Submit within 90 days of service ☑ Completed application

Send signed application and all required documents to:
Smart Saver Incentive Program, P.O. Box 525, Snellville, GA 30079
Or Fax: 1.866.728.8263 ***Or Email:*** incentives@dukeenergysmartsaver.com
Questions? Visit duke-energy.com/smartsaver or call 1-866-765-6209.

Terms and Conditions

I have read and hereby agree to the Program Requirements as stated on the Smart Saver Trade Ally Registration Form on file with Duke Energy. I hereby certify that the information contained on this application is true and accurate to the best of my knowledge.

[redacted] 5-15-14
Trade Ally Signature *Date*

**If repairs are required before the Health Check can be completed, the customer has the option to pay for these repairs or forfeit the Health Check incentive.*

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DUKE ENERGY. | Smart $aver®

North Carolina Residential Smart $aver Incentive Application – Health Check

Service Information:

☑ Air Conditioner ☐ Heat Pump ☐ Geothermal Heat Pump

Outdoor Unit Make: Trane
Indoor Unit Make: TXC037sKP
Outdoor Unit Model Number: 4TTX4036A1
Indoor Unit Model Number: 3244LX25G
Outdoor Unit Serial Number: 2512PKH2F
Size (tons): 3ton
Approx. System Age (years): 12
Date Serviced: 4-29-14
Service Technician Name: Willie Thornton
NATE/BPI Certification #: 7954958

Task	Description	Performed/Completed?
Initial System Measurements	Attach the Fieldpiece equipment to the system. Run the Pre-CheckMe!™ test and save the results in the HG3 analyzer.	☑
Check Suction Line Insulation	Inspect for proper suction line insulation, recommend insulation if necessary.	☑
Check Wiring for Physical Damage and Ensure Proper Electrical Connections	Safely inspect wiring and connections for signs of physical damage and extreme wear, repair if necessary. Safety repair(s) must be made in order to qualify for incentive. *Additional fees may apply	☑
Clean Condenser Coils	Inspect and rinse condenser coil, recommend chemical cleaning of condenser coils if necessary.	☑
Check Air Filters	Inspect air filters, recommend cleaning or replacement if necessary.	☑
Verify Thermostat Operation	Verify thermostat properly cycles, recommend replacement if necessary.	☑
Inspect Indoor Blower Wheel	Inspect blower wheel, recommend wash out and/or cleaning if accessible and necessary.	☑
Inspect Evaporator Coils	Inspect evaporator coils, recommend wash out and/or cleaning if necessary.	☑
Inspect Ductwork	Inspect ductwork for leakage or damage, make recommendations for improvements as necessary.	☑
Inspect and Clean Condensate Drain	Inspect condensate drain, recommend clean out if necessary.	☑
Final System Measurements	Run the CheckMe!™ post-test and save the results in the HG3 analyzer.	☑
Check Work Area and Customer Residence	Inspect and leave workspace neat and free of all service related debris and materials	☑
Recommendations Made		

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Pre-test

Jobsite: [redacted] Technician:

The Fieldpiece HVAC Guide was used to perform an analysis of your system.
The tests and results are reported below:

Customer ID:	[redacted]
Check Me! Analysis	
Date Performed:	2014/04/29
Time Performed:	23:07:21
INPUT FORM	
System Type:	AC
Grant:	DUKE
Indoor Model Number:	nC037s3hp
Furnace Model Number:	tjD100r9v5
Metering Device:	TXV/TEV
Indoor Voltage:	
Indoor Full Load Amperage:	A
Return Dry Bulb:	68.9 °F
Return Wet Bulb:	60.7 °F
Supply Dry Bulb:	51.7 °F
Supply Plenum Pressure:	IWC
Return Plenum Pressure:	IWC
Evaporator Fan Amperage:	A
Outdoor Model Number:	4ttx4036A1
Outdoor Year:	2002
Outdoor Serial Number:	2512pKH2F
Refrigerant:	R-410A(SH)
Outdoor Rated Amperage:	16.8 A
Outdoor Voltage:	240V 1 phase
Target Subcooling:	10 °F
Suction Line Pressure:	107.5 psig
Suction Line Temperature:	58.3 °F
Liquid Line Pressure:	225.7 psig
Liquid Line Temperature:	75.3 °F
Outdoor Dry Bulb:	58 °F
Condenser Amp Draw:	9.2 A

Phone Fax

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Pre-Test

Jobsite: [redacted] Technician:

The Fieldpiece HVAC Guide was used to perform an analysis of your system.
The tests and results are reported below:

Customer ID:	[redacted]
Check Mol Analysis	
Date Performed:	2014/04/29
Time Performed:	23:07:21
INPUT FORM(Continued)	
True Flow:	NO
Nominal Tonnage:	ton
Grid Size	
Flow Pressure:	IWC
Sup Plen Pressure With Grid:	IWC
Customer ID:	[redacted]
ID1:	
ID2:	
ID3:	

OUTPUT FORM

Probable OK Airflow.
Undercharged, add refrigerant until actual subcooling reaches target subcooling.
Actual subcooling is 2.0°F and target subcooling is 10.0°F.
Condenser airflow OK.
Outdoor amp draw OK.

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Post-test

Fieldpiece

Jobsite: [redacted] Technician:

The Fieldpiece HVAC Guide was used to perform an analysis of your system.
The tests and results are reported below.

Customer ID:	[redacted]
Check Me! Analysis	
Date Performed:	2014/04/29
Time Performed:	23:17:56
INPUT FORM	
System Type:	AC
Grant:	DUKE
Indoor Model Number:	nxC037s3hp
Furnace Model Number:	tuD100r5v5
Metering Device:	TXV/TEV
Indoor Voltage:	
Indoor Full Load Amperage:	A
Return Dry Bulb:	71.3 °F
Return Wet Bulb:	59.7 °F
Supply Dry Bulb:	53.6 °F
Supply Plenum Pressure:	IWC
Return Plenum Pressure:	IWC
Evaporator Fan Amperage:	A
Outdoor Model Number:	4ltx4036A1
Outdoor Year:	2002
Outdoor Serial Number:	2512pKH2F
Refrigerant:	R-410A(BH)
Outdoor Rated Amperage:	16.8 A
Outdoor Voltage:	240V 1 phase
Target Subcooling:	10 °F
Suction Line Pressure:	108.6 psig
Suction Line Temperature:	49.9 °F
Liquid Line Pressure:	250.5 psig
Liquid Line Temperature:	72 °F
Outdoor Dry Bulb:	60 °F
Condenser Amp Draw:	9.6 A

Phone Fax

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Fieldpiece

Jobsite: [redacted] Technician:

The Fieldpiece HVAC Guide was used to perform an analysis of your system.
The tests and results are reported below:

Customer ID:	[redacted]
Check Mel Analysis	
Date Performed:	2014/04/29
Time Performed:	23:17:56
INPUT FORM(Continued)	
True Flow:	NO
Nominal Tonnage:	ton
Grid Size	
Flow Pressure:	IWC
Sup Plen Pressure With Grid:	IWC
Customer ID:	[redacted]
ID1:	
ID2:	
ID3:	

OUTPUT FORM

Probable OK Airflow.
Charge OK
Condenser airflow OK.
Outdoor amp drew OK.

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KIRKLAND
Air Conditioning & Heating, Inc.

ENERGY SAVINGS AGREEMENT

3734 Monroe Road
Charlotte, NC 28205
Phone: 704-332-9276
Fax: 704-376-0244
www.kirklandac.com

K11685

Map #
Dispatched 1030 am/pm
Arrival Time 1040
Completed 1215

Date: 4/25/14

COOLING / HEATING

	GOOD CONDITION	NEEDS ATTENTION	NEEDS REPLACEMENT	PROBLEM CORRECTED
GENERAL				
1 Filters				
2 Ductwork				
3 Thermostat				
4 Blower Motor				
5 Electrical Supply				
6 Breaker				
HEATING (GAS)				
1 Burners				
2 Flue				
3 Safeties				
4 Temp. Rise				
5 Gas Pressure				
6 Heat Exchanger				
HEATING (HEAT PUMP)				
1 Temp. Rise A.H.				
2 Indoor Coil				
3 Air Flow C.F.M.				
4 Aux. Heat				
5 Refrigerant Charge				
6 Outdoor Fan Motor				
7 Compressor				
8 Outdoor Coil				
9 Defrost Function				
10 Electrical				
COOLING				
1 Outdoor Temp. Dry Bulb	61			
2 Indoor Temp. Dry Bulb	72			
3 Indoor Temp. Wet Bulb				
4 Refrig. Charge sh__ sc__			X	
5 Condenser Fan Motor				
6 Compressor				
7 Clean Condenser Coil				
8 Inspect Evaporator Coil				
9 Condensate Drains				
10 Electrical				

[redacted]

Customer's Signature

Service Technician's Signature

Name [redacted] LN
Bldg
City Charlotte State Zip
Home Phone # Job Location

Brand Trane Location Closet
Model Outdoor
Serial Outdoor
Model Indoor
Serial Indoor

NO.	COMMENTS OR REPAIRS RECOMMENDED	COST
	Date Energy Audit # [redacted]	
	Added refrigerant to correct subcooling	
	Date Energy Audit performed	
	Save Recommendation Letter	

RECOMMENDED ACTIONS

- Please schedule recommended repairs.
- I do not want recommended repairs at this time. Declined repairs voids warranty.
- Please call with cost estimate.
- Recommended repairs completed.

Reference Service Invoice No.
Additional Work Performed

WE ALSO OFFER: INSTALLATION • SALES • SERVICE

PREPAID

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Appendix F: Compressor Energy Savings Analysis

The fault detection diagnostics (FDD) data collected by the contractors were used to estimate changes in system efficiency as a result of the Health Check (HC) tune-up. FDD information collected by the technicians included:

- Suction (low side) temperature and pressure
- Liquid (high side) temperature and pressure
- Outdoor drybulb temperature
- Return air drybulb and wetbulb temperatures
- Supply air drybulb temperature
- Outdoor unit current (amps)
- Outdoor unit nominal voltage
- Refrigerant type (R-22 or R-410a)
- Expansion device type (fixed or thermal expansion valve (TXV))

The unit efficiency is defined as:

Efficiency = cooling delivered / input power

Changes in unit efficiency between the test-in and test-out conditions were calculated to estimate the impact of the charge adjustment on unit efficiency. A refrigerant-side analysis was used to estimate delivered cooling. The refrigerant enthalpy (in Btu/lb) entering and leaving the evaporator was estimated from the refrigerant temperature and pressure measurements. An on-line refrigerant property calculator from the Industrial Refrigeration Consortium (IRC) at the University of Wisconsin[13] was used to obtain refrigerant enthalpy at the temperature and pressure conditions recorded by the contractors. Gage pressure measurements were converted to absolute pressure (psia), and the recorded combinations of temperature and pressure in the dataset were entered into the IRC tool to obtain refrigerant enthalpy. Enthalpy lookups were done separately for R-22 and R-410a systems according to the refrigerant type recorded in the vendor FDD report.

The tool returned the refrigerant enthalpy along with a description of the "state" of the refrigerant – e.g. subcooled liquid, superheated vapor, and so on. Low side measurements expected to see refrigerant in the gaseous state, while high side measurements expected to see refrigerant in the liquid state. In some instances, the recorded temperature and pressure combinations returned "state" descriptions inconsistent with expectations. Data entry errors on the part of the contractor are likely the cause of the unexpected results. In some cases, high and low side pressures recorded by the contractors were in line with expectations for an R-22 system, but the refrigerant type was identified as R-410a, indicating a possible refrigerant type data entry error. Units with suspected data entry errors were omitted from the analysis.

[13] See www.irc.wisc.edu

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Note, the high side measurements were taken on the high pressure liquid line upstream of the expansion device. The evaporator entering enthalpy was estimated from the liquid side temperature and pressure assuming an isentropic (constant enthalpy) expansion process across the expansion device. The evaporator leaving enthalpy was calculated from the low side temperature and pressure measurements. Since the measurements were made at the service ports on the condensing (outdoor) unit, any heat gains in the liquid and suction lines between the evaporator (indoor) coil and the condensing unit are included in the delivered cooling calculation. Differences in these heat gains between the test-in and test-out conditions are assumed to be negligible.

Refrigerant mass flow rate (lb/hr) was estimated using a typical compressor curve and the compressor entering and leaving pressures. A 3-ton Copeland scroll compressor was used as a typical compressor based on the vintage of the units in the program. The objective of the compressor analysis was to estimate the incremental change in mass flow rate resulting from the change in pressure difference, so matching the exact compressor to the unit was not necessary.

Data from Copeland were downloaded according to the AHRI[14] standard compressor equations:

$$X = C1 + C2 \cdot (S) + C3 \cdot D + C4 \cdot (S^2) + C5 \cdot (S \cdot D) + C6 \cdot (D^2) + C7 \cdot (S^3) + C8 \cdot (D \cdot S^2) + C9 \cdot (S \cdot D^2) + C10 \cdot (D^3)$$

Where:

C = equation coefficient
S = saturated suction temperature
D = saturated discharge temperature
X = mass flow rate

Coefficient	Refrigerant	
	R-22	R-410a
c1	2.6562E+02	1.5465E+02
c2	5.4624E+00	7.3232E+00
c3	-1.2004E+00	1.6093E+00
c4	3.9459E-02	5.9968E-02
c5	-9.2919E-04	-5.6041E-02
c6	1.1024E-02	-5.1463E-03
c7	8.9638E-05	2.3456E-04
c8	5.6828E-05	-2.6136E-04
c9	-2.8049E-05	3.6651E-04
c10	-4.1261E-05	-4.5716E-05

Compressor outlet pressure was assumed to be 15 psig higher than the liquid line pressure, to account for condenser and liquid line pressure drop.

[14] Standard compressor rating methodology is described in ANSI/AHRI Standard 540.

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Gage pressure measurements were converted to absolute pressure, and the corresponding saturation temperature was estimated from curve fits to saturation temperature vs pressure data for R-22 and R-410a, as shown in Figure 4 through Figure 7.

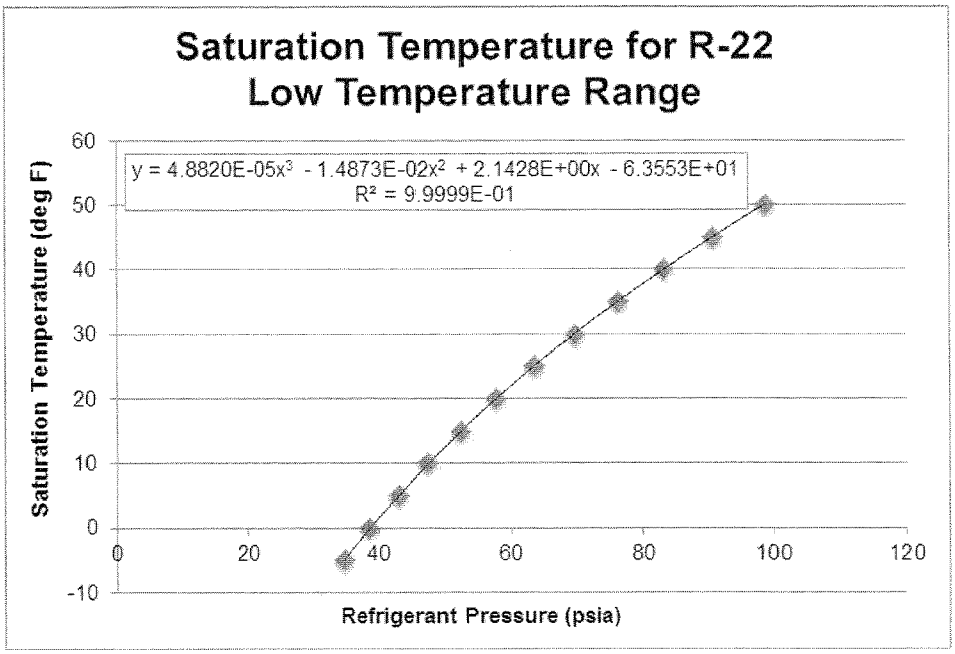

Figure 4. Saturation Temperature for R-22 Low Temperature Range

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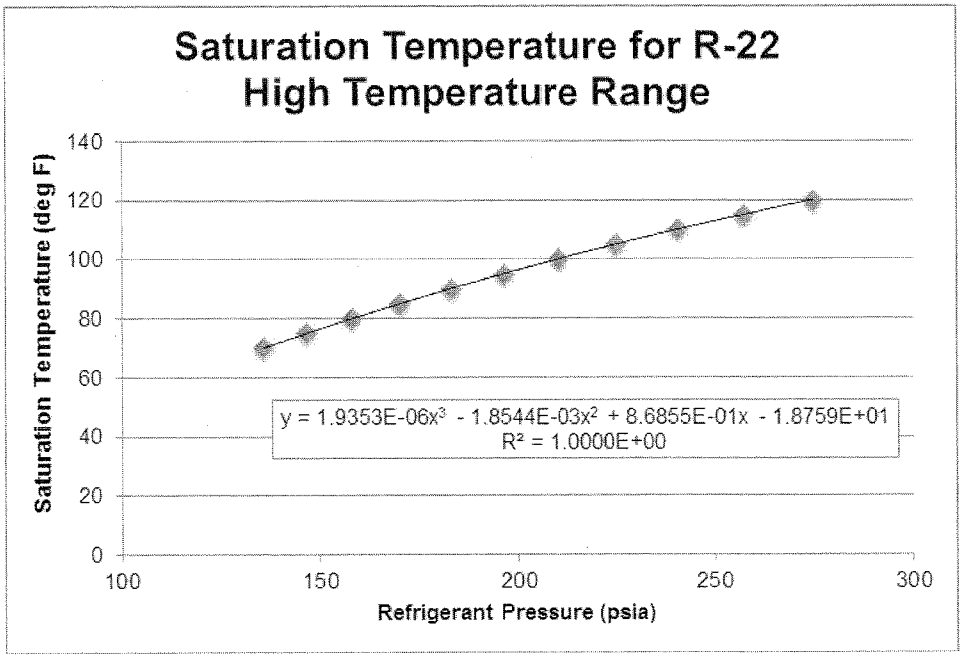

Figure 5. Saturation Temperature for R-22 High Temperature Range

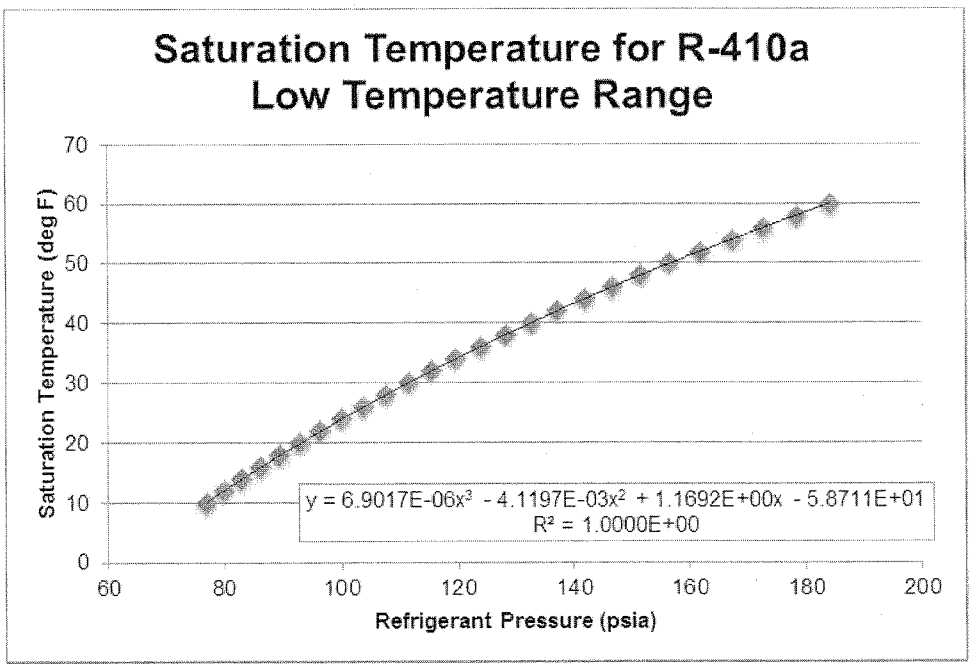

Figure 6. Saturation Temperature for R-410a Low Temperature Range

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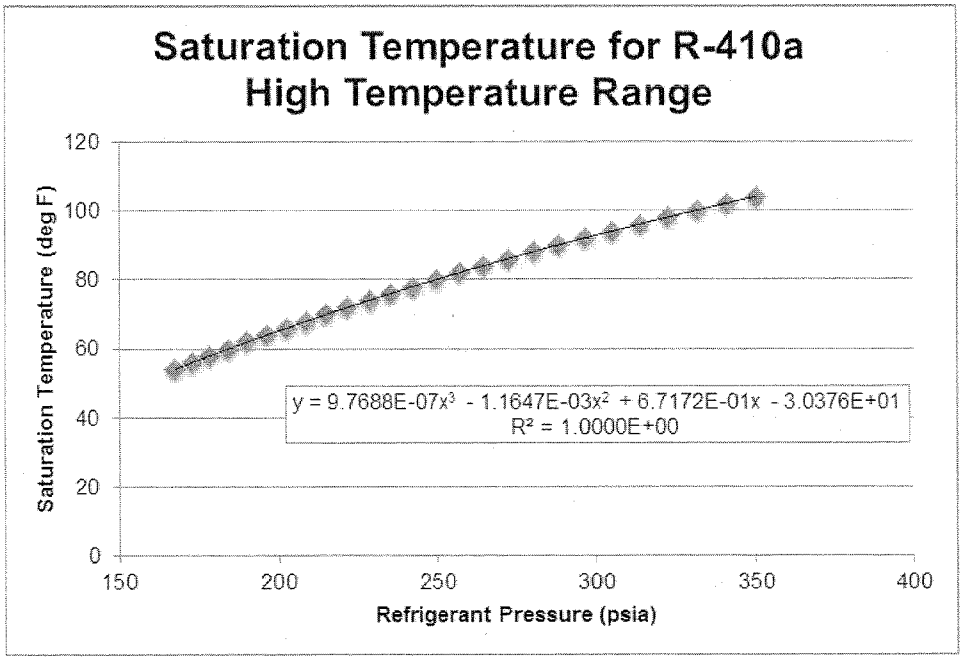

Figure 7. Saturation Temperature for R-410a High Temperature Range

Input power was estimated from the outdoor unit current and nominal voltage. A constant power factor assumption of 0.9 was used to calculate compressor input power from compressor amps.

A distribution of the results is shown in Figure 8.

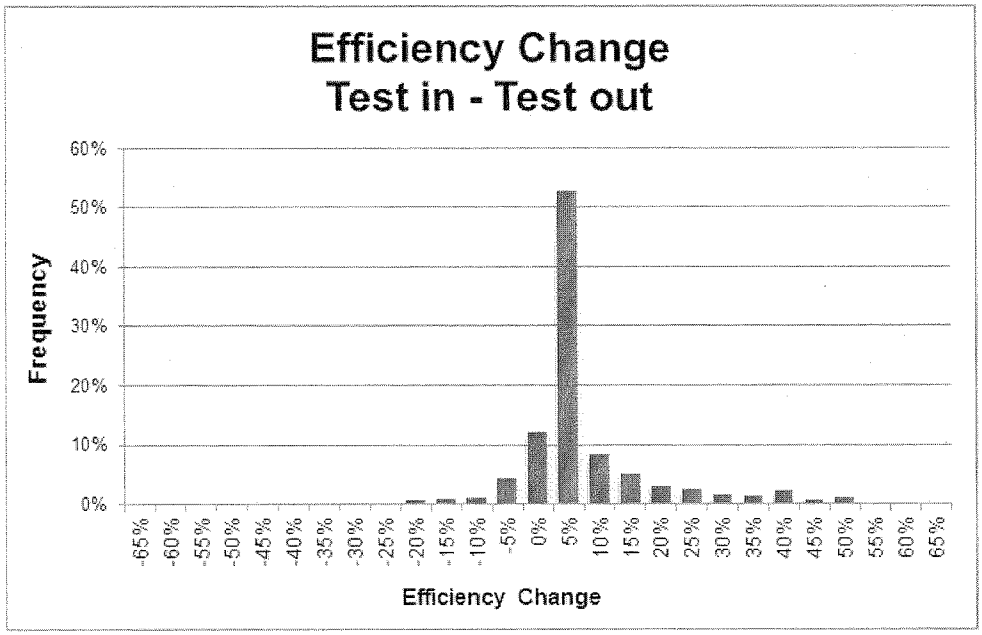

Figure 8. Efficiency Change, Test-In – Test-Out

The results of the efficiency improvement analysis are shown in Table 52.

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Table 52. Efficiency Improvement Analysis Results

Parameter	Number of Observations	Average Change	Relative Precision	Confidence Interval
Compressor efficiency	149	4.1%	+/- 56%	1.7% - 6.5%

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Appendix G: DSMore Table

Impacts ⇨ / Technology ⇩	Product code	State	EM&V gross savings (kWh/unit)	EM&V gross kW (coincident peak/unit)	EM&V gross kW (non-coincident peak/unit)	Unit of measure	Combined spillover less freeridership adjustment	EM&V net savings (kWh/unit)	EM&V net kW (coincident peak/unit)	EM&V net kW (non-coincident peak/unit)	EM&V load shape (yes/no)	EUL (whole number)
Attic insulation and air leakage sealing		Carolinas	1,163	N/A	0.202	home	9.6%	1,051	N/A	0.183	no	20
Duct sealing		Carolinas	255	N/A	0.066	home	9.6%	231	N/A	0.060	no	18
Duct insulation		Carolinas	519	N/A	0.094	home	9.6%	469	N/A	0.085	no	20
AC tune-up		Carolinas	70	N/A	0.087	HVAC system	9.6%	63	N/A	0.079	no	10
Heat Pump tune-up		Carolinas	237	N/A	0.087	HVAC system	9.6%	214	N/A	0.079	no	10
Program wide												

I/A

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Final Report

Process Evaluation of the 2013 Power Manager Program in the Carolina System

Prepared for
Duke Energy
139 East Fourth Street
Cincinnati, OH 45201

March 18, 2014

Submitted by

Nick Hall, Dave Ladd,
and Johna Roth

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Subcontractor:
Carol Yin
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Executive Summary

Significant Findings from Management Interviews

Over the last year this program has faced some technical challenges, however the Duke Energy program managers have found innovative solutions to address these challenges (see *Management Interview Findings* section of this report). Program operations are well-understood by the program implementation team. This team constantly seeks ways to better understand and address their customers' concerns. In light of the ongoing switch replacement efforts, the evaluation team suggests that the next full process evaluation not be conducted until after the switch replacements have been completed in the Carolina System. However, there is still value in conducting event surveys (as described in *Event and Non-Event Surveys* on page 12) with participants in 2014.

> RECOMMENDATION: Duke Energy should consider conducting continued participant event surveys to monitor the customer's experience. This will provide Duke Energy with timely data on the program's capacity to meet the aggressive switch replacement schedule while simultaneously maintaining the high satisfaction they have achieved with existing participants and meeting the need to install new switches for new participants.

Significant Findings from Participant Surveys

- The participant survey summarized in this section is conducted after the cooling season, and is designed to cover program-level topics such as awareness, enrollment and household demographics that are not related to specific Power Manager activation events. The event survey (summarized in the next section) is conducted during the cooling season and is designed to provide accurate data on event-related behavior by interviewing participants within 27 hours of activation events (and comparable high-temperature days without events).
- Most participants surveyed (81%) were personally involved in the decision to join the Power Manager program; however 10% had joined Power Manager after they moved into a home where the device had been installed by a previous occupant.
- Most participants who could recall how they first became aware of the program found out about it through mailings from Duke Energy (49%). However 37% of participants cannot recall how they first learned about the program.
- The primary benefits which participants recall from program promotions are saving money (58%), reducing power outages (31%) and saving energy (11%).
- The main reasons participants cited for joining the program are for the bill credits (29%), saving money through lower bills (15%), saving energy (13%) and avoiding power outages (10%). Overall, 56% of participants recalled reading about their main reason for joining the program in the program brochure.
- Most participants (70%) do not know how many Power Manager activation events to expect per year. Among those who were able to answer the question, most said it was activated "as needed based on demand".
- Nearly half of Carolina System participants (44%) do not know how much they should expect to receive in bill credits for participating in the program. Among those that were able to answer the question, the average estimated amount of bill credits was $35 per year

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and the median estimate was $32 (in fact, the usual bill credits paid to participants in the Carolina System would be $8 per month times four months of cooling, or $32). Although 60% recall receiving a bill credit for the program this year, 28% said they don't know if they have received bill credits, and 13% are sure they have not received bill credits (in fact, all participants received credits on their bills).

- Fifty-eight percent of participants surveyed are aware that their device had been activated since they joined the program. When asked to estimate the number of activation events which occurred in 2013, 73% did not know. Among those who were able to answer the question, the average estimated number of events was 3.6 and the median was 2.5. The actual number of Power Manager activation events during 2013 was eight for North Carolina and six for South Carolina (including the July 17 full shed test event for both states).
- There is typically someone at home on a weekday afternoon in 70% of households surveyed, although only 30% recalled being at home during a Power Manager event in 2013. Among those who recalled being at home, 42% reported a decline in comfort ratings during the event. Overall mean comfort ratings among those who recalled being at home during an event were 9.35 before the event and 7.22 during the event (on a 10-point scale where 10 is most comfortable). Ninety percent of participants who reported a decline in comfort blamed rising outdoor temperatures, while only 40% blamed the Power Manager device activation for their discomfort. Four participants (5%) reported that they had power outage issues on a day when they believed Power Manager had been activated, though only one blamed power outages for their decline in comfort during an event.
- Among those who recalled being at home during at least one activation event in 2013, the average estimate for the number of times during the year Power Manager activations made them uncomfortable was 1.2 times, and the median estimate was one time.
- Most participants use fans to keep cool during events (53% of those at home during an event), while 21% of those at home during an event reported adjusted their thermostats (turning it down by an average of 2.6 degrees among those who made adjustments). All other actions in response to events were taken by fewer than 10% of participants.
- In spite of the results above, only 13% of participants say that there is anything unclear to them about the program, and only 3% have contacted Duke to find more out about the program.
- When asked why Power Manager activation events happen when they do, 66% said it was due to peak demand for energy, 25% said it was during the hottest part of the day, and 24% said it was because there are fewer people at home.
- Sixty-four percent of Carolina System participants surveyed use their air conditioning every day during the cooling season; 76% are using their air conditioners (AC) before 5 p.m. on a typical weekday, and 98% typically use their AC after 5 p.m. Most participants (73%) have had their AC units serviced since joining program.
- Ninety-three percent of participants said environmental issues (in general) were "important" or "very important" to them. Among three specific environmental issues that were asked about, the most important to respondents was reducing air pollution ("important" or "very important" to 94%), with still positive but more mixed ratings for the importance of climate change issues (74%) and building fewer power plants (60%).

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- When asked about their awareness of other Duke Energy programs, 76% of participants could name at least one other Duke Energy program. The programs with the highest awareness are the CFL programs (53%) and the Home Energy House Call program (15%).
- Most Power Manager program participants (65%) would be interested in a similar program that would cycle water heaters or other equipment. Among those who were not interested, the most frequently cited reason was that their water heaters are not powered by electricity (60% of those who are not interested).
- Participants give high satisfaction ratings for Power Manager: on a 10-point scale where 10 is most satisfied, satisfaction with the process of enrolling in the program is 9.7 (among participants involved in enrollment), and overall satisfaction with the Power Manager program is 9.2. When asked to rate their likelihood of recommending Power Manager to others, the mean rating was 8.9. Overall satisfaction with Duke Energy is also high at 8.7.

Significant Findings from Event Surveys

- The event survey is conducted during the cooling season, on and immediately after days when the Power Manager device is activated, and on and after high-temperature days on which Power Manager was not activated. The event survey is designed to provide accurate data on event-related behavior by interviewing participants within 27 hours of the event (or high-temperature non-event). Furthermore, the first activation event in the Carolinas System in 2013 (on July 17 in both states) was a two hour test event in which cooling systems were cycled in the first hour and a "full shed" conducted in the second hour, while all other activations were "regular" cycling events. The participant surveys (summarized in the previous section) are conducted after the end of the cooling season and are designed to cover program-level topics such as awareness, enrollment and household demographics.
- Only 45% of Regular Event participants, 69% of the Full Shed test event participants and 53% of Non-Event participants surveyed are aware that Power Manager has been activated since they joined the program. The most frequently cited reasons for being aware of Power Manager activation events were "home temperature rises" followed by "air conditioner shuts down".
- Forty-six percent of Regular Event participants, 77% of Full Shed Event participants and 67% of Non-Event participants were at home during the Power Manager activation event or non-event high temperature day which triggered the Event or Non-Event survey.
- Among participants who were home during a Power Manager activation event, only 13% (9 of 67) of Regular Event participants and 20% (2 of 10) of Full Shed participants were aware that the activation had occurred. Among Non-Event participants who were at home on a high-temperature day when devices were not activated, none (0% of 24) believed that their Power Manager device had been activated. Both groups of Event participants are more likely to be aware of activations than Non-Event participants for whom there really was no activation event ($p<.05$ using Student's t-test), but at least half of all three respondent groups said they "don't know" if there was an activation or not.
- Among participants who were at home and were able to give comfort ratings for "before" and "during" the event or non-event high temperature day, 31% (19 out of 61) of those in

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the Regular Event group reported a decline in comfort ratings, compared to 88% (7 out of 8) of Full Shed Event participants and only 9% (2 out of 23) of those in the Non-Event group (all differences between groups are significant at $p<.05$ using Student's t-test).

- The amount of the decline in comfort ratings was also larger during activation events: On a 10-point scale, the Regular Event participants' mean comfort fell by 0.5 points overall during the activation event, versus an average decline of 2.4 points for the Full Shed Event group and 0.2 points in the Non-Event group (the amount of decline is significant at $p<.05$ using Student's t-test for both Event groups, but is not significant for the Non-Event group). Among only those participants who reported a decline in comfort, the average decline was 2.5 points for the Regular Event group (19 Event participants reported a decline in comfort), 2.7 points for the Full Shed Event group (seven Full Shed participants reported a decline in comfort) and 3.0 points for Non-Event participants (though only two Non-Event participants reported a decline in comfort).
- When asked to describe the cause of their decrease in comfort on the day of the activation event or non-event high temperature day, 86% of Regular Event participants and 90% of Full Shed Event participants blamed "rising temperatures", while only 5% of Regular Event participants and none of the Full Shed Event participants blamed a Power Manager device activation. Among Non-Event participants noticing a decrease in comfort (for whom there was no device activation), none blamed Power Manager.
- The age of the participants' air conditioner unit has an effect on decreasing comfort, but not as much effect as the presence of a Power Manager activation event, particularly a full shed event. When controlling for events and the age of the air conditioning unit, the outdoor high temperature had no significant effect on discomfort during activation events in the Carolinas System during the 2013 cooling season.
- During the activation event or non-event high temperature day, 10% of Regular Event participants adjusted their thermostat settings, compared to none of the Full Shed Event and Non-Event participants. Overall, 38% of participants turned on fans, which was the most common action taken.
- Satisfaction with this program is high: Mean satisfaction ratings on a 10-point scale (where 10 is "most satisfied") are 9.0 among Regular Event participants, 8.8 among Full Shed Event participants and 9.1 among Non-Event participants. Using the same scale, participants were also willing to recommend the program with mean scores of 8.6 for Regular Events, 9.2 for Full Shed Events and 8.4 for Non-Events. Satisfaction with Duke Energy overall was similarly high, with mean scores of 8.9 for Regular Events, 8.8 for Full Shed Events and 8.1 for Non-Events.
- Satisfaction ratings are not significantly different for Event participants based on the time of day the activation event concluded (all activation events in the Carolina System ended at either 4:00 p.m., 5:00 p.m. or 5:30 p.m. local time). Differences in comfort ratings by the ending time of the event are highly correlated to outdoor temperatures.

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Introduction and Purpose of Study

The purpose of this process study was to evaluate participant behavior, awareness of, and satisfaction with Duke Energy's Power Manager® Program as it was administered in the Carolina System.

Summary of the Evaluation

The evaluation was conducted by TecMarket Works and Yinsight, Inc. The interview and survey instruments were developed by TecMarket Works and Yinsight. The customer survey was administered and analyzed by TecMarket Works. Yinsight conducted in-depth interviews with program managers and trade allies.

Researchable Issues

1. Determine what percentage of program participants are aware of the occurrence of individual program events.
    - Only 6.8% (10 out of 146) of participants in the Regular Event group correctly reported that there had been a Power Manager event within the last week, while 15.4% (2 out of 13) of participants in the Full Shed Event group and only 2.8% (1 out of 36) of the participants in the Non-Event group believed there had been a Power Manager event (though there was no activation event for this group). The difference between Full Shed Event and Non-Event participants is significant at $p<.10$ using Student's t-test, though the Regular Event group does not differ significantly from either of the other groups. See *Summary of Event Awareness, Declines in Comfort and Blaming Power Manager* on page 82.

2. Determine whether customer comfort or discomfort during a Power Manager event is affecting participant behavior.
    - 13.0% (19 out of 146) of participants in the Regular Event group reported a decline in comfort during the Power Manager event, compared to 53.8% (7 out of 13) of participants in the Full Shed Event group, while only 5.6% (2 out of 36) of Non-Event participants reported a decline in comfort on a high-temperature non-event day (the differences between Full Shed Events and the other two groups are statistically significant at $p<.05$ using Student's t-test; this difference between Regular Events and Non-Events is not significant). During activation events, 47.8% (32 out of 67) Regular Event participants who were at home took no action in response, and another 23.9% (16 out of 67) either could not recall if they took any actions or refused to answer the question. Among Full Shed Event participants, 60.0% (6 out of 10) continued normal activities while none (0% of 10) could not recall. Only 10.4% (7 out of 67) of Regular Event participants at home during the activation event turned down the temperature on their air conditioning by an average of 1.6 degrees apiece, while none of the Full Shed Event participants adjusted their thermostats. See *Behaviors During Event Activation* on page 83.

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3. Determine overall participant satisfaction with the Power Manager program.
    - In the full participant survey, respondents' mean overall satisfaction rating for Power Manager is 9.24 on a 10-point scale where "10" means very satisfied. In the Event survey, Regular Event respondents' mean satisfaction rating is 9.03, while the mean satisfaction rating for Full Shed Event respondents is 8.77 and the mean satisfaction rating for Non-Event respondents is 9.09 (these differences are not statistically significant). See *Program Satisfaction* on page 45 for participant surveys and *Respondent Satisfaction and Willingness to Recommend the Program* on page 91 for Event and Non-Event surveys.

4. Determine whether recommendations could be made to improve the program's design or operations.
    - See *Summary* on page 23.

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Description of Program

Duke Energy offers the Power Manager (PM) voluntary residential demand response program to their customers who are homeowners with central air conditioning units with outside compressors that can be controlled by Duke Energy's load control technology. In return for participation, customers receive $32 each year, disbursed in $8 monthly bill credits from July through October. Customers are told that Power Manager events will not be called on nights, weekends, or holidays (except in a system emergency).

There are two types of events that may be implemented for PM, economic and emergency. Economic events may be called when energy demand and/or prices are high. For such an event, Duke Energy has permission from Power Manager participants to cycle their air conditioning off and on for a period of time. The target load reduction in the Carolina System is 1.3kW per device.

Emergency events can be called at any time Duke Energy has capacity problems, including generation, transmission or distribution system. Customers who participate in Power Manager are able to help Duke Energy prevent blackouts, by allowing their central air conditioning (AC) units to be turned off for the duration of the Power Manager emergency event. These events can be implemented by Duke Energy's system operations center (SOC) when emergency conditions warrant.

Operating Reserves

A recent change to Power Manager gives Duke Energy's System Operating Center (SOC) the ability to initiate an economic cycling event without having to go through Demand Side Management DSM Analytics. This allows them to use Power Manager to provide an operating reserve to meet FERC requirements. In the past, Duke Energy has provided the operating reserve through generation assets, but is now able to supplement that with the load shedding potential of Power Manager. The program manager reports that this capability was added at the beginning of the summer of 2013.

The program manager reports that this is a best practice learned from Progress Energy. This creates no changes in customers' program experience. To customers, it is just another Power Manager event.

Program History

The Power Manager program in the Carolina System began prior to Duke Energy's merger with Cinergy. Prior to the merger, this demand response program was a full-shed emergency-only program called Load Control. Beginning in 2009, Duke Energy converted the Load Control program to the Power Manager program that now includes economic events.

The vast majority of the switches that control the air conditioners in the Power Manager program were carry-overs from the Load Control program. A high percentage of these switches were no longer operating as they should. In addition, some of these legacy switches were available only for use in full shed in emergency events. As a result Duke Energy is the midst of a multi-year program to replace these older switches.

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When Power Manager was introduced in 2009, customers were still required to pay a $35 fee to pay for the switch installation, a legacy of the Load Control program. Duke Energy found that the fee posed a significant barrier to acquiring new participants, and began the process to obtain regulatory approval to remove the fee. Regulatory approval for the termination of this fee was received in 2012.

Faced with the combined need to upgrade switches and to remove the installation fee, in 2011 Duke Energy decided to focus program efforts on replacing switches, and not on initiating any wide-reaching marketing campaigns. Any new enrollments during this time would have diverted field technician resources away from the switch replacement project. Duke Energy's contract partner for Power Manager field work has added employees to meet the increased need. Toward the end of the switch replacement project, marketing efforts will increase.

Program Status

The program manager reports that at the end of September 2013, Power Manager has approximately 157,500 customers participating in the Carolina System, with over 183,000 air conditioning switches on call. Under a full shed, this would provide over 326 MW of capacity for the Carolina System.

Since the last program evaluation in 2011, Duke Energy has received regulatory approval to remove the $35 enrollment fee from the Power Manager program, and has begun using a new channel, outbound calling, to conduct marketing and outreach for the program.

Program Participation

Power Manager Program	Participation Count for 2013
Customers	EOM Sept. 2013 =157,538
Devices	EOM Sept. 2013 =183,402

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Methodology

Methodology

Overview of the Evaluation Approach

Management Interviews
In depth interviews were conducted with the Duke Energy program manager, three Duke Energy program staff members conducting the marketing efforts, two representatives from Eaton (formerly Cooper), and two representatives from GoodCents. These interviews were conducted in September and October of 2013, using interview guides developed by the evaluation team (see *Appendix A: Management Interview Instrument*). These management interviews were conducted by Yinsight, a subcontractor to TecMarket Works.

Full Participant Surveys
TecMarket Works developed a customer survey for the Power Manager Program participants, which was implemented in October and November of 2013 after they experienced control events over the summer of 2013.

The complete survey was conducted with a random sample of 80 Power Manager participants in the Carolina System (58 from North Carolina and 22 from South Carolina). The responses from the 80 surveyed participants are included in the analysis for all questions which they were able to complete. These participants were surveyed by TecMarket Works. The survey can be found in *Appendix B: Participant Survey Instrument.*

Event and Non-Event Surveys
TecMarket Works conducted after-event phone surveys (event surveys) to collect participant information for this evaluation. The survey was maintained in a "ready-to-launch" status until notified of a control event affecting switches used by Duke Energy. The surveys were launched as soon as possible following the end of the control event (at 5 p.m. Eastern) and continued over a 27 hour period with all call attempts made during regular surveying hours (10:00 a.m. to 8:00 p.m. Eastern Daylight Time, Monday through Saturday). For example, if a control event occurred on a Monday, calling hours for that particular event were:

- Monday 5 p.m.-8 p.m. Eastern
- Tuesday 10 a.m.-8 p.m. Eastern

Event surveys followed the Full Shed Event which occurred in both states on July 17 and Regular Events occurring on July 18, July 19, July 24, August 12, August 29, September 10 and September 11, 2013. TecMarket Works surveyed a total of 159 participants in the Carolina System (146 following Regular Events and 13 following Full Shed Events). The survey can be found in *Appendix C: Event Survey Instrument* (the same survey is used for both Full Shed and Regular Events).

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Before we asked the participants about the event, we inquired if they knew that there was a control event within the last 7 days so that we could understand if they are able to identify when a control event had occurred. The surveyor then notified the customer that they had just had a control event which had begun at *<start hour of control>* and ended at *<end hour of control>*. This allowed the participants to immediately recall the time period of the event and be able to respond to questions regarding the impact of that event on their use of their air conditioner and allow recollection of other actions taken, as well as the impact of the event on their comfort. Once informed of the event that had just occurred, the survey also assessed satisfaction with the program at the point of an event.

TecMarket Works also called Power Manager participants on hot days without control events to conduct the same survey (with slight wording alterations indicated in red text, as shown in *Appendix D: Non-Event Survey Instrument*). This survey was conducted on a non-event day when the outdoor high temperature was over 90°F. On and following the high temperature date of June 28, TecMarket Works surveyed at total of 36 Power Manager participants.

The schedule of Power Manager event days and non-event high temperature days used for this survey in North and South Carolina is shown in Table 1, along with the high temperatures and heat indexes for those dates.[1]

[1] High temperatures in Table 1 are taken from historical data for Charlotte (North Carolina) and Greenville (South Carolina) at wunderground.com. Heat index readings for survey days were recorded from Weather.com for the same cities on the days surveyed.

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Table 1. Schedule of Full Shed and Regular Events and Non-Event High Temperature Days in the Carolina System

Event ID	State	Type	Event Date	Event Hours	Date of Survey	High temp	Heat Index
NC-nonevent1	NC	Non	28-Jun-13	NA	28-Jun-13	91	98
NC-nonevent1	NC	Non	28-Jun-13	NA	29-Jun-13		
SC-nonevent1	SC	Non	28-Jun-13	NA	28-Jun-13	94	98
SC-nonevent1	SC	Non	28-Jun-13	NA	29-Jun-13		
NC-event1	NC	Full Shed Event	17-Jul-13	2:00 to 4 p.m.	17-Jul-13	90	99
NC-event1	NC	Full Shed Event	17-Jul-13	2:00 to 4 p.m.	18-Jul-13		
SC-event1	SC	Full Shed Event	17-Jul-13	2:00 to 4 p.m.	17-Jul-13	92	99
SC-event1	SC	Full Shed Event	17-Jul-13	2:00 to 4 p.m.	18-Jul-13		
NC-event2	NC	Regular Event	18-Jul-13	2:30 to 5 p.m.	18-Jul-13	89	96
NC-event2	NC	Regular Event	18-Jul-13	2:30 to 5 p.m.	19-Jul-13		
NC-event3	NC	Regular Event	19-Jul-13	1:30 to 4 p.m.	19-Jul-13	90	96
NC-event3	NC	Regular Event	19-Jul-13	1:30 to 4 p.m.	20-Jul-13		
NC-event4	NC	Regular Event	24-Jul-13	1:30 to 4 p.m.	24-Jul-13	92	96
NC-event4	NC	Regular Event	24-Jul-13	1:30 to 4 p.m.	25-Jul-13		
SC-event2	SC	Regular Event	24-Jul-13	1:30 to 4 p.m.	24-Jul-13	88	91
SC-event2	SC	Regular Event	24-Jul-13	1:30 to 4 p.m.	25-Jul-13		
NC-event5	NC	Regular Event	12-Aug-13	1:30 to 4 p.m.	12-Aug-13	92	98
NC-event5	NC	Regular Event	12-Aug-13	1:30 to 4 p.m.	13-Aug-13		
SC-event3	SC	Regular Event	12-Aug-13	1:30 to 4 p.m.	12-Aug-13	91	98
SC-event3	SC	Regular Event	12-Aug-13	1:30 to 4 p.m.	13-Aug-13		
NC-event6	NC	Regular Event	29-Aug-13	1:30 to 4 p.m.	29-Aug-13	93	99
NC-event6	NC	Regular Event	29-Aug-13	1:30 to 4 p.m.	30-Aug-13		
SC-event4	SC	Regular Event	29-Aug-13	1:30 to 4 p.m.	29-Aug-13	93	100
SC-event4	SC	Regular Event	29-Aug-13	1:30 to 4 p.m.	30-Aug-13		
NC-event7	NC	Regular Event	10-Sep-13	2:30 to 5 p.m.	10-Sep-13	90	93
SC-event5	SC	Regular Event	10-Sep-13	2:30 to 5 p.m.	10-Sep-13	87	89
SC-event5	SC	Regular Event	10-Sep-13	2:30 to 5 p.m.	11-Sep-13		
NC-event8	NC	Regular Event	11-Sep-13	2:30 to 5:30 p.m.	12-Sep-13	90	90
SC-event6	SC	Regular Event	11-Sep-13	2:30 to 5:30 p.m.	11-Sep-13	88	90

Data Collection Methods, Sample Sizes, and Sampling Methodology

Management Interviews

In depth interviews were conducted by phone with the Duke Energy program manager, three Duke Energy program staff members conducting the marketing efforts, two representatives from

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Eaton (formerly Cooper), and two representatives from GoodCents. This includes all intended interviews.

Full Participant Surveys

From the list of customers, 515 participants (398 in North Carolina and 117 in South Carolina) were called between October 30 and November 9, 2013, and a total of 80 usable telephone surveys (58 from North Carolina and 22 from South Carolina) were completed yielding a response rate of 15.5% (80 out of 515).

Participant Event and Non-Event Surveys

From the list of customers, 1,063 participants (538 in North Carolina and 525 in South Carolina) were called after events and non-event high temperature days between June 28 and September 12, 2013, and a total of 195 usable telephone surveys were completed (91 in North Carolina and 104 in South Carolina) yielding an overall response rate of 18.3% (195 out of 1063). Of the 195 completed surveys, thirteen (eight in North Carolina and five in South Carolina) were conducted following the full shed event on July 17, 146 Regular Event surveys (72 in North Carolina and 74 in South Carolina) were conducted following regular events, and 36 Non-Event surveys (eleven in North Carolina and 25 in South Carolina) were completed after high-temperature days when there was no activation event.[2]

Expected and achieved precision

Full Participant Surveys

The survey sample methodology for the full participant survey had an expected precision of 90% +/- 9.2% and an achieved precision of 90% +/- 9.2%.

Participant Event Surveys

The survey sample methodology had an expected precision for all surveys of 90% +/- 6.5% and an overall achieved precision of 90% +/- 6.5%. The achieved precision for regular events (N=146) is 90% +/- 6.8%, and the achieved precision for only the full shed event (N=13) is 90% +/- 22.8%.

Participant Non-Event Surveys

The survey sample methodology had an expected precision of 90% +/- 6.5% and an achieved precision of 90% +/- 13.7%.

[2] Due to the sampling design of this survey, reporting the number of calls and response rate separately for different Event groups would not be accurate. Event and Non-Event survey calls are made using the same participant list, and in some cases calls to the same participants may be attempted for both Event and Non-Event surveys. The only difference between Event and Non-Event participants is whether they are surveyed after an activation event or a high-temperature day without an activation event (and the only difference between Full Shed and Regular Event participants is the type of activation event that occurred before the survey).

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Number of completes and sample disposition for each data collection effort

Management Interviews

In depth interviews were conducted by phone with the Duke Energy program manager, three Duke Energy program staff members conducting the marketing efforts, two representatives from Eaton (formerly Cooper), and two representatives from GoodCents. This includes all intended interviews.

Full Participant Surveys

The Full Participant survey was conducted using a random sample from 75,621 Power Manager participants in the Carolina System (58,236 in North Carolina and 17,385 in South Carolina). There were 80 customers willing to participate in the survey.

Participant Event Surveys

The Event surveys were conducted on and following Power Manager device activation events that occurred between July 17 and September 11, 2013. TecMarket Works surveyed a total of 159 Power Manager participants.

Participant Non-Event Surveys

The Non-Event surveys were conducted on and following the high temperature date of June 28, 2013. TecMarket Works surveyed a total of 36 Power Manager participants.

Threats to validity, sources of bias and how those were addressed

There is a potential for social desirability bias[3] but the customer has no vested interest in their reported program participation, so, this bias is expected to be minimal.

Snapback and Persistence

The theoretical additional energy and capacity used by customers that may occur from implementing an energy efficiency product is often called "snapback." There is little to no literature or snapback analysis within the evaluation industry that has been able to identify a snapback condition.

In this process evaluation, survey participants were asked if they had adjusted the thermostat on their air conditioners during an event or non-event cycle. Seven Event participants and none of the Non-Event participants reported setting a lower thermostat temperature during the cycle. (See *Thermostat Adjustments* on page 83.)

[3] Social desirability bias occurs when a respondent gives a false answer due to perceived social pressure to "do the right thing."

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Evaluation Dates

Evaluation Component	Dates of Surveys/Interviews
Management Interviews	9/10/13 – 10/25/13
Full Participant Surveys	10/30/13 – 11/9/13
Event Surveys	7/17/13 – 9/12/13
Non-Event Surveys	6/28/13 – 6/29/13

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Management Interview Findings

Program Design and Implementation

Outreach

As reported in the 2011 evaluation, Power Manager decided to suspend active marketing of the program in the Carolina System until the switch replacements were completed and pending the removal of the $35 installation fee. A Duke Energy marketing manager reports that marketing in the Carolina System over the past three years has been limited to seasonal mailers sent in the spring to remind participants that the summer event season is starting. In 2012, Duke Energy began marketing via email campaigns to customers who have opted in to receiving emails from Duke Energy, and despite the low level of marketing efforts in the Carolina System, the program team has been actively refining marketing materials, leveraging lessons learned by Duke Energy in their Midwest service territory.

One of the biggest changes in marketing and outreach has come from Power Manager in the Midwest states, where Duke Energy has been using outbound calls to market the program. This has proved to be successful so far, both in terms of enrollment rate and in outreach costs. From their experience in the Midwest, the program manager reports that Duke Energy has been able to work with CustomerLink, the vendor providing call center services, to refine the outreach protocol to better respond to customer concerns.

The Power Manager outbound calling campaign started in the Carolina System at the beginning of October 2013, and the program manager and staff reported that they exceeded their enrollment objective of 1,600 within 2 weeks. The outbound calling campaign targeted Greenville and Spartanburg in South Carolina, and Charlotte, Winston-Salem, and Greensboro in North Carolina.

CustomerLink provides outbound telemarketing services for the Power Manager program, and the program manager reports that they played a key role in testing the outbound calling methodology to prove it was a viable outreach channel. The program manager reports, "We're very happy and satisfied with what they've done."

The marketing project manager also reported that direct mail will continue to play a role in future marketing efforts, since not all customers prefer to be contacted by phone. However, the program manager reports that as long as Duke Energy continues to see success with outbound calling, they intend to use that as the primary channel, and will resume direct mail at some point in the future. To support the direct mail campaign, the Power Manager team has refined the marketing collateral that is being used in the Midwest, and plans to make the same refinements in the Carolina System collateral as well.

The program manager reports that they tested the use of newspaper advertisements in 2013. Duke Energy sponsors a centerfold section in the B Section of the Charlotte Observer, a section that covers science, technology, and biotech. Power Manager ads were run in that section twice during the past summer as an experiment. The program manager reports Duke Energy acquired approximately 40 enrollments, and was able to learn about the pros and cons of conducting outreach through the newspaper advertisements.

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Cross Program Referrals

A Duke Energy marketing project manager reports that Power Manager is marketed by the My Home Energy Report (MyHER) program, but that Duke Energy does not track how many participants have been channeled to Power Manager by MyHER.

The marketing project manager also reports that Power Manager has successfully targeted customers who had participated in the residential Smart $aver HVAC program in the past, and may target these customers in the Carolina System as well. The evaluation team notes that because past Smart $aver HVAC participants may have high efficiency AC units, this strategy may not be as cost effective in the Carolina System, which offers a fixed incentive per month rather than an incentive based on the price of electricity. However, with the new operating reserve function that Power Manager now provides, Duke Energy may find it worthwhile to target these past Smart $aver HVAC participants.

Enrollments

Customers always had the option of enrolling in the Power Manager program via mail or telephone. In late 2011, Duke Energy had enhanced their online enrollment process. This allowed them to establish a direct secure connection with the customer. Once the customer provided their enrollment information, the installation vendor (GoodCents) was able to transmit the information directly and automatically to their work management system.

For 2013, Power Manager had an enrollment objective of 1,600, which the program manager reports was met handily.

For 2014, Duke Energy has an installation objective of 5,600 new switches[4] in the Carolina System.

The program manager reports that this objective represents an increase over the previously planned objective. However, because GoodCents (the vendor that is replacing the switches) has brought on additional staff to meet the accelerated timeline for switch replacement, Duke Energy decide to leverage the availability of trained technicians to install new switches and expand enrollment objectives. The program manager reports that in addition to the increased installation objectives for 2014, Power Manager will also ramp up marketing in 2015 to achieve more enrollments after the replacement project is complete.

Event Calls

While there is no maximum limit on the number of Power Manager events, per the agreement of the regulators there is a maximum of 100 hours of AC cycling per year, a maximum that the program manager points out they have never approached. In 2013, eight events were called in North Carolina and six in South Carolina[5].

[4] The program manager estimates approximately 20% of customers have more than one air conditioning unit, so the objective is stated in terms of switches installed and not customers enrolled.
[5] The program manager reports it is unusual for events not to be called for both states. Power Manager was not used in South Carolina on two consecutive days due to a multi-day outage restoration effort occurring in South Carolina during that time.

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The decision to call an economic event is made with the consensus of representatives of several groups. Duke Energy's DSM Analytics team monitors a set of data on a daily basis. These data include the heat index, the forecast load, and the price of meeting that load. If the indicators suggest that there is an opportunity to save money for both Duke Energy and their residential customers, then the DSM Analytics team convenes a meeting of representatives across several of Duke Energy's business units to decide whether or not an event should be called. This group includes the Power Manager program manager and representatives from the Systems Operating Center, the DSM Analytics team, the call center, the energy trading group, and the meteorology group. In this meeting, the Power Manager program manager sees his role as that of the advocate for the residential customer, so that the customers' experience is kept in mind for these economic events.

If the representatives agree that an economic event is worthwhile, then the DSM Analytics team prepares for the event. At the appointed time, the signal to start cycling is sent over Duke Energy's paging network. Over the course of the next 30 minutes, switches are signaled to start cycling in random order. At the end of the event, the switches are given the signal to stop cycling in the same order in which they started cycling. This gradual ramp up and down minimizes stress to the distribution system by gradually increasing the load.

Load Shed Verification

Duke Energy's DSM Analytics team conducts two ongoing research efforts in support of the Power Manager program. The first is a switch operability study, in which field technicians gather data used to estimate the percentage of switches that are in working order in the Carolina System. The switch operability study is conducted every two or three years. No operability study was scheduled for 2013 in the Carolina System. The second ongoing research effort is the AC duty cycle study. For this study, a sample is selected of approximately 100 Carolina System participants with working switches, but who are not included in the event calls. Their air conditioning cycling data is used as the "normal" duty cycle and serves as the baseline against which Power Manager impacts are measured. This study is concluded every year after the end of the event season.

Technology and Vendors

Duke Energy engages several vendors to help deliver this technology-driven program.

Switches and Switch Replacements

The Power Manager program was a legacy program from the days prior to the merger with Cinergy, and thus still was using some switches that were installed in the late 1970s. The Power Manager program has accelerated a project to replace older switches with low operability. The program manager reports that the operability rate of these older switches will improve from approximately 40% to the new switch rate of approximately 94%, based on the most recent operability study. The new completion date for the switch replacement is now the end of 2014, a 9-month acceleration from the original date of September 2015.

The decision to accelerate the switch replacement was driven by several factors. Increasing operability allowed Duke Energy to increase their achievable load shed with less cost than acquiring new participants, to use a single platform for all their switches, to increase program operations efficiency, and improve customer experience. As an example of the latter, customers

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opting out of the program can have their AC returned to normal operation during an event within 15 minutes via a signal sent to the new switches.

The Power Manager program uses Cooper-Cannon Target Cycle switches, supplied by Eaton (who acquired Cooper in 2013). These switches can respond to signals transmitted over Duke Energy's proprietary VHF channel in real time, and can store event data for several months. These switches were designed to deliver a target load reduction (of 1.3 kW) for each AC unit, after the AC amp draw is programmed into the switch. Each unit is then cycled off and on for a variable period of time within each half hour during an event, with the length of the period determined by the AC's load and recorded duty cycle.

Vendors

GoodCents is the vendor providing the field technicians who install, upgrade, and remove switches. In response to Power Manager's accelerated switch replacement deadline, GoodCents has brought on addition staff to meet the workload requirements.

GoodCents reports that they are currently replacing switches at a rate of approximately 1,000 per week, and will be increasing their staff of field technicians in order to increase the replacement rate to approximately 1,400 a week.

Eaton provides the switches, and reports that they hold periodic calls with Duke Energy on the status of the switch orders and shipments, and another weekly call on the status of the software application Field Scout that is used by the field technicians. Eaton reports that the Power Manager program manager maintains a positive atmosphere, and that the team members communicate well with one another, "It's so nice and efficient, things get done quickly and easily."

Eaton reports that the use of Power Manager as an operating reserve was enabled by a new software program. This program had been tested previously, and implemented in the Carolina System in the summer of 2013. When Power Manager is used as an operating reserve, the duration of the event is not predetermined, so the event is initiated and concluded using signals that are sent to the switches.

Program Improvements: Proactive Communications

The Power Manager program has begun to proactively communicate a field visit by a technician. Prior to a switch replacement visit, GoodCents mails the customer a postcard. The postcard contains a notice about the upcoming visit to upgrade their equipment, thanks the customer for their participation, and provides a phone number for the customer to call in case of questions. With this proactive communication, if the customer does not call and the field technician finds a missing or defective switch, the technicians now have implicit permission and are able to install a new replacement switch.

In previous years, if a switch was found either to be missing or not operational during a quality control visit, Duke Energy would not be able to replace the switch if the customer was not at home to give permission. The field technician would leave a door hanger, and Duke Energy would contact the customer to obtain permission before sending the technician out again to reinstall the switch.

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The use of proactive communications is a practice learned from Duke Energy's pilot in Indiana. This was then piloted in South Carolina, and incorporated into the Carolina System in 2013. During both pilot programs, Duke Energy carefully monitored the customers' responses to the proactive communications, and they found that very few customers called to ask the switch to be removed. Duke Energy considered this a significant improvement in program operations, saying, "We have retained many of the customers we had been losing."

As a GoodCents project manager describes the proactive communications, "It's the difference between night and day," in terms of customer acceptance and technician safety, particularly in the rural areas where an unannounced visit may mean, "You get greeted with a gun."

Once the switch replacement project is completed, Duke Energy will begin quality control checks on the switches to ensure correct operation. Over a five-year rotation period, field technicians will visit each customer site and conduct a visual inspection of the installed switches to make sure they are wired properly and working.

Program Challenges

Switch Supply

The program manager reports that there were some challenges in maintaining switch inventory in support of the switch replacement project. In 2013, The previous generation switches had components that were no longer available and a redesigned switch using new components was introduced. Eaton, the vendor that supplies the Power Manager switches, experienced a shortage in some parts that were needed in the manufacture of the new generation switches.

In order to meet the accelerated switch replacement schedule, the Power Manager program manager found a solution to meet the demand for switches in the Carolina System. He determined that the Power Manager program in Ohio had a surplus of switches in inventory that could be reconfigured for use in the Carolina System. Eaton paid for 3,000 switches to be shipped from the Midwest Power Manager warehouse to their plant, reconfigured the switches, and sent them to the Carolina System. Accounting entries were made to credit the Ohio Power Manager program and charge the Carolinas Power Manager program for the original cost of these switches. As a result of these actions, there was no delay in the switch replacement project in the Carolina System.

Field Scout

Another technological challenge the program faced was introduced as part of an effort by Eaton to provide an application that could be used on an Android handheld device (i.e., a field technician's smart phone). This application, Field Scout, was developed by a third party and allows the field technician to program the switches with the AC unit's amp draw so that the target load reduction could be obtained by the switch during events. Field Scout is also designed to collect event data that are logged by the individual switches. An Eaton project manager reports that this application works with both the new switches as well as the legacy switches. Eaton reports that the data are sent to cloud storage hosted by Eaton, but Eaton does not access the data themselves.

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However, there were two challenges with the initial use of the Field Scout tool. First, there was a delay in the development and shipment of the tool, which meant that the new generation switches were being installed without being programmed with the amp data for the cooling system. In response to the delay in Field Scout deployment, Duke Energy developed a temporary workaround where the newly installed switches would be programmed via the program's head-end system with signals sent out over Duke Energy's paging network. Switch specific signals are sent with the cooling system's amp data which is stored in the Power Manager switch. Second, GoodCents, the vendor carrying out the switch replacements, had switched from an Android operating system smart phone while the Field Scout tool was in development. To compensate, GoodCents' technicians were equipped with Android tablets configured with the Field Scout application.

At the time of these interviews, the application is working correctly, and Eaton had just completed a training session for GoodCents to use the application in the Carolina System.

Program Opportunities

Duke Energy considers the outbound calling campaign in the Carolina System to be a resounding success so far. They plan to monitor customer rate of un-enrollment in the coming year in order to determine whether customers who enrolled during the outbound calling are sincerely committed to participating, or, as a Duke Energy staff member puts it, if people said yes "to get them off the phone." The un-enrollment rate will allow Duke Energy to make a better determination of whether it is indeed more cost effective for Power Manager to acquire new participants with outbound calling compared to other channels.

The marketing team is also considering a number of other ideas for outreach including:

- A direct mail follow up with those customers who are undecided after speaking with a Power Manager representative in an outbound call.
- Advertising in business journals, because customers who are not home during the day are good prospects for participation.
- Automated outbound calling, and
- Giving customers a refrigerator magnet with the Power Manager phone number on it.

Summary

The Power Manager program devoted 2013 to completing a multiyear transition of both technologies and regulations that were a legacy from the Load Control program. During this time, the program team has sought to improve program marketing and outreach, leveraging lessons learned from both Power Manager in the Midwest service territory and from Progress. The evaluation team found three key achievements by the Power Manager program in the Carolina System since the last process evaluation study. First is the removal of the $35 installation fee, that occurred in 2012. Duke Energy initiated the process in June 2011 and with the agreement and support of the regulatory bodies in the Carolina System, has successfully removed a major barrier to enrolling new participants. Second is the decision to accelerate the replacement of the legacy switches. Duke Energy recognized that upgrading the switches provided a low cost means to increase their load capacity, as well as enabled the use of newer

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Cannon Target Cycle switch technology that made program operation more efficient while improving customer experience. The fact that the program was met with a number of technological challenges is unfortunate, but the Power Manager team at Duke Energy found ways to work with their vendors to innovate solutions. As the evaluation team reported in the evaluation of Power Manager in 2011, the Target Cycle switch was considered an innovation that was developed by Cooper (now Eaton) at the request of Duke Energy. The evaluation team notes that it is not unusual for early adopters of new technology to also bear the brunt of working out "bugs" in that technology. The third major achievement was the development and testing of outbound calls as a cost effective channel for marketing the Power Manager program. The Power Manager team has not only been able to test the viability of this marketing channel but also to develop a deeper understanding of customers who are reluctant to enroll. The marketing team took that understanding and modified the messaging to assuage customer concerns.

In 2014, Power Manager will ramp up their marketing and enrollment campaigns while completing the switch replacements in the Carolina System. The evaluation team notes that Duke Energy has already identified a need to monitor the participants enrolled through the outbound calling campaign to assess their level of commitment. At this point, the evaluation team suggests that a full process evaluation may not be needed until after the switch replacements are complete. However, Duke Energy may wish to continue with the participant event surveys (as discussed in the section *Event Surveys Results*) to help monitor customer satisfaction with response times, given that field technician resources may need to be divided between increased new installations and accelerated switch replacements.

> RECOMMENDATION: Duke Energy should consider conducting continued participant event surveys to monitor the customer's experience. This will provide Duke Energy with timely data on the program's capacity to meet the aggressive switch replacement schedule while simultaneously maintaining the high satisfaction they have achieved with existing participants and meeting the need to install new switches for new participants.

The evaluation team also has some suggestions for the program team's consideration. The Power Manager marketing team has demonstrated that they have the capability to quickly gather customer information, and that presents a number of opportunities that the program manager no doubt is already considering. Because Power Manager is still operating under a rider that does not allow customers to opt out of single events (they can only un-enroll), the program may be losing otherwise satisfied participants. The evaluation team makes the following suggestions:

- When a customer calls to request a disconnect, perhaps the call center can be instructed to find out whether the customer would be willing to stay on the program if they could opt out of one event a month, as Power Manager participants in the Midwest are able to do. This data can be used to inform Duke Energy on whether the inability to opt out of single events is indeed an important barrier to continued participation, and perhaps be used to support any future regulatory filings.
- When a customer who was acquired when the $35 enrollment fee was still in place calls to un-enroll, perhaps the call center could be instructed to remind the customer of that investment, and ask if they would be willing to be contacted a year from now, to see if they would like to resume participation at no cost.

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There are likely many other questions that may be asked of customers who are asking to be un-enrolled, so long as they are worded in a way that removes pressure from the customer to stay on the program unwillingly. Because the Power Manager marketing team was successful at understanding customer concerns during the enrollment process, they may be equally successful at understanding why customers are un-enrolling.

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Participant Survey Results

TecMarket Works completed telephone surveys with 80 randomly selected program participants in the Carolina System (58 in North Carolina and 22 in South Carolina). This section presents the results from these surveys. The survey instrument can be found in *Appendix B: Participant Survey Instrument*. Note that these surveys were conducted prior to Power Manager's outbound calling campaign began in the Carolina System.

The results from the 80 completed surveys are presented below, and additional household descriptive information and participant comments can be found in in *Appendix E: Participant Survey Customer Descriptive Data*.

Participation Drivers

The vast majority (81.3% or 65 out of 80) of Power Manager program participants surveyed in the Carolina System were involved with the decision to participate in the Power Manager Program, as shown in Table 2. Eight participants (10.0% of 80) joined the program when they moved into a home where Power Manager had been installed by a previous occupant, and another five (6.3% of 80) were not sure ("don't know").

Table 2. Were you involved in the decision to participate in Duke Energy's Power Manager program?

	Carolina System	
	N	Percent
No	2	2.5%
Yes	65	81.3%
It was already installed when I moved in	8	10.0%
Don't know	5	6.3%

Figure 1 shows that most participants who could recall where they first heard about the program learned of the Power Manager program through mailings from Duke Energy (49.2% or 32 out of 65 participants who were involved in the decision to join the program). However just over a third of participants who signed up for the program themselves could not recall where they first learned about the programs (36.9% or 24 out of 65). Relatively few participants surveyed learned of the program through word of mouth (10.8% or 7 out of 65) or the Duke Energy web site (4.6% or 3 out of 65).

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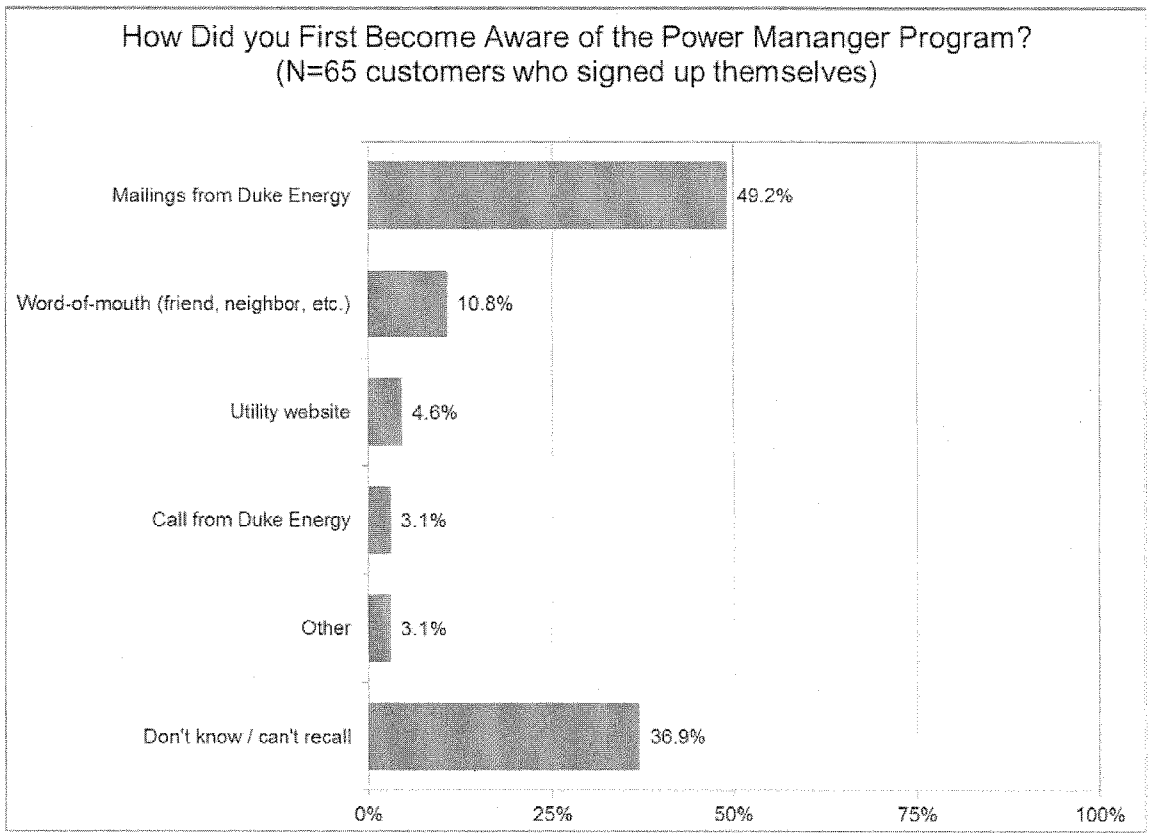

Figure 1. How Participants First Learned of the Power Manager Program
Note: percentages total to more than 100% because respondents could name multiple sources.

Two participants (3.1% of 65) mentioned "other" sources of awareness of the program. These sources are listed below.

- *"I learned about the program when I first signed up for Duke service at our new residence."*
- *"From the manager of the Duke Energy store."*

Recalling Promoted Program Benefits

Participants were asked to recall what program benefits were originally promoted to them to get them to join the program. The results are presented in Table 3; the most commonly recalled benefits have to do with saving money (overall mentioned by 57.5% or 46 out of 80 who signed up for the program themselves) – in particular the bill credits for activation (41.3% or 33 out of 80). The other frequently-mentioned benefits are managing peak demand and preventing outages (31.3% or 25 out of 80) and conserving energy (11.3% or 9 out of 80). None of the surveyed participants in the Carolina System mentioned helping the environment, though one (1.3% of 80) did mention reducing the need to build more power plants. Eleven participants (13.8% of 80) could not recall any promoted benefits, and fifteen (18.8% of 80) were not involved in the decision to participate in the program.

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Table 3. Participants' Recalled Program Benefits

To the best of your ability, could you please tell me what the promoted benefits of the program were?	Count	Percent (N=80)
Saving money – total mentions:	46	57.5%
- bill credit for activation	33	41.3%
- incentive payment for joining	0	0.0%
- lower bills / saving money in general	13	16.3%
Conserve energy / use less electricity	9	11.3%
Reduce outages / manage peak demand	25	31.3%
Helping the environment	0	0.0%
Build fewer power plants	1	1.3%
Don't know / not specified	11	13.8%
Not involved in decision to join program	15	18.8%

Note: responses total to more than 100% because respondents could mention multiple benefits.

In addition to asking about the benefits of the program, TecMarket Works also asked participants for the main reason they joined the Power Manager program. The most commonly cited main reasons for joining the program were for the bill credits (28.8% or 23 out of 80) and to save money on energy bills (15.0% or 12 out of 80). Another 12.5% (10 out of 80) said the main reason they joined was to save energy and 10.0% (8 out of 80) mentioned helping Duke Energy avoid power shortages.

Table 4. Main Reasons for Participation in Power Manager

What was the main reason why you chose to participate in this program?	Count	Percent (N=80)
For the bill credits	23	28.8%
To save money (through lower utility bills)	12	15.0%
To save energy	10	12.5%
To help Duke Energy avoid power shortages	8	10.0%
To help the environment	3	3.8%
Usually not home when events occur	2	2.5%
Other (listed below)	4	5.0%
Don't know / not specified	3	3.8%
Not involved in decision to join program	15	18.8%

Four participants (5.0% of 80) offered "other" reasons for participating in the program, which are listed below.

- *To do my patriotic duty, to help the country conserve energy.*
- *I had just moved in and it seemed convenient to enroll in the program when I initially signed up Duke services.*
- *It was not inconvenient.*
- *They said it was free and that it would be no hassle.*

Three participants (3.8% of 80) mentioned "helping the environment" as their main reason for participating in the program. These customers were asked to specify what it was about the environment that they wished to help; their answers are listed below.

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- *Reducing carbon use.*
- *Don't know.* (N=2)

After respondents gave their main reason for participating in Power Manager, TecMarket Works asked them if they recalled reading about that benefit or reason in the program brochure; Table 5 summarizes their responses. Only six respondents (9.7% of 62 who were involved in the decision to join the program and could name a main reason for joining) did not remember the brochure, and only four (6.5% of 62) said they did not receive the brochure. Overall, more than half of participants surveyed (56.5% or 35 out of 62) remembered reading about the benefits they cited in the program brochure.

Half of the customers (5 out of 10) whose main reason for joining the program was to "save energy" did not recall reading about this benefit in the program brochure (significantly higher than the percentage of customers naming other main reasons for joining the program who did not recall reading about those benefit in the brochure at $p<.05$ using Student's t-test).

Table 5. Main Reason for Participation: Read in Program Brochure

Count and percentage of those mentioning reason	Do you recall reading about this benefit on the program brochure?					Total (N=80)
	No	**Yes**	**Do not remember brochure**	**Did not get brochure**	**Don't Know**	
To save money (through lower utility bills)	0 0.0%	8 66.7%	0 0.0%	3 25.0%	1 8.3%	**12** 100%
For the bill credits	3 13.0%	15 65.2%	3 13.0%	0 0.0%	2 8.7%	**23** 100%
To save energy	5 50.0%	3 30.0%	1 10.0%	0 0.0%	1 10.0%	**10** 100%
Helping Duke avoid power shortages/outages	1 12.5%	6 75.0%	1 12.5%	0 0.0%	0 0.0%	**8** 100%
To help the environment	0 0.0%	1 33.3%	0 0.0%	0 0.0%	2 66.7%	**3** 100%
Usually not home when events occur	0 0.0%	1 50.0%	1 50.0%	0 0.0%	0 0.0%	**2** 100%
Other reasons (listed above)	2 50.0%	1 25.0%	0 0.0%	1 25.0%	0 0.0%	**4** 100%
Don't know reason / not involved in joining program	NA	NA	NA	NA	NA	**18**
Total (valid N=62)	**11** 17.7%	**35** 56.5%	**6** 9.7%	**4** 6.5%	**6** 9.7%	-

After asking for the main reason they joined the program and whether they recalled reading about it in the program brochure, TecMarket Works asked if there were any other reasons participants joined the program. The combined results (total times mentioned as "main reason" or "other reason") are presented in Figure 2. As with the main reason for joining the program, the most mentioned reason overall is the bill credits (48.8% or 39 out of 80). The next-most

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mentioned reasons for joining the program are avoiding outages (28.8% or 23 out of 80), saving money on bills (27.5% or 22 out of 80) and saving energy (25.0% or 20 out of 80).

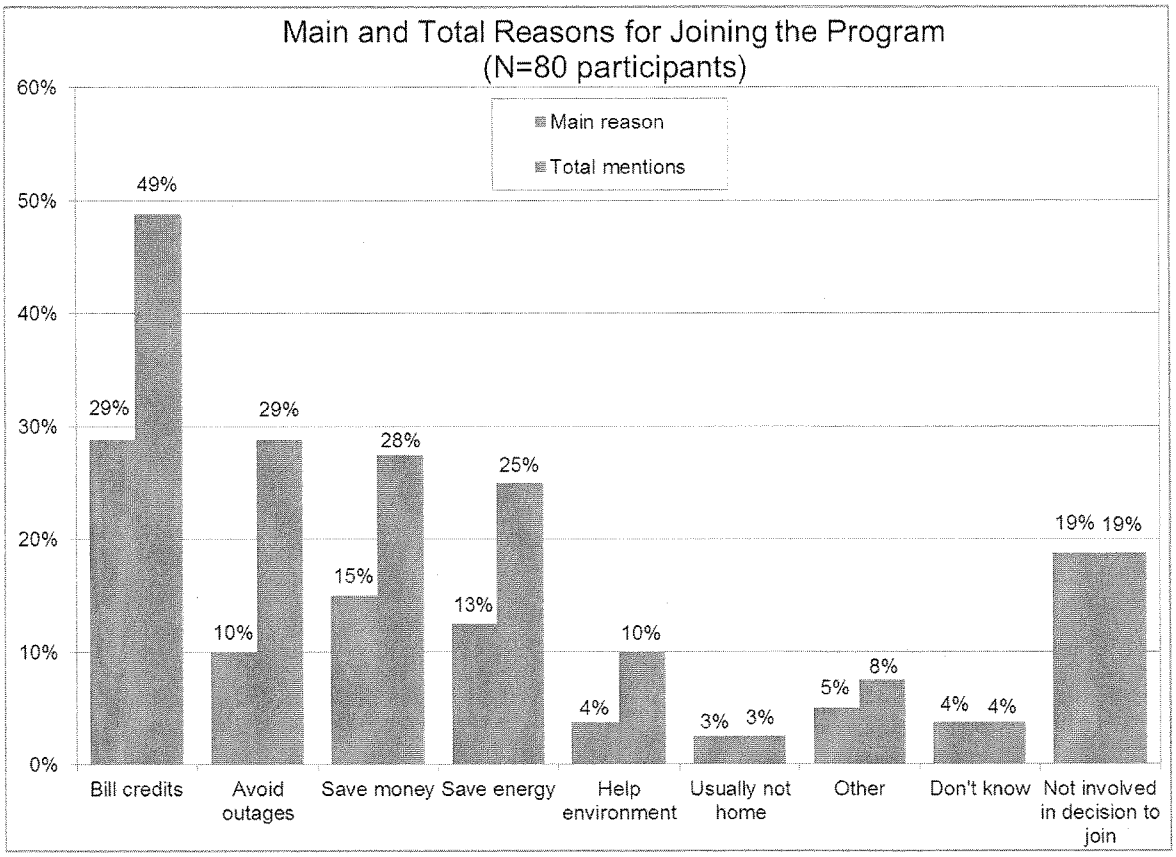

Figure 2. Main Reasons and Total Mentions of Reasons for Joining the Program
Note: "Total mentions" adds to more than 100% because multiple responses were allowed per participant.

In addition to the "other" main reasons for joining the program given by four participants (listed after Table 4), two more participants offered additional "other" reasons for participating in the program which are listed below.

- *To avoid having to increase power production.*
- *I didn't think the program would negatively affect me.*

Three surveyed customers said "helping the environment" was the main reason they joined the program, and they were asked to specify what about the environment concerned them (these responses are listed after Table 4). Five more participants said "helping the environment" was a reason they joined Power Manager, but not the main reason. These customers were also asked to specify what about the environment concerns them; these responses are listed below.

- *Being "green".*

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- *Reducing carbon emissions and being "green".*
- *Helping to reduce world energy demand.*
- *Maintaining coal reserves.*
- *Don't know.*

Surveyed participants were also asked if the "other reasons" (besides their main reason) for joining the program were covered in the program brochure. Table 6 shows the six top reasons for participating in the program (combined "main reasons" and "other reasons") and whether the customers read about these reasons in the program brochure. Customers who gave "saving energy" (40.0% or 8 out of 20) and "helping the environment" (25.0% or 2 out of 8) as reasons for participating in the program are less likely to say they read about these benefits in the program brochure compared to "bill credits" (71.8% or 28 out of 39), "saving money" (63.4% or 14 out of 22) and "avoiding outages" (60.9% or 14 out of 23; differences significant at $p<.10$ or better using Student's t-test).

Table 6. All Reasons for Participation: Read in Program Brochure

Count and percentage of those mentioning reason	Do you recall reading about this benefit on the program brochure?					Total Recalling Reason
	No	Yes	Do not remember brochure	Did not get brochure	Don't Know	
To save money (through lower utility bills)	3 13.6%	14 63.4%	0 0.0%	3 13.6%	2 9.1%	**22** 100.0%
For the bill credits	5 12.8%	28 71.8%	3 7.7%	0 0.0%	3 7.7%	**39** 100.0%
To save energy	7 35.0%	8 40.0%	1 5.0%	0 0.0%	4 20.0%	**20** 100.0%
Helping Duke avoid power shortages/outages	5 21.7%	14 60.9%	1 4.3%	0 0.0%	3 13.0%	**23** 100.0%
To help the environment	0 0.0%	2 25.0%	0 0.0%	0 0.0%	6 75.0%	**8** 100.0%
Usually not home when events occur	0 0.0%	1 50.0%	1 50.0%	0 0.0%	0 0.0%	**2** 100.0%

Note: the count of reasons recalled is greater than the number of participants surveyed because participants could recall multiple reasons.

Importance of Environmental Issues to Participants

TecMarket Works asked participants to rate the importance of environmental issues in general, as well as three specific environmental issues. These results are shown in Figure 3 through Figure 6.

A large majority (92.5% or 74 out of 80) of Power Manager participants surveyed indicated that environmental issues are either "important" or "very important" to them. Only two (2.5% of 80) of the participants surveyed in the Carolina System said environmental issues were "unimportant" and none said environmental issues were "very unimportant."

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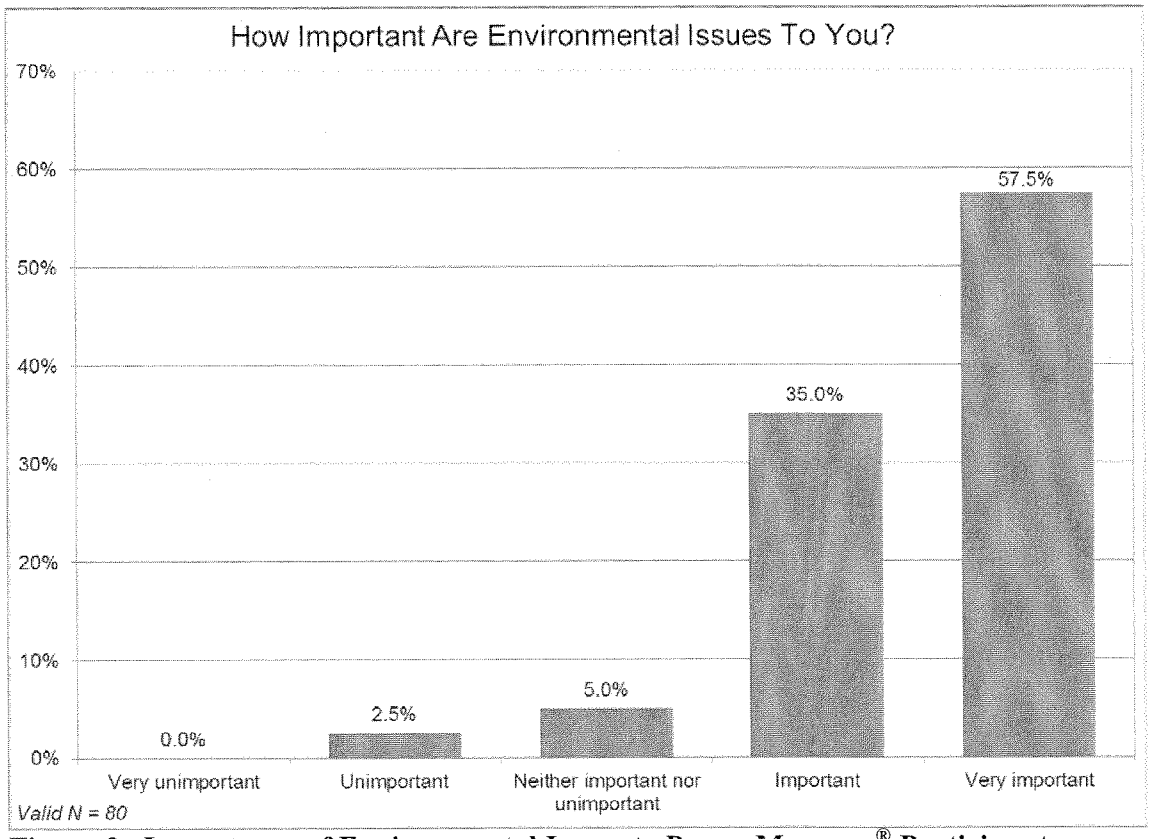

Figure 3. Importance of Environmental Issues to Power Manager® Participants

Reducing air pollution is the most important environmental issue to participants among the three specific issues that were asked about. As seen in Figure 4, a very large majority of 93.8% of participants surveyed (75 out of 80) said that reducing air pollution was "important" or "very important." Only two (2.5% of 80) of the participants surveyed in the Carolina System said reducing air pollution is "unimportant" and none it was "very unimportant."

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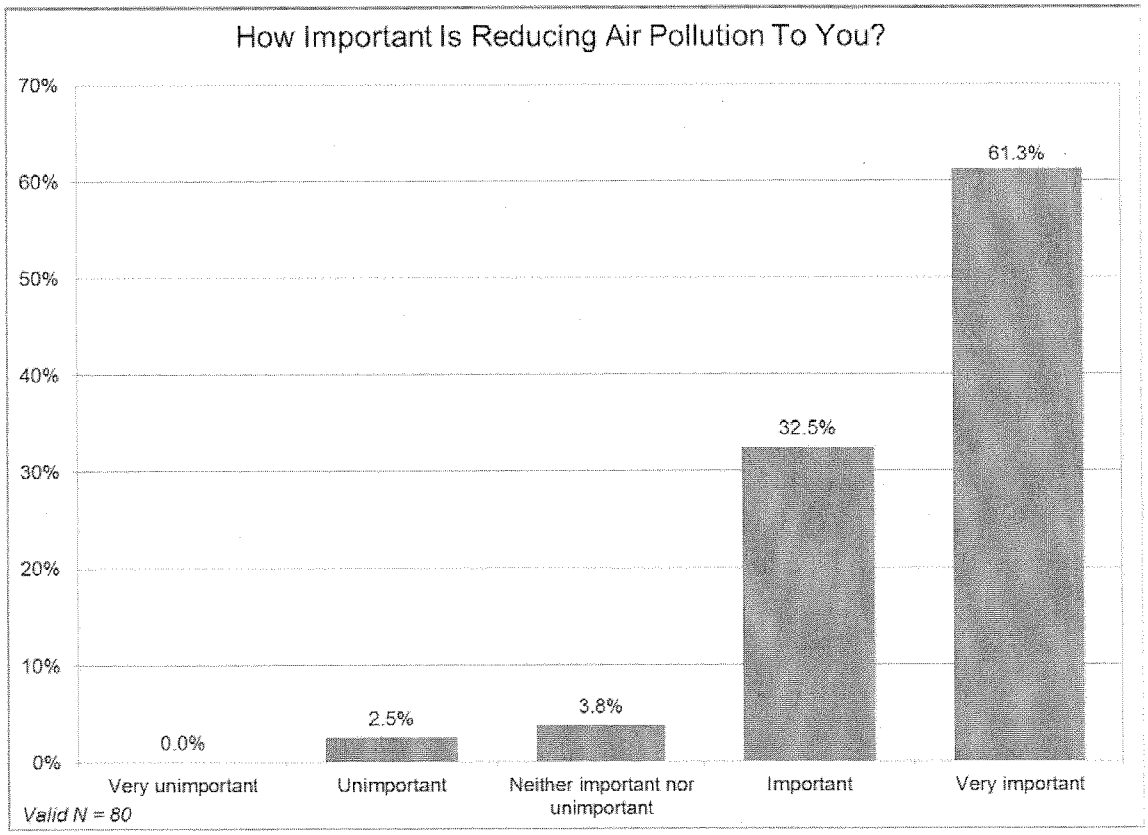

Figure 4. Importance of Reducing Air Pollution to Power Manager Participants

When TecMarket Works asked about the importance of climate change issues, opinion was more divided but a clear majority still said these issues are "important" or "very important" (74.3% or 58 out of 78). About one in seven participants (14.1% or 11 out of 78) think climate change issues are "unimportant" or "very unimportant."

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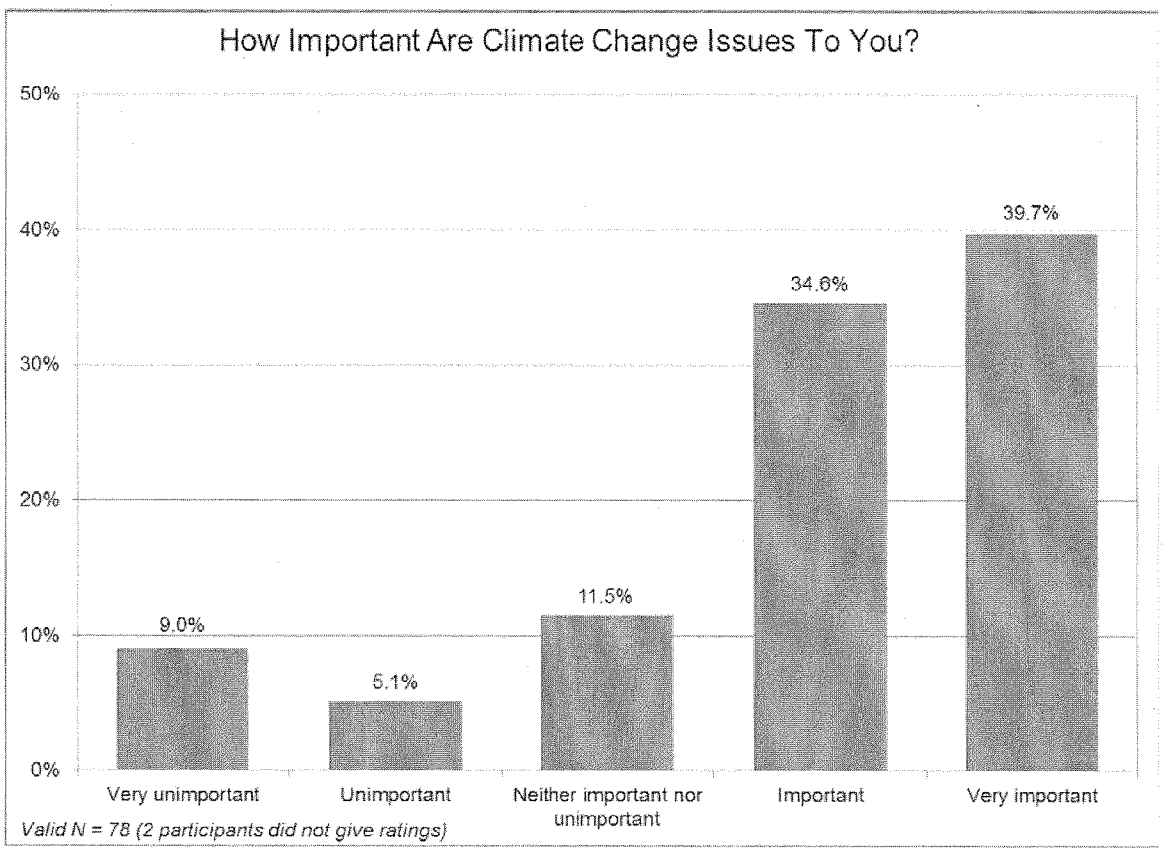

Figure 5. Importance of Climate Change Issues to Power Manager Participants

When respondents were asked how important it was to reduce the need for new power plants, opinions varied more than for the other two specific environmental issues TecMarket Works asked about. Only 28.4% (19 out of 67) describe this issue as "very important" with another 31.3% (21 out of 67) saying it is "important." Though only 14.9% (10 out of 67) say reducing the need for more power plants is "unimportant" or "very unimportant", another 25.4% (17 out of 67) say it is "neither important nor unimportant."

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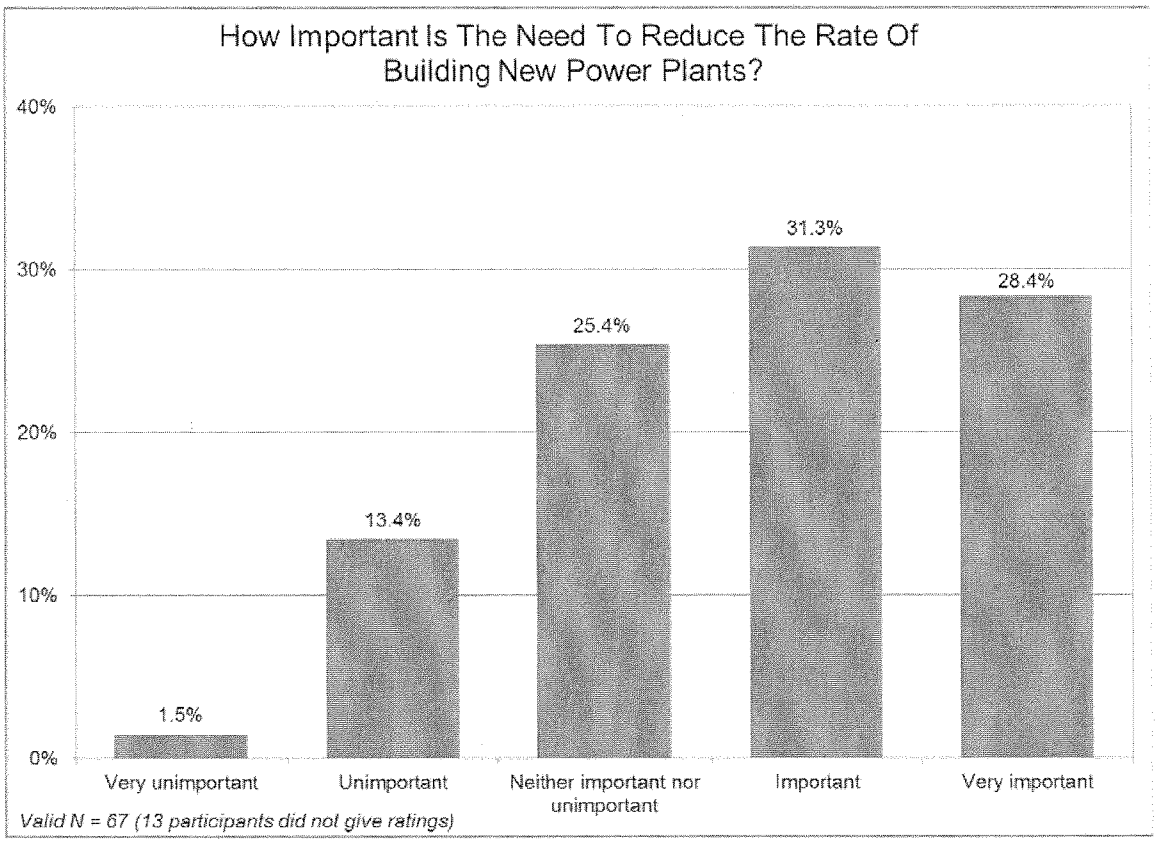

Figure 6. Importance of Reducing Need for New Power Plants to Power Manager Participants

While environmental issues are important to the majority of Power Manager participants, only five of those surveyed (6.3% of 80) are members of a group or club that has an environmental mission.

Table 7. Membership in Environmental Organizations

Are you a member of any groups or clubs that have environmental missions?	Count	Percent (N=80)
Yes	5	6.3%
No	75	93.8%
Don't Know	-	0%

If respondents indicated that there were a member of an organization with an environmental mission, they were asked for the name of the organization. The organizations mentioned by these five respondents are listed below.

- *Greenpeace*
- *Kayaking river clean up*
- *YMCA*

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- *Republican party*
- *Our church*

Participant Understanding of the Program

Participants are satisfied with the program information that was provided to them, giving the program information a mean score of 9.27 on a 10-point scale with "10" indicating that they are "very satisfied". Only 9.1% (5 out of 55 participants involved in the decision to join the program) rated the program information a "7" or less on a 10-point scale, and two-thirds (67.3% or 37 out of 55) rated the program information a "10 out of 10". The complete distribution is shown in Figure 7.

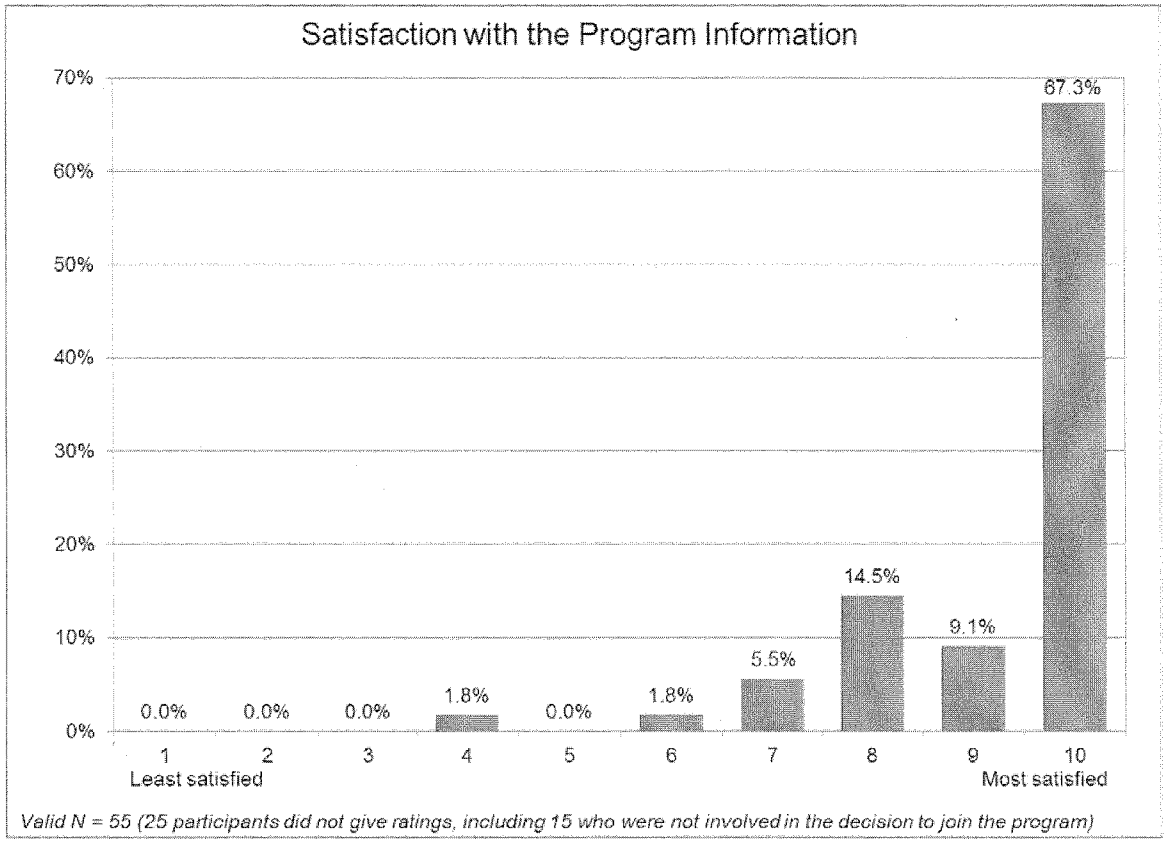

Figure 7. Participant Satisfaction with Program Details

If a respondent rated their satisfaction with the program information at "7" or lower, TecMarket Works asked them why they were less than satisfied. Five participants surveyed (9.1% of 55 involved in the decision to join the program) gave ratings of "7" or less, and their reasons for their lower satisfaction scores are listed below.

- *I was less than satisfied because the wording was tricky. The information could be clarified.*
- *They never really explained what the whole thing was about.*

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- *I didn't have any trouble understanding why they wanted to do this. I don't remember now if they said at the time that after the power switch was paid for, how long the savings would keep going.*
- Don't know / don't remember (N=2)

Expectations of Power Manager Events

Surveyed participants were asked how many times Duke Energy said it would activate the Power Manager device in a summer. About two-thirds of participants surveyed (65.0% or 52 out of 80) didn't know how many control events to expect. Among participants who were able to give an answer, most correctly indicated that Power Manager is activated "as needed, based on demand and/or temperature" (21.3% or 17 out of 80) or "less than 10 times per year" (3.8% or 3 out of 80).

Table 8. Participant Recall of How Often Duke Energy Said it Would Activate the Power Manager Device

How often per year did Duke Energy say it would activate the Power Manager device?	Count	Percent (N=80)
As needed / based on demand and/or temperature	17	21.3%
Less than 10 times per year	3	3.8%
10 or more times per year	0	0.0%
Every day / whenever AC is on	0	0.0%
Other (listed below)	4	5.0%
Duke Energy never said how often	2	2.5%
I did not read the program information / already installed when I moved in	2	2.5%
Don't know / can't recall	52	65.0%

Four surveyed participants gave "other" descriptions of how often the expected Power Manager to be activated; these are listed below.

- *I don't recall exactly, but there are several months out of the year when they usually send a notice to say when it's going to start and how long it will last.*
- *They do it over the course of four months, but I'm not exactly sure.*
- *It was relatively vague; they just said it was periodic.*
- *I don't remember other than hopefully it would be infrequently. We used to have to reset the air conditioner ourselves whenever the device was used, but we haven't had to do this for about five or six years now.*

Expectations of Monetary Incentives for Participation

Surveyed participants were asked to estimate how many dollars they would receive in bill credits for their participation in the Power Manager program. The responses are shown in Table 9; nearly half of participants were unable to provide an estimate ("don't know" 45.0% or 36 out of 80). Among the 41 respondents that provided specific annual dollar amounts, answers ranged

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from $8 to $96 per year with a mean of $35 and median of $32 (not including three participants who correctly stated the credit was $8 per month, but did not specify the number of months).

Table 9. Expected Bill Credits for Participating in Power Manager

What's your best estimate of how many dollars you will receive in yearly bill credits?	Count	Percent (N=80)
Less than $10	1	1.3%
$10 to $24.99	3	3.8%
$25 to $49.99	34	42.5%
More than $50	3	3.8%
"$8 per month" (months not specified)	3	3.8%
Don't know	36	45.0%

When participants were asked if they have received any bill credits during 2013 for their Power Manager program participation, a majority of 60.0% (48 out of 80) said that they did, while 12.5% (10 out of 80) said that they did not receive credits, and the remaining 27.5% (22 out of 80) were not sure.[6]

Table 10. Participant Awareness of Bill Credits Received

Have you received any bill credits this year from Duke Energy for participating in this program?	Count	Percent (N=80)
Yes	48	60.0%
No	10	12.5%
Don't Know	22	27.5%

The 48 participants who recalled receiving bill credits during 2013 were asked how many times they noticed Power Manager credits on their bill: four participants (8.3% of 48) recall noticing the credits once, four participants recall noticing them twice (8.3% of 48), seven participants noticed the credits three times (14.6% of 48), and twelve respondents (25.0%) noticed them four or more times, while fourteen respondents (29.2% of 48) said they saw credits on every bill over the summer. Seven respondents (14.6% of 48) could not recall how many times they saw bill credits. On average, the 41 participants who could recall how many times they noticed bill credits noticed them 3.3 times apiece ("every bill this summer" and "four or more" responses are counted as noticing the credits four times: for the monthly bills covering June, July, August and September).

Understanding the Program and Getting More Information

Despite the uncertainty of many of the participants over bill credits and control events, a minority of survey respondents indicated that anything about the program was unclear to them. Only 12.5% (10 out of 80) of participants surveyed in the Carolina System had questions about how the program works.

[6] Duke Energy confirmed that all surveyed participants are in fact receiving credits on their bills for activation events.

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Table 11. Participant Understanding of How the Program Works

Is anything unclear to you about how the program works?	Count	Percent (N=80)
Yes	10	12.5%
No	62	77.5%
Don't Know	8	10.0%

Respondents who indicated that they were unclear on something about the program were asked what was unclear. The responses of the ten participants who were unclear on something are listed below; most of these comments indicate a lack of knowledge about the program in general.

- *Everything is unclear.*
- *All of it is unclear.*
- *The entire program is unclear; I'm not really sure what it does.*
- *I don't know much about the program.*
- *I really don't know anything about the program other than it's supposed to help conserve electricity. The person who owned the house before us was signed up, and since I haven't noticed it, I never really think about it.*
- *I have not noticed any interruption in service, so I don't know how the device is supposed to affect me.*
- *I'm not sure how we got signed up for the program.*
- *Everything is unclear except that I get bill credits.*
- *The bill credits are unclear.*
- *The program has rotating areas where the power will be shut down.*

Only two surveyed participants surveyed (2.5% of 80) contacted Duke Energy to find out more about the Power Manager program, as seen in Table 12.

Table 12. Did you ever call or email Duke Energy to find out more about the Power Manager® Program?

Did you ever contact Duke Energy to find out more about the program?	Count	Percent (N=80)
Yes	2	2.5%
No	77	96.3%
Don't Know	1	1.3%

Both of the respondents who contacted Duke Energy about Power Manager said that they did so by telephone. They were also asked to give satisfaction ratings for the ease of reaching a Duke Energy representative, and for how well the representative responded to their questions. On a 10-point scale where 10 means "very satisfied", one respondent gave a "10 out of 10" score for the ease of reaching a Duke Energy rep, while the other gave a rating of "5" (this customer explained

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their relatively low rating for the ease of reaching customer service as follows: "*I had to go through multiple layers of the phone tree messages which took about 5 minutes.*") These customers' ratings for how the Duke Energy representative responded to their questions were a "10" and a "9" on the same 10-point scale, where "10" means the highest level of satisfaction.

Awareness and Response to Activation

More than half of participants surveyed (57.5% or 46 out of 80) are aware that their Power Manager device has been activated since they joined the program, however more than a quarter (28.8% or 23 out of 80) did not know whether it has been activated and 13.8% (11 out of 80) believe that it has not been activated at all.

Table 13. Awareness of Power Manager Activation Since Joining the Program

Has Duke Energy activated the Power Manager device since you joined the program?	Count	Percent (N=80)
Yes	46	57.5%
No	11	13.8%
Don't Know	23	28.8%

Table 14 indicates that in the Carolina System, about half of participants surveyed (53.8% or 43 out of 80) did not know how to tell if their Power Manager device has been activated. The most commonly cited reasons for participants being aware of an activation are "home temperature rises" (17.5% or 14 out of 80), "bill credits" (16.3% or 13 out of 80), and "AC shuts down" (15.0% or 12 out of 82).

Table 14. Reason for Awareness of Power Manager Activations

How do you know when the device has been activated?	Count	Percent (N=80)
Home temperature rises	14	17.5%
Bill credits	13	16.3%
AC shuts down	12	15.0%
Light on the meter is on	6	7.5%
Contact or notification from Duke Energy (other than bill)	3	3.8%
Light on AC unit flashes	2	2.5%
Lower bills	0	0.0%
Unique reasons (listed below)	2	2.5%
Don't know / not aware	43	53.8%

Note: Multiple responses were allowed per participant.

Two participants in the Carolina System (2.5% of 80) offered unique reasons for their awareness of Power Manager activation. These participants' responses are listed below.

- *We temporarily lose all power to our home.*
- *The fan goes into cycling mode.*

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TecMarket Works next asked participants how many times they believe Power Manager has been activated during 2013. A large majority (72.5% or 58 out of 80) said they do not know and did not offer a guess, as seen in Table 15. Among the participants who estimated a specific number of activation events, the mean number of activations mentioned is 3.6[7] and the median number of activations is 2.5. About half of the 22 participants who answered this question (54.5% or 12 out of 22) said that there were between one and five Power Manager activation events in 2013. Four respondents (18.2% of 22, or 5.0% of 80 overall) believed there had been no activation events in 2013.

A total of eight control events actually occurred in North Carolina during the 2013 cooling season, and six events occurred in South Carolina[8]. These participants were all surveyed in October and November, at least six weeks after the last activation events of the season.

Table 15. Perceived Number of Power Manager Activations in 2013

About how many times did Duke Energy activate your Power Manager device in 2013?	Count	Percent (N=80)
Zero	4	5.0%
1 to 5 times	12	15.0%
6 to 9 times	2	2.5%
10 or more times	3	3.8%
"every day" or "every week"	1	1.3%
Don't Know	58	72.5%

Most participants do not know how many times their units have been activated, with many not sure if they have been activated at all. However, 70.0% of participants surveyed in the Carolina System (56 out of 80) report that someone is usually home on weekday afternoons during the summer, and only 25.0% of respondents (20 out of 80) said that no one is usually home during this time.

Table 16. Participants at Home on Weekday Afternoons in the Summer

When Duke Energy activates your Power Manager device, it usually does so on summertime afternoons. Is someone usually home on weekday afternoons during the summertime?	Count	Percent (N=80)
Yes	56	70.0%
No	20	25.0%
Don't know	4	5.0%

[7] Twenty-two participants responded to the question with an estimate of how many times Power Manager was activated in the past year, though one of these was an outlier response which was left out of the calculation of the mean and median but reported in Table 15 as "every day or every week"; this participant estimated that their Power Manager device is activated "*every day, three or four times a week*".

[8] During the 2013 cooling season, general population device activations occurred in in North Carolina on July 17, July 18, July 19, July 24, August 12, August 29, September 10 and September 11. South Carolina device activations occurred on the same days, except for July 18 and 19 (there were only six activation events in South Carolina).

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When TecMarket Works asked participants if they were home during any of the control events, most (41.3% or 41 out of 80) did not know, but about one participant in three (30.0% or 24 out of 80) said that there was someone at home during at least one of the events.

Table 17. Number of Occupants at Home During Power Manager Device Activation

Were you or any members of your household home when Duke Energy activated your Power Manager device this past summer?	Count	Percent (N=80)
Yes	24	30.0%
No	15	18.8%
Don't know	41	51.3%

TecMarket Works then asked the 24 respondents who reported being at home during control events to think back to the event time and then to rate their comfort before and during the event on a 1-to-10 scale with "1" being very uncomfortable and "10" being very comfortable.

Ten of the 24 participants (41.7%) who were at home during an event reported a decline in comfort during the Power Manager activation event. These declines in comfort ratings ranged from 2 to 8 points (on a 10-point scale), with an average decrease of 2.13 points on a 10-point scale.

Table 18. Comfort Ratings Before and During Control Events (All Respondents At Home During Event)

	Rating before event (N=24)	Rating during event (N=24)	Change
Mean	9.35	7.22	-2.13
Median	9.00	9.00	0.00

Table 18 shows that across all 24 respondents who recall being at home during an event, the average decline in comfort ratings was 2.13 points (from 9.35 to 7.22), a difference which is statistically significant ($p<.01$ using Student's t-test). Among just the ten participants whose comfort ratings declined, average comfort ratings fell from 9.30 before the event to 4.40 after the event (significant at $p<.01$ using Student's t-test), as seen in Table 19. For the fourteen customers whose comfort ratings did not decline, the average comfort ratings were 9.38, both before and during the activation event.

Table 19. Comfort Ratings Before and During Control Events (Only Respondents Who Reported a Decline in Comfort)

	Rating before event (N=10)	Rating during event (N=10)	Change
Mean	9.30	4.40	-4.90
Median	9.50	4.50	-5.00

Most of the participants who indicated that they felt less comfortable during the period of activation blamed "rising temperature" for their decline in comfort (90.0% or 9 out of 10).

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However four participants surveyed (40.0% of 10) blamed Power Manager, at least in part, for their decline in comfort.

Table 20. Causes of Comfort Decline During Power Manager Activation Events

What do you feel caused your decrease in comfort?	Count	Percent (N=10)
Rising temperature	9	90.0%
Power Manager	4	40.0%
Rising humidity	2	20.0%
Power outage	1	10.0%
Don't know	0	0.0%

Note: Multiple responses were allowed per participant.

TecMarket Works also asked participants to estimate how many times over the most recent cooling season their comfort level was negatively affected by Power Manager activation; results are shown in Table 21. Only one participant surveyed (4.2% of 24 who recalled being at home during an event) said that their comfort was affected more than five times, while 37.5% (9 out of 24) said there were no events that affected their comfort during 2013. Across all 24 participants who recalled being home during at least one event during the past year, the mean number of times their comfort was affected was 1.2 and the median was 1.0.

Table 21. Perception of Power Manager Affecting Level of Comfort

Thinking about this summer, how many times do you think the activation of Power Manager affected your level of comfort?	Count	Percent (N=24)
Zero	9	37.5%
1 to 5 times	10	41.7%
6 or more times	1	4.2%
Don't know	4	16.7%

Four participants surveyed (5.0% of 80) said they had a power outage on a day when they believed Power Manager had been activated (though as seen in Table 20, only one surveyed participant blamed power outages for a decline in comfort during an activation event). Another 31.3% (25 out of 80) of participants were not sure if there was a power outage ("don't know"), as seen in Table 22.

Table 22. Power Outages During Power Manager Events

Did you experience any power outage issues on any of the days that Duke Energy activated your Power Manager device?	Count	Percent (N=80)
Yes	4	5.0%
No	51	63.8%
Don't know	25	31.3%

TecMarket Works also asked participants if they recalled doing anything to keep cool during the control event; these responses are shown in Table 23. Five respondents (20.8% of 24 at home during an event) recalled trying to keep cool during the event by adjusting their thermostats; all

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five set their thermostats lower, by an average of 2.6 degrees apiece. Most participants who were at home during the event either turned on fans (25.0% or 6 out of 24) or already had fans running during the event (37.5% or 9 out of 24). The vast majority of participants surveyed (70.8% or 17 out of 24) took no further actions and continued their normal activities during the activation event.

Table 23. Actions Taken During Power Manager Activation Events

	Count	Percent (N=24)
Adjusted thermostat settings	5	20.8%
Did not adjust thermostat settings	19	79.2%
Turned on fans	6	25.0%
Already had fans running	9	37.5%
Did not turn on fans	9	37.5%
Other actions: wore less clothing	2	8.3%
Other actions: turned on room/window AC	1	4.2%
Other actions: closed blinds / shades	1	4.2%
Other actions: drank more water/cool drinks	1	4.2%
Other actions: cooled off with water (shower, sprinkler, hose, pool, etc.)	1	4.2%
Other actions: moved to a cooler part of the house and stopped doing things / stayed still	1	4.2%
Other actions: nothing (continued normal activities)	17	70.8%

Reasons for the Power Manager Program and Activation Events

TecMarket Works asked participants the following question: "*Why do you think Duke Energy activates your Power Manager device on summertime weekdays during the afternoon, as opposed to other times of the day or year?*" The responses are presented in Table 24. About two-thirds of participants surveyed (66.3% or 53 out of 80) mentioned peak energy demand, while high outdoor temperatures were mentioned by 25.0% (20 out of 80) and 23.8% (19 out of 80) mentioned that it was a time of day when fewer people are at home. Only 6.3% (5 out of 80) could not give a reason ("don't know").

Table 24. Perceived Reasons for Power Manager Activations

Why do you think Duke Energy activates your Power Manager device on summertime weekdays during the afternoon as opposed to other times of the year?	Count	Percent (N=80)
Peak demand	53	66.3%
Hottest time of day	20	25.0%
Fewer people are home	19	23.8%
To avoid outages / brown-outs	4	5.0%
Unique responses (listed below)	5	6.3%
Don't know	5	6.3%

Note: Multiple responses were allowed per participant.

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Five participants (6.3% of 80) gave unique reasons why Power Manager activation events occur when they do. These reasons are listed below.

- *It keeps the rates down.*
- *I would guess that it's supposed to reduce the cost of energy at that time.*
- *It helps save electricity in some manner.*
- *Duke runs the device on a need-to basis when they are tapped out pretty hard.*
- *That's when they told me they were going to do it.*

Program Satisfaction

Respondents indicate a high level of satisfaction with the enrollment process of the Power Manager program, as shown in Figure 8. Among survey participants in the Carolina System who were involved in the decision to enroll in the program, the mean satisfaction score with the enrollment process is 9.70 on a 10-point scale where "10" means very satisfied. None of the surveyed participants who enrolled in the program themselves (0% of 65) gave the enrollment process a rating of"7" or less on a 10-point scale.

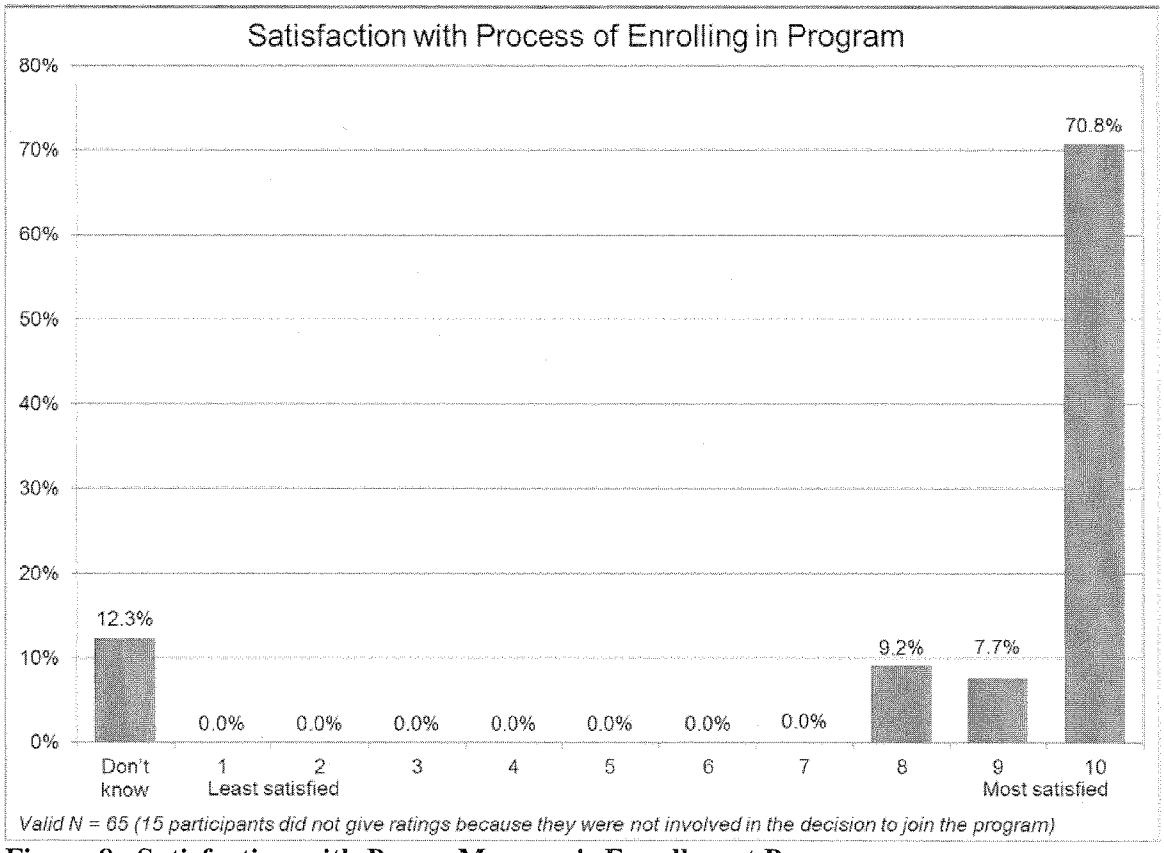

Figure 8. Satisfaction with Power Manager's Enrollment Process

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Participants were also asked to give a satisfaction rating for the Power Manager program overall; the distribution of responses is shown in Figure 9. The mean rating is 9.24 on a 10-point scale, with nearly two-thirds of participants (66.3% or 51 out of 80) rating the program a "10 out of 10" overall, and only 7.5 % (6 out of 80) give the program a rating of "7" or less.

Overall mean program satisfaction is 9.73 in South Carolina, compared to 9.05 in North Carolina (this difference is significant at $p<.10$ using ANOVA).

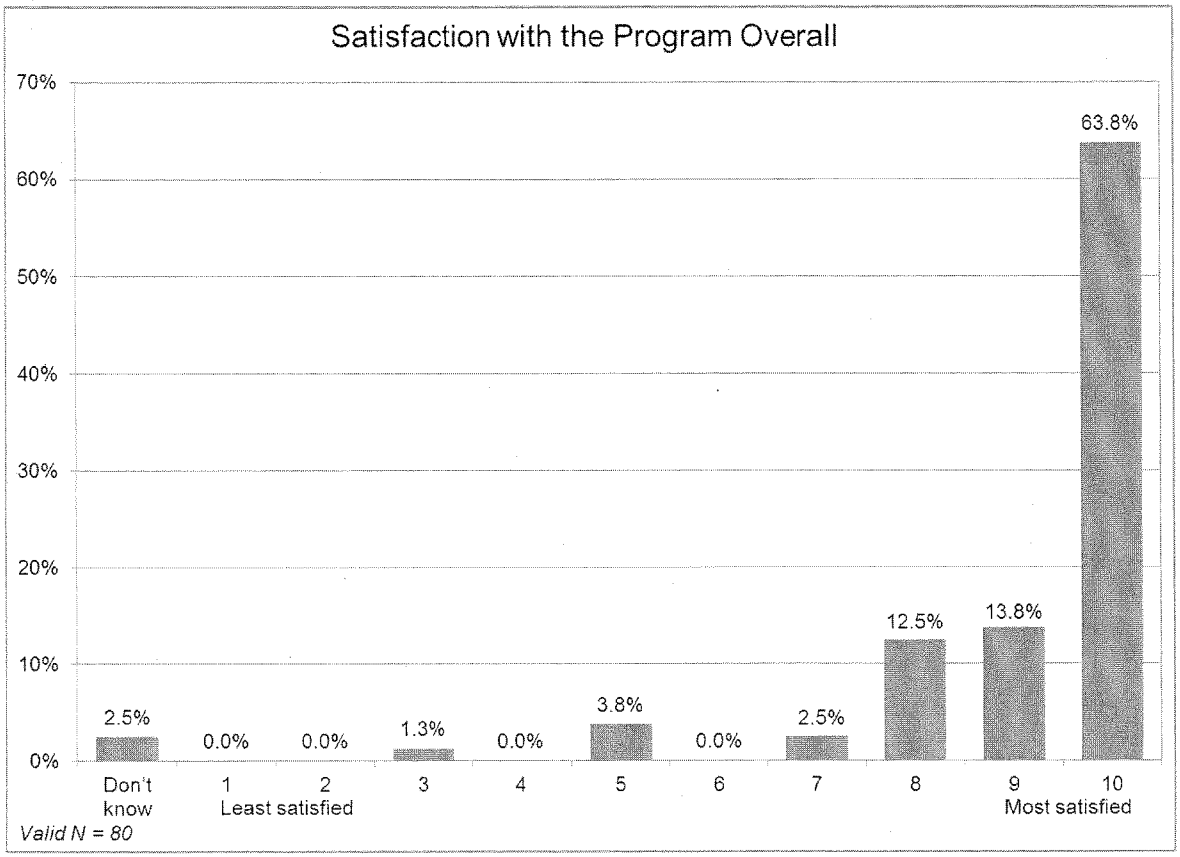

Figure 9. Overall Satisfaction with the Power Manager Program

The six respondents who rated their satisfaction with the program overall at "7" or lower were asked to give a reason for their low scores. Their responses are listed below.

- *The bill credits were not large enough.* (N=2)
- *I was uncomfortable when my Power Manager device was activated.*
- *My wife and I are actually home during the day, which we did not expect when we signed up. We both lost our jobs, and the house gets so hot. It is uncomfortable.*
- *They didn't give any warning or notice when they turned it on, and they turned it on more often than I would like.*
- *I have no control over it.*

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Participants were also asked to rate the likelihood that they would recommend Power Manager to others on a 10-point scale; this distribution is shown in Figure 10. The mean rating given by respondents is 8.89, with 62.5% (50 out of 80) giving "10 out of 10" scores and only 12.5% (10 out of 80) rating their likelihood of recommending the program at "7" or lower.

The overall mean likelihood rating for recommending the program is 9.48 in South Carolina, compared to 8.66 in North Carolina (not a statistically significant difference).

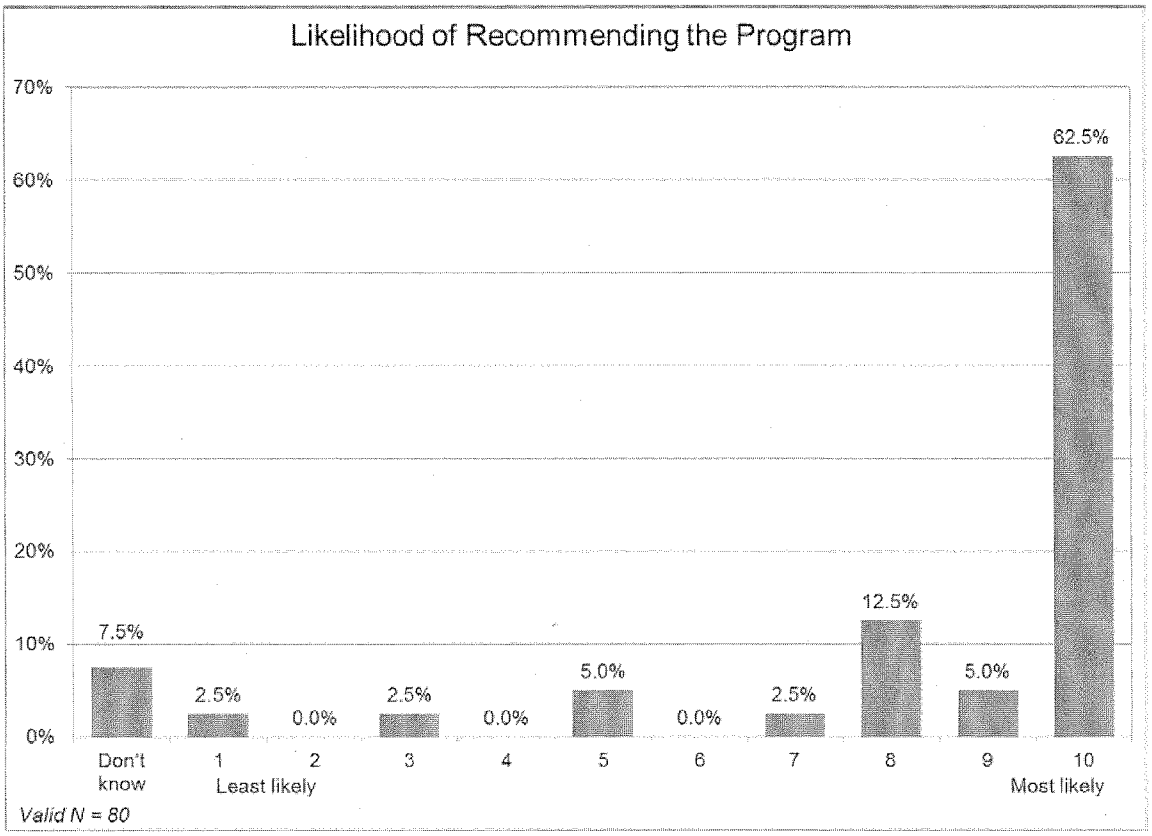

Figure 10. Recommending the Power Manager Program to Others

The ten respondents who gave ratings of "7" or lower for their likelihood of recommending the program were asked to give a reason for their low scores. Their responses are listed below.

- *I really don't know much about the program, because we didn't sign up for it; the former homeowners signed up for it. The program really hasn't affected us at all, so we don't mind being in the program.*
- *I have no input on it, and they just put it in without me saying I wanted it.*
- *I don't know enough about the program to be telling other people the benefits of being in it. If someone asked about the program, I would tell them that it hasn't affected our comfort.*

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- *I don't know much about the program, but it doesn't seem to make any difference on our bill.*
- *They turn the device on too often without any notice. They don't give people time to prepare.*
- *The saving versus the discomfort is not proportional.*
- *It's selfish. If I was at work all day long, it'd be different, because then it wouldn't affect me.*
- *We signed up for the program back in 1979, so I really can't remember any details of the program. If someone was talking about the program, I would tell them to try it out because it hasn't affected us and we like the bill credits.*
- *We're in our upper seventies, so we don't have co-workers and many of our friends have died. There just aren't many people for us to talk to about energy savings, and at our ages saving energy isn't something we really think about anymore.*
- *I probably wouldn't bring it up.*

Awareness of Other Duke Energy Programs

TecMarket Works asked participants if they were aware of any other Duke Energy programs. A majority of participants (76.2% or 61 out of 80) were able to name at least one program, with the most-mentioned Duke Energy programs being the CFL program (52.5% or 42 out of 80) followed by Home Energy House Call (15.0% or 12 out of 80), My Home Energy Report (12.5% or 10 out of 80) and Personalized Energy Reports (12.5% or 10 out of 80). All of the other Duke Energy programs were mentioned by fewer than 10% of participants surveyed.

Table 25. Awareness of Other Duke Energy Programs

What other Duke Energy programs or services have you heard of that help customers save energy?	Count	Percent (N=80)
CFL Program	42	52.5%
Home Energy House Call	12	15.0%
My Home Energy Report	10	12.5%
Personalized Energy Report	10	12.5%
Equal Payment Plan	4	5.0%
Appliance Recycling	3	3.8%
Low Income Weatherization / Low Income Programs	3	3.8%
Energy Star Homes	1	1.3%
Smart $aver (other than CFL)	1	1.3%
Unique responses (listed below)	4	5.0%
Don't know / none	19	23.8%

Note: Multiple responses were allowed per participant.

Four respondents gave unique responses to this question, which are listed below. Note that some of these may or may not be Duke Energy programs.

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- *I followed weatherization recommendations.*
- *I received $400 in credit for various home improvements.*
- *Kits for the kids online.*[9]
- *I pay the "time of day" rate.*

Air Conditioner Usage

The Power Manager program in the Carolina System is successfully enrolling participants that routinely use their air conditioners throughout the cooling season, and are therefore likely to be affected by Power Manager activation events. Most participants surveyed (63.8% or 51 out of 80) have their AC on "every day" during the cooling season, and only 16.3% (13 out of 80) have their AC on "only on the hottest days" or merely "frequently" (as opposed to "most days" or "every day"). None of the participants surveyed in the Carolina System indicated that they "never" use their air conditioner.

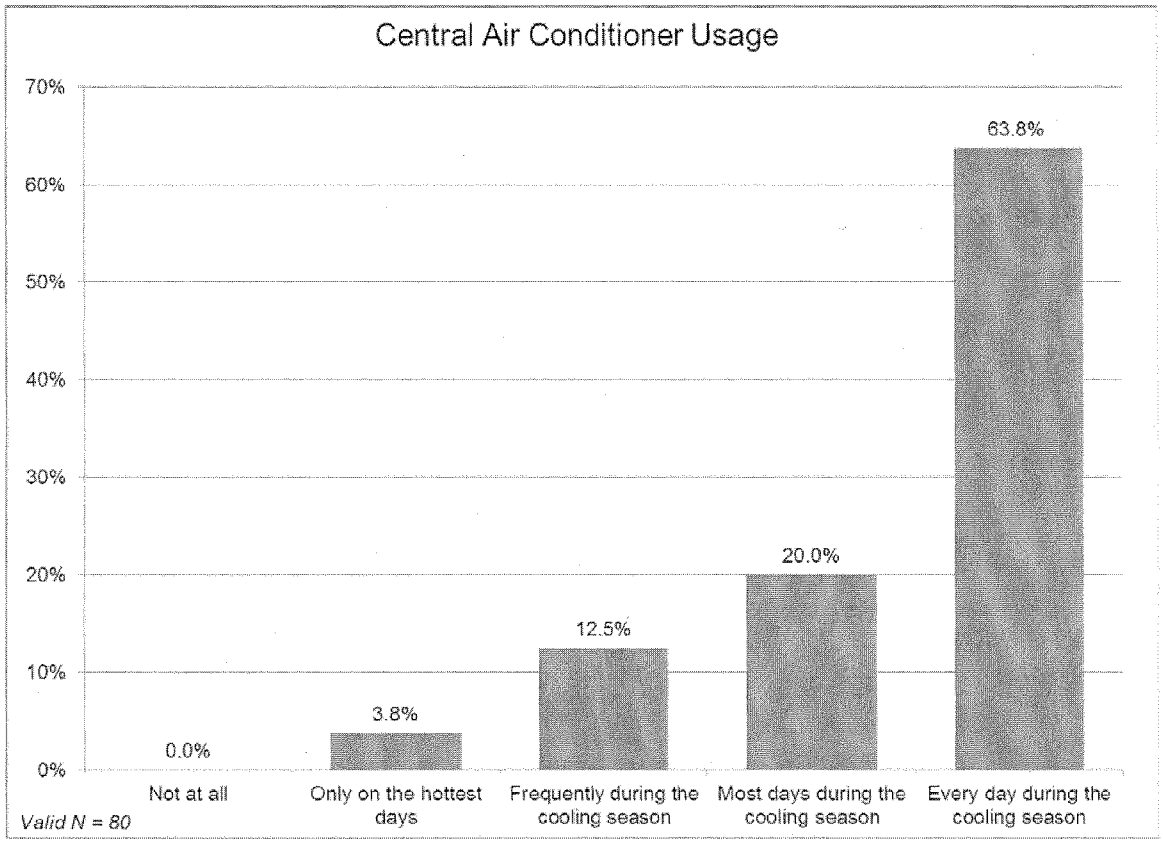

Figure 11. Air Conditioner Use of Power Manager Participants

[9] The comments in the first three bullets may be referring to Home Energy House Call and Energy Efficiency for Schools programs.

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Participants were also asked to estimate how many days they had used their central air conditioning during 2013[10]; these results are presented in Figure 12. Just over half of participants surveyed used their AC "every day" (51.3% or 41 out of 80). Only 15.0% (12 out of 80) said they used their AC on 80 or fewer days, and nobody surveyed (0% of 80) said they used their AC for fewer than 21 days.

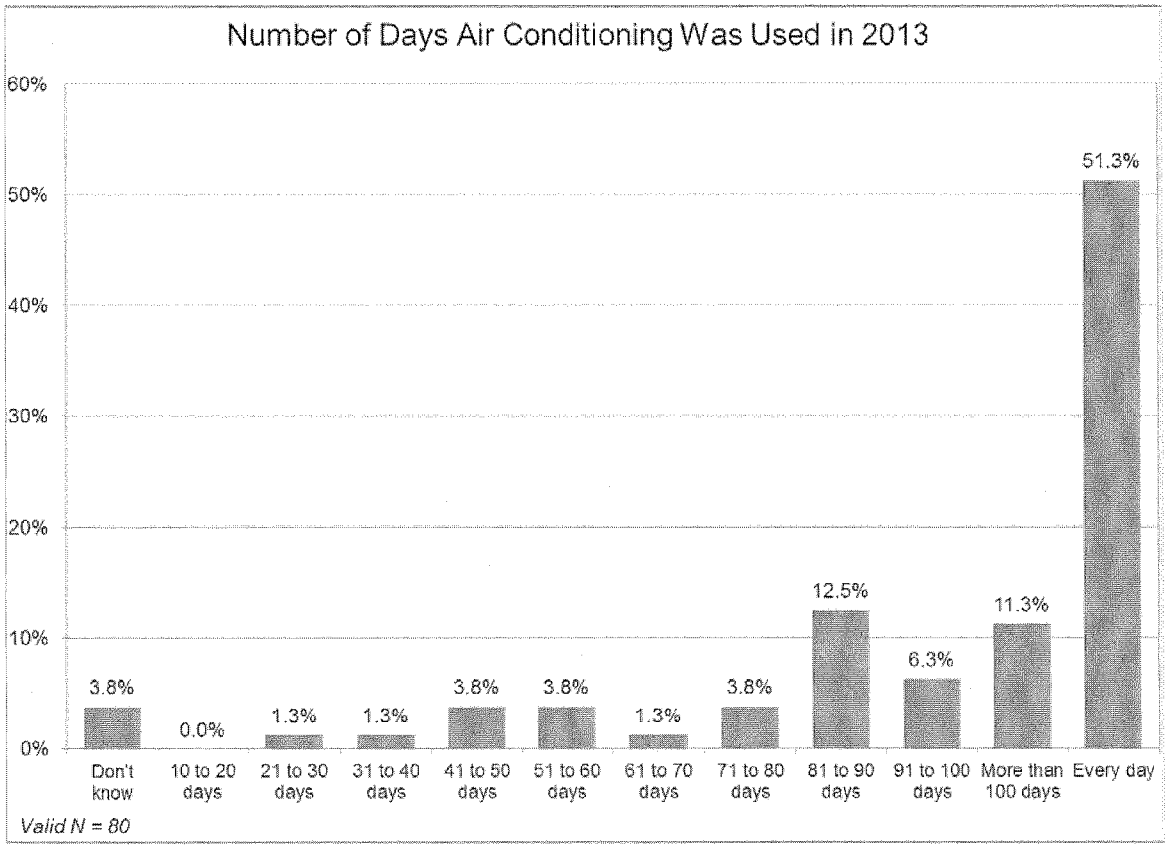

Figure 12. Estimated Number of Days Air Conditioning Was Used During 2013

Most participants surveyed in the Carolina System have had their air conditioner serviced since joining the Power Manager program (72.5% or 58 out of 80). Additionally, one participant (1.3% of 80) has installed a new AC system since joining the program.

Table 26. Air Conditioner Maintenance

Have you had your air conditioner tuned-up or serviced since you enrolled in the Power Manager program?	**Count**	**Percent** (N=80)
Yes	58	72.5%
Replaced AC system since joining	1	1.3%
No	17	21.3%
Don't know	4	5.0%

[10] These survey interviews were completed in October and November, after the end of the regular cooling season.

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The vast majority of participants who had their air conditioners serviced hired a professional AC contractor or electrician (91.4% or 53 out of 58), and two participants called on a relative who is an AC contractor (3.4% of 58).

Table 27. Air Conditioner Maintenance – Service Provider

Who serviced your air conditioner?	Count	Percent (N=58 participants who had AC serviced)
HVAC contractor or electrician	53	91.4%
Family member who is an HVAC contractor	2	3.4%
Did it myself	2	3.4%
Don't know	1	1.9%

Only about one in five of the respondents who had their air conditioning systems serviced reported that the performance improved (20.7% or 12 out of 58), while another third said it did not improve (32.8% or 16 out of 58) and a plurality of 46.6% (27 out of 58) "don't know" if it improved or not.

Table 28. Air Conditioner Maintenance – Performance Improvement

Did the performance of your air conditioner improve after you had it serviced?	Count	Percent (N=58 participants who had AC serviced)
Yes	12	20.7%
No	19	32.8%
Don't know	27	46.6%

A large majority of participants surveyed report that there is typically someone at home using the AC on summer weekday afternoons before 5 p.m. (76.3% or 61 out of 80), and virtually all participants report that someone is typically at home using the AC on summer weekdays after 5 p.m. (97.5% or 78 out of 80).

Table 29. Typical Air Conditioner Usage on Summer Weekdays

Is the air conditioning typically used to keep someone at home comfortable during . . . ?	Count	Percent (N=80)
Weekday summer afternoons before 5 p.m.	61	76.3%
Summer weekdays after 5 p.m.	78	97.5%

Outside Temperatures and Thermostat Settings

Power Manager participants were asked to think about a hot and humid summer day, and then to tell us at what outside temperature they start to feel uncomfortably warm. The responses are presented in Figure 13. The median temperature range of discomfort is 85-87°F in the Carolina System, and nearly half of participants surveyed (43.8% or 35 out of 80) said they become uncomfortable when the temperature is between 85°F and 90°F. Another 40.0% (32 out of 80)

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become uncomfortable at temperatures of 84°F or less, and only 13.8% (11 out of 80) become uncomfortable only when the temperature reaches 91°F or above.

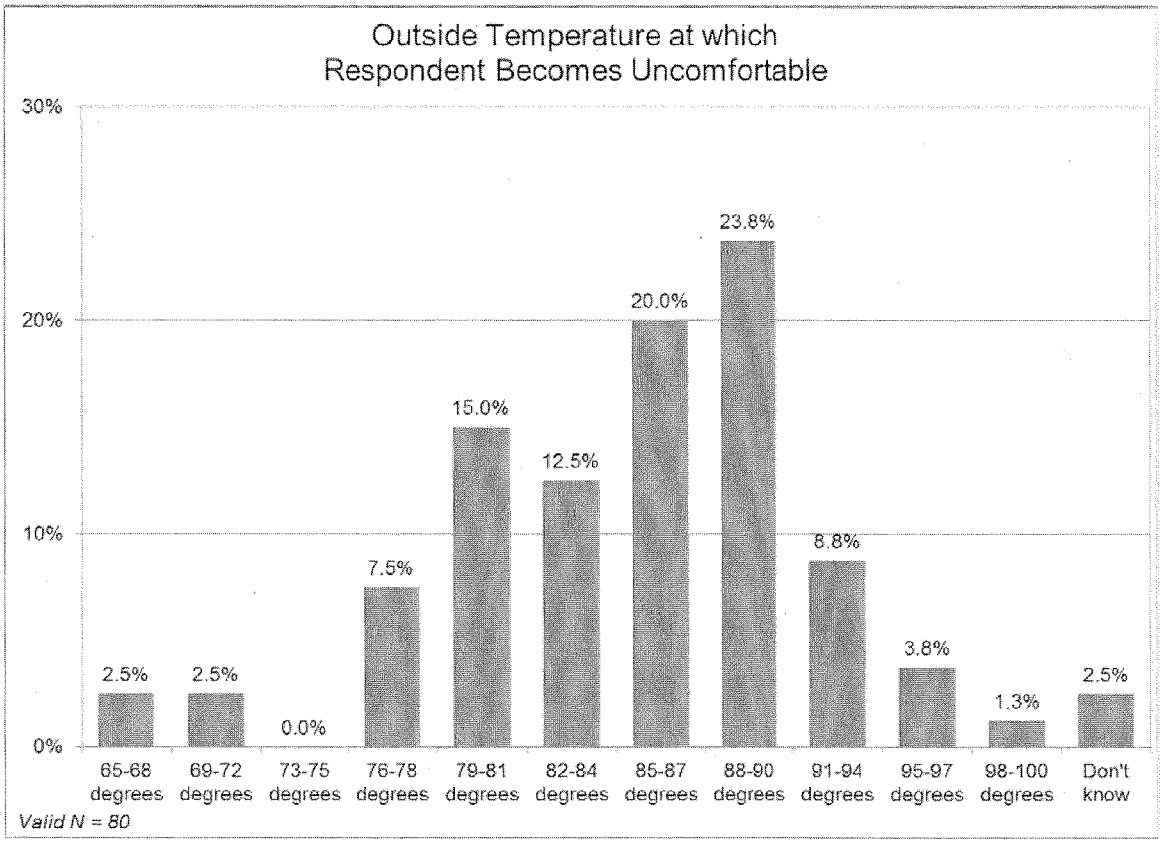

Figure 13. Outside Temperatures at Which Participants Feel Uncomfortably Warm

TecMarket Works next asked participants at what outside temperature they tend to turn their air conditioners on. The median outside temperature range for which air conditioners are turned on is 82-84°F in the Carolina System (one range lower than their discomfort level), with 42.5% of participants (34 out of 80) turning their AC on when the temperature is between 79°F and 87°F. A quarter (25.0% or 20 out of 80) turn their AC units when the outdoor temperature is 78°F or lower, while only 15.0% (12 out of 80) wait until the temperature is 88°F or higher; another 15.0% of participants (12 out of 80) did not give a number, instead saying "it is programmed into the thermostat". The distribution of responses is presented in Figure 14.

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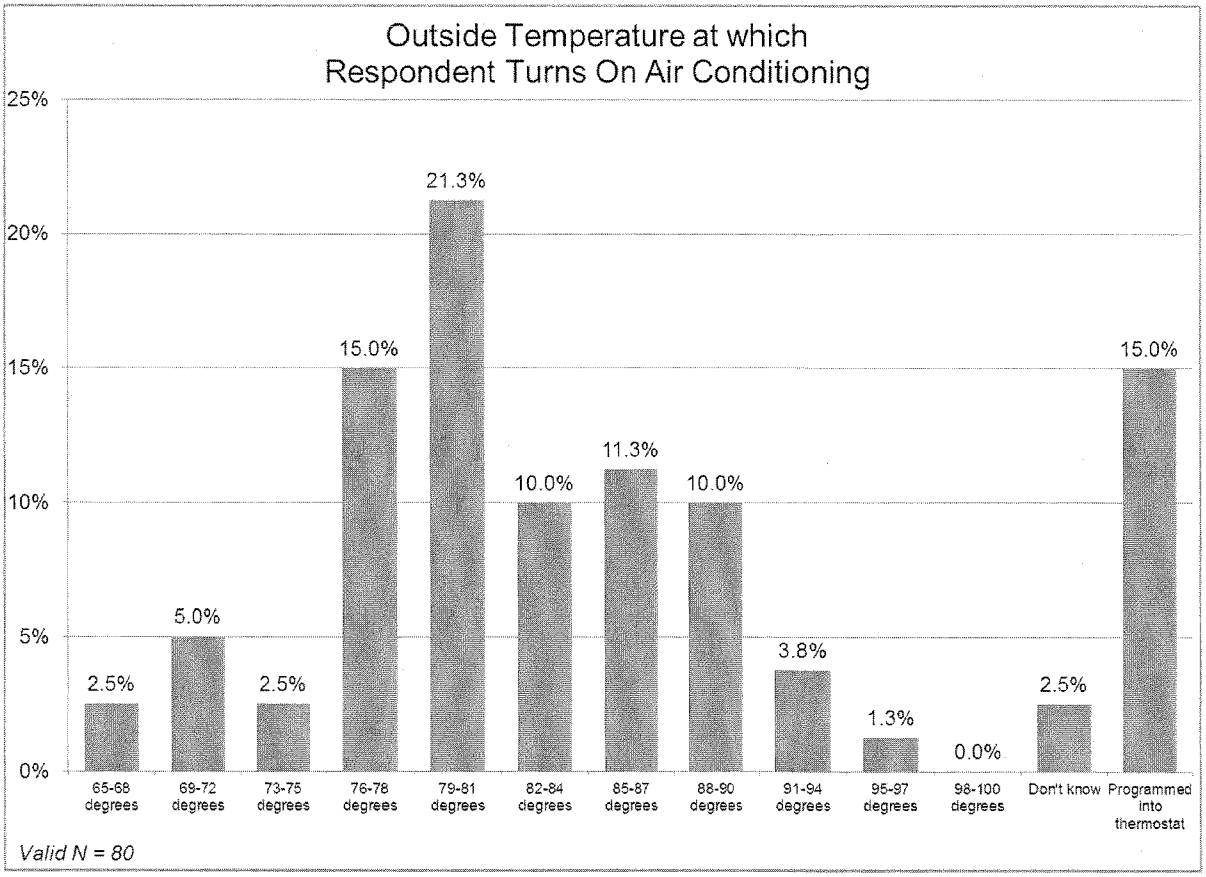

Figure 14. Outside Temperatures at which Participants Turn On Their Air Conditioners

Comparing the two temperature points from Figure 13 (discomfort) and Figure 14 (when participants turn on their air conditioners) yields Figure 15, which indicates that more than half of participants in the Carolina System (57.8% or 37 out of 64) turn on their air conditioners *before* the temperature becomes uncomfortable. About a third (34.4% or 22 out of 64) turn it on when the temperature becomes uncomfortable, and only a few participants (7.8% or 5 out of 64) wait until the temperature is higher than the level at which they begin to feel uncomfortable.

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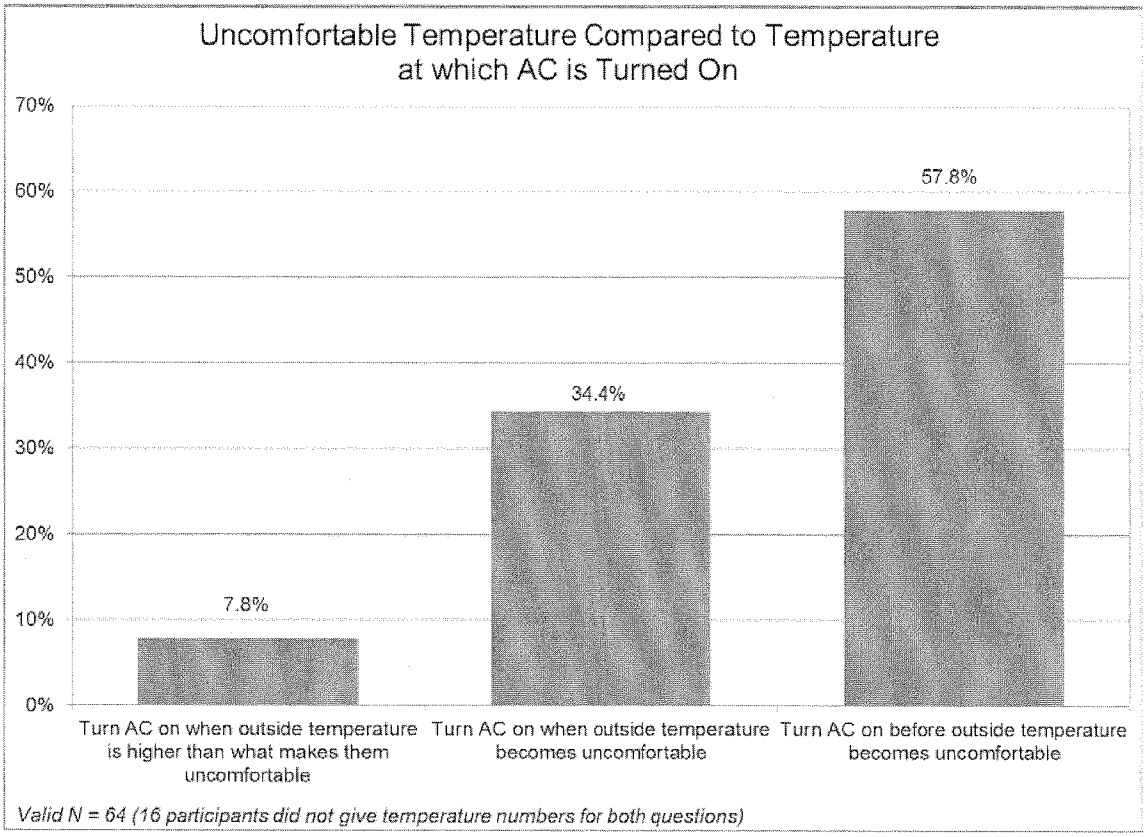

Figure 15. Turning On Air Conditioners When Temperatures Reach an Uncomfortable Level

Twelve participants in the Carolina System (15.0% of 80) did not give a specific temperature at which they turn on their air conditioning because "it is programmed into the thermostat." These respondents were asked a follow-up question about how they program their thermostats, the results of which are shown in Table 30.

Table 30. Programmable Thermostats

Do you set your thermostat seasonally or when the weather gets hot?	**Count**	**Percent** (N=12 participants who program thermostats)
When the weather gets hot	5	41.7%
I program the thermostat seasonally	7	58.3%
We have it programmed to about the same temperature year-round	0	0.0%

Thermostat Settings

Figure 16 shows participants' thermostat settings on high temperature weekdays at four time periods throughout the day (6 a.m.-12 p.m., 12 p.m.-5 p.m., 5 p.m.-10 p.m., and 10 p.m.-6 a.m.). About 60% of participants surveyed set their thermostats between 69°F and 75°F on hot days. There is not much variation between day parts, though between 5 p.m. and 10 p.m. participants

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are marginally more likely to set their thermostats lower at 69-72°F (none of the differences between day parts are statistically significant).

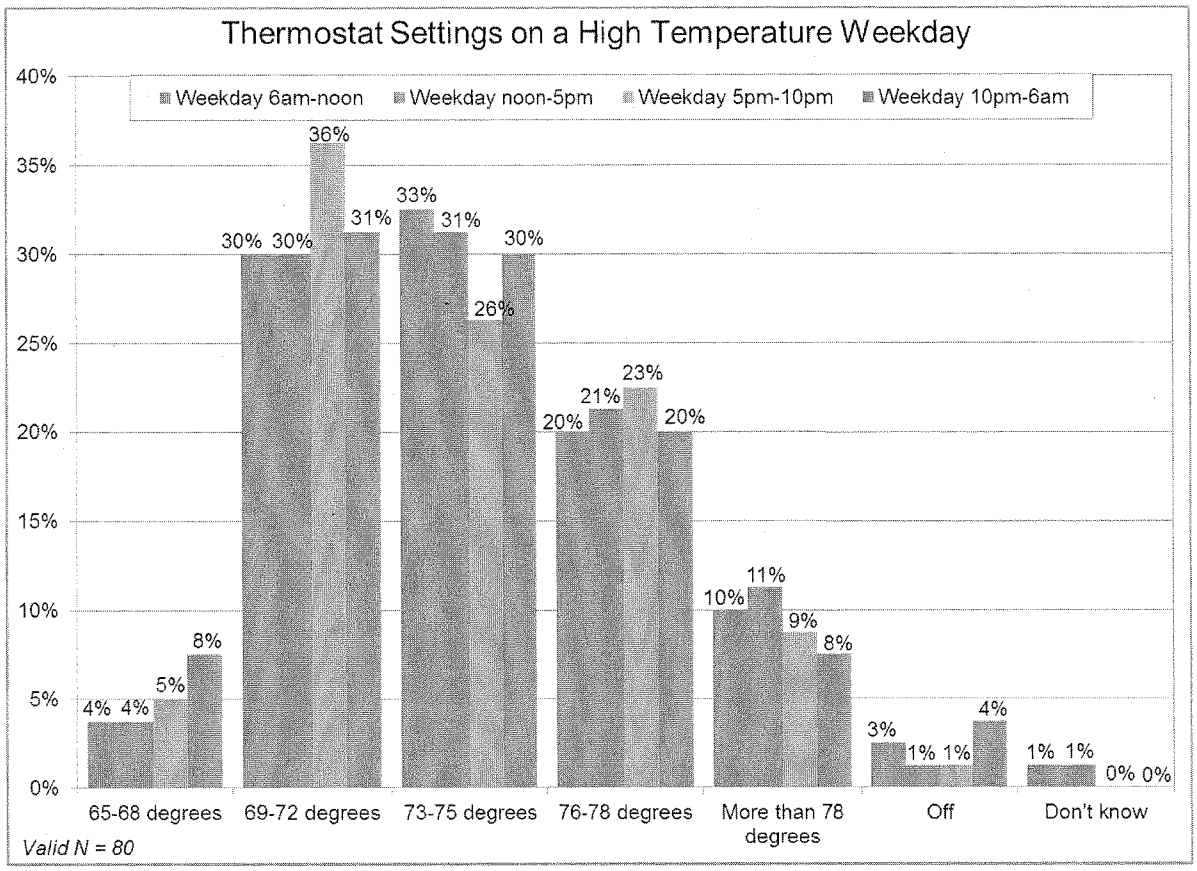

Figure 16. Thermostat Settings on a High Temperature Weekday

Figure 17 shows participants' thermostat settings on a typical weekend day during the same four time periods. The vast majority of surveyed participants (73% to 80% depending on time of day) set their thermostats the same on weekends as they do on weekdays. There are no statistically significant differences on weekend thermostat settings by time of day.

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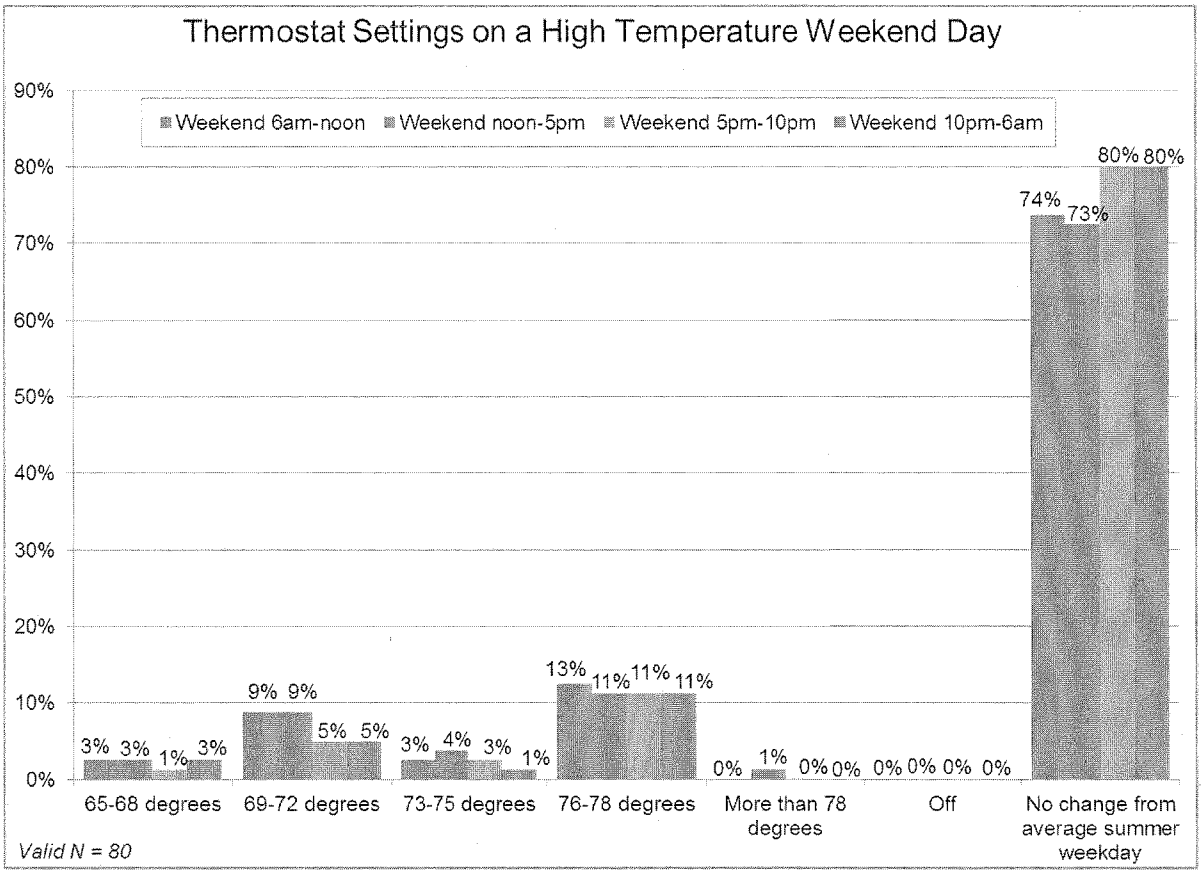

Figure 17. Thermostat Settings on a High Temperature Weekend Day

The vast majority of Power Manager participants surveyed leave their settings the same throughout the week, from weekdays to weekends, as seen in Table 31. However, 12.5% of participants (10 out of 80) set their thermostats lower on weekends between 6 a.m. and 5 p.m. than they do on weekdays during these times of day. This is significantly higher than the percent of participants who set their thermostats lower on weekends after 5 p.m. (3.8% or 3 out of 80; difference significant at $p<.05$ using Student's t-test). None of the surveyed participants set their thermostats higher on weekends than weekdays.

Table 31. Changes in Thermostat Settings of Power Manager Participants by Days of Week

Time period	Same on weekdays and weekends	Lower AC temperature on weekends	Higher AC temperature on weekends
6 a.m.-12 p.m.	86.3%	12.5%	0.0%
12 p.m.-5 p.m.	86.3%	12.5%	0.0%
5 p.m.-10 p.m.	96.3%	3.8%	0.0%
10 p.m.-6 a.m.	96.3%	3.8%	0.0%

Note: "Don't know" responses are not shown, so rows may total to less than 100%.

TecMarket Works divided Power Manager participants into two groups: those that turn their air conditioners on to a set temperature and leave it at that temperature all day, every day ("Non-

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adjusters"), and those that change their temperature settings ("Adjusters"). Figure 18 below shows that only 26.3% (21 out of 80 of Power Manager participants surveyed in the Carolina System are Adjusters.

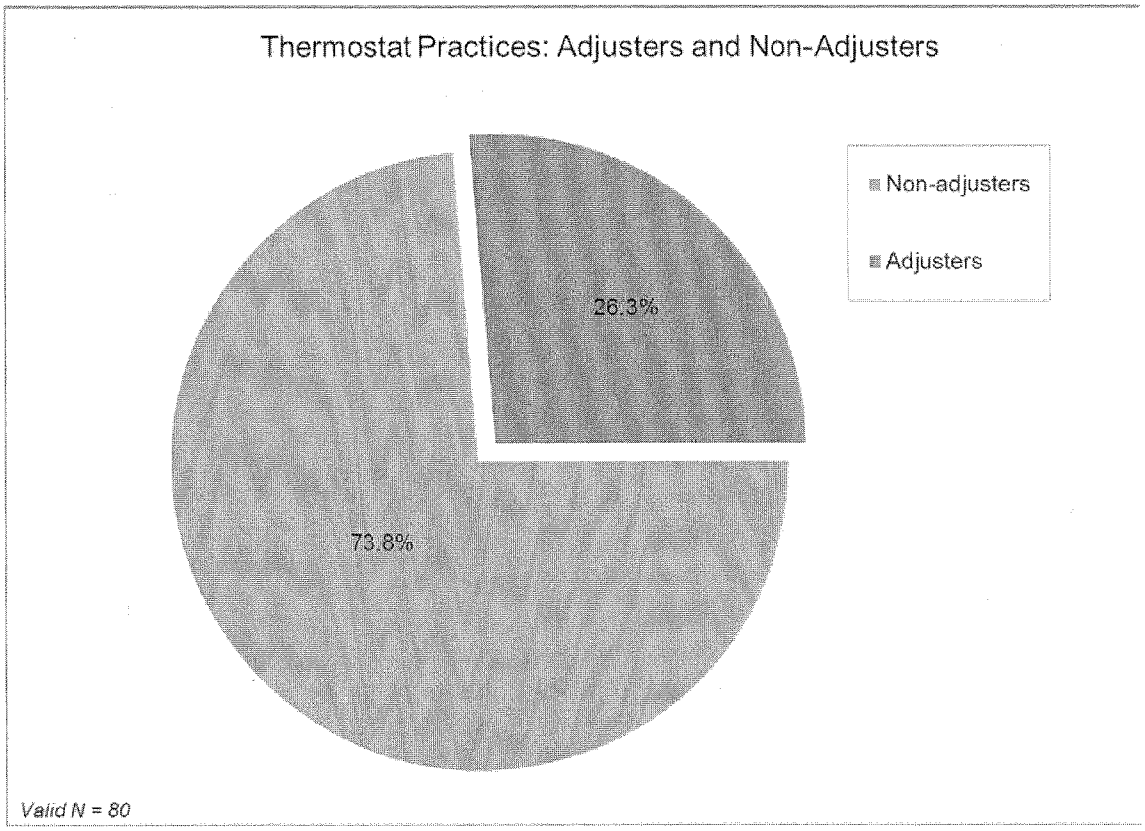

Figure 18. Thermostat Practices of Power Manager Participants

The outside temperature points at which Adjusters and Non-adjusters say they become uncomfortable and turn on their air conditioners are shown in Table 32.

Both Adjusters and Non-adjusters tend to become uncomfortable when the outside temperature reaches 85-87°F (as measured by the group medians). Both groups also tend to turn their air conditioners on when the outside temperature reaches 79-81°F. However, Non-Adjusters leave their thermostats set at 73-75°F throughout the week, while Adjusters usually have their thermostats set slightly higher (median 76-78°F) for most hours of the day, though they tend to turn the thermostat lower at night (median 73-75°F during weekdays10 p.m.-6 a.m.).

Table 32. Temperature Points for Non-Adjusters and Adjusters

Non-Adjusters (N=59)	
Median temperature range of discomfort	85-87°
Median temperature to turn AC on	79-81°
Median temperature thermostat setting (constant throughout day and week)	73-75°
Adjusters (N=21)	
Median temperature range of discomfort	85-87°

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Median temperature to turn AC on	79-81°
Median temperature thermostat setting weekdays 6 a.m.-noon	76-78°
Median temperature thermostat setting weekdays noon-5 p.m.	76-78°
Median temperature thermostat setting weekdays 5 p.m.-10 p.m.	76-78°
Median temperature thermostat setting weekdays 10 p.m.-6 a.m.	73-75°

Table 33 further illustrates that Adjusters are more likely to set their thermostats higher than Non-Adjusters: For every weekday time period, a higher percentage of Adjusters have set their thermostats to "78°F or higher" (the highest temperature category) or turned their AC units off. Between roughly a quarter (23.8% or 5 out of 21) and a third (33.3% or 7 out of 21) of Adjusters have their thermostats set high or AC units turned off at any given time during a weekday, compared to just 5.1% (3 out of 59) of Non-Adjusters (these differences are significant at $p<.05$ using Student's t-test for every part of the day).

Although more Adjusters set their thermostats high or turn off AC units during weekday mornings and afternoons (33.3% during 6 a.m.-5 p.m.), there are no statistically significant differences in the percent of thermostats set high and AC units turned off by time of day for either Adjusters or Non-Adjusters.

Table 33. Incidence of High Weekday Thermostat Settings by Adjusters and Non-Adjusters

Percent of participants who set thermostat to 78+ degrees or turn off AC during time period on a hot summer day	**Adjusters (N=21)**	**Non-Adjusters (N=59)**
Weekday 6 a.m.-12 p.m.	33.3%	5.1%
Weekday 12 p.m.-5 p.m.	33.3%	5.1%
Weekday 5 p.m.-10 p.m.	23.8%	5.1%
Weekday 10 p.m.-6 a.m.	28.6%	5.1%

Table 34 further illustrates that Non-Adjusters use their air conditioners more than Adjusters: While a little more than half of Adjuster households (57.1% or 12 out of 21) report using the AC to keep someone comfortable in the home on weekdays before 5 p.m., more than three-quarters of Non-Adjusters (83.1% or 49 out of 59) report using the AC to keep comfortable on weekdays before 5 p.m. (this difference is statistically significant at $p<.05$ using Student's t-test). After 5 p.m. on weekdays, virtually all Adjusters (100.0% of 21) and Non-Adjusters (96.6% or 57 out of 59) use their AC to keep comfortable in the home (this difference is not statistically significant).

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Table 34. AC Usage to Keep Someone Comfortable At Home on Weekdays for Adjusters and Non-Adjusters

Is the AC typically used to keep someone at home comfortable during…	Adjusters (N=21)	Non-Adjusters (N=59)
Weekday summer afternoons before 5 p.m.	57.1%	83.1%
Summer weekdays after 5 p.m.	100.0%	96.6%

Satisfaction with Duke Energy

Overall satisfaction with Duke Energy among these customers is quite high. Participants in the Carolina System report an overall average satisfaction score of 8.73 on a 10-point scale where "10" means very satisfied. The mean satisfaction rating is 8.65 in North Carolina and 8.95 in South Carolina (not a statistically significant difference). The distribution of responses is presented in Figure 19; only nine participants (11.3% of 80) rated their satisfaction with Duke Energy at a "7" or lower, while a plurality of 42.5% (34 out of 80) gave the highest possible "10 out of 10" ratings.

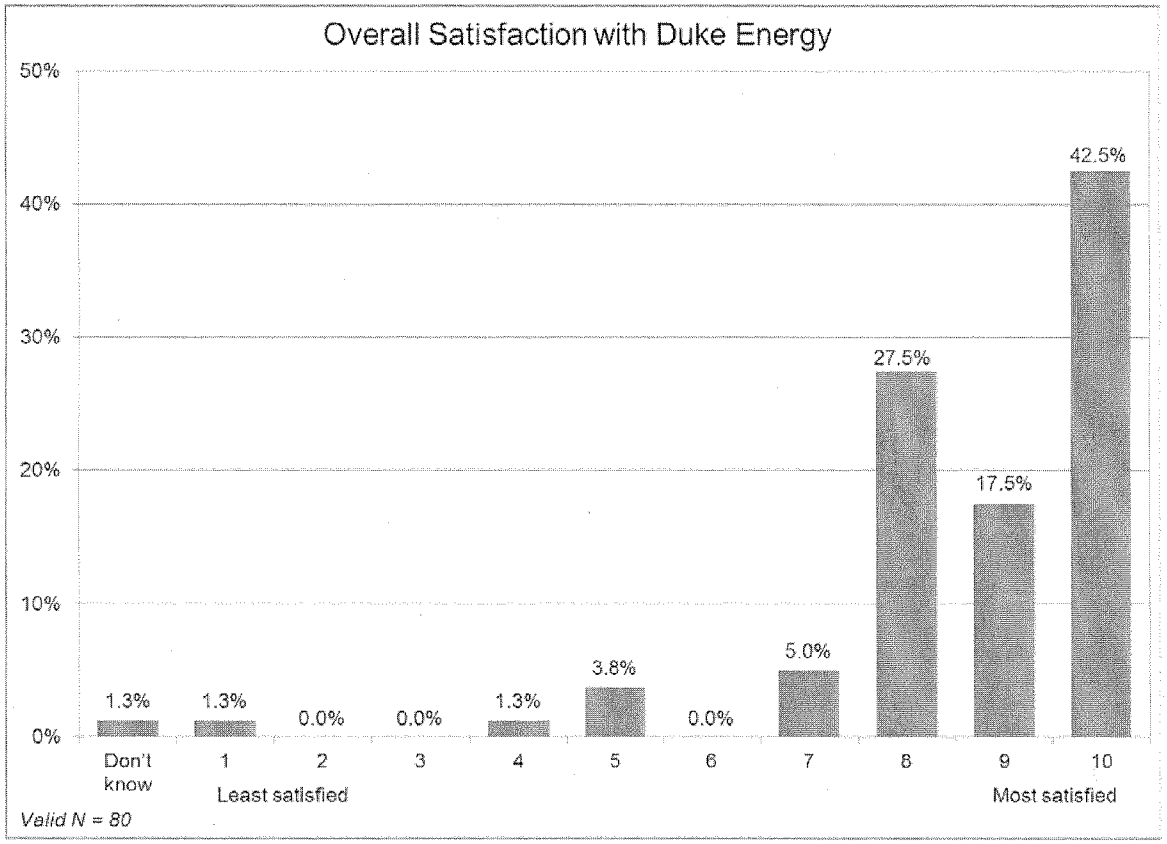

Figure 19. Overall Satisfaction with Duke Energy

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Participants in the Carolina System that gave a satisfaction score of "7" or lower were asked why they were less than satisfied with Duke Energy. Their responses are categorized and listed below.

Rates (N=7):

- *We rarely get a bill. We always get a disconnect notice without warning. We have all energy-efficient equipment, and set everything on energy-efficient settings, and we still have bills that are about $50 higher than they should be. They also charge ridiculous prices.*
- *The rates are high and seem to go up often. It feels like Duke is a bit slow when it comes to getting things fixed after storms. The customer service is pretty good.*
- *The rates are high and they keep getting higher. I have had problems with customer service when I call about how high our bills are. I've made many upgrades to increase the energy efficiency of the house but the bills are well over average and much higher than my neighbors. I've asked for someone to come and check the meter but they refuse. I know that there's something wrong and I just want someone to actually come and check the meter.*
- *They're raising the rates and I'm not happy with that.*
- *They're rates are high.*
- *Their rates seem higher.*
- *High rates are an issue, but their services are good.*

Other (N=2):

- *I lost power four times this summer. Right now, I'm not happy with them.*
- *They put a monitor on my A/C unit, and I have no control over it, and I wasn't even asked if I wanted it or not.*

Interest in Other Potential Energy Efficiency Programs

TecMarket Works asked Power Manager participants if they would be interested in a similar program for electric water heaters or other devices. As seen in Table 35, most participants (65.0% or 52 of 80) expressed interest in this program. Among the 15 participants who were not interested, most said it was because their water heaters do not run on electricity (60.0% or 9 of 15 participants who were not interested in this program).

Table 35. Interest in Programs to Cycle Water Heaters or Other Equipment

If Duke Energy were to offer a program that cycles other equipment at your home such as an electric water heater, would you be interested in participating?	Count	Percent (N=80)
Yes	52	65.0%
No (our water heater does not run on electricity)	9	11.3%
No (don't want to run out of hot water)	1	1.3%
No (other reasons, listed below)	5	6.3%
Don't know	13	16.3%

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Five participants who were not interested in participating in this potential program gave "other" reasons why they were not interested, which are listed below.

- *I don't use my appliances enough to make a difference.*
- *I live by myself so I don't think there would be much need for it.*
- *They don't give you a choice, they just do it and I have no control over it.*
- *I am not interested at this time.*
- Don't know

Participants were next asked if they had any suggestions for other programs or services Duke Energy could offer their customers. Sixteen participants (20.0% of 80) offered further suggestions.

Table 36. Other Programs or Services Duke Energy Should Provide

Are there any programs or services that you think Duke Energy should provide to its residential customers that are currently not provided?	Count	Percent (N=80)
Yes	16	20.0%
No	48	60.0%
Don't know	16	20.0%

The verbatim suggestions of the 16 respondents who suggested additional programs and services Duke Energy might offer are categorized and listed below.

Power Manager-related (N=2):

- *Automated notices that they're going to activate the Power Manager.*
- *A program that could cycle the heater or other electronics in the home.*

More information and communication (N=3):

- *Duke needs to provide better education and open the lines of communication between themselves and their customers.*
- *Offer information about utilizing solar energy for water heating.*
- *Send out more information on how to get rid of or recycle light bulbs.*

Other programs (N=7):

- *A program in which they provide contractors to caulk and seal windows and doors for a nominal price.*
- *Offer appliance repair services.*
- *A recycling program for washers and dryers*

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- *If they can find a way to correct the heat pumps and make them sellable and warm, then they've got a good one.*
- *A program that could somehow harness the energy generated by bicycles and exercise equipment.*
- *A program that offers free or discounted LEDs. I would like specialty LEDS and 60W, 75W and 100W-equivalent LEDs. But I would also be concerned about the light 'rendering' (white light vs. warm light) of the offered LEDs.*
- *I'd like to receive the comparison report less often; quarterly would be plenty.*

Rates (N=4):

- *They need to lower rates. It keeps going up and up. I don't like that at all.*
- *I'd like bigger rebates on anything, like my bill. They need to give senior citizens discounts.*
- *Lower the rates. Being an accountant, I kind of watch things. If I wanted to buy electricity from someone else, I couldn't. It's a monopoly here. They are wasting millions of dollars and public relations on advertising and events. They should be spending money on keeping our rates low. Also, they should be redirecting all these advertising dollars to burying more power lines to prevent outages.*
- *When I lived in Arizona the power company offered a 'Time of Use' program, where electricity usage cost more during peak hours. Customers had the option of joining the program and the company installed a special '1 hour meter' so the meter readers would have a usage reading for the different rates. I set up timers on things that would use a lot of electricity, like the pool pump and water heater, so those items would run during the off peak hours, which ended up saving me about $80 a month. The peak hours of usage were different during the warmer months and the colder months so I had to change the timers seasonally.*

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Event Surveys Results

TecMarket Works surveyed current Power Manager participants in order to better gauge their awareness of Power Manager events and their perception of discomfort caused by Power Manager curtailment events.

TecMarket Works conducted the event surveys regarding each event during a 27-hour window beginning at 5 p.m. EPT on the day that a curtailment event occurred and ending at 8 p.m. EPT the day after the curtailment event. Calling hours were 10 a.m.- 8 p.m. EPT following the full shed event which occurred on July 17 and regular events occurring on July 18, July 19, July 24, August 12, August 29, September 10 and September 11, 2013. TecMarket Works surveyed a total of 159 participants in the Carolina System (80 from North Carolina and 79 from South Carolina; 13 are Full Shed Event surveys and 146 are Regular Events). The Event survey protocol is located in *Appendix C: Event Survey Instrument* (the same survey is used for both Full Shed and Regular Events).

In order to control for customer perceptions and experiences not caused by Power Manager curtailment events, TecMarket Works also surveyed participants referencing days on which the temperature was high enough to trigger a curtailment event, but on which no curtailment event actually occurred. On and following the high temperature date of June 28, TecMarket Works surveyed a total of 36 participants in the Carolina System (11 from North Carolina and 25 from South Carolina). The high temperature Non-Event survey is located in *Appendix D: Non-Event Survey Instrument*.

Home Occupancy During Power Manager Activation

TecMarket Works asked Event respondents whether they were home during the actual event timeframe (typically between the hours of 1:30-5:30 p.m. EPT) and asked Non-Event survey respondents if they were home at 3 p.m. EPT on the date of the high temperature. The results in Figure 20 show that a little less than half of Regular Event respondents (45.9% or 67 out of 146) were at home, while majorities of Full Shed Event (76.9% or 10 out of 13) and Non-Event survey respondents (66.7% or 24 out of 36) were home during these times (Regular Events are significantly different from the other groups at $p<.05$ using Student's t-test).

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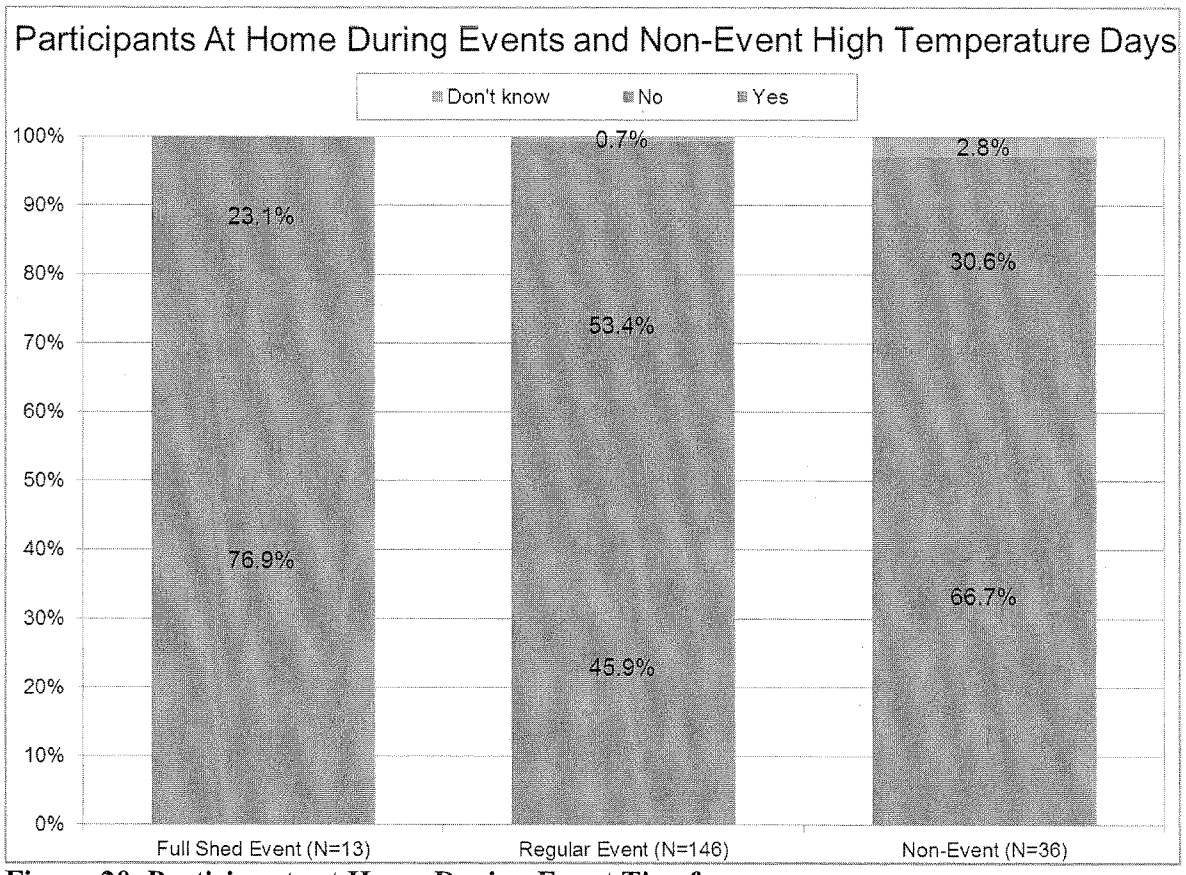

Figure 20. Participants at Home During Event Timeframe

General Awareness of Device Activations

In order to gauge awareness of the Power Manager device activation, TecMarket Works first asked Event and Non-Event participants if they were aware of a device activation occurring since they had joined the program. The results in Figure 21 show that a majority of Full Shed Event participants (69.2% or 9 out of 13) and a little less than half of Regular Event participants (44.5% or 65 out of 146) are aware that an activation had occurred at some point since their enrollment (this difference is significant at $p<.05$ using Student's t-test). About half of Non-Event participants (52.8% or 19 out of 36) are also aware of their device's activation since joining the program (not significantly different from either of the other groups). Only about 15% of surveyed participants are certain that Power Manager has not been activated, while up to a third or more are not sure if their device has been activated or not.

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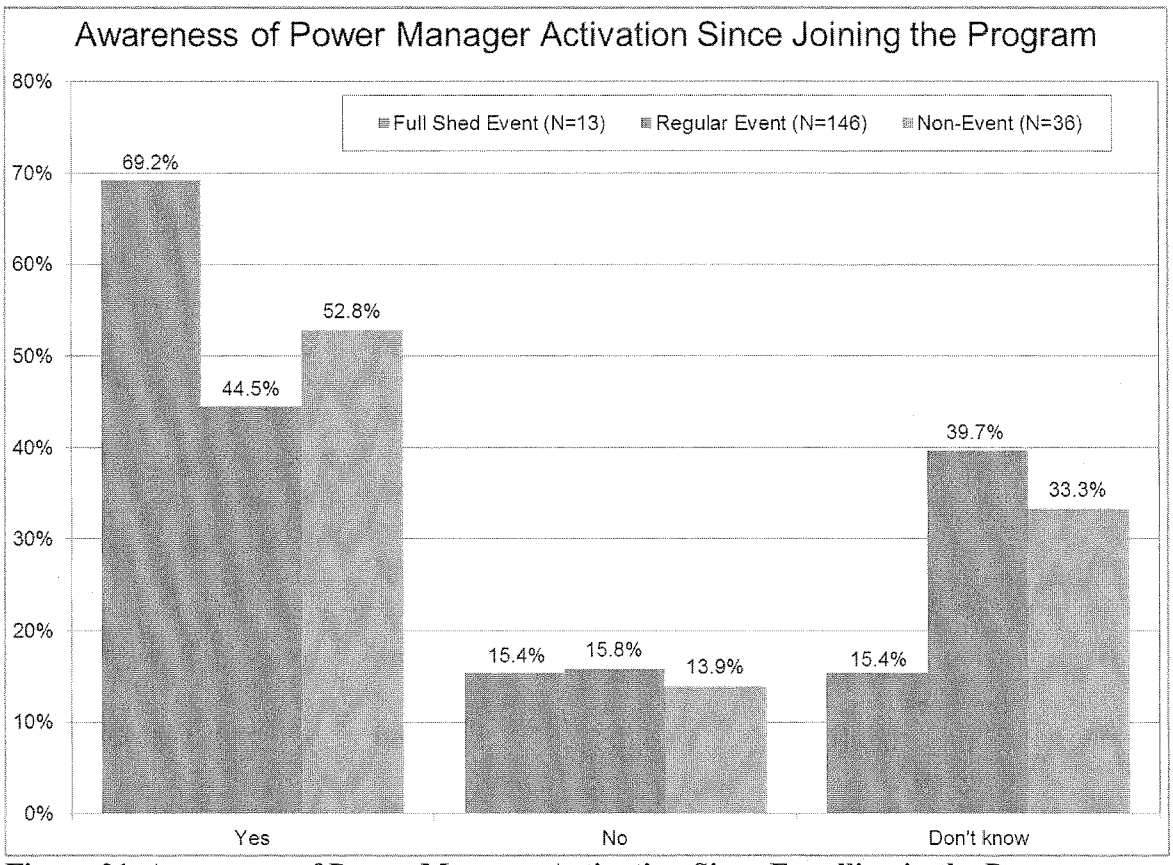

Figure 21. Awareness of Power Manager Activation Since Enrolling in the Program

TecMarket Works followed up the initial awareness question by asking participants an open-ended question as to how they knew that the Power Manager device had been activated. More than half of participants stated that they did not know how to tell if the Power Manager device had been activated, as seen in Table 37. For Regular Event participants, the most commonly mentioned indicator of Power Manager activation is "home temperature rises" (19.2% or 28 out of 146) followed by "air conditioning shuts down" (13.0% or 19 out of 146). For Full Shed Event participants, "air conditioning shuts down" (23.1% or 3 out of 13) is most-mentioned, followed by "home temperature rises" (15.4% or 2 out 13; differences between Full Shed and Regular Events are not statistically significant). For Non-Event participants, both of these indicators were mentioned by 11.1% (4 out of 36), along with "bill credits" (also 11.1% or 4 out of 36). There is only one statistically significant difference between groups: Non-Event participants are more likely to mention "bill credits" compared to Regular Event participants (4.1% or 6 out of 146; this difference is significant at $p<.05$ using Student's t-test).

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Table 37. Reasons for Awareness of Activation

	Full Shed Event Participants (N=13)	Regular Event Participants (N=146)	Non-Event Participants (N=36)
Home temperature rises	15.4%	19.2%	11.1%
AC shuts down	23.1%	13.0%	11.1%
The light on the meter is on	0.0%	3.4%	2.8%
Bill credits	0.0%	4.1%	11.1%
The light on the AC unit flashes	7.7%	2.7%	8.3%
Lower bills	0.0%	0.7%	2.8%
Fan goes into cycling mode / fan is on but AC is off	0.0%	2.1%	0.0%
Unique response (listed below)	0.0%	7.5%	2.8%
Don't know	61.5%	58.2%	58.3%

Note: Columns may total to more than 100% because respondents could give multiple responses.

Twelve participants offered unique responses to this question, which are listed below.

Regular Event participants (N=11)

- *Duke sends me info in the mail letting me know that the device was activated recently.*
- *My wife complains that the air conditioner is broken.*
- *Electricity fluctuations.*
- *The lights go off.*
- *My computer shuts off.*
- *I feel uncomfortable in the house.*
- *I currently don't know, because there used to be a notification light on the AC unit.*
- *Power cut back? Lights flicker? I'm not sure.*
- *By the time I noticed that I was feeling warm the heat pump started cooling the house again, so I didn't mind.*
- *I was here when it happened.*
- *I am not home during the day.*

Non-Event participants (N=1)

- *I had a Power Manager malfunction two weeks ago. The contractor came out and the system had been switched off for three days. The contractor reset the system late that evening. Before this malfunction, I had never noticed it going off before.*

Event participants' reasons for awareness of Power Manager activations are broken out separately in Figure 22 (Regular Events) and Figure 23 (Full Shed) for those who were aware that Power Manager had been activated since they joined the program, who were not aware, and who "don't know" if they were aware. Regular Event participants who were aware of Power Manager being activated were significantly less likely to not be able to name a reason why they

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were aware of the activation (aware but "don't know" reason 28.8% or 42 out of 146, versus not aware and "don't know" 100% or 23 out of 23 and don't know if activated and "don't know" reason 74.1% or 43 out of 58; differences are significant at $p<.05$ using Student's t-test). Among Full Shed Event participants, the sample size is too small for any of the differences in Figure 23 to be statistically significant.

Event participants who were aware that Power Manager has been activated since they joined the program were significantly more likely to mention "home temperature rises" (38.5% or 25 out of 65) as a reason why they know the device has been activated compared to the other groups (0% of 23 for "not aware" and 5.2% or 3 out of 58 for "don't know if aware"; differences are significant at $p<.05$ using Student's t-test).

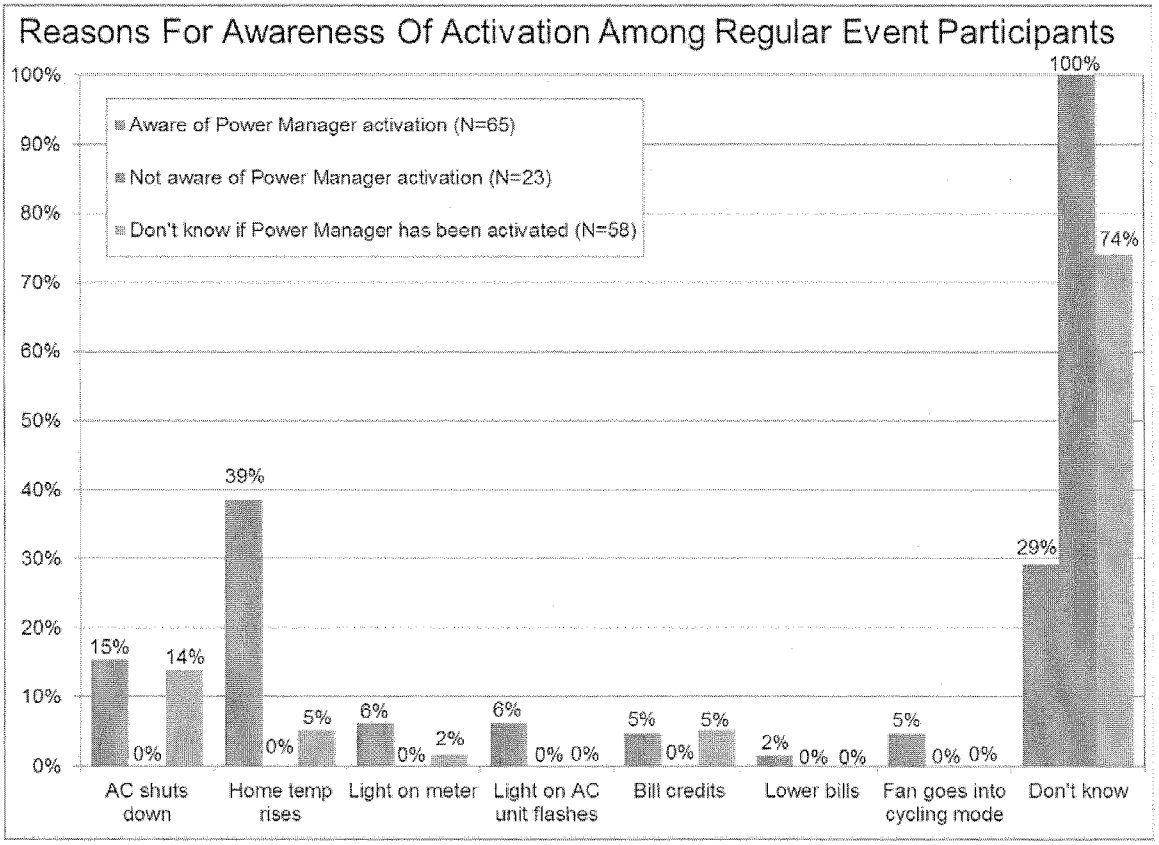

Figure 22. Reasons for Awareness of Power Manager Activation Among Regular Event Participants

Note: Multiple responses were allowed per participant.

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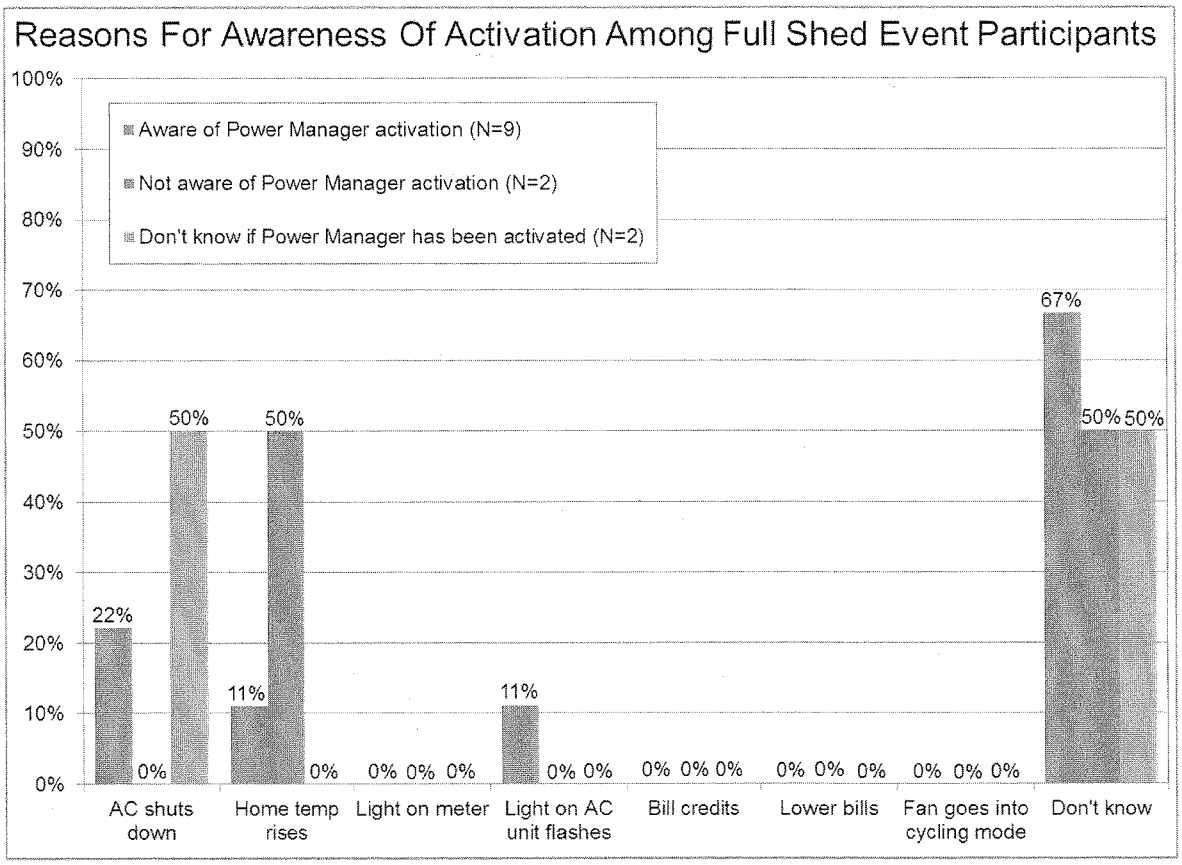

Figure 23. Reasons for Awareness of Power Manager Activation Among Full Shed Event Participants

Note: Multiple responses were allowed per participant.

Non-Event participants' reasons for awareness of Power Manager activation are broken out separately in Figure 24 for those who were aware that Power Manager had been activated since they joined the program, who were not aware, and who "don't know" if they were aware. Figure 24 shows a similar pattern to that of Event participants. Most of the Non-Event participants who believe that Power Manager has not been activated since they joined the program (60.0% or 3 out of 5) and most who state that they "don't know" how to tell if Power Manager is activated (91.7% or 11 out of 12) could not name a reason for their awareness of the device activating ("don't know"). This is significantly higher than the percentage of Non-Event participants aware of device activation who "don't know" how to tell if the device is activated (36.8% or 7 out of 19; significantly different from those who are not sure if Power Manager has been activated at $p<.05$ using Student's t-test. There are only five Non-Event participants who believe Power Manager has not been activated, which is too small for significance testing).

Two Non-Event participants who were not aware that Power Manager has been activated since they joined the program mentioned "bill credits" (40.0% of 5) and one Non-Event participant who was not sure if Power Manager has been activated mentioned "air conditioner shuts down" (8.3% or 1 out of 12). All of the remaining Non-Event participants who believe Power Manager

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has not been activated, or who are not sure if it has been activated, could not name any reasons for being aware of Power Manager activation.

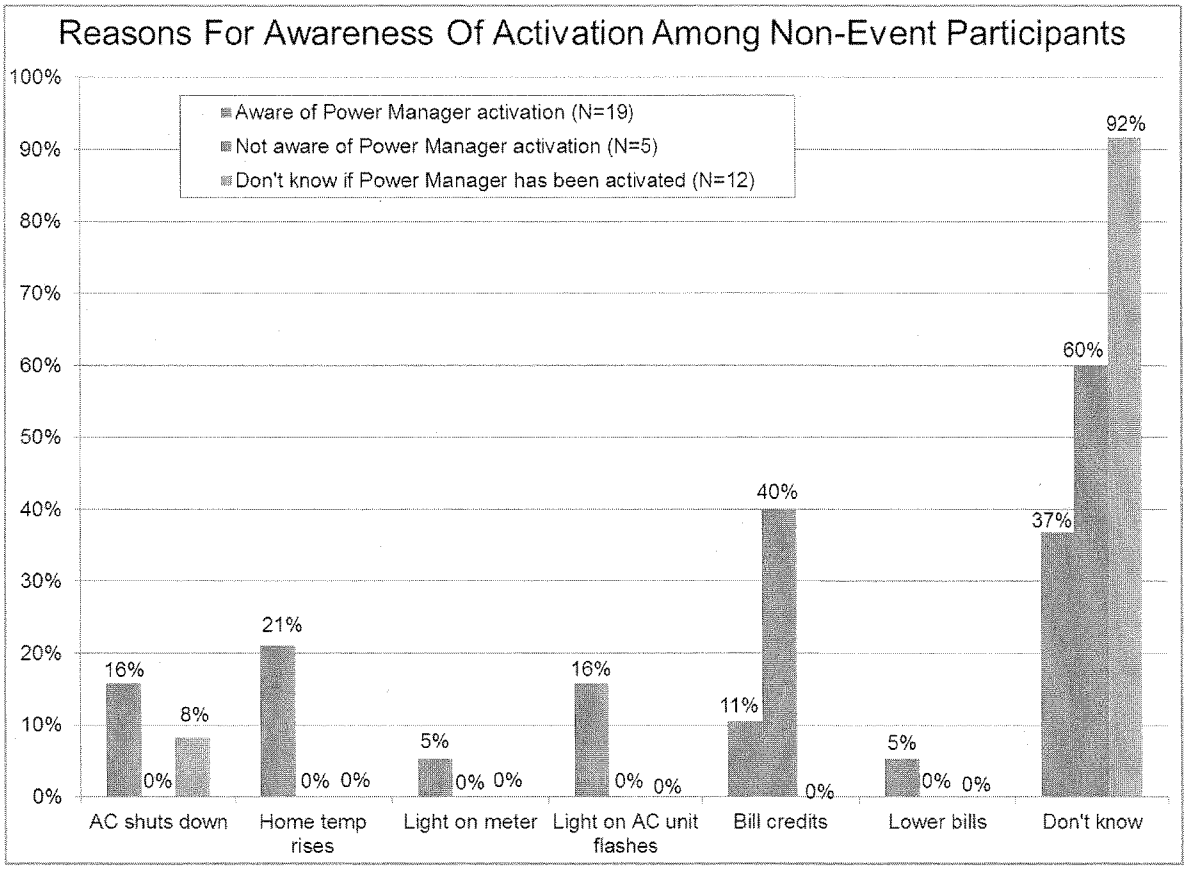

Figure 24. Reasons for Awareness of Power Manager Activation Among Non-Event Participants

Note: Multiple responses were allowed per participant

Figure 25 shows reasons for awareness of device activation for all Event and Non-Event groups combined. Among all 93 customers surveyed after Events or Non-Event high temperature days who were aware that their device has been activated since enrollment, the most-mentioned reason for being aware of activations is "home temperature rises" (32.3% or 30 out of 93; significantly higher than all other responses aside than "don't know" at $p<.05$ using Student's t-test). Among those who are not aware that their device has been activated since joining the program, the most-mentioned reason for awareness is "bill credits" (6.7% or 2 out of 30, significantly higher than all other responses aside from "home temperature rises" and "don't know" at $p<.10$ using Student's t-test), however 90.0% (27 out of 30) of these customers "don't know" how to tell if their device is activated. Among customers who "don't know" if their device has been activated, the two most-frequently mentioned reasons "home temperature rises" (16.7% or 12 out of 72) and "air conditioning shuts down" (12.5% or 9 out of 72) are mentioned significantly more often than any of the other responses aside from "don't know" ($p<.10$ or better using Student's t-test).

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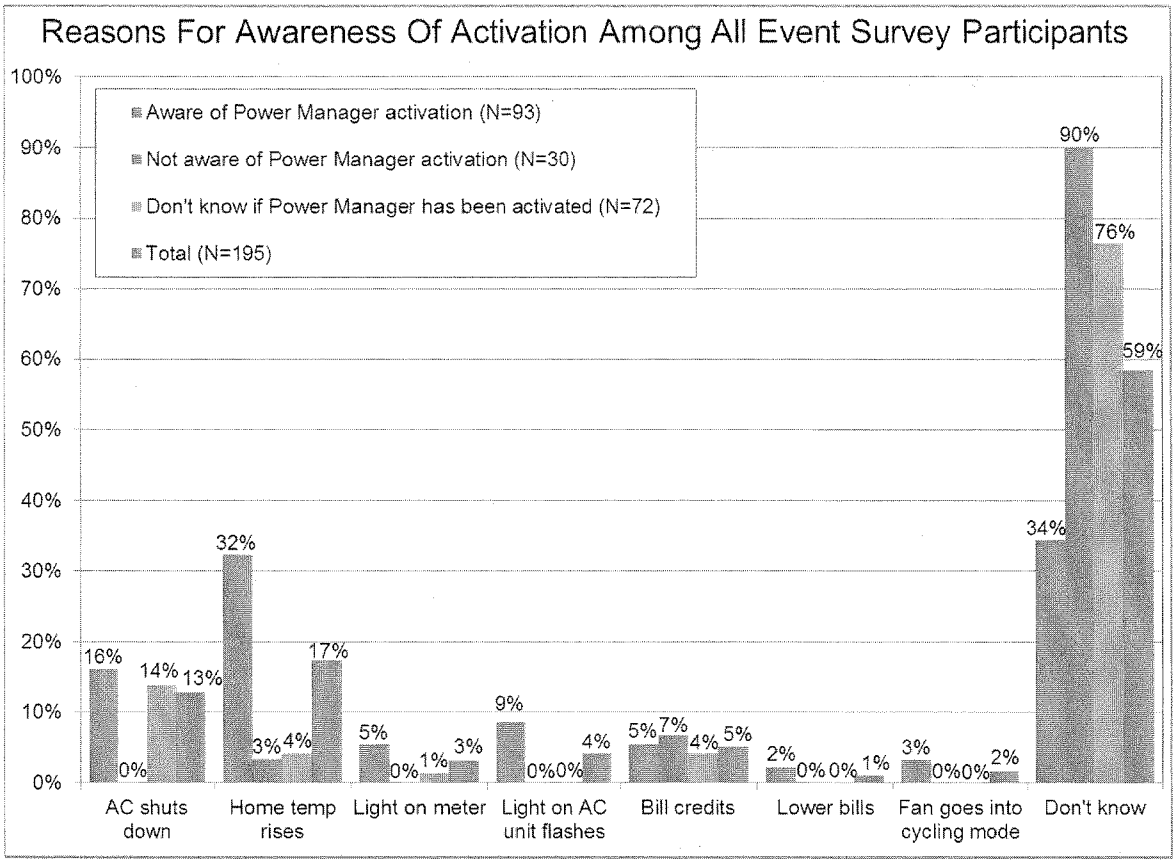

Figure 25. Reasons for Awareness of Power Manager Activation Among All Participants
Note: Multiple responses were allowed per participant; all Event and Non-Event respondents are combined in this chart.

Awareness of Activation and Monthly Billing

Table 38 shows differences in awareness of Power Manager activation according to whether participants receive their monthly energy bills by email notification to view online (referred to as "by email" in this report) or regular mail. There is no significant difference between these groups in overall awareness of Power Manager activation since joining the program. Participants who get their bills by email are more likely to mention "bill credits" (13.2% or 5 out of 38, versus 3.2% or 5 out of 154 for participants who receive their bills by mail) and "the light on the meter is on" (7.9% or 3 out of 38, versus 1.9% or 3 out of 154 for participants who receive bills by mail) as reasons for their awareness (both differences are statistically significant at $p<.05$ using Student's t-test).

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Table 38. Awareness of Activation: Mail Versus email

	Receive bills by mail (N=154)	Receive bills by email (N=38)
Aware of Power Manager activation since joining the program	47.4%	50.0%
How can you tell when Power Manager is activated?		
Home temperature rises	18.2%	13.2%
AC shuts down	13.6%	10.5%
The light on the meter is on	1.9%	7.9%
The light on the AC unit flashes	3.9%	5.3%
Bill credits	3.2%	13.2%
Lower bills	0.6%	2.6%
Don't know	59.7%	52.6%

Note: Full Shed Even, Regular Event and Non-Event participant results are combined in this table. Three participants were excluded from this table because they receive their bills through both mail and email, their bills are sent to a third party, or they didn't know how they receive their bills.

Table 39 compares awareness of Power Manager activation among participants who review their Duke Energy bills regularly (more than half the time) versus those who do not (less than half the time, never, and "don't know"). Participants who review their bills more than half the time are significantly more likely to be aware that Power Manager has been activated since they joined the program (52.9% or 82 out of 155, versus 27.5% or 11 out of 40 among those who check their bills less than half of the time; this difference is statistically significant at $p<.05$ using Student's t-test). Participants who check their bills more often were also significantly more likely to mention "home temperature rises" (19.4% or 30 out of 155) and "A/C shuts down" (15.5% or 24 out of 155) compared to those who read their bills less often (differences statistically significant at $p<.10$ or better using Student's t-test). Participants who do not review their bills often are less likely to be able to give any reasons for being aware of activation ("don't know" 80.0% or 32 out of 40) compared to those who regularly check their bills (52.9% or 82 out of 155, difference significant at $p<.05$ using Student's t-test).

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Table 39. Awareness of Activation: Reviewing Monthly Bills

	Every month / more than half the time (N=155)	Less than half the time / never / don't know (N=40)
Aware of Power Manager activation since joining the program	52.9%	27.5%
How can you tell when Power Manager is activated?		
Home temperature rises	19.4%	10.0%
AC shuts down	15.5%	2.5%
The light on the meter is on	3.9%	0.0%
The light on the AC unit flashes	3.9%	5.0%
Bill credits	5.8%	2.5%
Lower bills	1.3%	0.0%
Don't know	52.9%	80.0%

Note: Full Shed Event, Regular Event and Non-Event participant results are combined in this table.

Table 40 shows differences between customers who participate in the Power Manager program according to the method they use to pay their bills. The group of customers that is the most likely to be aware of Power Manager activation is the "pay other ways" group (most of these customers pay by phone, in-person, or through banks or credit unions: 66.7% or 14 out of 21 report that they are certain Power Manager has been activated since they joined the program, significantly higher than other respondents at $p<.05$ using Student's t-test). However, "pay other way" customers are also the most likely to say they don't know how to tell when Power Manager is activated ("don't know" 71.4% or 15 out of 21, significantly higher than other respondents at $p<.10$ using Student's t-test). Customers who pay via mail are the most likely to be aware of activations because "home temperature rises" (24.1% or 21 out of 87, significantly higher than other respondents at $p<.05$ using Student's t-test). Customers who pay online via the Duke Energy website are the most likely to notice "bill credits" (19.4% or 7 out of 36, significantly higher than other respondents at $p<.05$ using Student's t-test).

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Table 40. Awareness of Activation: Paying Monthly Bills

	Pay by mail with check (N=87)	Pay online through Duke Energy website (N=36)	Have Autopay set up for account (N=50)	Pay other ways (N=21)
Aware of Power Manager activation since joining the program	43.7%	41.7%	52.0%	66.7%
How can you tell when Power Manager is activated?				
Home temperature rises	24.1%	11.1%	18.0%	0.0%
AC shuts down	14.9%	11.1%	10.0%	14.3%
The light on the meter is on	1.1%	2.8%	6.0%	4.8%
The light on the AC unit flashes	4.6%	5.6%	2.0%	4.8%
Bill credits	1.1%	19.4%	2.0%	4.8%
Lower bills	1.1%	2.8%	0.0%	0.0%
Don't know	57.5%	58.3%	54.0%	71.4%

Note: Full Shed Event, Regular Event and Non-Event participant results are combined in this table. One respondent who did not know how they usually pay their bills is not included in this table. "Pay other ways" includes telephone and in-person payments as well as payments made through banks and credit unions.

Awareness of Power Manager Device Activation in the Past Seven Days

TecMarket Works then asked both Event and Non-Event participants who were home during the event (or high temperature non-event) whether they were aware of their Power Manager device being activated in the past seven days. However, in the case of the Non-Event participants, such activation had not occurred[11]. These results are shown in Figure 26.

As seen in Figure 26, just 20.0% (2 out of 10) of Full Shed Event participants and 13.4% (9 out of 67) of Regular Event participants were aware of a Power Manager activation, while larger numbers believed there had been no event, and majorities of 50% or more did not know whether an activation had occurred or not.

Compared to Event participants, none of the Non-Event participants who were home during the high temperature day believed there had been a Power Manager activation in the past seven days (0% of 24; statistically different from Full Shed and Regular Event participants at $p<.05$ using Student's t-test). A larger number of Non-Event participants (50.0% or 12 out of 24) correctly stated that there had been no Power Manager event in the past seven days (significantly different from Regular Event participants at $p<.05$ using Student's t-test), while the remaining Non-Event participants (50.0% or 12 out of 24) said they could not tell if there had been a Power Manager activation or not.

[11] Non-Event surveys in the Carolina System were completed in June, before any 2013 Power Manager activation events had occurred.

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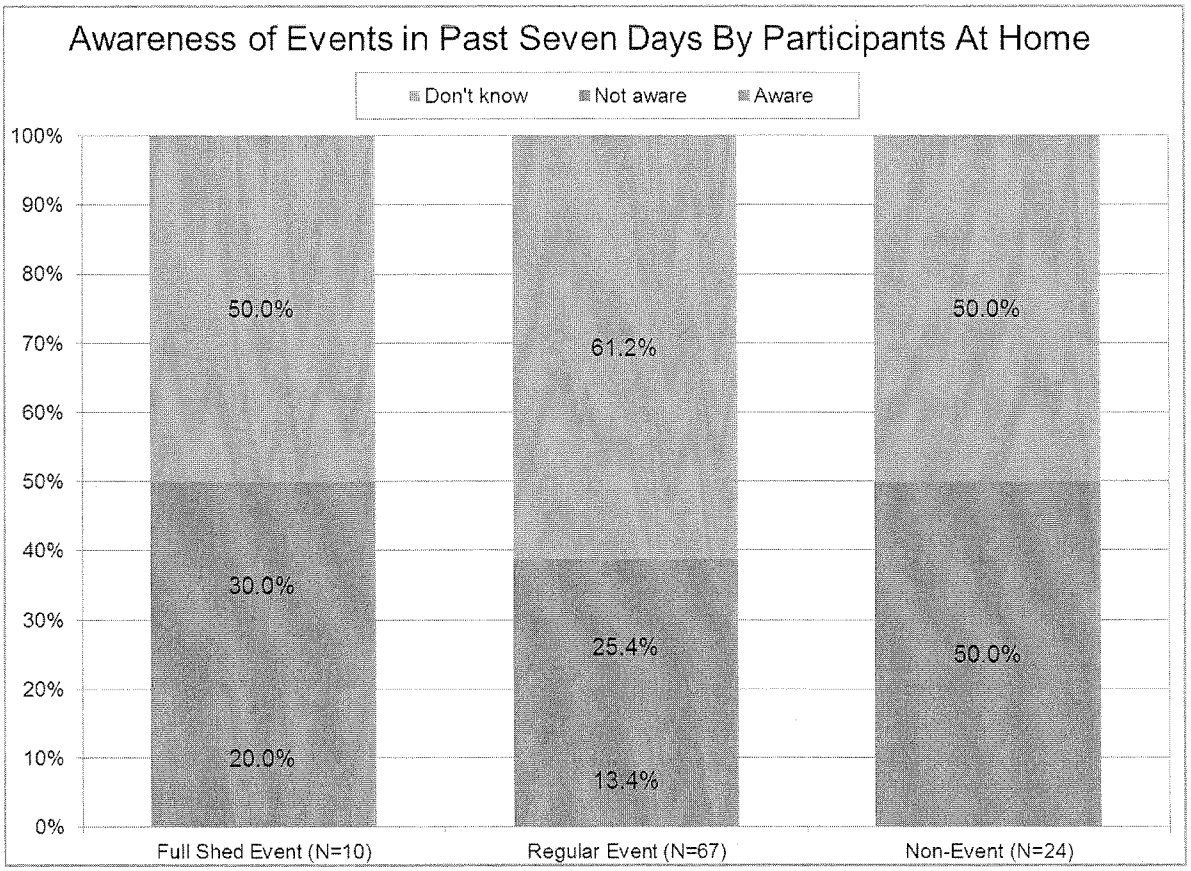

Figure 26. Awareness of Activation in Past Seven Days by Participants at Home

TecMarket Works also asked participants who were not at home during the event timeframe (or high temperature non-event day) whether they were aware of a Power Manager device activation. As shown in Figure 27, only 1.3% (1 out of 67) of Regular Event participants and none (0% of 3) of the Full Shed Event participants who were not at home during an event thought that a Power Manager activation had occurred. A slightly higher 9.1% (1 out of 11) of Non-Event participants who were not at home thought that a Power Manager activation had occurred although there was no activation event for this group.

Event participants who were home during a Power Manager event were significantly more likely to believe there was an activation than Event participants who were not at home (significant at $p<.05$ using Student's t-test for Full Shed Events and Regular Events).

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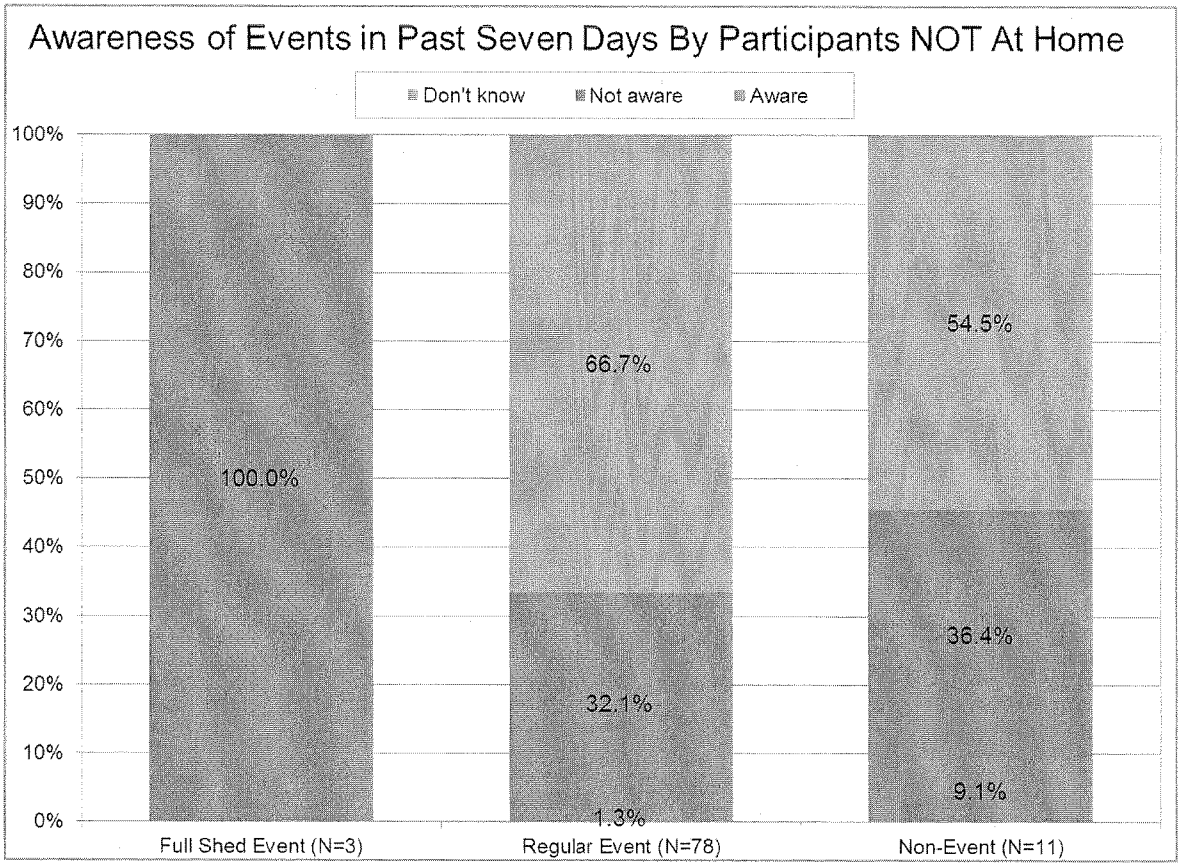

Figure 27. Awareness of Activation in Past Seven Days by Participants NOT at Home

Changes in Comfort and Comfort Drivers

The next part of the survey for both Event and Non-Event participants dealt with any perceived change in comfort being ascribed to a Power Manager activation and whether there were other drivers of that comfort change beyond the activation.

TecMarket Works asked two comfort related questions to the Event and Non-Event participants who indicated that they or a family member were home during the event or high temperature. The first question asked for the participant to rate their level of comfort before the activation or time of high temperature on a 1-to-10 scale with one being very uncomfortable and ten being very comfortable. TecMarket Works then asked participants to rate their comfort level during the event or time of high temperature using the same scale.

Figure 28 below shows that although the majority of both Regular Event and Non-Event survey respondents indicated no change in their comfort level during the Power Manager activation or time of high temperature, most of those who were surveyed after the Full Shed event reported a decline in comfort (87.5% or 7 out of 8 full shed event participants at home during the event; this is significantly higher than the other groups at $p<.05$ using Student's t-test). Participants who were at home during a "regular" Power Manager event were also significantly more likely to notice a decrease in comfort (31.1% or 19 out of 61) compared to Non-Event participants for

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whom there was no device activation (8.7% or 2 out of 23; significant at p<.05 using Student's t-test).

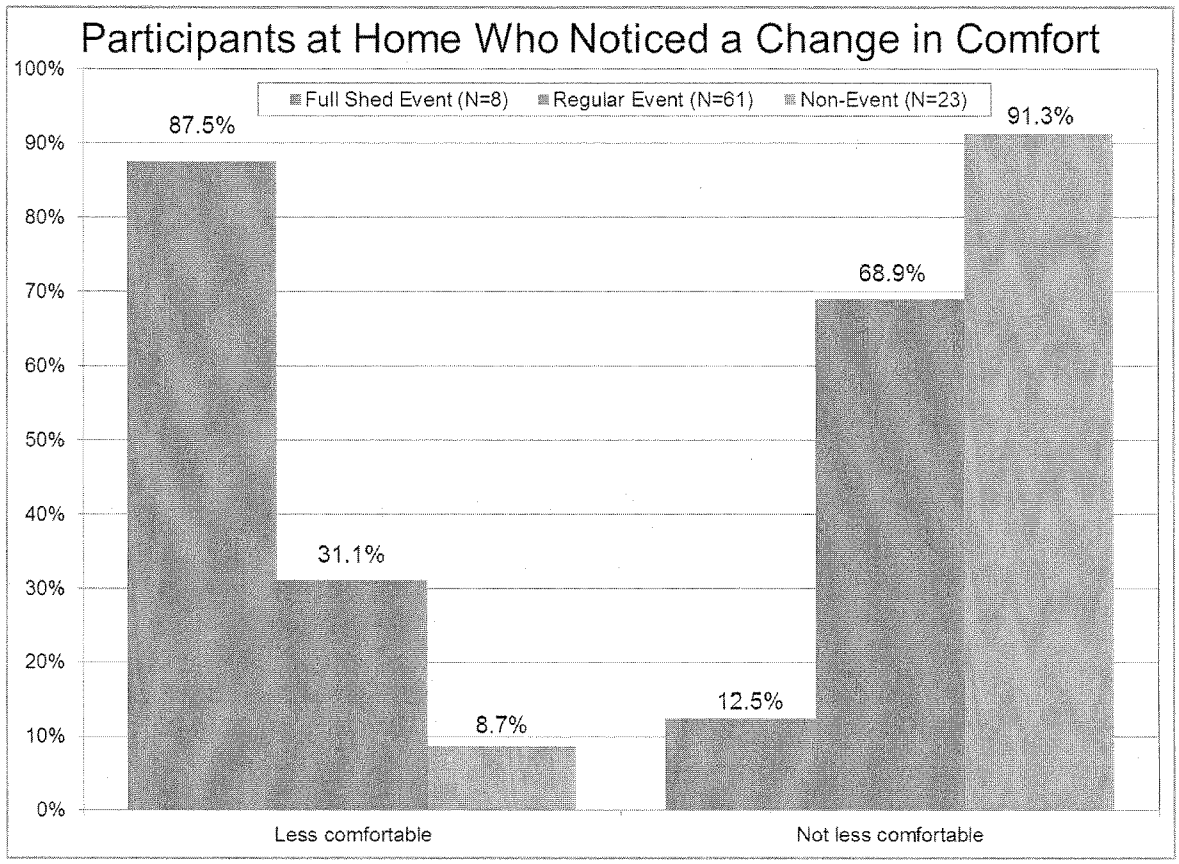

Figure 28. Comfort Change Perception by Participants at Home
Note: Only respondents who answered both comfort rating questions are included in this table.

There is also a significant difference between North and South Carolina in Power Manager participants noticing a decline in comfort during events, shown in Figure 29. Both of the surveyed Non-Event participants who noticed a decline in comfort live in North Carolina, so the percent noticing a decline is 28.6% (2 out of 7) in North Carolina and 0.0% (0 out of 16) in South Carolina (this difference is statistically significant at p<.05 using Student's t-test). While the difference between Regular Event and Non-Event participants noticing a decline in comfort is statistically significant in South Carolina (36.4% or 12 out of 33 for Regular Events and 0.0% or 0 out of 16 for Non-Events, significant at p<.05 using Student's t-test), this difference is not significant in North Carolina (25.0% or 7 out of 28 for Regular Event participants and 28.6% or 2 out of 7 for Non-Event participants). However, in both states an overwhelming majority of Full Shed Event participants reported a decline in comfort (80.0% or 4 out of 5 in North Carolina and 100% of 3 in South Carolina).

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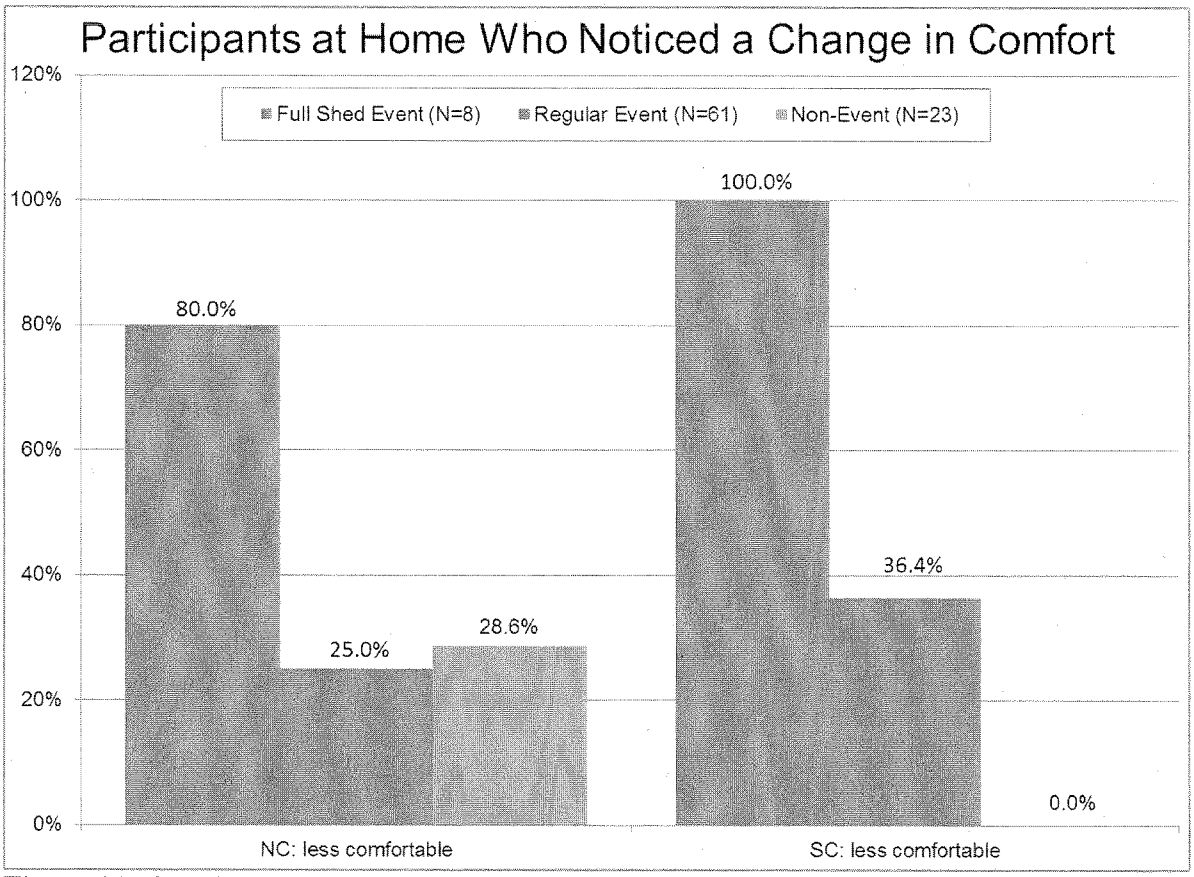

Figure 29. Comfort Change Perception by Participants at Home by State
Note: Only respondents who answered both comfort rating questions are included in this table.

Table 41 shows the mean ratings for before and during the event or high temperature as well as the high, low and mean differences for Full Shed Event, Regular Event and Non-Event participants. Customers from all three groups give similar ratings for comfort before the activation event or non-event high temperature day (9.00 for Full Shed Events, 8.87 for Regular Events, 8.96 for Non-Events). During the event or non-event high temperature day, Full Shed Event participants report a significantly lower level of comfort (6.63), compared to Regular Events (8.33) and Non-Events (8.78; both groups different from Full Shed at $p<.05$ using ANOVA). The decline in comfort ratings among Full Shed Event participants of 2.38 points during an event is statistically significant ($p<.05$ using Student's t-test), and the decline of 0.54 points among Regular Event participants is also statistically significant ($p<.05$ using Student's t-test), while the decline in comfort ratings for Non-Events (0.17 points) is not statistically significant.

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Table 41. Comfort Rating Differences for Events and Non-Events by Customers at Home

	Full Shed Event (N=8)	Regular Event (N=61)	Non-Event (N=23)
Mean comfort rating before event or high temperature day	9.00	8.87	8.96
Mean comfort rating during event or high temperature day	6.63	8.33	8.78
Mean difference of ratings	-2.38	-.054	-0.17
Highest difference (among those who became less comfortable)	5	7	5
Lowest difference (among those who became less comfortable)	1	1	1

Note: Only respondents who answered both comfort rating questions are included in this table.

Table 42 shows the range of comfort decline among those respondents who reported a decline in comfort. The average reported decline in comfort is about the same for Full Shed Event participants (declined by 2.71), Regular Event participants (declined by 2.53) and Non-Event participants (declined by 3.00). Although as previously reported in Figure 28, the percentage of participants whose comfort declined is significantly greater for Full Shed and Regular Event participants than for Non-Event participants.

Table 42. Comfort Rating Differences for Events and Non-Events Among Those Who Reported Their Comfort Level Declined During Event or High Temperature Day

	Full Shed Event (N=7)	Regular Event (N=19)	Non-Event (N=2)
Mean of pre-event comfort rating	8.86	8.74	8.50
Mean of rating during event or high temperature	6.14	6.21	5.50
Mean difference of ratings	-2.71	-2.53	-3.00
Comfort rating declined by 1 point	42.9%	36.8%	50.0%
Comfort rating declined by 2 points	14.3%	31.6%	0.0%
Comfort rating declined by 3 points	0.0%	5.3%	0.0%
Comfort rating declined by 4 points	14.3%	5.3%	0.0%
Comfort rating declined by 5 points	28.6%	15.8%	50.0%
Comfort rating declined by 6 points	0.0%	0.0%	0.0%
Comfort rating declined by 7 points	0.0%	5.3%	0.0%

Note: Only respondents whose comfort ratings declined during the event/high temperature day are included in this table.

Figure 30 shows the percentage of participants who reported a decline in comfort by the outdoor high temperature on the day of the event or non-event. In the Carolina System during the 2013 cooling season, Regular Power Manager activation events occurred on days when the outdoor high temperature ranged from 87 to 93 degrees. The only full shed event occurred on a day (July 17) when the high temperatures were 90 in North Carolinas and 92 in South Carolina, while the only surveyed non-event high temperature day had highs of 91 degrees (in North Carolina) and

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94 degrees (in South Carolina). By design, activation events occur on days when electricity demand for cooling is at its highest, which tend to be the hottest days of the season; in 2013, there was only one sufficiently high temperature day in the Carolina System where there was not a Power Manager activation event. Thus there are no Non-Event respondents who were surveyed for days when the temperature was 90 degrees or less, as well as no Full Shed Event respondents surveyed on days when the temperature was 93 or higher.

On surveyed days when the high temperature was 90 degrees or lower, Full Shed Event respondents are significantly more likely to report a decline in comfort (80% or 4 out of 5) compared to Regular Event respondents (22.7% or 5 out of 22; significant at $p<.05$ using Student's t-test). On days when the temperature peaked at 91 or 92 degrees, Full Shed Events are more likely to report a decline in comfort (100% or 3 out of 3) than either Regular Events (33.3% or 7 out of 21) or Non-Events (28.6% or 2 out of 7; differences significant at $p<.05$ using Student's t-test). When the temperature was 93 or 94 degrees (the hottest outdoor high temperatures of 2013 in the Carolina System), significantly more Event participants (38.9% or 7 out of 18) than Non-Event participants (0.0% out of 16) reported a decline in comfort (significant at $p<.05$ using Student's t-test).

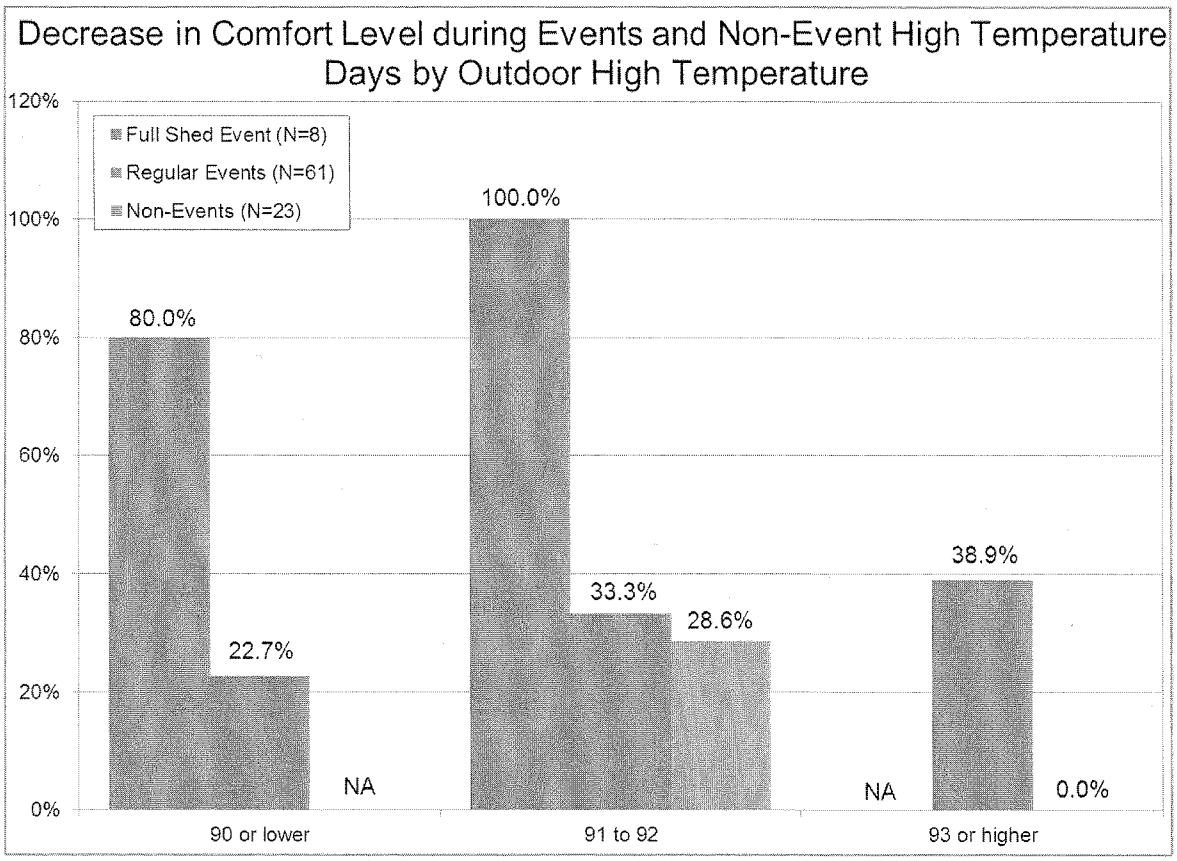

Figure 30. Decrease in Comfort by Outdoor High Temperature

Note: There was only one surveyed non-event high temperature day in the Carolina System during the 2013 cooling season (June 28); on this date the outdoor high temperature was 91 degrees in North Carolina and 94 degrees in South Carolina. During the only full shed event of

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the season (on July 17), the outdoor high temperature was 90 degrees in North Carolina and 92 degrees in South Carolina.

The complete distribution of high temperatures for event and non-event days in the Carolina System can be found in Table 1 on page 14. For further discussion, see *Comfort Ratings by High Temperature* on page 95.

Participant Perceptions Relative to Comfort Change

TecMarket Works asked participants who noted a change in comfort during the event or non-event timeline an open-ended question as to what they believe caused the change in comfort. The responses are shown below in Figure 31. The vast majority of Event participants who reported a decrease in their comfort level during an event attribute their change in comfort to rising outdoor temperatures (85.7% or 6 out of 7 for Full Shed and 89.5% or 17 out of 19 for Regular Events). Among the two Non-Event participants who reported a decrease in comfort ratings, one blamed rising humidity (50% of 2) and one was not sure of the cause ("don't know" 50% of 2).

Only one Regular Event participant (5.3% of 19) and none of the Full Shed Event (0% of 7) or Non-Event participants (0% of 2) cited Power Manager as contributing to their decline in comfort. Power outage was mentioned as a factor contributing to comfort change by only one Regular Event respondent (5.3% of 19) and nobody (0%) from the other two groups.

This data – along with the data from Figure 26 showing that only a small minority of Event participants who were at home were aware of Power Manager device activations occurring – suggests there is uncertainty among many participants as to how Power Manager affects their air conditioner and home comfort level. That is, many participants may be unaware that the Power Manager device is causing the changes they feel in comfort.

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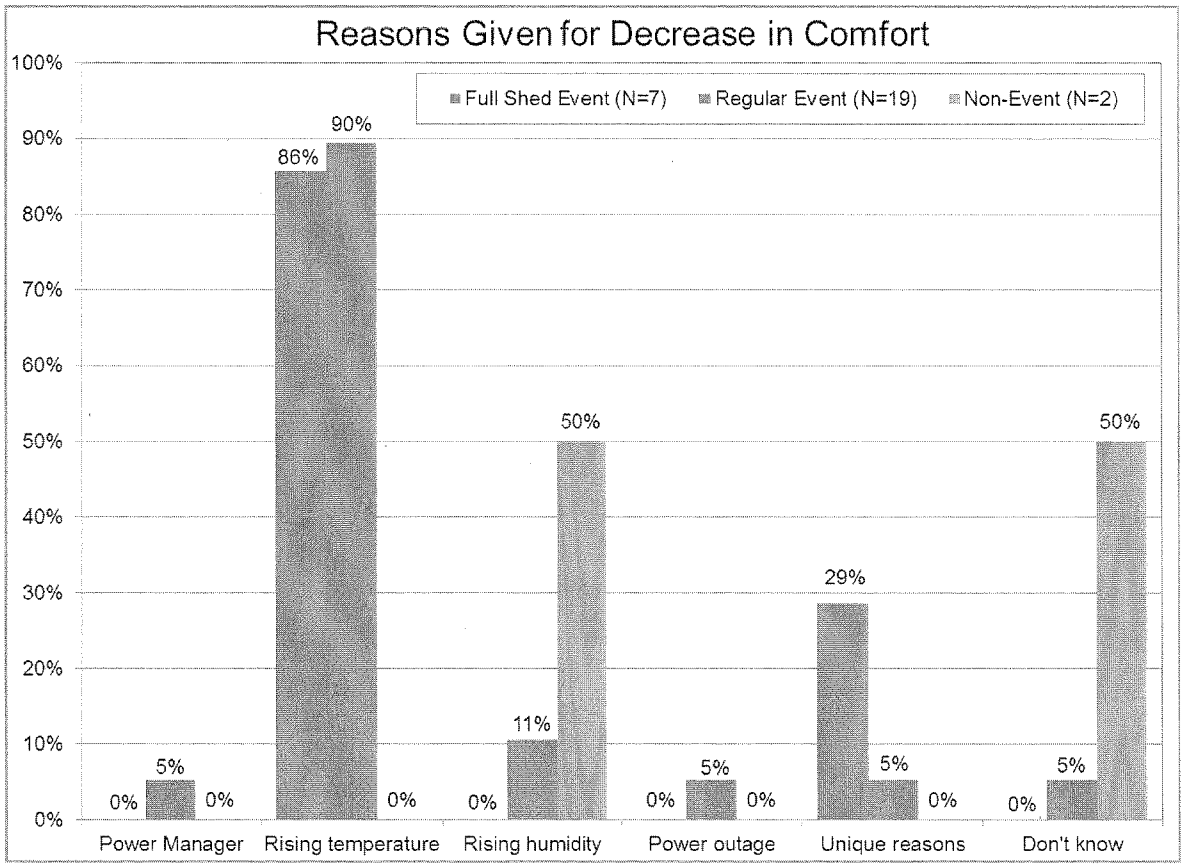

Figure 31. Reasons for Comfort Change

Note: Only respondents whose comfort ratings declined during the event/high temperature day are included in this table.

Three surveyed Event participants blamed other factors for their decrease in comfort ratings; these are listed below.

Full Shed Event participants (N=2)

- *I noticed that my home got hotter last year during an event, but it was something that I didn't mind. However I am having health problems this year that makes the increase in heat unbearable.*
- *I did not notice a decrease in comfort.* [This respondent rated their comfort before the event at "7" out of 10, and their comfort during the event at "6" out of 10.]

Regular Event participants (N=1)

- *I have been experiencing hot flashes while taking a new medication.*

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Summary of Event Awareness, Declines in Comfort and Blaming Power Manager

Figure 32 shows the overall percentages of surveyed Event and Non-Event participants who were at home during the event or non-event high temperature day, who were aware of an event (or believed there was an event on a non-event high temperature day), those whose comfort ratings showed a decline in comfort during the event or non-event high temperature day, and finally the percentage who blame Power Manager for their decline in comfort.

There are several statistically significant differences between participant groups: Regular Event participants were less likely to be at home than the other two groups ($p<.05$ using Student's t-test); Full Shed Event participants are more likely than Non-Events to be aware of an activation event in the past seven days ($p<.10$ using Student's t-test), although there is no significant difference in awareness between Regular Events and Non-Events. Full Shed Events are also much more likely than either of the other groups to report a decrease in comfort after device activation ($p<.05$ using Student's t-test), while there is no significant difference between Regular Events and Non-Events in terms of comfort decline. There is no statistically significant difference between participant groups in terms of blaming Power Manager for a decrease in comfort (only one Regular Event respondent blamed Power Manager).

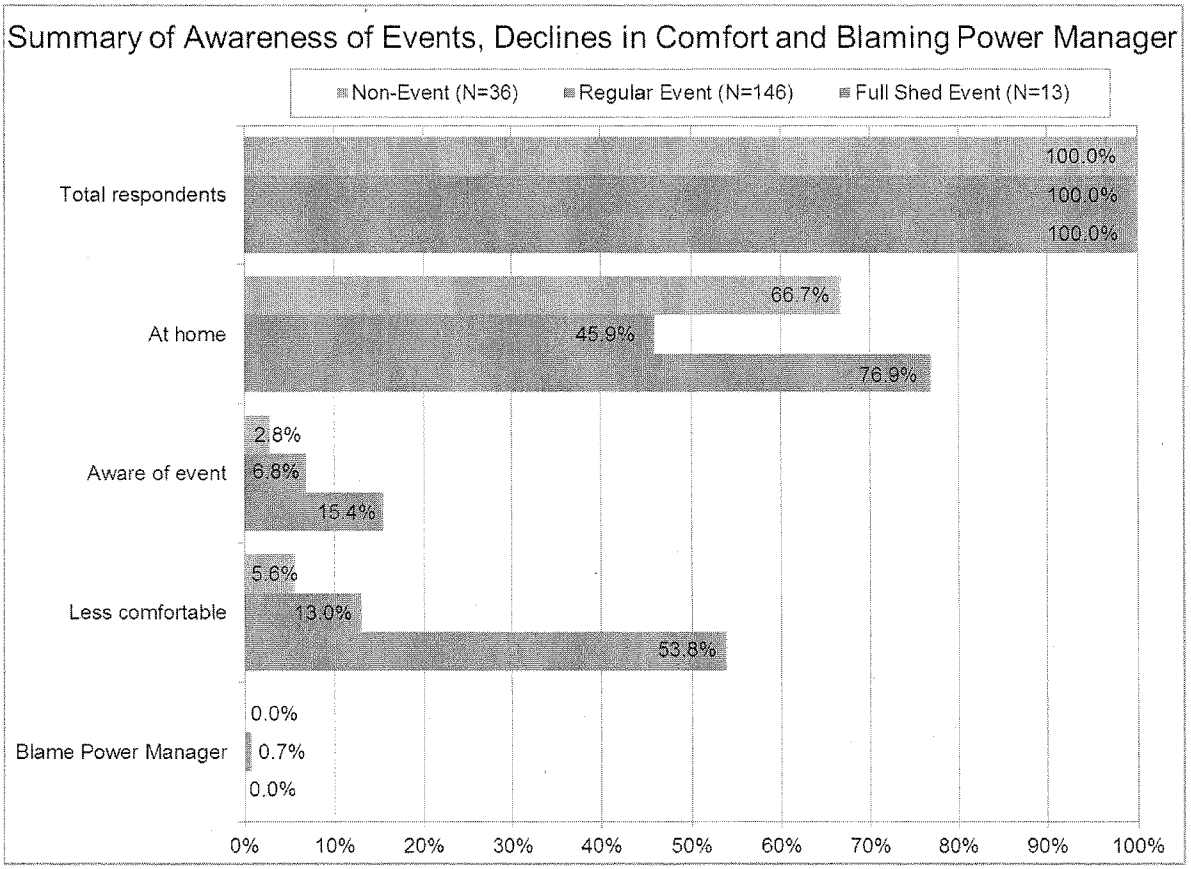

Figure 32. Summary of Event Awareness, Declines in Comfort and Blaming Power Manager

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Decreases in Comfort and Age of Air Conditioning Units

Only one Event participant in the Carolina System blamed Power Manager for their decrease in comfort; their air conditioning unit is less than 6 years old. Among the 28 surveyed participants who reported a decline in comfort, half (50% or 14 out of 28) have air conditioners that are less than 6 years old. Table 43 shows the distribution of air conditioner ages among participants who were home during an event and provided comfort ratings, with all survey groups combined. Participants who reported a decrease in comfort ratings are more likely to have air conditioners that are more than 20 years old (14.3% of 28) than those whose comfort did not decline (4.7% or 3 out of 64; this difference is significant at $p<.10$ using Student's t-test).

Table 43. Age of Air Conditioners among Participants Whose Comfort Declined

Age of air conditioner	Comfort Rating Decreased (N=28)	Comfort Rating Did Not Decrease (N=64)
0 to 6 years old	50.0%	51.6%
7 to 12 years old	17.9%	20.3%
13 to 20 years old	7.1%	10.9%
More than 20 years old	14.3%	4.7%
Don't know / not specified	10.7%	12.5%

Note: Only respondents who were at home and gave both comfort ratings are included in this table. Full Shed Events, Regular Events and Non-Events are combined in this table.

Behaviors During Event Activation

TecMarket Works asked several questions regarding behavior associated with a Power Manager device activation.

Thermostat Adjustments

Participants who indicated that they or a family member had been home during the time of the event or high temperature non-event day were asked if they had adjusted their thermostat during that time.

Seven Regular Event participants (10.4% of 67 at home during the event) stated that they adjusted their thermostats: three turned their thermostats down by one degree, and four turned their thermostats down two degrees. The average change for these seven Event respondents was down 1.6 degrees.

None of the ten Full Shed Event participants (0.0%) and none of the 24 Non-Event participants (0.0%) at home during the high temperature day stated that they had adjusted their thermostats.

Use of Fans and Other Ways to Keep Cool

Participants who indicated that they or a family member had been home during the time of the event or high temperature period were then asked if they had turned on any fans during that time period. This was the most common response to high temperatures reported by respondents; the results are shown in Table 44. There is no significant difference between surveyed Event and Non-Event participants.

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Table 44. Did You or Your Family Turn on a Fan During Event or High Temperature?

Base: at home during event or high temperature day	Full Shed Event (N=10)	Regular Event (N=67)	Non-Event (N=24)
Yes	50.0%	34.3%	41.7%
No	50.0%	58.2%	58.3%
Don't Know	0.0%	7.5%	0.0%

Participants were also asked an open-ended question as to whether they did anything else to keep cool during the timeframe of the Power Manager device activation or high temperature. About half of the customers in each group stated that they did nothing else (or nothing at all) in response to the device activation or high temperature. The remaining responses are included in Table 45; none of the differences between Event and Non-Event participants in this table are statistically significant.

None of the surveyed participants in the Carolina System (0% of 101 respondents at home during an event) indicated that they had used room or window air conditioners to keep cool or to compensate for the Power Manager device activation.

Table 45. Other Activities Participants Took to Cool Down

Base: at home during event or high temperature day	Full Shed Event (N=10)	Regular Event (N=67)	Non-Event (N=24)
Continued normal activities / nothing different	60.0%	47.8%	54.2%
Closed blinds / shades	10.0%	9.0%	16.7%
Drank water / cool drinks	10.0%	9.0%	12.5%
Moved to a cooler part of the house	10.0%	4.5%	0.0%
Left the house and went somewhere cool	0.0%	4.5%	0.0%
Took a nap	10.0%	1.5%	0.0%
Cooled off with water (shower, sprinkler, hose, pool)	0.0%	1.5%	0.0%
Wore less clothing	0.0%	1.5%	0.0%
Opened windows	10.0%	0.0%	0.0%
Went outside / stayed out of the house	10.0%	0.0%	0.0%
Turn on room / window AC	0.0%	0.0%	0.0%
Don't know / refused	0.0%	23.9%	12.5%

Note: Multiple responses were allowed per participant

Age of Air Conditioner and Change in Comfort Levels During Event

TecMarket Works asked participants for the age of their air conditioner. The distributions are shown below in Figure 33; a plurality of participants' units are six years old or less (30.8% of 13 for Full Shed Events, 42.5% or 62 out of 146 for Regular Events, 36.1% or 13 out of 36 for Non-Events).

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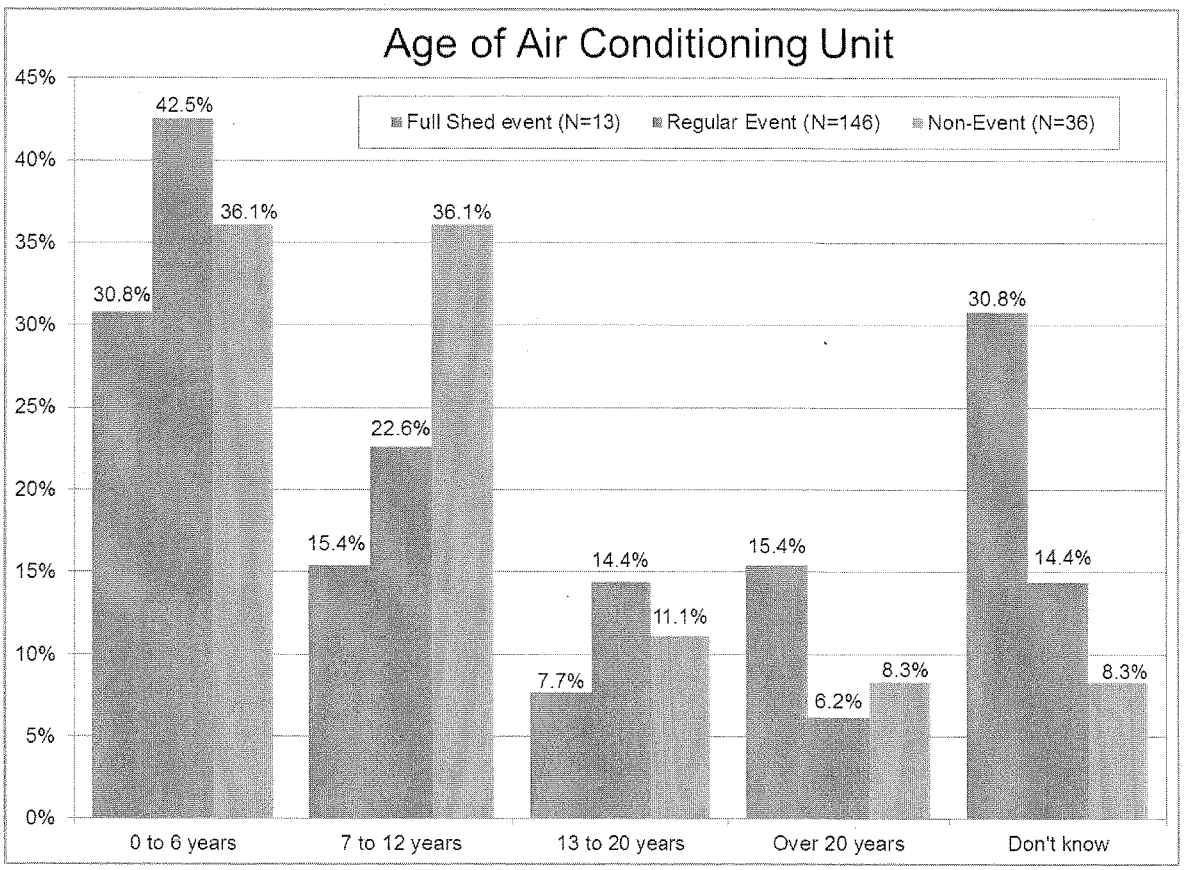

Figure 33. Air Conditioner Age

Figure 34 shows mean comfort ratings by age of air conditioner. Participants with AC units more than 20 years old have slightly lower mean comfort ratings during events or high temperature days compared to participants with newer AC units, although there is no statistically significant relationship between age of air conditioner and comfort levels before or during an event or high-temperature day.[12]

[12] The lack of significance is partly due to sample size: there were only seven participants surveyed in the Carolina System who were at home during the event or high temperature day, who provided comfort ratings, and had A/C units over 20 years old.

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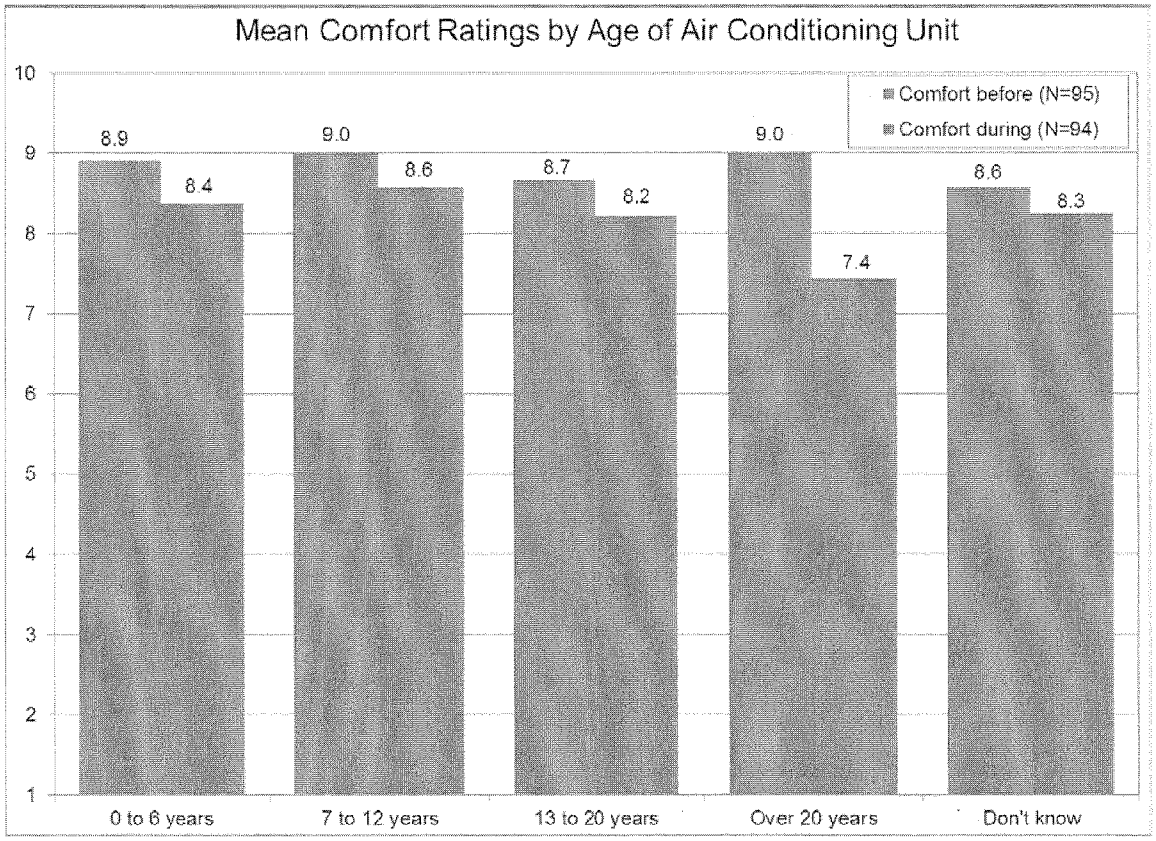

Figure 34. Mean Comfort Ratings by Air Conditioner Age

Note: Only respondents who were at home during an event or high temperature day gave comfort ratings. Event and Non-Event participants are combined in this table.

The distribution of air conditioner ages is similar between all three participant groups, with about two-third of air conditioners in all groups being less than 12 years old (as seen in Figure 33). Cross-tabulating air conditioner age with comfort, and using age of air conditioner to predict a decrease in comfort (using a simple linear regression), yields the following line chart (Figure 35).

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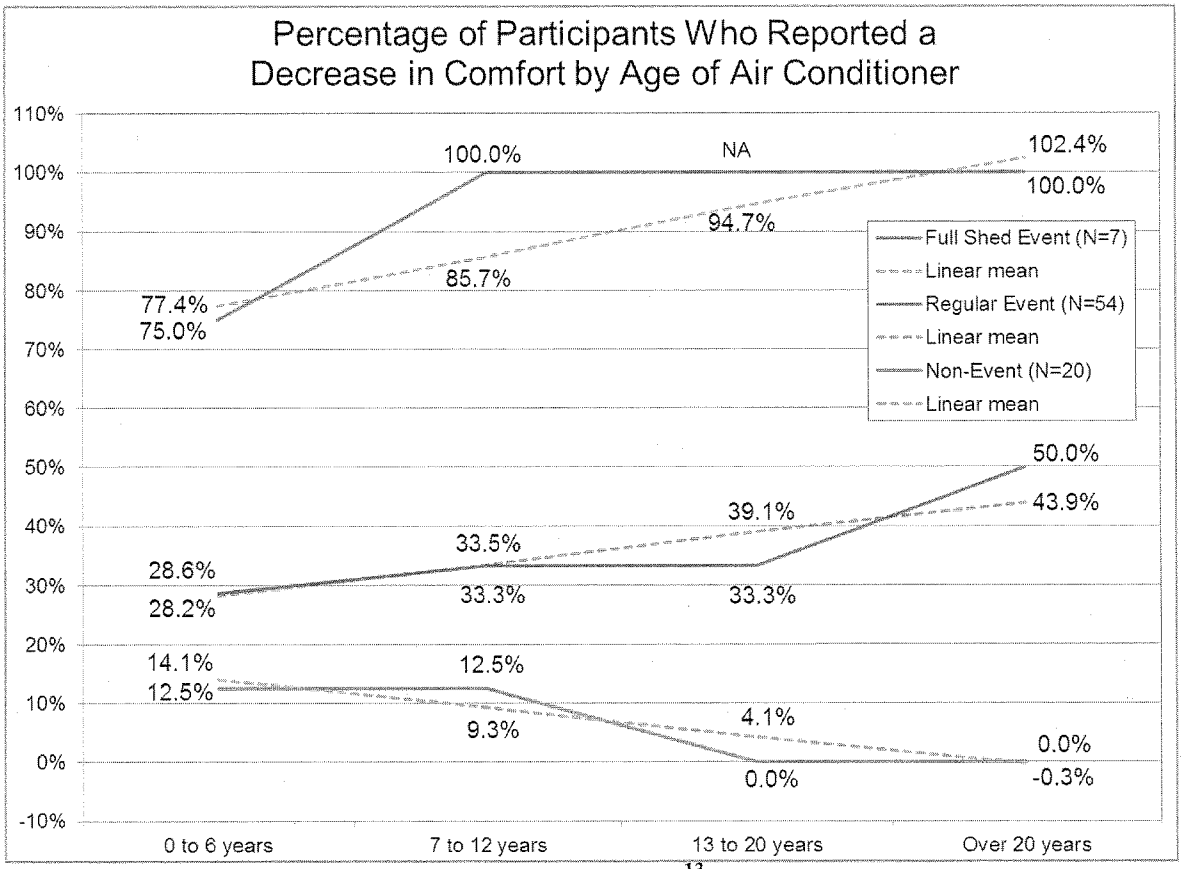

Figure 35. Comfort Decline vs. Air Conditioner Age[13]

In Figure 35, the linear means (regression lines[14]) for the three survey subgroups indicates that age of air conditioner has different effects on discomfort during Power Manager activation events than on non-event high temperature days: the older the AC unit, the more likely a participant will notice a decline in comfort during a Power Manager activation event (the dotted blue and red lines slope upwards), though on high temperature days when there is no event, participants are more likely to report a decline in comfort if their AC unit is newer (the dotted green line slopes down). However the effect of air conditioner age on comfort levels is not statistically significant: for Regular Event participants, the age of the AC unit explains only 1.2% of variance (R-squared) in change in comfort, for Full Shed Event participants it explains 9.7% of variance, and for Non-Event participants age of AC unit explains only 1.9% of variance (R-squared). None of these regression lines is significantly different from a slope of zero (meaning no effect) at $p<.10$ or better.

[13] The number marked as "NA" on the charts because there are no Full Shed participants with 13-20 year old AC units. The lines are still plotted for the missing points (via a straight line between the adjacent categories).
[14] Three regressions were run separately and plotted together, one for Full Shed Event participants, one for Regular Event participants and one for Non-Event participants (dotted lines). All three regression models predict the percent of participants noticing a decline in comfort using only the age of air conditioner. Actual percentages noticing a decline in comfort by age of AC unit are also plotted for the three participant groups (solid lines).

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However, recall from Figure 28 that activation of Power Manager on event days causes discomfort for significantly more Full Shed and Regular Event participants overall (this is also indicated in Figure 35 because the dotted blue and red lines are always higher than the dotted green line). It should also be noted that comfort ratings are fundamentally subjective measures (respondents with the same AC units may give different scores on the same temperature days; while respondents with different AC units on different temperature days may give identical ratings; these models do not account for any individual characteristics of respondents, which remain "unexplained variance.")

Figure 36 shows a similar analysis using the same model but predicting the amount of decline in comfort ratings (rather than whether or not there was a decline in comfort ratings[15]). The result for Non-Event participants in consistent with other findings: There is much less decline in comfort ratings on high temperature non-event days than during Power Manager activation events (the blue and red lines are almost always higher than the green lines).

This model shows that Regular Event participants with AC units more than 20 years old reported their comfort declined by 1.25 points, versus 0.50 to 0.67 points for those with AC units less than 20 years old; Full Shed Events also show the largest point decline for AC units more than 20 years old (3.00 points) though this relationship is practically linear (solid and dotted blue lines are very close together). However, none of the regression lines in Figure 36 are statistically significant at $p<.10$ or better; the regression for Full Shed Event participants explains 15.0% of variance, while the regression for Regular Event participants explains just 0.6% of variance and the regression for Non-Event participants explains 0.1% of the variance in comfort ratings point decline.

[15] Three regressions were run separately and plotted together, one for Full Shed Event participants, one for Regular Event participants and one for Non-Event participants (dotted lines). All three regression models predict the change in comfort ratings on a 10-point scale using only the age of air conditioner. Actual mean decline in comfort rating points (on a 10-point scale) by age of AC unit are also plotted all participant groups (solid lines).

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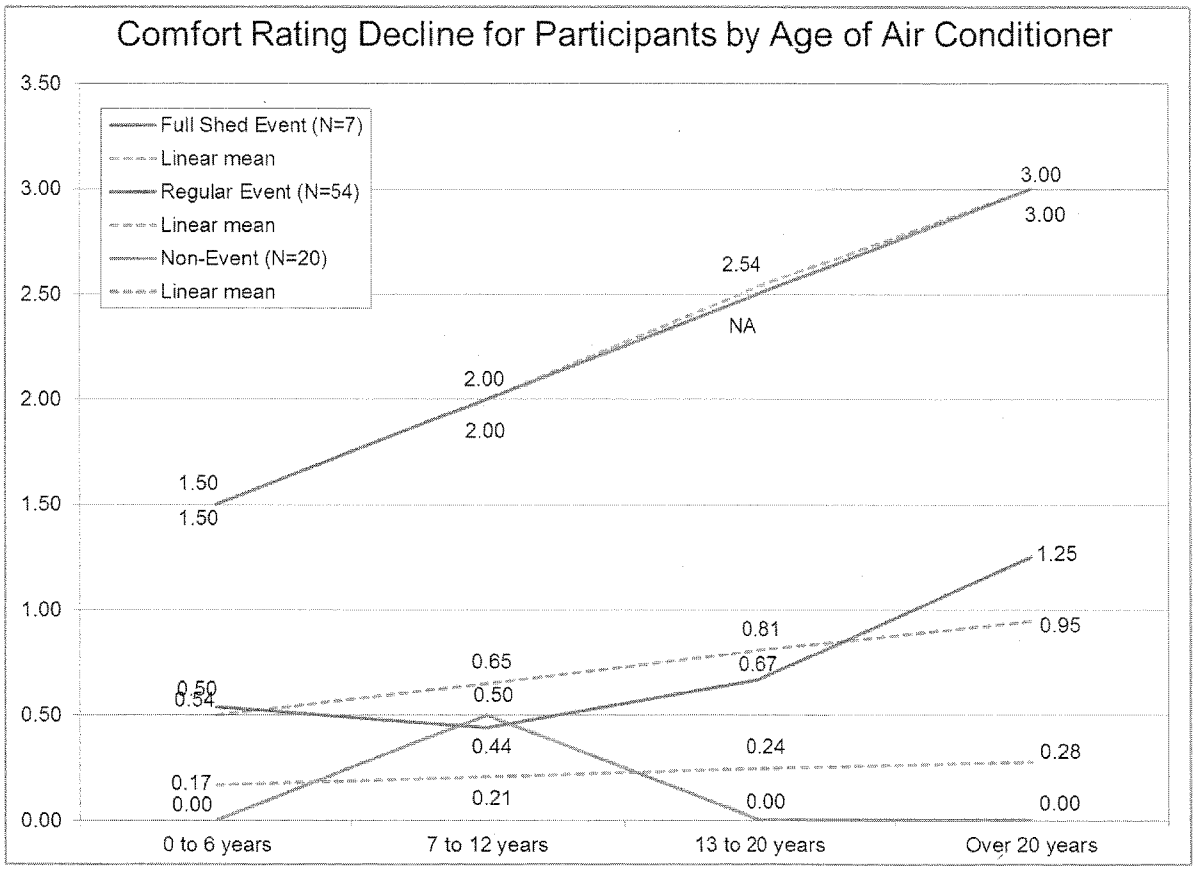

Figure 36. Comfort Ratings Point Decline vs. Air Conditioner Age

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Age of Air-Conditioner and Change in Comfort Levels During Event: Controlling for Outdoor High Temperatures

TecMarket Works also used regression analysis to predict changes in comfort level taking both age of air conditioner and the high temperature on the event day (or non-event high temperature day) into account[16]. This analysis allows us to separate the effects of the outdoor temperature and the age of the air conditioner unit. The results are shown in Figure 37.

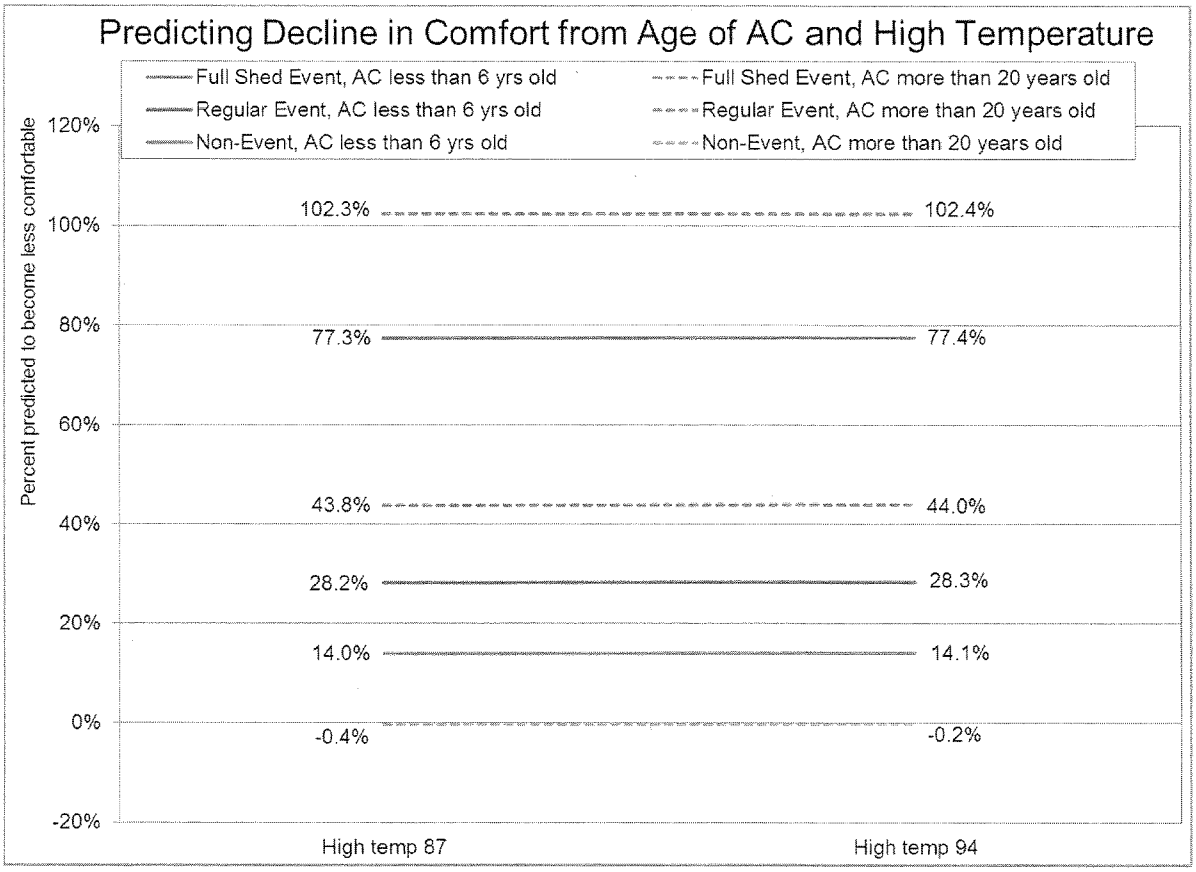

Figure 37. Comfort Change vs. Air Conditioner Age and High Temperature

Figure 37 indicates that having an older air conditioner unit is related to increasing discomfort for Full Shed Event and Regular Event participants, but not for Non-Event participants, even when controlling for the effect of outdoor temperature. Among households with an air conditioner 6 years old or less (solid lines), Regular Event participants are predicted to be twice as likely as Non-Events to report a decline in comfort (predicted 28.2% to 28.3% % of Regular Events and 14.0% to 14.1% of Non-Events), while a majority of Full Shed Event participants are predicted to have a decline in comfort (77.3% to 77.4%). For those with AC units more than 20

[16] One regression was run, predicting the percent of participants noticing a decline in comfort using the following predictors: outdoor high temperature, age of AC unit, Event vs. Non-Event, and an interaction term for Event-by-age-of-air-conditioner. The interaction term allows the effect of age of air conditioner to vary for Event and Non-Event participants. The chart only plots the predicted regression lines (not the actual distributions).

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years old, the differences are even greater (predicted 43.8% to 44.0% for Regular Events, negative 0.2% to 0.4% for Non-Events and over 100% for Full Shed Events[17]).

The differences between predicted levels of discomfort at 87 degrees and 94 degrees (no more than 0.2%) are much less than the differences of predicted newer vs. older AC units (about 14% to 25%) or for different Event groups (about 14% to 63%). This indicates that the effect of outdoor temperature is really not a factor in participant comfort when controlling for the age of their AC unit and whether or not Power Manager was activated. The standardized coefficients[18] from the regression model also indicate that temperature is less important than age of AC or the occurrence of Power Manager events: Temperature had the least effect (beta=0.001) of any predictors in the model, while the presence of a Power Manager full shed event had the most (beta=0.348). The age of the air conditioner (beta=-0.102) and the presence of a regular Power Manager event (beta=0.097) also have more effect on comfort levels than outdoor high temperature.

The regression model in Figure 37 explains 18.7% of the variance (R-squared) in comfort decline, and the model as a whole is statistically significant at $p<.05$ using ANOVA. The only individual predictor in the model which has a statistically significant coefficient is the presence of a full shed event (at $p<.10$ using Student's t-test).

Respondent Satisfaction and Willingness to Recommend the Program

Participants' satisfaction with the Power Manager program is high with an overall mean of 9.02 on a 10-point scale with "1" being not at all satisfied and "10" being very satisfied, and about half (54.4% or 106 out of 195) of participants rating their satisfaction with Power Manager a "10 out of 10". Full Shed Event respondents' mean satisfaction with Power Manager is 8.77 and the mean satisfaction rating for Regular Event participants is 9.03, while the mean for Non-Event respondents is 9.09 (the difference between these groups is not statistically significant, nor is the difference between ratings by North and South Carolina customers). The distribution of ratings is shown in Figure 38 below.

[17] All Non-Event participant surveys were conducted on days when the outdoor high temperature was 91 or 94 degrees (the range of observed temperatures is very limited for this group), and only one Non-Event participant with an AC unit more than 20 years old was at home and answered comfort questions (the dotted green line in Figure 37 is based on a minute sample size). Since this is a linear regression, the model can predict negative percentages for values at the extremes of the distribution; though logically, the number of participants who say their comfort level declined cannot be less than 0%. Similarly, there are a very small number of Full Shed Event participants in the study (in total only seven of these participants were at home during the event, answered both comfort questions, and knew how old their AC unit was). The model predicts percentages over 100% for Full Shed Events with 20-year old units, though logically the number of participants who say their comfort level declined cannot exceed 100%.

[18] The standardized coefficient (also known as beta) is rescaled so that variance equals 1.0. This allows the effect of variables scaled in different units (such as years and degrees) to be compared with each other.

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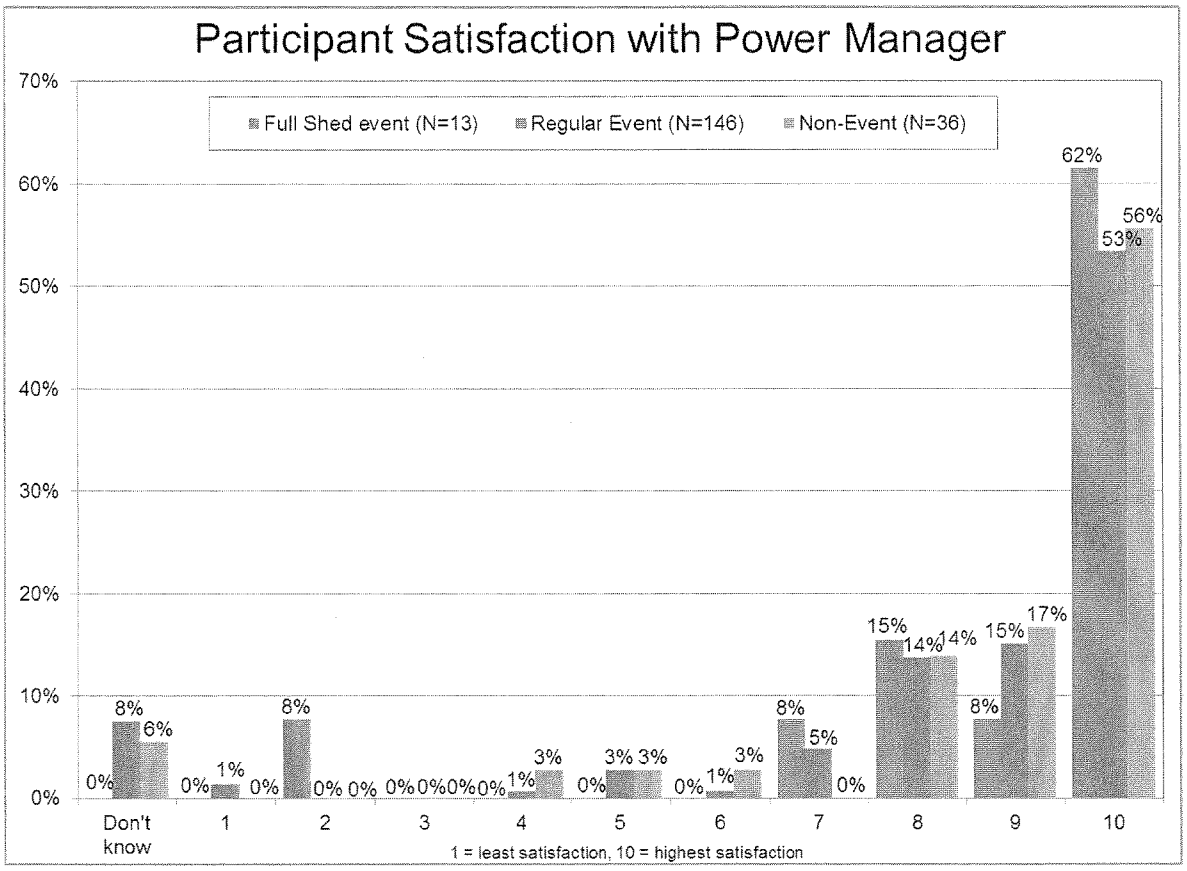

Figure 38. Distribution of Power Manager Satisfaction Ratings

Participants in the event survey were also asked to rate the likelihood that they would recommend Power Manager to a friend or colleague on a 10-point scale where "1" means "very unlikely" and "10" means "very likely". Nearly half (46.2% or 90 out of 195) of participants surveyed rated their likelihood of recommending the program at "10 out of 10", and the mean rating for likelihood of recommending the program was 8.59 overall. By subgroups, the mean recommendation rating was 9.15 among Full Shed Event participants, 8.58 among Regular Event participants and 8.43 among Non-Event participants (the difference between these groups is not statistically significant, nor is the difference between ratings by North and South Carolina customers). Responses to this question are shown in Figure 39.

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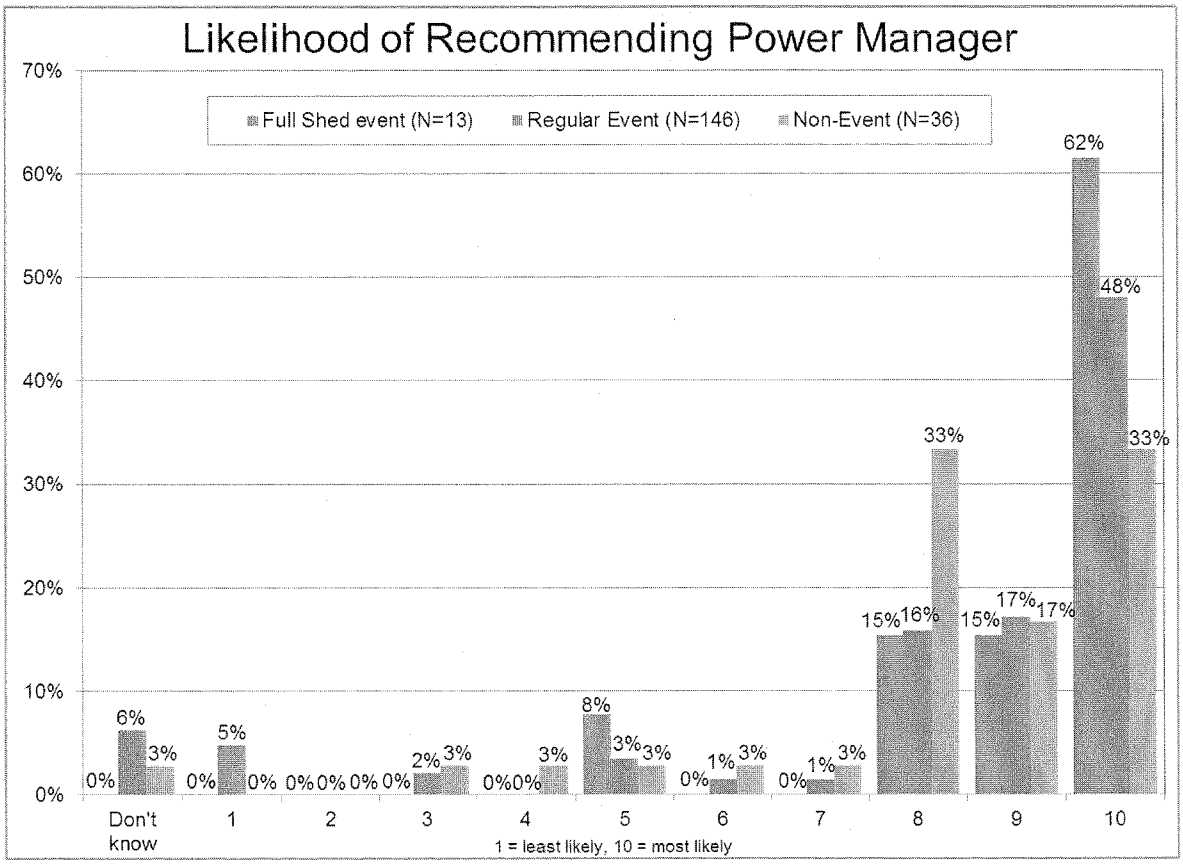

Figure 39. Distribution of Likelihood Ratings for Recommending Power Manager

Participants' overall satisfaction with Duke Energy is also high with an overall mean of 8.77 on a 10-point scale with "1" being not at all satisfied and "10" being very satisfied, and almost half (43.1% or 84 out of 195) of participants rating their satisfaction with Duke Energy a "10 out of 10". Full Shed Event respondents' mean satisfaction with Duke Energy is 8.85 and Regular Event participants' mean satisfaction rating is 8.93, while the mean for Non-Event respondents is 8.14 (the difference between Regular Event and Non-Event groups is statistically significant at $p<.10$ using ANOVA, although there is no significant difference between customers in North and South Carolina). The distribution of ratings is shown in Figure 40 below.

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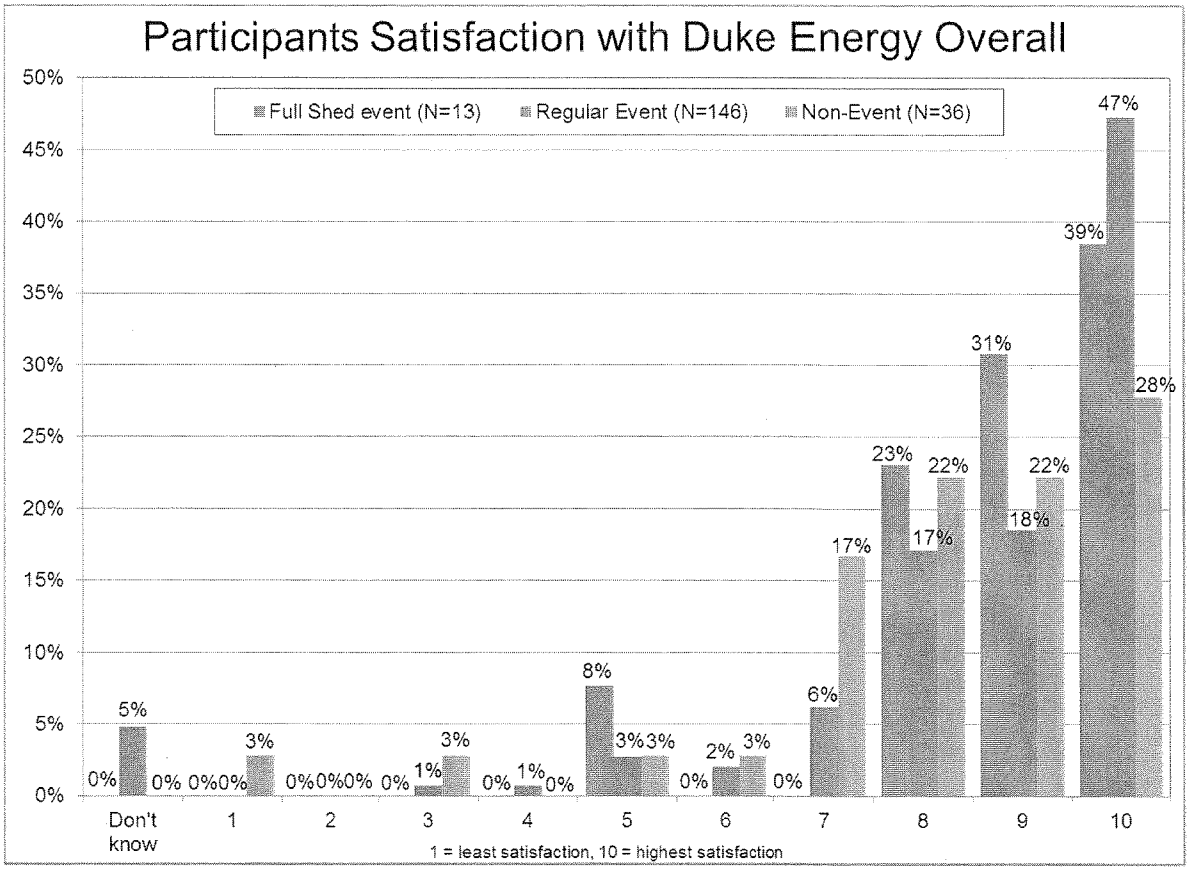

Figure 40. Distribution of Duke Energy Overall Satisfaction Ratings

Satisfaction with Power Manager and Comfort Ratings by Activation Event End Time

As shown previously in Table 1, Power Manager activation events occurred on weekday afternoons during the summer. Activation events in the Carolina System during the summer of 2013 began at either 1:30 p.m., 2:00 p.m. or 2:30 p.m. and all concluded at either 4:00 p.m., 5:00 p.m. or 5:30 p.m.. Since many customers arrive home from work around the time activation events end, Table 46 shows the mean satisfaction ratings for respondents who were at home during the activation period separated by the end time of the event, and also comfort ratings by event end time.

There are no statistically significant differences in program satisfaction, likelihood of recommending the program, or satisfaction with Duke Energy based on the end time of the activation event. However, surveyed participants for whom activation events ended at 4:00 p.m. showed a significant drop in comfort ratings during events (from 8.74 to 7.86, $p<.05$ using Student's t-test) while customers for whom events ended at 5:00 p.m. (from 9.00 to 8.91) and 5:30 p.m. (from 9.63 to 8.75) did not.

However, differences in comfort ratings by activation event end time can largely be explained by the coinciding difference in outdoor high temperatures; activation events which ended at 4:00

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p.m. tended to occur on hotter days (85.4% or 111 out of 130 surveys for events which ended at 4:00 p.m. were conducted on days when the outdoor temperature was 91 degrees or higher, including the thirteen surveys conducted after the July 17 full shed event). However none of the 29 surveys conducted for activation events which ended at 5:00 p.m. or 5:30 p.m. occurred on days when the temperature was 91 degrees or hotter; this difference is significant at $p<.05$ using Student's t-test).

Table 46. Satisfaction and Comfort Ratings by Activation Event End Time

Mean ratings on 10-point scale (10 is highest, 1 is lowest)	Event ended at 4:00 p.m. local time (total N=130)	Event ended at 5:00 p.m. local time (total N=20)	Event ended at 5:30 p.m. local time (total N=9)
Satisfaction with Power Manager	9.04	9.26	8.00
Likelihood of recommending Power Manager to a friend or colleague	8.74	8.20	8.11
Satisfaction with Duke Energy	9.02	8.44	8.44
Comfort rating before event	8.74	9.00	9.63
Comfort rating during event	7.86	8.91	8.75
Change in comfort during event	-0.88	-0.09	-0.88
Percent of surveys conducted on days when the high temperature was 91 degrees or higher	85.4%	0.0%	0.0%

Note: satisfaction ratings only include Full Shed and Regular Event participants who were at home during the event (there was no device activation for Non-Event participants). For mean comfort ratings, only participants who were at home and who gave both comfort ratings are included.

Exploring Factors that Affect Comfort Ratings

High Temperature Correlations with Comfort Levels

The outdoor high temperature[19] during an activation event or non-event high temperature day correlates negatively with ratings of comfort before (Pearson correlation -.149) and has a correlation close to zero during (Pearson correlation -.013) the device activation or high temperature non-event (neither of these correlations achieves statistical significant at $p<.10$ or better). This indicates that participants tend to be slightly less comfortable, in general, on days when the outdoor temperature is hotter. Outdoor high temperature does not correlate significantly with noticing a decline in comfort (Pearson correlation 0.100) or absolute change in comfort ratings (Pearson correlation -0.083) either.

Comfort Ratings by High Temperature

Figure 41 through Figure 43 show the mean comfort ratings before and during Power Manager events (Regular and Full Shed), and for non-event high temperature days, by the outdoor high temperature on that day (the schedule of events and non-events and corresponding high

[19] Heat Index is very highly correlated with High Temperature (Pearson Correlation = 0.830 which is significant at $p<.01$), and correlates with measures of respondent comfort at about the same levels that High Temperature does. Therefore only High Temperature correlations are reported in this section.

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temperatures and heat index readings can be found in Table 1). As seen previously (such as in Figure 28), non-event high temperature days have little effect on participants' comfort levels (small differences between red and blue bars at every temperature level), while the Power Manager full shed event caused a significant decrease in comfort ratings (large differences between red and blue bars). There overall decline in comfort ratings for Regular Event participants during events is also statistically significant (as seen previously in Table 41).

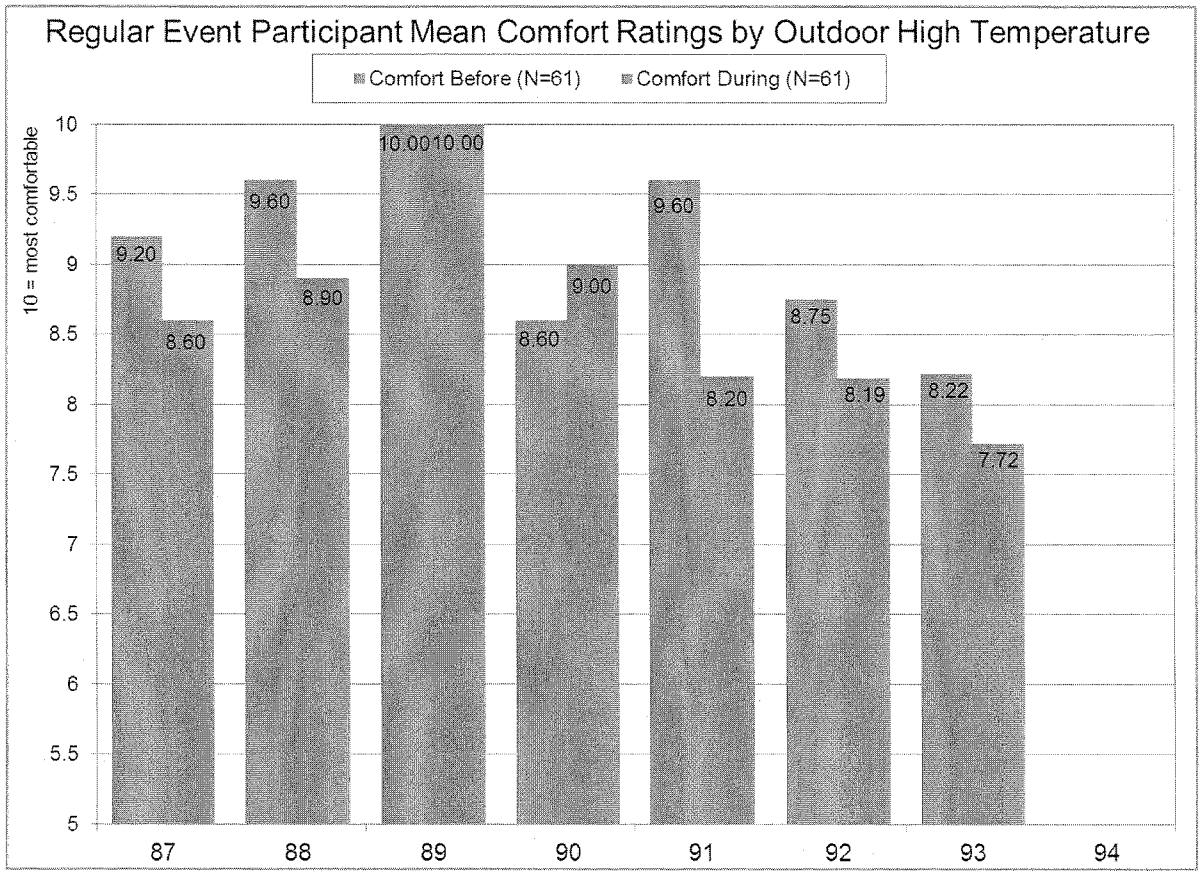

Figure 41. Comfort Ratings Before and During Regular Events by Outdoor High Temperature

Note: Only respondents who were at home during the event and who provided both comfort ratings are included in this chart.

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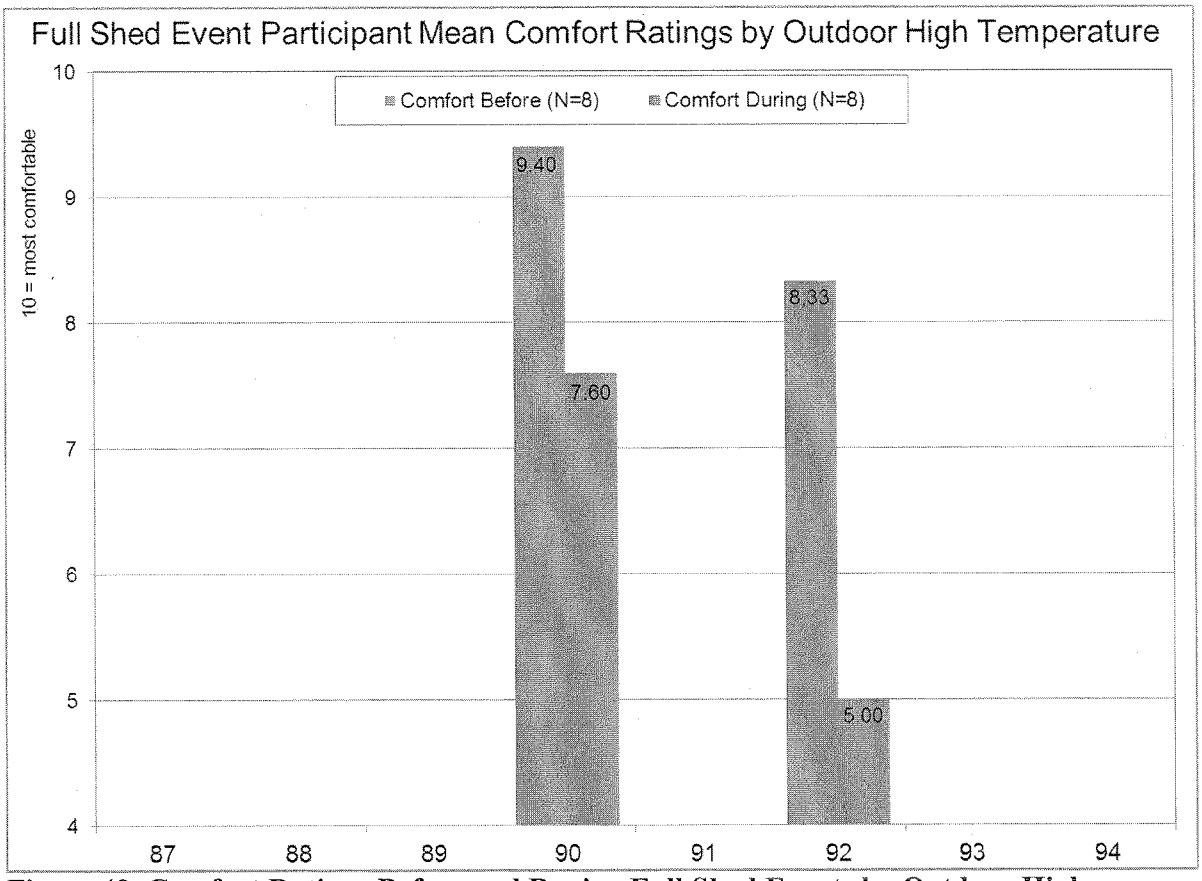

Figure 42. Comfort Ratings Before and During Full Shed Events by Outdoor High Temperature

Note: Only respondents who were at home during the event and who provided both comfort ratings are included in this chart.

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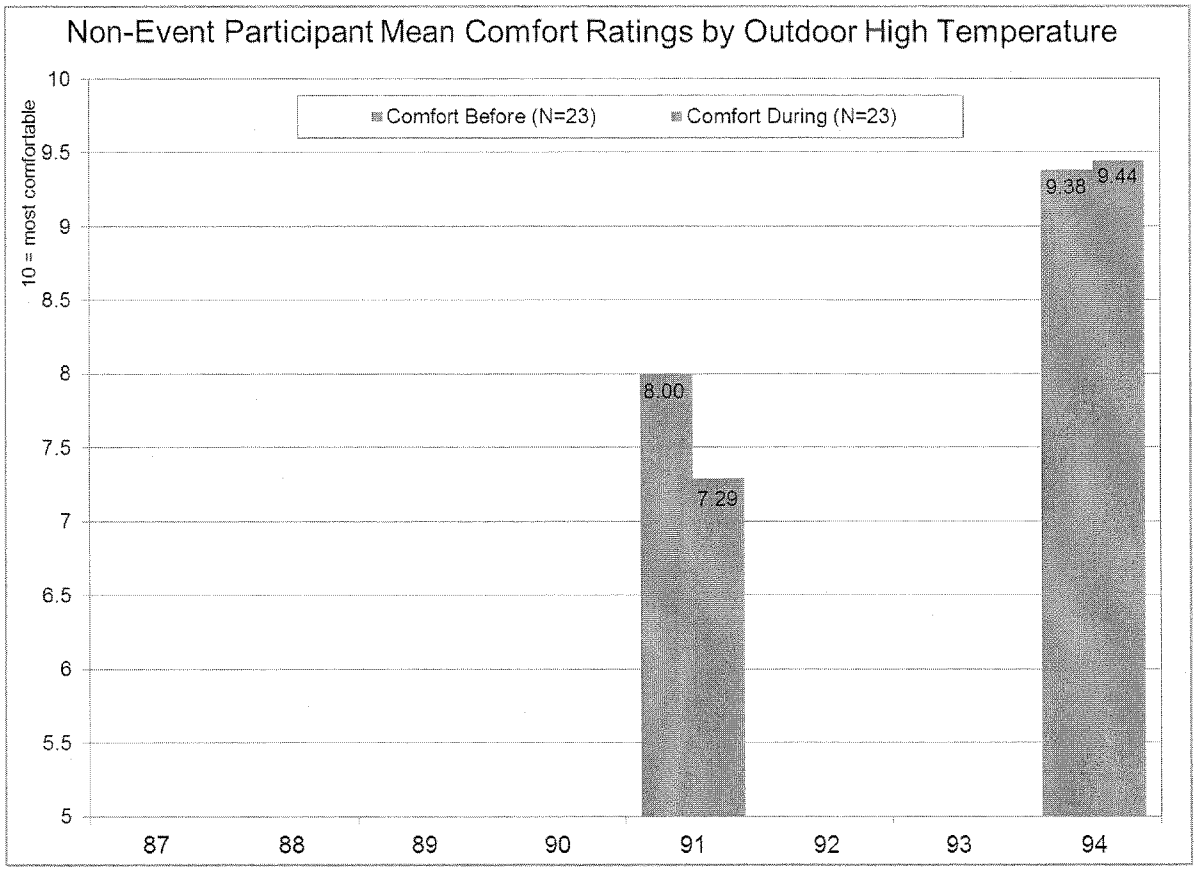

Figure 43. Comfort Ratings Before and During Non-Events by Outdoor High Temperature
Note: Only respondents who were at home during the event and who provided both comfort ratings are included in this chart.

Figure 44 through Figure 46 shows the same mean comfort ratings by three outdoor high temperature ranges. Both Full Shed Event participants and Regular Event participants report a decrease in comfort ratings for every temperature category, and these comfort ratings tend to be lower (before and during events) when the outdoor temperature is higher. For Regular Event participants, the difference between "before" and "during" comfort levels is statistically significant overall at the $p<.05$ level (as reported in Table 41), however it is not significant at any of the specific temperature categories shown in Figure 44. Similarly, though Full Shed Event participants report a significant decrease in comfort ratings overall, the differences are not significant for the specific temperature categories shown in Figure 45 (this lack of significance is largely due to sample size: Only five Full Shed participants who were at home and gave comfort ratings were surveyed on days when the temperature peaked at 90 or lower, and only three were surveyed on days when the temperature was 91 or 92 degrees). The differences between "before" and "during" comfort ratings for Non-Event participants are not statistically significant at any temperature level (as shown in Figure 46).

There are no statistically significant differences in comfort ratings by Event groups when the outdoor high temperature peaks at 90 or lower (there were no Non-Events surveyed on days of this temperature range). On survey days when the temperature was 91 or 92 degrees, Full Shed

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Event participants give significantly lower ratings during activation events (5.00) than Regular Event participants (8.19; significant at p<.05 using ANOVA), though neither group differs significantly from Non-Event participants' comfort ratings (7.29 based on seven respondents). On days when the outdoor high temperature reached 93 degrees or higher, Non-Events give higher comfort ratings before (9.38) and during (9.44) compared to Regular Events (8.22 before and 7.72 during; these differences between groups are significant at p<.10 or better using ANOVA). There were no Full Shed Event surveys on days when the temperature peaked at 93 degrees or higher.

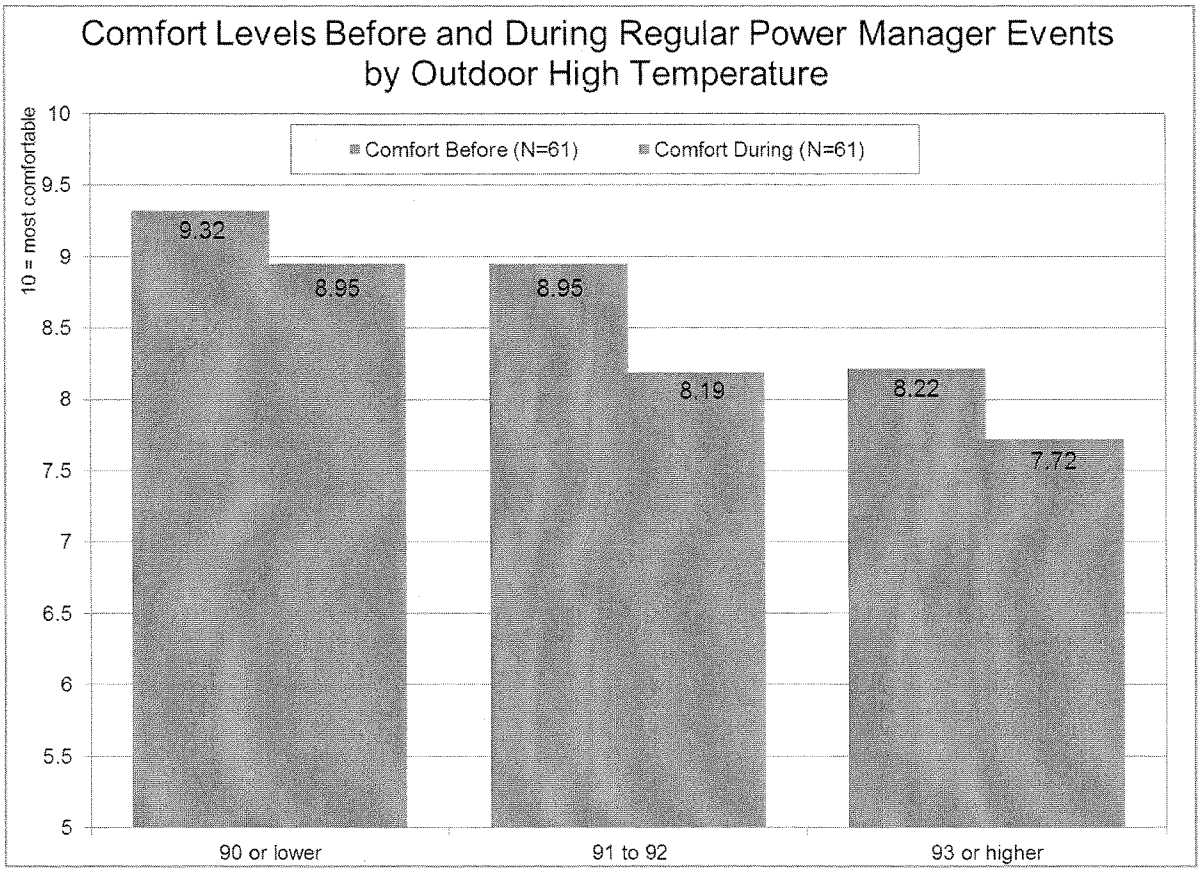

Figure 44. Comfort Ratings Before and During Regular Events by Outdoor High Temperature

Note: Only respondents who were at home during the event and who provided both comfort ratings are included in this chart.

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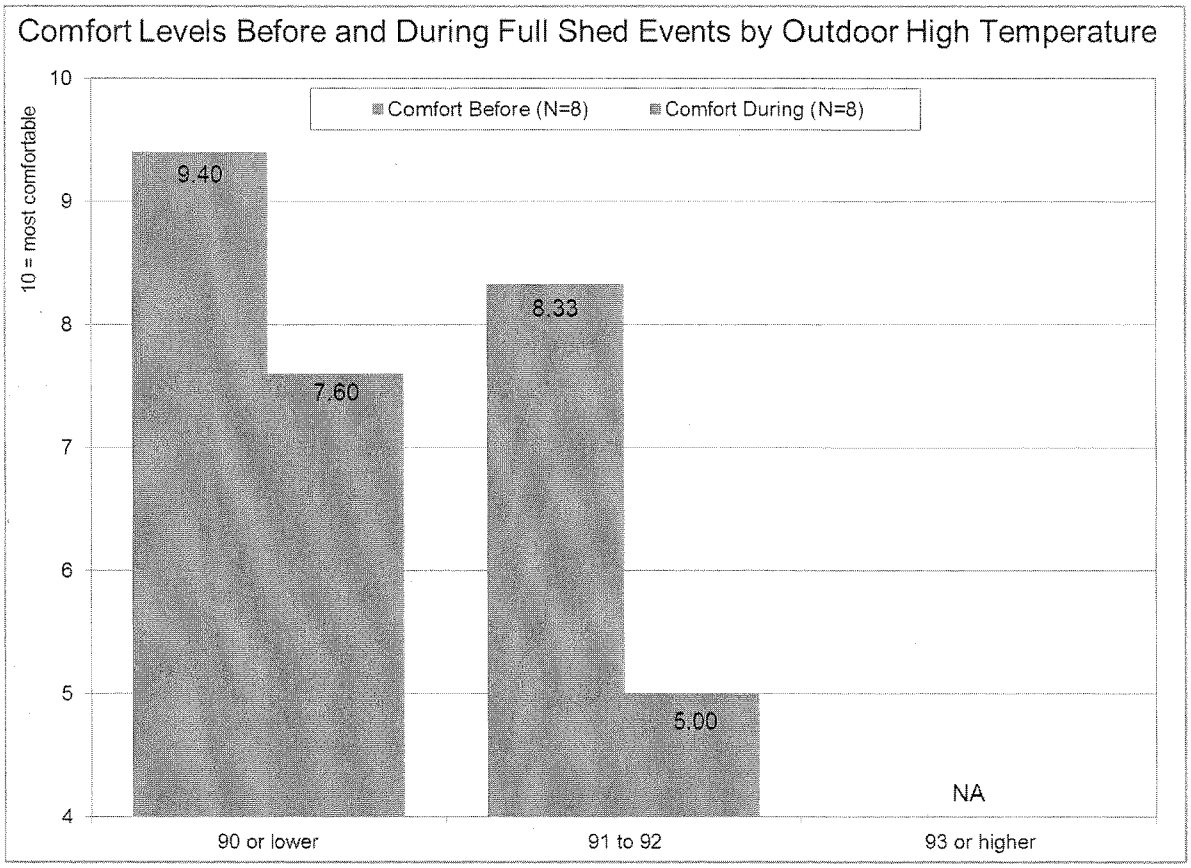

Figure 45. Comfort Ratings Before and During Full Shed Events by Outdoor High Temperature

Note: There were no Full Shed Event days in the Carolina System where the outdoor temperature was 93 degrees or higher. Only respondents who were at home during the event and who provided both comfort ratings are included in this chart.

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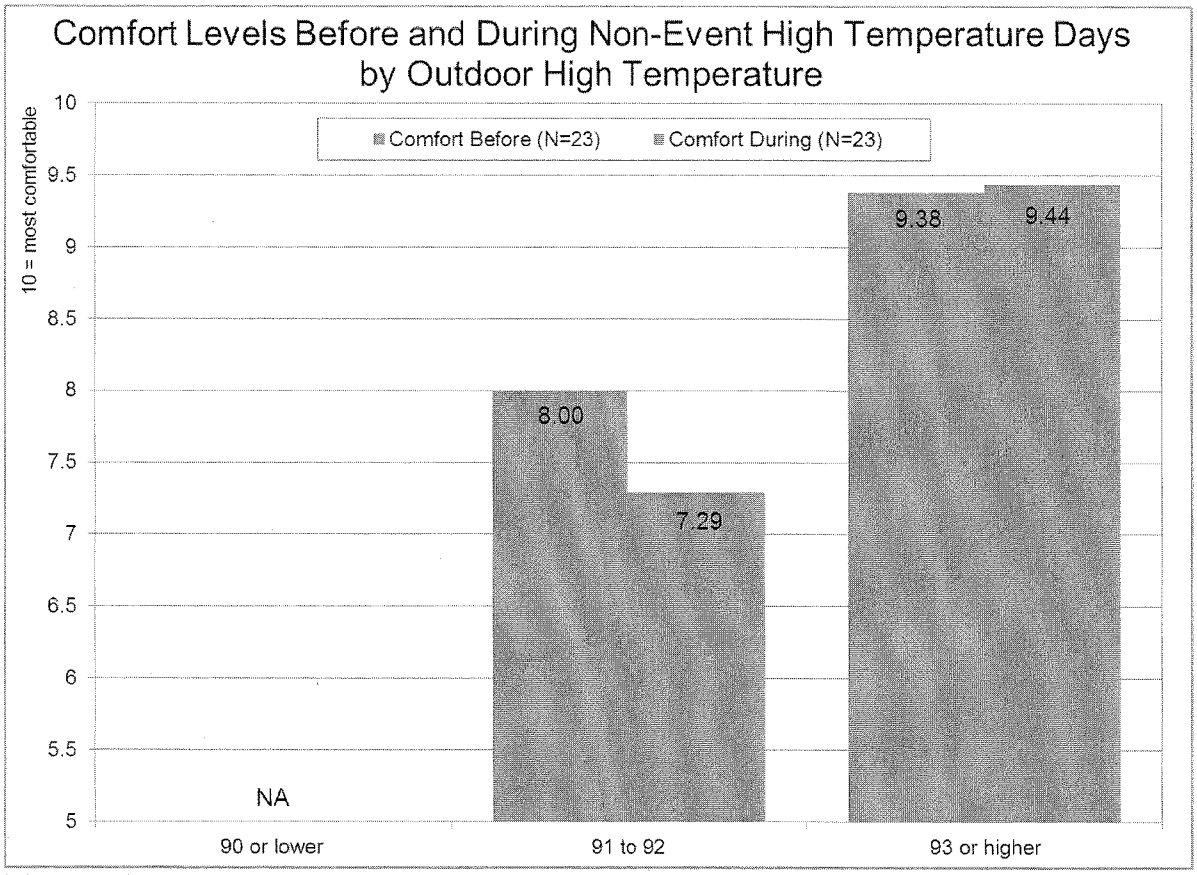

Figure 46. Comfort Ratings Before and During Non-Events by Outdoor High Temperature
Note: There were no non-event high temperature days in the Carolina System where the outdoor temperature was 90 degrees or lower. Only respondents who were at home on the non-event high temperature day and who provided both comfort ratings are included in this chart.

Figure 47 shows the percentage of participants who reported a decline in comfort ratings during an event or non-event high temperature day. On surveyed days when the high temperature was 90 degrees or lower, Full Shed Event respondents are significantly more likely to report a decline in comfort (80% or 4 out of 5) compared to Regular Event respondents (22.7% or 5 out of 22; significant at $p<.05$ using Student's t-test). On days when the temperature peaked at 91 or 92 degrees, Full Shed Events are more likely to report a decline in comfort (100% or 3 out of 3) than either Regular Events (33.3% or 7 out of 21) or Non-Events (28.6% or 2 out of 7; differences significant at $p<.05$ using Student's t-test). When the temperature was 93 or 94 degrees (the hottest outdoor high temperatures of 2013 in the Carolina System), significantly more Event participants (38.9% or 7 out of 18) than Non-Event participants (0.0% out of 16) reported a decline in comfort (significant at $p<.05$ using Student's t-test).

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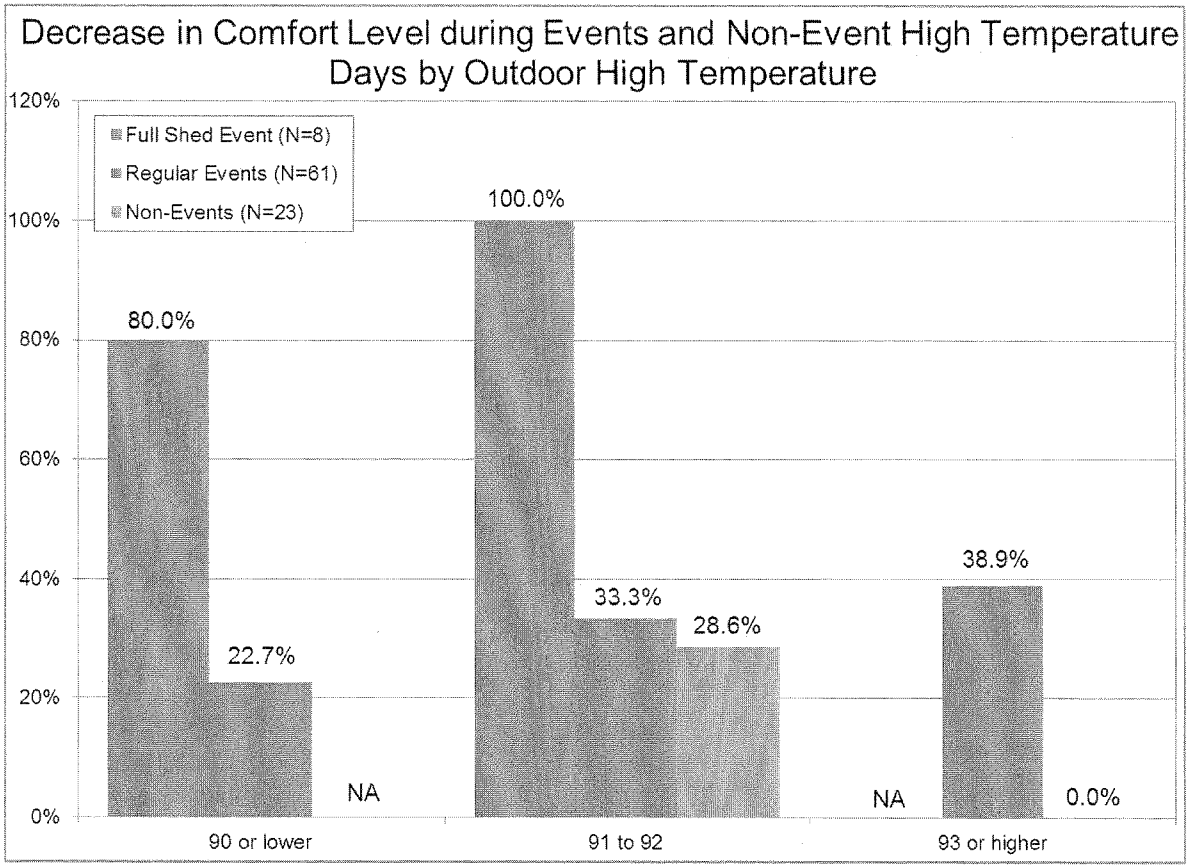

Figure 47. Decrease in Comfort by Outdoor High Temperature

Note: There was only one surveyed non-event high temperature day in the Carolina System during the 2013 cooling season (June 28); on this date the outdoor high temperature was 91 degrees in North Carolina and 94 degrees in South Carolina. During the only full shed event of the season (on July 17), the outdoor high temperature was 90 degrees in North Carolina and 92 degrees in South Carolina.

Comfort Ratings by Thermostat Settings

Full Shed and Regular Event participants are more likely to notice a change in comfort during Power Manager activation events than Non-Event participants are to notice a change in comfort on a high temperature non-event day. Comfort ratings before and after events are shown by thermostat settings in Figure 48. Comfort ratings did not decline (they actually increased) for the seven Regular Event participants who had their thermostats set to 79 degrees or higher, while ratings declined somewhat for all of the thermostat setting categories for 78 degrees or lower. However, the magnitude of the change in comfort ratings for Regular Event participants is not statistically significant at any of the thermostat setting ranges shown, just as the change in comfort ratings for this group during events is not significant overall (see Table 41 and accompanying text).

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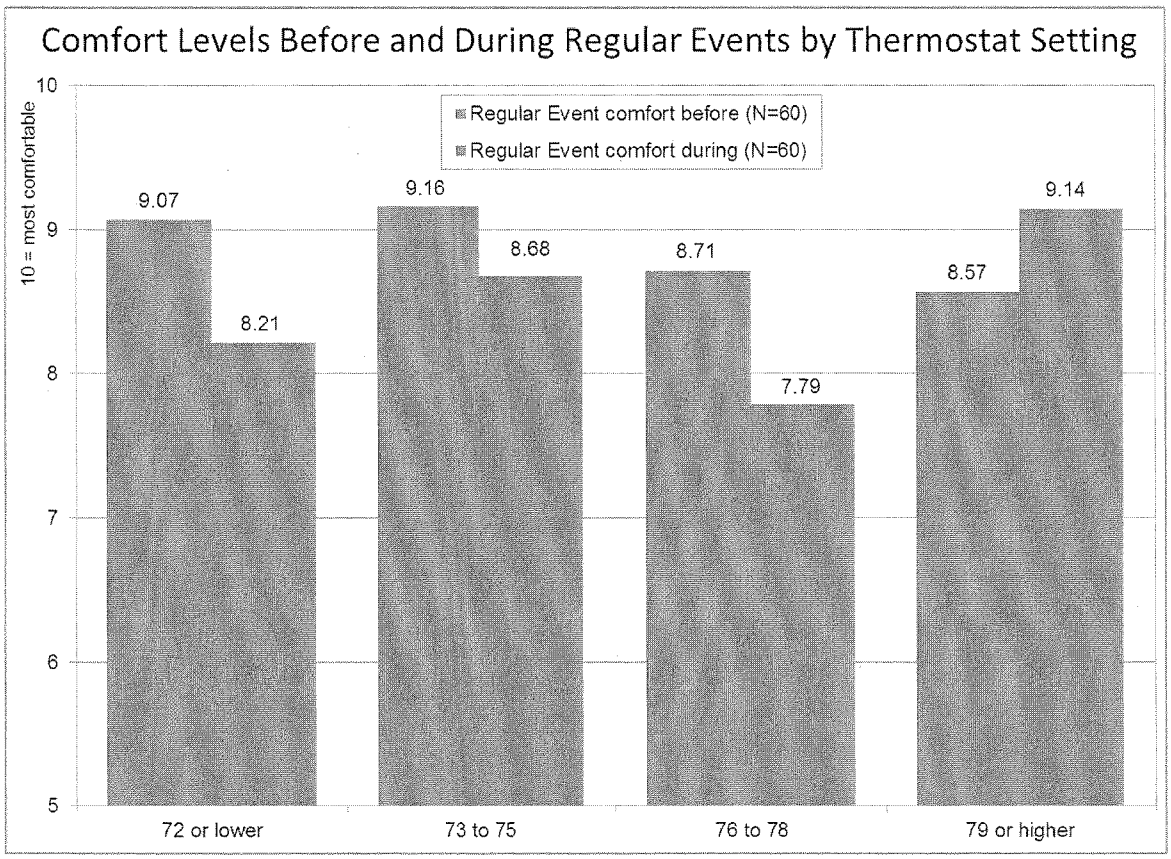

Figure 48. Changes in Comfort by Thermostat Settings During Power Regular Manager Events (Not Including Full Shed Event)

There were only seven participants in the Carolinas System who were surveyed after the full shed event of July 17, 2013, who were at home and who answered both comfort ratings questions and also the question about thermostat settings. Their ratings by thermostat setting are shown in Figure 49 and further illustrate that Full Shed Event participants reported the greatest decrease in comfort, as seen previously in Figure 28. However, the sample size of seven participants (split across three categories) is too small for statistical significance testing.

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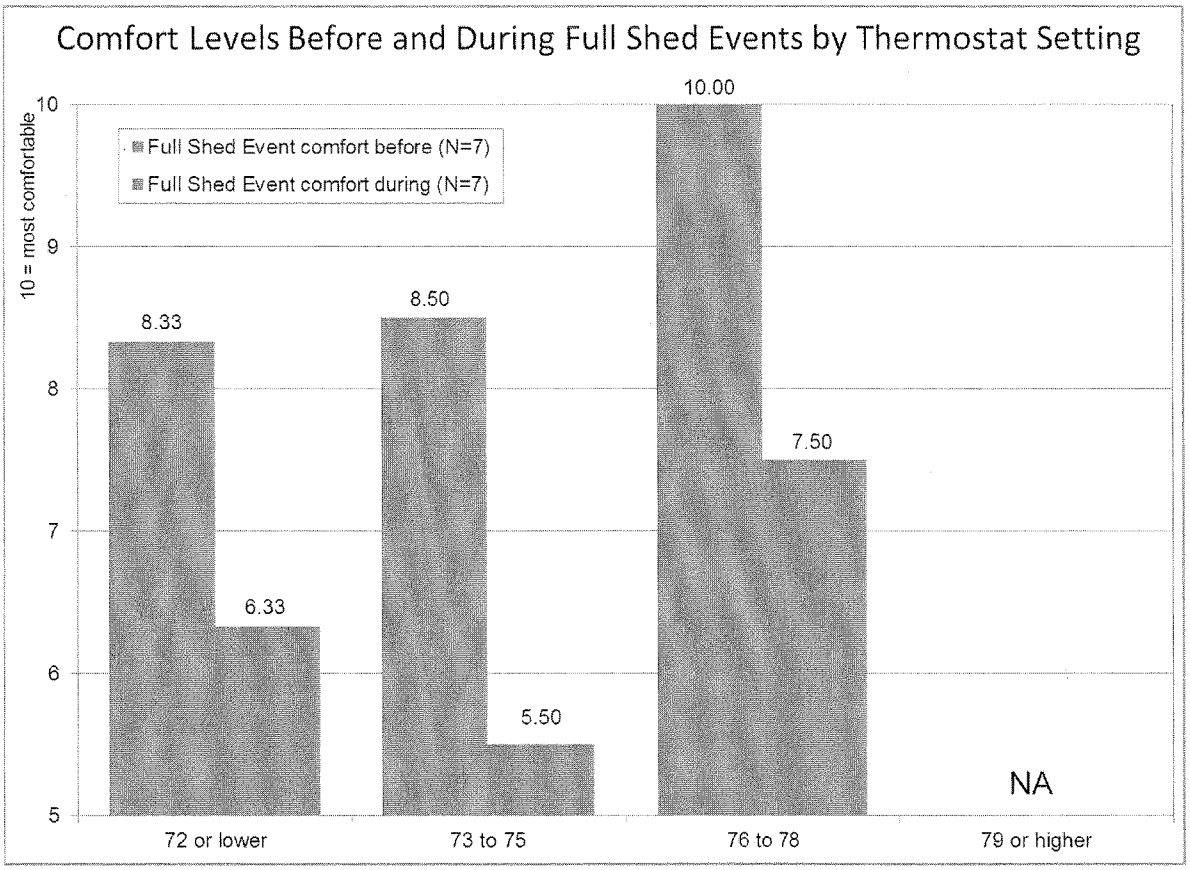

Figure 49. Changes in Comfort by Thermostat Settings During Power Manager Full Shed Event (July 17, 2013)

Changes in comfort ratings by thermostat setting for Non-Event participants on high temperature days are shown in Figure 50. For these participants, there were no significant changes in comfort ratings from "before" to "during" at any thermostat level.

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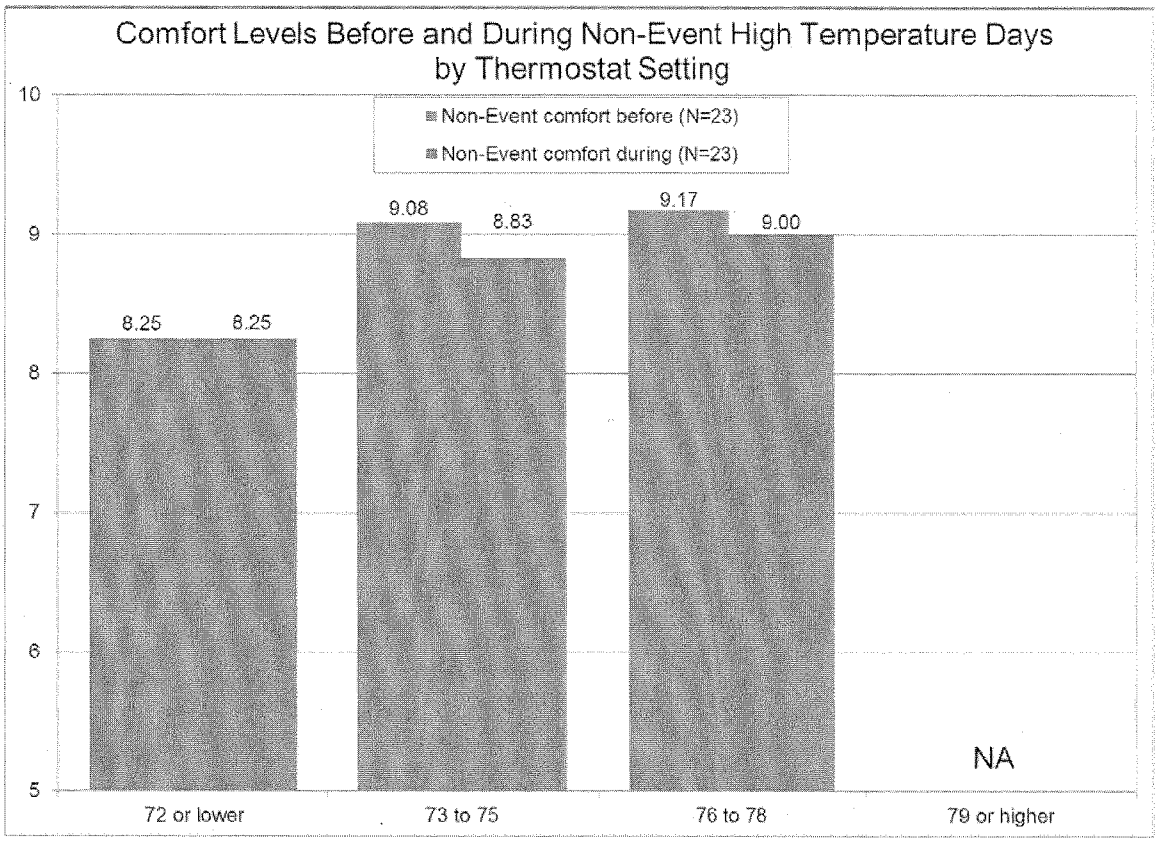

Figure 50. Changes in Comfort by Thermostat Settings During High Temperature Non-Event Days

Thermostat Settings by Age of Air Conditioner

There is one set of statistically significant differences in terms of the temperature participants had their thermometers set to during an event or non-event high temperature day by the age of their air conditioning unit: Compared to other groups, Carolina System participants with A/C units that are between 7 and 12 years old are much more likely to set their thermostats to 76 to 78 degrees (47.6% or 20 out of 42) and much less likely to set their thermostats to 72 degrees or lower (2.4% or 1 out of 42; both differences significant at $p<.05$ using Student's t-test). A clear majority of participants (ranging from 62.5% to 85.7%) set their thermostats between 73 and 78 degrees regardless of the age of their air conditioning unit, as seen in Figure 51.

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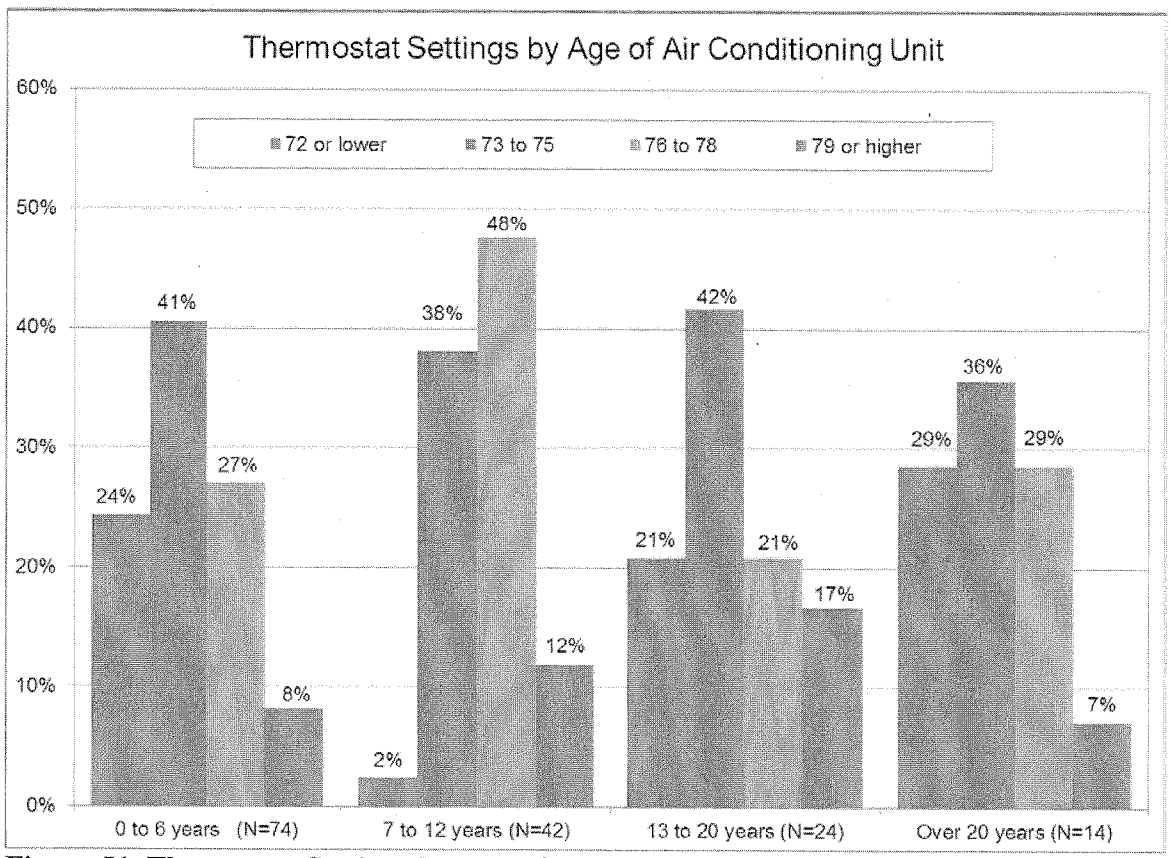

Figure 51. Thermostat Settings by Age of Air Conditioning Unit (Event and Non-Event Participants Combined)

Note: Only respondents who were able to specify thermostat settings and ages of air conditioning units are included in this chart (total N=154).

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Appendix A: Management Interview Instrument

Name: _____

Title: _____

Position description and general responsibilities:

_____

_____

_____

We are conducting this interview to obtain your opinions about and experiences with the Power Manager program. We'll talk about the Power Manager Program and its objectives and your thoughts on improving the program. The interview will take about one hour to complete.

Background

1. Please describe your role and scope of responsibility in detail. When did you take on this role?

2. Can you please give me some history of the Power Manager program in _____, and tell me about the energy market in _____.

3. Are there any major differences between Power Manager in _____ and the other states in Duke Energy's service territory?

Program Implementation and Customers

Please explain how the Power Manager program works: Walk us through the participatory steps starting with a customer who knows nothing about the program.

Targeting and marketing

4. How does Duke determine the best target markets or customer segments to focus on? Do you use any type of strategic targeting of customers in order to market to those that have the size of home and AC unit that is capable of providing load reductions?

5. Do you use other Duke Energy EE programs to generate leads for PM?

6. Are there any market information, research or market assessments that you are using to identify market barriers, or to target customers?

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Enrollment

7. What are the options for enrolling?

8. What is the enrollment process?

Event calls

9. Under what conditions would you call an event? Who is involved in the call?

10. How do you coordinate event calls between your residential and non-residential DR programs?

11. Please explain the customer's options for opting out of events

Demand Response Capacity

12. What is the current enrollment in Power Manager?

13. What is the current dropout rate for Power Manager? What are some of the typical reasons for dropping out?

14. What is the current demand response capacity you have with Power Manager, assuming you have 100% switch operability?

15. Is Duke Energy planning to increase this capacity in the next few years? Why or why not?

16. If yes, do you think the incentives offered through the Power Manager program are adequate enough to entice the residential customer to enroll in the program? Why or why not?

Program Objectives

17. In your own words, please briefly describe the Power Manager Program's objectives as a program?

18. What are Power Manager's objectives as a part of Duke Energy's demand response portfolio?

19. In your opinion, how well are the energy impact objectives being met? How do you know if the objectives are met or not?

20. Have these objectives changed in the last year or so, and if so how? Why?

21. I understand that Duke Energy's Retail Energy Desk has responsibility for conducting the two main studies. Can you share with me what has found with the AC duty cycle study and the switch operability study?

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22. Are there other studies that Duke Energy has been carrying out to better understand the response of the market?

23. Are there any new internal or external influences on the program since the objectives were developed, that might be affecting program operations? How is Duke Energy responding to those objectives?

Analysis and Technology

24. How do you verify load shed? What is the quality control, tracking and accounting process for determining how well control strategies work?

25. (for post-season interview) Please tell me about the events that were called in 2013. How many events were called? Why were they called (what type of call event)?

26. Where there any surprises or problems with the process? Are there changes that you would recommend to the event call process?

27. (for post-season interview) Did you achieve the load shift you needed for these events? How do you know this?

28. (for post-season interview) How well did the payment accounting and application process operate this last year? Did the program staff come across any issues or problems with payment? How were they resolved?

29. (summer interview) During the last process evaluation of Power Manager, Duke Energy was in the process of addressing some problems in communication with the switches and failure rates. Can you describe this so that we understand it well? Are you experiencing the same problems in 2013? What is being done to deal with this issue? Do you have any suggestions for improving this in addition to the approaches being taken?

30. How are the event calls transmitted to the participants? Is there anything that you would like to change about this process?

31. We understand there is an IT project that allows better administration of the customers' participation or opt out status. Could you please explain this to me in detail?

Program Planning and Design

32. Do you use any vendors to help implement the program? Please tell me their roles and responsibilities for Power Manager

33. Do you currently use any smart grid technologies in your DR programs? Do you have any plans to do so in the future? What do you hope that smart grid technology would provide?

Program Successes and Challenges

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34. Describe the use of any internal or outside program advisors, technical groups or organizations that have in the past or are currently helping you think through the program's various approaches or methods. How often do you use these resources? What do you use them for?

35. In what ways do you think the Power Manager Program's operations could be improved?

36. If you could change any part of the program what would you change first?

37. What would you say are the program's biggest successes?

38. We've covered a lot of areas today, but are there any other issues or topics you think we should know about and discuss for this evaluation?

39. Do you have any questions for me, about this interview or this process evaluation?

Thank you for your time.

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Appendix B: Participant Survey Instrument

Use four attempts at different times of the day and different days before dropping from contact list. Call times are from 10:00 a.m. to 8:00 p.m. EPT, Monday through Saturday. No calls on Sunday. Note: Only read words in bold type, italics are instructions.

Survey ID _____
Surveyor Name _____

State

( ) Kentucky
( ) Ohio
( ) South Carolina
( ) North Carolina

for answering machine 1st through penultimate attempts:
Hello, my name is _____ and I am calling with a survey about Duke Energy's Power Manager Program. I'm sorry I missed you. I'll try again another time.
for answering machine - Final Attempt:
Hello, my name is _____ and I am calling with a survey about Duke Energy's Power Manager Program. This is my last attempt at reaching you, my apologies for any inconvenience.
if person answers:
Hello, my name is _____, and I'm calling on behalf of Duke Energy. According to our information, you presently participate in Duke Energy's Power Manager Program. This program allows Duke Energy to cycle your air conditioner when there is a critical need for electricity in the region. We are conducting this survey to obtain your opinion about the program. If you qualify, we will send you a check for $20 for completing the survey. This survey will take 25 minutes or less to complete, and the information you provide will be confidential and will help to improve the program.

1. **Are you aware of your participation in the Power Manager program?**
( ) Yes
( ) No
( ) DK/NS

If no,
May I please speak to the person who would be most familiar with your household's participation in the Power Manager program?
If not available, try to schedule a callback time. If transferred, begin survey from beginning.

We would like to collect some information on why you agreed to participate in the program and how you heard about it.

2. **Were you involved in the decision to participate in Duke Energy's Power Manager Program?**

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( ) Yes
( ) No
( ) It was already installed when I moved in
( ) DK/NS

if No, DK/NS or Already Installed, skip to question 7

3. **Do you recall how you first heard about the program?**
( ) Yes
( ) No
( ) DK/NS

If yes,
3a. **How did you hear about the Power Manager Program?**
[ ] Utility bill insert
[ ] Direct mail offer from Duke Energy
[ ] Utility website
[ ] Word-of-mouth (friend/neighbor/landlord)
[ ] Newspapers
[ ] Social network _____
[ ] DK/NS
[ ] Other _____

4. **To the best of your ability, could you please tell me what the promoted benefits of the program were?**
( ) *benefits* _____
( ) DK/NS

5. **What was the <u>main</u> reason why you chose to participate in the program?**
( ) For the bill credits
( ) Helping Duke avoid power shortages/outages
( ) To save energy
( ) To save money (through lower utility bills)
( ) To help the environment
Please explain: (to reduce carbon or GHG, etc.) _____
( ) I don't use the air conditioner much
( ) I'm usually not home when the events are supposed to occur
( ) DK/NS
( ) Other _____

5a. **Do you recall reading about this benefit in the program brochure or materials sent to you?**
( ) Yes
( ) No
( ) DK/NS
( ) Did not get brochure
( ) Do not remember brochure

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6. **What were your other reasons for choosing to participate in this program?**

[ ] No other reasons
[ ] For the bill credits
[ ] Helping Duke avoid power shortages/outages
[ ] To save energy
[ ] To save money (through lower utility bills)
[ ] To help the environment
Please explain: (to reduce carbon or GHG, etc...) _____
[ ] I don't use the air conditioner much
[ ] I'm usually not home when the events are supposed to occur
[ ] DK/NS
[ ] Other _____

Repeat question 6a to 6e for all benefits checked in q6
But, if Customer answered "Did not get brochure" or "Do not remember brochure" above in 5a. DO NOT ASK 6a to 6e:

6a. **Do you recall reading anything about "bill credits" in the program brochure or materials sent to you?**

( ) Yes
( ) No
( ) DK/NS

6b. **Do you recall reading anything about "Helping Duke avoid power shortages or outages" in the program brochure or materials sent to you?**

( ) Yes
( ) No
( ) DK/NS

6c. **Do you recall reading anything about "saving energy" in the program brochure or materials sent to you?**

( ) Yes
( ) No
( ) DK/NS

6d. **Do you recall reading anything about "saving money (through lower utility bills)" in the program brochure or materials sent to you?**

( ) Yes
( ) No
( ) DK/NS

6e. **Do you recall reading anything about "helping the environment" in the program brochure or materials sent to you?**
if asked, Please explain: (to reduce carbon or greenhouse gases, etc...)

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( ) Yes
( ) No
( ) DK/NS

7. **Generally speaking, how important are environmental issues to you? Would you say they are…**
read answers in bold aloud until they reply
( ) **Very Important**
( ) **Important**
( ) **Neither Important nor Unimportant**
( ) **Unimportant, or**
( ) **Very Unimportant**
( ) DK/NS

8. **How important are climate change issues to you? Would you say they are…**
( ) **Very Important**
( ) **Important**
( ) **Neither Important nor Unimportant**
( ) **Unimportant, or**
( ) **Very Unimportant**
( ) DK/NS

9. **How important is reducing air pollution to you? Would you say it is…**
( ) **Very Important**
( ) **Important**
( ) **Neither Important nor Unimportant**
( ) **Unimportant, or**
( ) **Very Unimportant**
( ) DK/NS

10. **How important is the need to reduce the rate of building new power plants? Would you say it is…**
( ) **Very Important**
( ) **Important**
( ) **Neither Important nor Unimportant**
( ) **Unimportant, or**
( ) **Very Unimportant**
( ) DK/NS

11. **Are you a member of any groups or clubs that have environmental missions?**
( ) Yes *ask* **Which ones?** _____
( ) No
( ) DK/NS

12. **Before you enrolled in the program, you received program information from Duke Energy that described how the program works. Using a scale of 1 to 10 where 1 indicates**

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"Very Dissatisfied" and 10 indicates "Very Satisfied", how satisfied were you with this information in helping you to understand how the program works?

( ) 1
...
( ) 10
( ) I did not enroll/It was already installed when I moved in
( ) DK/NS

If 7 or below,
12b. **Why were you less than satisfied with this information?** _____

13. **How often per year did Duke Energy say it would activate the Power Manager device on your air conditioner?** _____

14. **What's your best estimate of how many dollars you will receive in yearly bill credits from Duke Energy for participating in the Power Manager program?**

( ) $ _____
( ) DK/NS

15. **Have you received any bill credits this year from Duke Energy for participating in this program?**

( ) Yes
( ) No
( ) DK/NS

If yes,
15a. **How many times have you noticed the Power Manager credits on your bill this summer?**

( ) Every bill this summer
( ) Once
( ) Twice
( ) Three
( ) Four or more times
( ) Other
( ) DK/NS

16. **Is anything unclear to you about how the program works?**

( ) Yes **16a. What is unclear to you?** _____
( ) No
( ) DK/NS

17. **Did you ever contact Duke Energy to find out more about the Power Manager Program?**

( ) Yes
( ) No
( ) DK/NS

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If yes,
17a. **What method did you use to contact Duke Energy?**
(check all that apply)
[ ] Phone
[ ] Email
[ ] In person
[ ] Other _____
[ ] DK/NS

If yes,
17b. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", how satisfied were you with the ease of reaching a Duke Energy representative?**
( ) 1
...
( ) 10
( ) DK/NS

If 7 or below,
17c. **Why were you less than satisfied?** _____

17d. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", how satisfied were you with how the Duke Energy representative responded to your questions?**
( ) 1
...
( ) 10
( ) DK/NS

If 7 or below,
17e. **Why were you less than satisfied with this information?**
[ ] Didn't respond to my questions/ concerns
[ ] Unable to answer/address my questions/concerns
[ ] Not professional/courteous
[ ] Other _____
[ ] DK/NS

18. **Has Duke Energy activated the Power Manager device since you joined the program?**
[If they ask what this means, respond with:
*"***Duke Energy has the ability to send a signal to activate the device to cycle your central air conditioner on and off during an event.***"** *Repeat the question.*
( ) Yes
( ) No
( ) DK/NS

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19. **How do you know when the device has been activated?**

[ ] A/C shuts down
[ ] Home temperature rises
[ ] The light on the meter is on
[ ] Light on AC unit flashes
[ ] Fan goes into cycling mode
[ ] Bill credits
[ ] Lower bill
[ ] Contact or notification from Duke Energy (other than bill)
[ ] Other _____
[ ] DK/NS

20. **About how many times did Duke Energy activate your Power Manager device in 2013?**

_____

21. **Were you or any members of your household home when Duke Energy activated your Power Manager device this past summer?**

( ) Yes
( ) No
( ) DK/NS

If no or don't know, skip to question 28.

22. **During this activation, using a scale of 1 to 10 where 1 means very uncomfortable and 10 means very comfortable, how would you describe your level of comfort before the control event?**

( ) 1
...
( ) 10
( ) DK/NS

23. **Using the same scale of 1 to 10 where 1 means very uncomfortable and 10 means very comfortable, how would you describe your level of comfort during the control event?**

( ) 1
...
( ) 10
( ) DK/NS

If score from Q23 is lower than score from Q22:

24. **What do you feel caused your decrease in comfort?**

[ ] No Change *(q22 = q23)*
[ ] Power Manager
[ ] Rising Temperature
[ ] Rising Humidity
[ ] Power Outage
[ ] Other _____
[ ] DK/NS

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25. **When Duke Energy activated your Power Manager device, did you or any other members of your household adjust the settings on your thermostat?**

( ) Yes
( ) No
( ) DK/NS

If yes,

25a. **At what temperature was it originally set, and what temperature did you set it to during the control event?**

Original temperature setting: degrees F _____
Adjusted temperature setting: degrees F _____

26. **Thinking about this summer, how many times do you think the activation of the Power Manager program affected your level of comfort?** _____

27. **When Duke Energy activated your Power Manager device, did you or any other members of your household turn on any fans to keep cool?**

( ) Yes
( ) No
( ) DK/NS
( ) Already had fans running.

27a. **What else did you or other members of your household do to keep cool?**

[ ] Continued normal activities/ Didn't do anything different
[ ] Turned on room/window air conditioners
[ ] Closed blinds/shades
[ ] Moved to a cooler part of the house
[ ] Left the house and went somewhere cool
[ ] Wore less clothing
[ ] Drank more water/cool drinks
[ ] Cooled off with water (shower, bath, sprinkler, hose, pool)
[ ] Turned on fans
[ ] Opened windows
[ ] Other _____
[ ] DK/NS

28. **When Duke Energy activates your Power Manager device, it usually does so on summertime afternoons. Is someone usually home on weekday afternoons during the summertime?**

( ) Yes
( ) No
( ) DK/NS

29. **Why do you think Duke Energy activates your Power Manager device on summertime weekdays during the afternoon as opposed to other times of the day or year?** _____

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30. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", how satisfied were you with the process of enrolling in the program?**

( ) 1
...
( ) 10
( ) I did not enroll/It was already installed when I moved in
( ) DK/NS

If 7 or below,

30b. **Why were you dissatisfied with this enrollment process?** _____

31. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", how satisfied are you with the Power Manager program in general?**

( ) 1
...
( ) 10
( ) DK/NS

If 7 or below,

31b. **Why were you less than satisfied with Power Manager?**

( ) They activated my Power Manager device more often than I would like
( ) The bill credits/incentives were not large enough
( ) I was uncomfortable when my Power Manager device was activated
( ) Other _____
( ) DK/NS

If 7 or below,

31c. **Were there any other reasons you were less than satisfied with Power Manager?**

[ ] No other reasons
[ ] They activated my Power Manager device more often than I would like
[ ] The bill credits/incentives were not large enough
[ ] I was uncomfortable when my Power Manager device was activated
[ ] Other _____
[ ] DK/NS

32. **Using a scale of 1 to 10, where 1 means "Extremely Unlikely" and 10 means "Extremely Likely", how likely is it that you would recommend this program to a friend, neighbor, or co-worker?**

( ) 1
...
( ) 10
( ) DK/NS

If 7 or below,

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32a. **Why would you not recommend the program?** _____

33. **What, if any, Duke Energy programs or services have you heard of that help customers save energy? Any others?**

[ ] Smart Saver (other than CFL)
[ ] Personalized Energy Report
[ ] Home Energy House Call
[ ] Home Energy Comparison Report
[ ] CFL Program
[ ] Energy Star Homes
[ ] Low Income, Weatherization, or Low Income Weatherization
[ ] K12, NEED, or "Get Energy Smart"
[ ] Other _____
[ ] DK/NS or None

Now I'm going to ask you some questions about your air conditioning use.

34. **How often do you use your central air conditioner? Would you say you use it ...**
Read answers aloud until they reply

( ) **Not at all**
( ) **Only on the hottest days**
( ) **Frequently during the cooling season**
( ) **Most days during the cooling season**
( ) **Every day during the cooling season**
( ) DK/NS

If customer did use AC
34a. **About how many days would you estimate that you had your air conditioner on so far this year?**

( ) Fewer than 10 days
( ) 10 to 20 days
( ) 21 to 30 days
( ) 31 to 40 days
( ) 41 to 50 days
( ) 51 to 60 days
( ) 61 to 70 days
( ) 71 to 80 days
( ) 81 to 90 days
( ) 91 to 100 days
( ) More than 100 days
( ) every day
( ) DK/NS

35. **Have you had your air conditioner tuned-up or serviced since you enrolled in the Power Manager program?**

( ) Yes

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( ) No
( ) DK/NS
( ) Other _____

If yes,

35a. **Did the performance of your air conditioner improve after you had it serviced?**
( ) Yes
( ) No
( ) DK/NS

35b. **Who serviced your air conditioner?**
( ) Air conditioning contractor
( ) Duke Energy
( ) Electrician
( ) Other _____
( ) DK/NS

36. **Is the air conditioner typically used to keep someone at home comfortable during weekday summer afternoons before 5 P.M.?**
'someone' includes pets, if applicable
( ) Yes
( ) No
( ) DK/NS

37. **Is the air conditioner typically used to keep someone at home comfortable during summer weekdays after 5 P.M.?**
'someone' includes pets, if applicable
( ) Yes
( ) No
( ) DK/NS

38. **When you think of a typical hot and humid summer day, at what outside temperature do you tend to feel uncomfortably warm?**
( ) <65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) 79-81 degrees
( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) >100 degrees

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( ) DK/NS

39. **At what outside temperature do you tend to turn on the air conditioner?**
( ) It is programmed into the thermostat.
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) 79-81 degrees
( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) greater than 100 degrees
( ) DK/NS

If "It's programmed into the thermostat",
39a. **Do you set your thermostat seasonally or when the weather gets hot?**
( ) I program the thermostat seasonally
( ) When the weather gets hot
( ) Other _____

40. **I am going to read a list of time periods. For each time period, please tell me the temperature that your thermostat is typically set to on a hot summer weekday when you are using the air conditioner, or if it is turned off.**

40a. **On a hot weekday morning from 6 am to noon.**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees
( ) OFF
( ) DK/NS

40b. **On a hot weekday afternoon from noon to 5 pm**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees

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( ) OFF
( ) DK/NS

40c. **On a hot weekday evening from 5 pm to 10pm.**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees
( ) OFF
( ) DK/NS

40d. **During a hot weekday night from 10pm to 6am.**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees
( ) OFF
( ) DK/NS

41. **I would now like to know the thermostat temperature setting for those same time periods but on a hot summer weekend.**

41a. **On a hot weekend morning from 6 am to noon.**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees
( ) No change from an average summer week day
( ) OFF
( ) DK/NS

41b. **On a hot weekend afternoon from noon to 5 pm**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees
( ) No change from an average summer week day
( ) OFF

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( ) DK/NS

41c. **On a hot weekend evening from 5 pm to 10pm.**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees
( ) No change from an average summer week day
( ) OFF
( ) DK/NS

41d. **During a hot weekend night from 10pm to 6am.**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) greater than 78 degrees
( ) No change from an average summer week day
( ) OFF
( ) DK/NS

42. **Duke Energy is always looking for other ways to help their customers. If Duke were to offer a program that cycles other equipment at your home such as an electric water heater, would you be interested in participating??**
( ) Yes
( ) No *ask* **Why not?** _____
( ) DK/NS *comments optional* _____

43. **Are there any programs or services that you think Duke Energy should provide to its residential customers that are currently not provided?**
( ) Yes
( ) No
( ) DK/NS

If yes,
43b. **What services or types of programs?** _____

44. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", What is your overall satisfaction with Duke Energy?**
( ) 1
...
( ) 10
( ) DK/NS

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If 7 or below,
44b. **Why were you less than satisfied with Duke Energy?** _____

45. **Did you experience any power outage issues on any of the days that Duke Energy activated your Power Manager device?**
( ) Yes
( ) No
( ) DK/NS

Finally, we have some general demographic questions…

d1. **In what type of building do you live?**
( ) Single-family home, detached construction
( ) Single-family home, factory manufactured/modular
( ) Single family, mobile home
( ) Row House
( ) Two or Three family attached residence-traditional structure
( ) Apartment (4 + families)---traditional structure
( ) Condominium---traditional structure
( ) Other _____
( ) Refused
( ) DK/NS

d2. **What year was your residence built?**
( ) 1959 or before
( ) 1960-1979
( ) 1980-1989
( ) 1990-1997
( ) 1998-2000
( ) 2001-2007
( ) 2008-present
( ) DK/NS

d3. **How many rooms are in your home (excluding bathrooms, but including finished basements)?**
( ) 1 to 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8
( ) 9
( ) 10 or more
( ) DK/NS

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d4. **Which of the following best describes your home's heating system?**
Check all that apply

[ ] None
[ ] Central forced air furnace
[ ] Electric Baseboard
[ ] Heat Pump
[ ] Geothermal Heat Pump
[ ] Other _____

d5. **How old is your heating system?**

( ) 0-4 years
( ) 5-9 years
( ) 10-14 years
( ) 15-19 years
( ) 19 years or older
( ) DK/NS
( ) Do not have

d6. **What is the primary fuel used in your heating system?**

( ) Electricity
( ) Natural Gas
( ) Oil
( ) Propane
( ) Other _____

d7. **What is the secondary fuel used in your primary heating system, if applicable?**

( ) Electricity
( ) Natural Gas
( ) Oil
( ) Propane
( ) Other _____
( ) None

d8. **Do you use one or more of the following to cool your home?**
(Mark all that apply)

[ ] None, do not cool the home
[ ] Heat pump for cooling
[ ] Central air conditioning
[ ] Through the wall or window air conditioning unit
[ ] Geothermal Heat pump
[ ] Other *(please specify)* _____

d9. **How many window-unit or "through the wall" air conditioner(s) do you use?**

( ) None
( ) 1

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( ) 2
( ) 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8 or more

d10. **What is the fuel used in your cooling system?**
[ ] Electricity
[ ] Natural Gas
[ ] Oil
[ ] Propane
[ ] Other _____
[ ] None

d11. **How old is your cooling system?**
( ) 0-4 years
( ) 5-9 years
( ) 10-14 years
( ) 15-19 years
( ) 19 years or older
( ) DK/NS
( ) Do not have

d12. **What is the fuel used by your water heater?**
(Mark all that apply)
[ ] Electricity
[ ] Natural Gas
[ ] Oil
[ ] Propane
[ ] Other _____
[ ] No water heater

d13. **How old is your water heater?**
( ) 0-4 years
( ) 5-9 years
( ) 10-14 years
( ) 15-19 years
( ) More than 19 years
( ) DK/NS

d14. **What type of fuel do you use for indoor cooking on the stovetop or range?**
(Mark all that apply)
[ ] Electricity
[ ] Natural Gas

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[ ] Oil
[ ] Propane
[ ] Other _____
[ ] No stovetop or range

d15. **What type of fuel do you use for indoor cooking in the oven?**
(Mark all that apply)
[ ] Electricity
[ ] Natural Gas
[ ] Oil
[ ] Propane
[ ] Other _____
[ ] No oven

d16. **What type of fuel do you use for clothes drying?**
(Mark all that apply)
[ ] Electricity
[ ] Natural Gas
[ ] Oil
[ ] Propane
[ ] Other _____
[ ] No clothes dryer

d17. **About how many square feet of living space are in your home?**
(Do not include garages or other unheated areas)
Note: A 10-foot by 12-foot room is 120 square feet
( ) Less than 500
( ) 500 to 999
( ) 1000 to 1499
( ) 1500 to 1999
( ) 2000 to 2499
( ) 2500 to 2999
( ) 3000 to 3499
( ) 3500 to 3999
( ) 4000 or more
( ) DK/NS

d18. **Do you own or rent your home?**
( ) Own
( ) Rent

d19. **How many levels are in your home (not including your basement)?**
( ) One
( ) Two
( ) Three

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d20. **Does your home have a heated or unheated basement?**
( ) Heated
( ) Unheated
( ) No basement

d21. **Does your home have an attic?**
( ) Yes
( ) No

d22. **Are your central air/heat ducts located in the attic?**
( ) Yes
( ) No
( ) N/A

d23. **Does your house have cold drafts in the winter?**
( ) Yes
( ) No

d24. **Does your house have sweaty windows in the winter?**
( ) Yes
( ) No

d25. **Do you notice uneven temperatures between the rooms in your home?**
( ) Yes
( ) No

d26. **Does your heating system keep your home comfortable in winter?**
( ) Yes
( ) No

d27. **Does your cooling system keep your home comfortable in summer?**
( ) Yes
( ) No

d28. **Do you have a programmable thermostat?**
( ) Yes
( ) No

d28b. **How many thermostats are there in your home?**
( ) 0
( ) 1
( ) 2
( ) 3
( ) 4 or more
( ) DK/NS

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d29. **What temperature is your thermostat set to on a typical summer weekday afternoon?**
( ) Less than 69 degrees
( ) 69-72 degrees
( ) 73-78 degrees
( ) Higher than 78 degrees
( ) Off
( ) DK/NS

d30. **What temperature is your thermostat set to on a typical winter weekday afternoon?**
( ) Less than 67 degrees
( ) 67-70 degrees
( ) 71-73 degrees
( ) 74-77 degrees
( ) 78 degrees or higher
( ) Off
( ) DK/NS

d31. **Do You Have a Swimming Pool or Spa?**
( ) Yes
( ) No

Read all answers until they reply
d32. **Would a two-degree increase in the summer afternoon temperature in your home affect your comfort..**
( ) **Not at all**
( ) **Slightly**
( ) **Moderately, or**
( ) **Greatly**

d33. **How many people live in this home?**
( ) 1
( ) 2
( ) 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8 or more
( ) Prefer not to answer

d34. **How many of them are teenagers?** *(age 13-19)*
If they ask why, explain that teenagers are generally associated with higher energy use.
( ) 0
( ) 1
( ) 2
( ) 3

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( ) 4
( ) 5
( ) 6
( ) 7
( ) 8 or more
( ) Prefer not to answer

d35. **How many persons are usually home on a weekday afternoon?**
( ) 0
( ) 1
( ) 2
( ) 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8 or more
( ) Prefer not to answer

d36. **Are you planning on making any large purchases to improve energy efficiency in the next 3 years?**
( ) Yes
( ) No
( ) DK/NS

The following questions are for classification purposes only and will not be used for any other purpose than to help Duke Energy continue to improve service.

d37. **What is your age group?**
( ) 18-34
( ) 35-49
( ) 50-59
( ) 60-64
( ) 65-74
( ) Over 74
( ) Prefer not to answer

d38. **Please indicate your annual household income.**
( ) Under $15,000
( ) $15,000-$29,999
( ) $30,000-$49,999
( ) $50,000-$74,999
( ) $75,000-$100,000
( ) Over $100,000
( ) Prefer Not to Answer

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We've reached the end of the survey. As I mentioned earlier, we would like to send you $20 for your time and feedback today. Should we send the $20 to *{address on calling sheet}*, or would a different address be better?

Confirm Name & complete address from calling sheet. If needed, make any changes to Name or Address on calling sheet, and mark "Changed Info" column.

You should receive your $20 check in about 4-6 weeks. It will come in an envelope from our company: TecMarket Works. Thanks again for your time today!

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Appendix C: Event Survey Instrument

Only calls to homes, please. Businesses are not eligible for this survey.
Use two attempts at different times of the day within 27 hours of event notification before dropping contact from the contact list. Call times are from 10:00 a.m. to 8:00 p.m. EPT Monday through Saturday. No calls on Sunday. For example, if a control event occurs on a Monday, calling hours for that particular event would be:

Monday 5pm-8pm EPT
Tuesday 10am-8pm EPT

Note: Only read words in bold type, italics are instructions.

Survey ID _____
Event ID _____
Surveyor Name _____

State

( ) Indiana
( ) Ohio
( ) Kentucky
( ) North Carolina
( ) South Carolina

Option

( ) 0.5 kW
( ) 1.0 kW
( ) 1.5 kW
( ) DK/NS

Introduction

Hello, my name is _____, and I'm calling on behalf of Duke Energy. According to our information, you presently participate in Duke Energy's Power Manager Program. This program allows Duke Energy to cycle your air conditioner when there is a critical need for electricity in the region. This is a short survey that will take about 5 minutes to complete, and the information you provide will be confidential and will help to improve the program.

for answering machine 1st attempt:

Hello, my name is _____. I am calling on behalf of Duke Energy to conduct a customer survey about the Power Manager Program. I'm sorry I missed you. I'll try again tomorrow.

for answering machine - Final Attempt:

Hello, my name is _____. I am calling on behalf of Duke Energy to conduct a customer survey about the Power Manager Program. This is my last attempt at reaching you, my apologies for any inconvenience.

on the second and final call attempt

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Hello, this is _____ calling again on behalf of Duke Energy, with a survey about their Power Manager Program. This is my last attempt to reach you. Sorry for any inconvenience.

1. **Are you aware of your participation in the Power Manager program?**
   ( ) Yes
   ( ) No
   ( ) DK/NS

If no,
May I please speak to the person who would be most familiar with your household's participation in the Power Manager program?

If not available, try to schedule a callback time within the 27 hour time-frame for the particular event. If transferred, begin survey from beginning (Introduction).

2. **Has Duke Energy activated the Power Manager device since you joined the program?**
*[If they ask what this means, respond with: "***Duke Energy has the ability to send a signal to activate the device to cycle your central air conditioner on and off during an event.***" Then repeat the question.]*
   ( ) Yes
   ( ) No
   ( ) DK/NS

3. **How do you know when the device has been activated?**
   [ ] A/C shuts down
   [ ] Home temperature rises
   [ ] The light on the meter is on
   [ ] Light on AC unit flashes
   [ ] Bill credits
   [ ] Lower bill
   [ ] Other _____
   [ ] DK/NS

4. **Has your device been activated within the last 7 days?**
   ( ) Yes
   ( ) No
   ( ) DK/NS

Your Power Manager device was recently activated on {*date*} starting at {*start time*} and ending at {*end time*}.

5. **At what temperature was your thermostat set to during the time of the event?**
   ( ) less than 65 degrees
   ( ) 65-68 degrees
   ( ) 69-72 degrees

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( ) 73-75 degrees
( ) 76-78 degrees
( ) 79-81 degrees
( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) greater than 100 degrees
( ) It's programmed into the thermostat
( ) Thermostat was turned off
( ) Air conditioner was turned off
( ) DK/NS

6. **Were you or any members of your household home when Duke Energy activated your Power Manager device at that time?**
( ) Yes
( ) No
( ) DK/NS
If no or don't know, skip to question 13.

7. **During this recent activation, using a scale of 1 to 10 where 1 means very uncomfortable and 10 means very comfortable, how would you describe your level of comfort before the control event?**
( ) 1
...
( ) 10
( ) DK/NS

8. **Using the same scale of 1 to 10 where 1 means very uncomfortable and 10 means very comfortable, how would you describe your level of comfort during the control event?**
( ) 1
...
( ) 10
( ) DK/NS

Ask question 9 if score from question 8 is lower than score from question 7
(Select all that apply.)
9. **What do you feel caused your decrease in comfort?**
[ ] Power Manager
[ ] Rising Temperature
[ ] Rising Humidity
[ ] Power Outage
[ ] Other _____
[ ] DK/NS

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10. **When Duke Energy activated your Power Manager device *{today OR yesterday}*, did you or any other members of your household adjust the settings on your thermostat?**
( ) Yes
( ) No
( ) DK/NS

If yes to question 10,
NOTE: enter a numeral for a temperature, or DK if not sure.
10a. **At what temperature was it originally set, and what temperature did you set it to during the control event?**
Original temperature setting (degrees F) _____
Adjusted temperature setting (degrees F) _____

11. **When Duke Energy activated your Power Manager device, did you or any other members of your household turn on any fans to keep cool?**
( ) Yes
( ) No
( ) DK/NS

12. **What else did you or other members of your household do to keep cool?**
Select all that apply.
[ ] Continued normal activities/ Didn't do anything different
[ ] Turned on room/window air conditioners
[ ] Closed blinds/shades
[ ] Moved to a cooler part of the house
[ ] Left the house and went somewhere cool
[ ] Wore less clothing
[ ] Drank more water/cool drinks
[ ] Turned on fans
[ ] Opened windows
[ ] Other _____
[ ] DK/NS

Now I'm going to ask you some questions about your air conditioning use.

13. **How often do you use your central air conditioner? Would you say you use it ...**
(Read first 5 answers aloud, stop when they answer.)
( ) **Not at all**
( ) **Only on the hottest days**
( ) **Frequently during the cooling season**
( ) **Most days during the cooling season**
( ) **Everyday during the cooling season**
( ) DK/NS

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14. **When you think of a typical hot and humid summer day, at what outside temperature do you tend to feel uncomfortably warm?**

( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) 79-81 degrees
( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) greater than 100 degrees
( ) DK/NS

15. **At what outside temperature do you tend to turn on the air conditioner?**

( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) 79-81 degrees
( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) greater than 100 degrees
( ) It's programmed into the thermostat
( ) DK/NS

16. **How old is your air conditioner?**

( ) 0 to 6 years old
( ) 7 to 12 years old
( ) 13 to 20 years old
( ) over 20 years old
( ) DK/NS

17. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", what is your overall satisfaction with the Power Manager program?**

( ) 1
...
( ) 10

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( ) DK/NS

If 7 or below ask,
17a. **Why are you less than satisfied with Power Manager?**
(Select all that apply)
[ ] They activated my Power Manager device more often than I would like
[ ] The bill credits/incentives were not large enough
[ ] I was uncomfortable when my Power Manager device was activated
[ ] Other _____
[ ] DK/NS

18. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", what is your overall satisfaction with Duke Energy?**
( ) 1
…
( ) 10
( ) DK/NS

If 7 or below,
18a. **Why are you less than satisfied with Duke Energy?** _____

19. **Using a scale of 1 to 10, where 1 means "Extremely Unlikely" and 10 means "Extremely Likely", how likely is it that you would recommend this program to a friend or colleague?**
( ) 1
…
( ) 10
( ) DK/NS

If 7 or below,
19a. **Why would you not recommend the program?** _____

20. **Did you experience any power outage issues on the day of the event?**
( ) Yes
( ) No
( ) DK/NS

21. **Do you get your Duke Energy bill in the mail or by email?**
( ) Mail
( ) Email
( ) DK/NS
( ) Other _____

22. **How do you pay your bill? Do you…**
(Read first 3 answers aloud, stop when they answer.)
( ) **Mail a check**
( ) log into your Duke Energy account and pay online

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( ) or do you have an auto-pay set up for your account?
( ) Other _____

23. **On average, how often do you review the details of your Duke Energy bill?**
(Read first 4 answers aloud, stop when they answer.)

( ) Every month
( ) More than half the time
( ) Less than half the time
( ) Never
( ) Other _____
( ) DK/NS

24. **How many people live in this home?**

( ) 1
( ) 2
( ) 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8 or more
( ) prefer not to answer

Thank you for your time and feedback today!
Politely end call.

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Appendix D: Non-Event Survey Instrument

Note: Text that is in red font indicates the changed wording from the Event survey to this Non-Event survey. Use two attempts at different times of the day within 27 hours of hot weather (exceeding 90°F in Midwest, or exceeding 93 in Carolina System) and no Power Manager event being called. Call times are from 10:00 a.m. to 8:00 p.m. EPT Monday through Saturday. No calls on Sunday. For example, if a high-temperature/no-event day occurs on a Monday, calling hours for that particular non-event would be:

Monday 5pm-8pm Eastern
Tuesday 10am-8pm Eastern

Note: Only read words in bold type. Italics are instructions.

Survey ID _____
Event ID _____
Surveyor Name _____

State

( ) Indiana
( ) Ohio
( ) Kentucky
( ) North Carolina
( ) South Carolina

Option *(if applicable)*

( ) 0.5 kW
( ) 1.0 kW
( ) 1.5 kW
( ) DK/NS

(if person answers)

Hello, my name is _____, and I'm calling on behalf of Duke Energy. According to our information, you presently participate in Duke Energy's Power Manager Program. This program allows Duke Energy to cycle your air conditioner when there is a critical need for electricity in the region. This is a short survey that will take about 5 minutes to complete, and the information you provide will be confidential and will help to improve the program.

for answering machine 1st attempt:

Hello, my name is _____. I am calling on behalf of Duke Energy to conduct a customer survey about the Power Manager Program. I'm sorry I missed you. I'll try again tomorrow.

for answering machine - Final Attempt:

Hello, my name is _____. I am calling on behalf of Duke Energy to conduct a customer survey about the Power Manager Program. This is my last attempt at reaching you, my apologies for any inconvenience.

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on the second and final call attempt
Hello, this is _____ calling again on behalf of Duke Energy, with a survey about their Power Manager Program. This is my last attempt to reach you. Sorry for any inconvenience.

1. **Are you aware of your participation in the Power Manager program?**
   ( ) Yes
   ( ) No
   ( ) DK/NS

If no,
May I please speak to the person who would be most familiar with your household's participation in the Power Manager program?
If not available, try to schedule a callback time within the 27 hour time-frame for the particular event. If transferred, begin survey from beginning.

2. **Has Duke Energy activated the Power Manager device since you joined the program?**
*[If they ask what this means, respond with: "***Duke Energy has the ability to send a signal to activate the device to cycle your central air conditioner on and off during an event.***" Then repeat the question.]*
   ( ) Yes
   ( ) No
   ( ) DK/NS

3. **How do you know when the device has been activated?**
   [ ] A/C shuts down
   [ ] Home temperature rises
   [ ] The light on the meter is on
   [ ] Light on AC unit flashes
   [ ] Bill credits
   [ ] Lower bill
   [ ] Other _____
   [ ] DK/NS

4. **Has your device been activated within the last 7 days?**
   ( ) Yes
   ( ) No
   ( ) DK/NS

5. **At what temperature was your thermostat set to at 3pm on** *{day of high temperature}***?**
   ( ) less than 65 degrees
   ( ) 65-68 degrees
   ( ) 69-72 degrees
   ( ) 73-75 degrees
   ( ) 76-78 degrees
   ( ) 79-81 degrees

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( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) greater than 100 degrees
( ) It's programmed into the thermostat
( ) Thermostat was turned off
( ) Air conditioner was turned off
( ) DK/NS

6. **Were you or any members of your household home at that time?**
( ) Yes
( ) No
( ) DK/NS
If no or don't know, skip to question 13.

7. **During this time using a scale of 1 to 10 where 1 means very uncomfortable and 10 means very comfortable, how would you describe your level of comfort on** *{day before high temperature}*?
( ) 1
...
( ) 10
( ) DK/NS

8. **Using the same scale of 1 to 10 where 1 means very uncomfortable and 10 means very comfortable, how would you describe your level of comfort on** *{day of high temperature}*?
( ) 1
...
( ) 10
( ) DK/NS

Ask question 9 if score from question 8 is lower than score from question 7:
9. **What do you feel caused your decrease in comfort?**
(Select all that apply.)
[ ] Power Manager
[ ] Rising Temperature
[ ] Rising Humidity
[ ] Power Outage
[ ] Other _____
[ ] DK/NS

10. **On** *{day of high temperature}*, **did you or any other members of your household adjust the settings on your thermostat?**
( ) Yes

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( ) No
( ) DK/NS

If yes to question 10,
NOTE: enter a numeral for a temperature, or DK if not sure.
10a. **At what temperature was it originally set, and what temperature did you set it to on** *{day of high temperature}*?
Original temperature setting (degrees F) _____
Adjusted temperature setting (degrees F) _____

11. **On** *{day of hot temperature}*, **did you or any other members of your household turn on any fans to keep cool?**
( ) Yes
( ) No
( ) DK/NS

12. **What else did you or other members of your household do to keep cool?**
[ ] Continued normal activities/ Didn't do anything different
[ ] Turned on room/window air conditioners
[ ] Closed blinds/shades
[ ] Moved to a cooler part of the house
[ ] Left the house and went somewhere cool
[ ] Wore less clothing
[ ] Drank more water/cool drinks
[ ] Turned on fans
[ ] Opened windows
[ ] Other _____
[ ] DK/NS

Now I'm going to ask you some questions about your air conditioning use.

13. **How often do you use your central air conditioner? Would you say you use it ...**
(Read first 5 answers aloud.)
( ) **Not at all**
( ) Only on the hottest days
( ) Frequently during the cooling season
( ) Most days during the cooling season
( ) Everyday during the cooling season
( ) DK/NS

14. **When you think of a typical hot and humid summer day, at what outside temperature do you tend to feel uncomfortably warm?**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees

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( ) 76-78 degrees
( ) 79-81 degrees
( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) greater than 100 degrees
( ) DK/NS

15. **At what outside temperature do you tend to turn on the air conditioner?**
( ) less than 65 degrees
( ) 65-68 degrees
( ) 69-72 degrees
( ) 73-75 degrees
( ) 76-78 degrees
( ) 79-81 degrees
( ) 82-84 degrees
( ) 85-87 degrees
( ) 88-90 degrees
( ) 91-94 degrees
( ) 95-97 degrees
( ) 98-100 degrees
( ) greater than 100 degrees
( ) It's programmed into the thermostat
( ) DK/NS

16. **How old is your air conditioner?**
( ) 0 to 6 years old
( ) 7 to 12 years old
( ) 13 to 20 years old
( ) over 20 years old
( ) DK/NS

17. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", what is your overall satisfaction with the Power Manager program?**
( ) 1
…
( ) 10
( ) DK/NS

If 7 or below ask,
17a. **Why are you less than satisfied with Power Manager?**
(Select all that apply)
[ ] They activated my Power Manager device more often than I would like

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[ ] The bill credits/incentives were not large enough
[ ] I was uncomfortable when my Power Manager device was activated
[ ] Other _____
[ ] DK/NS

18. **Using a scale of 1 to 10 where 1 indicates "Very Dissatisfied" and 10 indicates "Very Satisfied", what is your overall satisfaction with Duke Energy?**
( ) 1
...
( ) 10
( ) DK/NS

If 7 or below,
18a. **Why are you less than satisfied with Duke Energy?** _____

19. **Using a scale of 1 to 10, where 1 means "Extremely Unlikely" and 10 means "Extremely Likely", how likely is it that you would recommend this program to a friend or colleague?**
( ) 1
...
( ) 10
( ) DK/NS

If 7 or below,
19a. **Why would you not recommend the program?** _____

20. **Did you experience any power outage issues on** *{day of high temperature}*?
( ) Yes
( ) No
( ) DK/NS

21. **Do you get your Duke Energy bill in the mail or by email?**
( ) Mail
( ) Email
( ) DK/NS
( ) Other _____

22. **How do you pay your bill? Do you…**
(Read first 3 answers aloud.)
( ) **Mail a check**
( ) log into your Duke Energy account and pay online
( ) or do you have an auto-pay set up for your account?
( ) Other _____

23. **On average, how often do you review the details of your Duke Energy bill?**
(Read first 4 answers aloud.)
( ) **Every month**

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( ) More than half the time
( ) Less than half the time
( ) Never
( ) Other _____
( ) DK/NS

24. **How many people live in this home?**
( ) 1
( ) 2
( ) 3
( ) 4
( ) 5
( ) 6
( ) 7
( ) 8 or more
( ) prefer not to answer

Thank you for your time and feedback today!
Politely end call.

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Appendix E: Participant Survey Customer Descriptive Data

TecMarket Works surveyed 80 participants about their homes and households. Additional descriptive data is provided in this appendix.

In what type of building do you live? * State

			State		Total
			South Carolina	North Carolina	
In what type of building do you live?	Single-family home, detached construction	Count	20	55	75
		% within State	90.9%	94.8%	93.8%
	Single family home, factory manufactured/modular	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	Row House	Count	1	0	1
		% within State	4.5%	0.0%	1.3%
	Apartment (4 + families)---traditional structure	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	Condominium---traditional structure	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	Other: duplex	Count	1	0	1
		% within State	4.5%	0.0%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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What year was your residence built? * State

			State		Total
			South Carolina	North Carolina	
What year was your residence built?	1959 or before	Count	4	12	16
		% within State	18.2%	20.7%	20.0%
	1960-1979	Count	10	22	32
		% within State	45.5%	37.9%	40.0%
	1980-1989	Count	3	11	14
		% within State	13.6%	19.0%	17.5%
	1990-1997	Count	1	6	7
		% within State	4.5%	10.3%	8.8%
	1998-2000	Count	1	1	2
		% within State	4.5%	1.7%	2.5%
	2001-2007	Count	2	1	3
		% within State	9.1%	1.7%	3.8%
	2008-present	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	DK/NS	Count	1	4	5
		% within State	4.5%	6.9%	6.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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How many rooms are in your home (excluding bathrooms, but including finished basements)? * State

			State		Total
			South Carolina	North Carolina	
How many rooms are in your home (excluding bathrooms, but including finished basements)?	4	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	5	Count	1	9	10
		% within State	4.5%	15.5%	12.5%
	6	Count	1	14	15
		% within State	4.5%	24.1%	18.8%
	7	Count	7	7	14
		% within State	31.8%	12.1%	17.5%
	8	Count	8	10	18
		% within State	36.4%	17.2%	22.5%
	9	Count	3	3	6
		% within State	13.6%	5.2%	7.5%
	10 or more	Count	2	13	15
		% within State	9.1%	22.4%	18.8%
	DK/NS	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Which of the following best describes your home's heating system?	South Carolina N=22		North Carolina N=58		Total N=80	
None	0	0.0%	0	0.0%	0	0.0%
Central forced air furnace	12	54.5%	34	58.6%	46	57.5%
Multiple central forced air furnaces	1	4.5%	1	1.7%	2	2.5%
Electric Baseboard	0	0.0%	0	0.0%	0	0.0%
Heat Pump	10	45.5%	23	39.7%	33	41.3%
Geothermal Heat Pump	0	0.0%	0	0.0%	0	0.0%
Boiler / radiators	0	0.0%	1	1.7%	1	1.3%
"*Radiant electric plus water stove*"	0	0.0%	1	1.7%	1	1.3%
Don't know	1	4.5%	1	1.7%	2	2.5%

May total to more than 100% because respondents could give multiple responses.

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How old is your heating system? * State

			State		Total
			South Carolina	North Carolina	
How old is your heating system?	0-4 years	Count	4	16	20
		% within State	18.2%	27.6%	25.0%
	5-9 years	Count	4	9	13
		% within State	18.2%	15.5%	16.3%
	10-14 years	Count	7	9	16
		% within State	31.8%	15.5%	20.0%
	15-19 years	Count	3	5	8
		% within State	13.6%	8.6%	10.0%
	19 years or older	Count	2	10	12
		% within State	9.1%	17.2%	15.0%
	DK/NS	Count	2	9	11
		% within State	9.1%	15.5%	13.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

What is the primary fuel used in your heating system? * State

			State		Total
			South Carolina	North Carolina	
What is the primary fuel used in your heating system?	Electricity	Count	8	25	33
		% within State	36.4%	43.1%	41.3%
	Natural Gas	Count	13	30	43
		% within State	59.1%	51.7%	53.8%
	Oil	Count	1	1	2
		% within State	4.5%	1.7%	2.5%
	Propane	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	DK/NS	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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What is the secondary fuel used in your primary heating system, if applicable? * State

			State		Total
			South Carolina	North Carolina	
What is the secondary fuel used in your primary heating system, if applicable?	Electricity	Count	6	17	23
		% within State	27.3%	29.3%	28.8%
	Natural Gas	Count	1	2	3
		% within State	4.5%	3.4%	3.8%
	Other	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	None	Count	15	38	53
		% within State	68.2%	65.5%	66.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Do you use one or more of the following to cool your home?	**South Carolina N=22**		**North Carolina N=58**		**Total N=80**	
None, do not cool the home	0	0.0%	0	0.0%	0	0.0%
Heat pump for cooling	9	40.9%	21	36.2%	30	37.5%
Central air conditioning	16	72.7%	38	65.5%	54	67.5%
Through the wall or window air conditioning unit	0	0.0%	0	0.0%	0	0.0%
Geothermal Heat pump	0	0.0%	0	0.0%	0	0.0%
Fans (ceiling, window, portable)	0	0.0%	1	1.7%	1	1.3%
Don't know	0	0.0%	0	0.0%	0	0.0%

May total to more than 100% because respondents could give multiple responses.

How many window-unit or through the wall air conditioner(s) do you use? * State

			State		Total
			South Carolina	North Carolina	
How many window-unit or through the wall air conditioner(s) do you use?	1	Count	2	1	3
		% within State	9.1%	1.7%	3.8%
	None	Count	20	57	77
		% within State	90.9%	98.3%	96.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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What is the fuel used in your cooling system?	South Carolina N=22		North Carolina N=58		Total N=80	
Electricity	22	100.0%	58	100.0%	80	100.0%
Natural Gas	0	0.0%	0	0.0%	0	0.0%
Oil	0	0.0%	0	0.0%	0	0.0%
Propane	0	0.0%	0	0.0%	0	0.0%
Butane	0	0.0%	0	0.0%	0	0.0%
None (no cooling system)	0	0.0%	0	0.0%	0	0.0%
DK/NS	0	0.0%	0	0.0%	0	0.0%

May total to more than 100% because respondents could give multiple responses.

How old is your cooling system? * State

			State		Total
			South Carolina	North Carolina	
How old is your cooling system?	0-4 years	Count	6	17	23
		% within State	27.3%	29.3%	28.8%
	5-9 years	Count	5	9	14
		% within State	22.7%	15.5%	17.5%
	10-14 years	Count	4	9	13
		% within State	18.2%	15.5%	16.3%
	15-19 years	Count	3	5	8
		% within State	13.6%	8.6%	10.0%
	19 years or older	Count	2	10	12
		% within State	9.1%	17.2%	15.0%
	DK/NS	Count	2	8	10
		% within State	9.1%	13.8%	12.5%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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What is the fuel used by your water heater?	South Carolina N=22		North Carolina N=58		Total N=80	
Electricity	10	45.5%	36	62.1%	46	57.5%
Natural Gas	12	54.5%	21	36.2%	33	41.3%
Oil	0	0.0%	0	0.0%	0	0.0%
Propane	0	0.0%	0	0.0%	0	0.0%
No water heater	0	0.0%	0	0.0%	0	0.0%
"solar system that heats the water before it goes into the water heater"	0	0.0%	1	1.7%	1	1.3%
DK/NS	0	0.0%	1	1.7%	1	1.3%

May total to more than 100% because respondents could give multiple responses.

How old is your water heater? * State

			State		Total
			South Carolina	North Carolina	
d13 How old is your water heater?	0-4 years	Count	6	13	19
		% within State	27.3%	22.4%	23.8%
	5-9 years	Count	2	11	13
		% within State	9.1%	19.0%	16.3%
	10-14 years	Count	8	12	20
		% within State	36.4%	20.7%	25.0%
	15-19 years	Count	2	7	9
		% within State	9.1%	12.1%	11.3%
	More than 19 years	Count	1	4	5
		% within State	4.5%	6.9%	6.3%
	DK/NS	Count	3	11	14
		% within State	13.6%	19.0%	17.5%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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What type of fuel do you use for indoor cooking on the stovetop or range?	South Carolina N=22		North Carolina N=58		Total N=80	
Electricity	21	95.5%	47	81.0%	68	85.0%
Natural Gas	1	4.5%	11	19.0%	12	15.0%
Oil	0	0.0%	0	0.0%	0	0.0%
Propane	0	0.0%	1	1.7%	1	1.3%
None (no stove)	0	0.0%	0	0.0%	0	0.0%
DK/NS	0	0.0%	0	0.0%	0	0.0%

May total to more than 100% because respondents could give multiple responses.

What type of fuel do you use for indoor cooking in the oven?	South Carolina N=22		North Carolina N=58		Total N=80	
Electricity	22	100.0%	49	84.5%	71	88.8%
Natural Gas	2	9.1%	10	17.2%	12	15.0%
Oil	0	0.0%	0	0.0%	0	0.0%
Propane	0	0.0%	1	1.7%	1	1.3%
None (no oven)	0	0.0%	0	0.0%	0	0.0%
DK/NS	0	0.0%	0	0.0%	0	0.0%

May total to more than 100% because respondents could give multiple responses.

What type of fuel do you use for clothes drying?	South Carolina N=22		North Carolina N=58		Total N=80	
Electricity	20	90.9%	54	93.1%	74	92.5%
Natural Gas	1	4.5%	4	6.9%	5	6.3%
Oil	0	0.0%	0	0.0%	0	0.0%
Air dry (clothesline)	0	0.0%	0	0.0%	0	0.0%
Propane	0	0.0%	0	0.0%	0	0.0%
None (no dryer)	1	4.5%	0	0.0%	1	1.3%
DK/NS	0	0.0%	0	0.0%	0	0.0%

May total to more than 100% because respondents could give multiple responses.

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About how many square feet of living space are in your home? * State

			State		Total
			South Carolina	North Carolina	
About how many square feet of living space are in your home?	500 to 999	Count	1	2	3
		% within State	4.5%	3.4%	3.8%
	1000 to 1499	Count	0	9	9
		% within State	0.0%	15.5%	11.3%
	1500 to 1999	Count	9	21	30
		% within State	40.9%	36.2%	37.5%
	2000 to 2499	Count	6	5	11
		% within State	27.3%	8.6%	13.8%
	2500 to 2999	Count	3	3	6
		% within State	13.6%	5.2%	7.5%
	3000 to 3499	Count	2	3	5
		% within State	9.1%	5.2%	6.3%
	3500 to 3999	Count	1	4	5
		% within State	4.5%	6.9%	6.3%
	4000 or more	Count	0	4	4
		% within State	0.0%	6.9%	5.0%
	DK/NS	Count	0	7	7
		% within State	0.0%	12.1%	8.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Do you own or rent your home? * State

			State		Total
			South Carolina	North Carolina	
Do you own or rent your home?	Own	Count	20	53	73
		% within State	90.9%	91.4%	91.3%
	Rent	Count	2	5	7
		% within State	9.1%	8.6%	8.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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How many levels are in your home (not including your basement)? * State

			State		Total
			South Carolina	North Carolina	
How many levels are in your home (not including your basement)?	One	Count	10	40	50
		% within State	45.5%	69.0%	62.5%
	Two	Count	11	18	29
		% within State	50.0%	31.0%	36.3%
	Three	Count	1	0	1
		% within State	4.5%	0.0%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Does your home have a heated or unheated basement? * State

			State		Total
			South Carolina	North Carolina	
Does your home have a heated or unheated basement?	Heated	Count	3	19	22
		% within State	13.6%	32.8%	27.5%
	Unheated	Count	3	4	7
		% within State	13.6%	6.9%	8.8%
	No basement	Count	16	35	51
		% within State	72.7%	60.3%	63.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Does your home have an attic? * State

			State		Total
			South Carolina	North Carolina	
Does your home have an attic?	Yes	Count	22	54	76
		% within State	100.0%	93.1%	95.0%
	No	Count	0	4	4
		% within State	0.0%	6.9%	5.0%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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Are your central air/heat ducts located in the attic? * State

			State		Total
			South Carolina	North Carolina	
Are your central air/heat ducts located in the attic?	Yes	Count	11	16	27
		% within State	50.0%	27.6%	33.8%
	No	Count	11	37	48
		% within State	50.0%	63.8%	60.0%
	N/A	Count	0	5	5
		% within State	0.0%	8.6%	6.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Does your house have cold drafts in the winter? * State

			State		Total
			South Carolina	North Carolina	
Does your house have cold drafts in the winter?	Yes	Count	5	12	17
		% within State	22.7%	20.7%	21.3%
	No	Count	17	46	63
		% within State	77.3%	79.3%	78.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Does your house have sweaty windows in the winter? * State

			State		Total
			South Carolina	North Carolina	
Does your house have sweaty windows in the winter?	Yes	Count	1	11	12
		% within State	4.5%	19.0%	15.0%
	No	Count	21	47	68
		% within State	95.5%	81.0%	85.0%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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Do you notice uneven temperatures between the rooms in your home? * State

			State		Total
			South Carolina	North Carolina	
Do you notice uneven temperatures between the rooms in your home?	Yes	Count	11	26	37
		% within State	50.0%	44.8%	46.3%
	No	Count	11	32	43
		% within State	50.0%	55.2%	53.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Does your heating system keep your home comfortable in winter? * State

			State		Total
			South Carolina	North Carolina	
Does your heating system keep your home comfortable in winter?	Yes	Count	22	55	77
		% within State	100.0%	94.8%	96.3%
	No	Count	0	3	3
		% within State	0.0%	5.2%	3.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Does your cooling system keep your home comfortable in summer? * State

			State		Total
			South Carolina	North Carolina	
Does your cooling system keep your home comfortable in summer?	Yes	Count	22	53	75
		% within State	100.0%	91.4%	93.8%
	No	Count	0	5	5
		% within State	0.0%	8.6%	6.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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Do you have a programmable thermostat? * State

			State		Total
			South Carolina	North Carolina	
Do you have a programmable thermostat?	Yes	Count	11	28	39
		% within State	50.0%	48.3%	48.8%
	No	Count	11	30	41
		% within State	50.0%	51.7%	51.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

How many thermostats are there in your home? * State

			State		Total
			South Carolina	North Carolina	
How many thermostats are there in your home?	1	Count	15	47	62
		% within State	68.2%	81.0%	77.5%
	2	Count	7	8	15
		% within State	31.8%	13.8%	18.8%
	3	Count	0	2	2
		% within State	0.0%	3.4%	2.5%
	4 or more	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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What temperature is your thermostat set to on a typical summer weekday afternoon? * State

			State		Total
			South Carolina	North Carolina	
What temperature is your thermostat set to on a typical summer weekday afternoon?	Less than 69 degrees	Count	0	3	3
		% within State	0.0%	5.2%	3.8%
	69-72 degrees	Count	7	19	26
		% within State	31.8%	32.8%	32.5%
	73-78 degrees	Count	13	27	40
		% within State	59.1%	46.6%	50.0%
	Higher than 78 degrees	Count	1	8	9
		% within State	4.5%	13.8%	11.3%
	Off	Count	1	1	2
		% within State	4.5%	1.7%	2.5%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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What temperature is your thermostat set to on a typical winter weekday afternoon? * State

			State		Total
			South Carolina	North Carolina	
What temperature is your thermostat set to on a typical winter weekday afternoon?	Less than 67 degrees	Count	2	7	9
		% within State	9.1%	12.1%	11.3%
	67-70 degrees	Count	8	26	34
		% within State	36.4%	44.8%	42.5%
	71-73 degrees	Count	10	16	26
		% within State	45.5%	27.6%	32.5%
	74-77 degrees	Count	2	5	7
		% within State	9.1%	8.6%	8.8%
	78 degrees or higher	Count	0	2	2
		% within State	0.0%	3.4%	2.5%
	Off	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	DK/NS	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

Do You Have a Swimming Pool or Spa? * State

			State		Total
			South Carolina	North Carolina	
Do You Have a Swimming Pool or Spa?	Yes	Count	2	4	6
		% within State	9.1%	6.9%	7.5%
	No	Count	20	54	74
		% within State	90.9%	93.1%	92.5%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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Would a two-degree increase in the summer afternoon temperature in your home affect your comfort * State

			State		Total
			South Carolina	North Carolina	
Would a two-degree increase in the summer afternoon temperature in your home affect your comfort	Not at all	Count	5	22	27
		% within State	22.7%	37.9%	33.8%
	Slightly	Count	10	14	24
		% within State	45.5%	24.1%	30.0%
	Moderately, or	Count	5	13	18
		% within State	22.7%	22.4%	22.5%
	Greatly	Count	2	9	11
		% within State	9.1%	15.5%	13.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

How many people live in this home? * State

			State		Total
			South Carolina	North Carolina	
How many people live in this home?	1	Count	1	12	13
		% within State	4.5%	20.7%	16.3%
	2	Count	15	20	35
		% within State	68.2%	34.5%	43.8%
	3	Count	3	12	15
		% within State	13.6%	20.7%	18.8%
	4	Count	3	11	14
		% within State	13.6%	19.0%	17.5%
	5	Count	0	2	2
		% within State	0.0%	3.4%	2.5%
	7	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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How many of them are teenagers? * State

			State		Total
			South Carolina	North Carolina	
How many of them are teenagers?	0	Count	18	47	65
		% within State	81.8%	81.0%	81.3%
	1	Count	3	9	12
		% within State	13.6%	15.5%	15.0%
	2	Count	1	2	3
		% within State	4.5%	3.4%	3.8%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

How many persons are usually home on a weekday afternoon? * State

			State		Total
			South Carolina	North Carolina	
How many persons are usually home on a weekday afternoon?	0	Count	3	12	15
		% within State	13.6%	20.7%	18.8%
	1	Count	7	13	20
		% within State	31.8%	22.4%	25.0%
	2	Count	9	20	29
		% within State	40.9%	34.5%	36.3%
	3	Count	3	7	10
		% within State	13.6%	12.1%	12.5%
	4	Count	0	3	3
		% within State	0.0%	5.2%	3.8%
	5	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	6	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
	Prefer not to answer	Count	0	1	1
		% within State	0.0%	1.7%	1.3%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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Are you planning on making any large purchases to improve energy efficiency in the next 3 years? * State

			State		Total
			South Carolina	North Carolina	
Are you planning on making any large purchases to improve energy efficiency in the next 3 years?	Yes	Count	4	13	17
		% within State	18.2%	22.4%	21.3%
	No	Count	16	41	57
		% within State	72.7%	70.7%	71.3%
	NS/DK	Count	2	4	6
		% within State	9.1%	6.9%	7.5%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

What is your age group? * State

			State		Total
			South Carolina	North Carolina	
What is your age group?	18-34	Count	3	5	8
		% within State	13.6%	8.6%	10.0%
	35-49	Count	3	13	16
		% within State	13.6%	22.4%	20.0%
	50-59	Count	5	8	13
		% within State	22.7%	13.8%	16.3%
	60-64	Count	2	10	12
		% within State	9.1%	17.2%	15.0%
	65-74	Count	5	12	17
		% within State	22.7%	20.7%	21.3%
	Over 74	Count	4	10	14
		% within State	18.2%	17.2%	17.5%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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Please indicate your annual household income * State

			State		Total
			South Carolina	North Carolina	
Please indicate your annual household income	Under $15,000	Count	0	2	2
		% within State	0.0%	3.4%	2.5%
	$15,000-$29,999	Count	0	3	3
		% within State	0.0%	5.2%	3.8%
	$30,000-$49,999	Count	3	5	8
		% within State	13.6%	8.6%	10.0%
	$50,000-$74,999	Count	5	4	9
		% within State	22.7%	6.9%	11.3%
	$75,000-$100,000	Count	2	4	6
		% within State	9.1%	6.9%	7.5%
	Over $100,000	Count	4	8	12
		% within State	18.2%	13.8%	15.0%
	Prefer Not to Answer	Count	8	32	40
		% within State	36.4%	55.2%	50.0%
Total		Count	22	58	80
		% within State	100.0%	100.0%	100.0%

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Appendix F: Event Survey Customer Descriptive Data

Event study participants were asked during the survey how many people currently live in their home. This distribution is shown below in Figure 52. Most Power Manager households surveyed have one or two people living in them; overall, only 25.6% (50 out of 195) of these households have three or more members (and there is no statistically significant difference between groups in the percentage of households with three or more members). However, surveyed Full Shed Event participants are more likely to be one-person households (53.8% or 7 out of 13) compared to either Regular Event participants (25.3% or 37 out of 146) or Non-Event participants (25.0% or 9 out of 36; differences significant at $p<.05$ using Student's t-test). There are no significant differences in household size between North and South Carolina (not shown).

No other household or demographic questions were asked during Event and Non-Event surveys. For further household and demographic characteristics of program participants in the Carolina System, see *Appendix E: Participant Survey Customer Descriptive Data.*

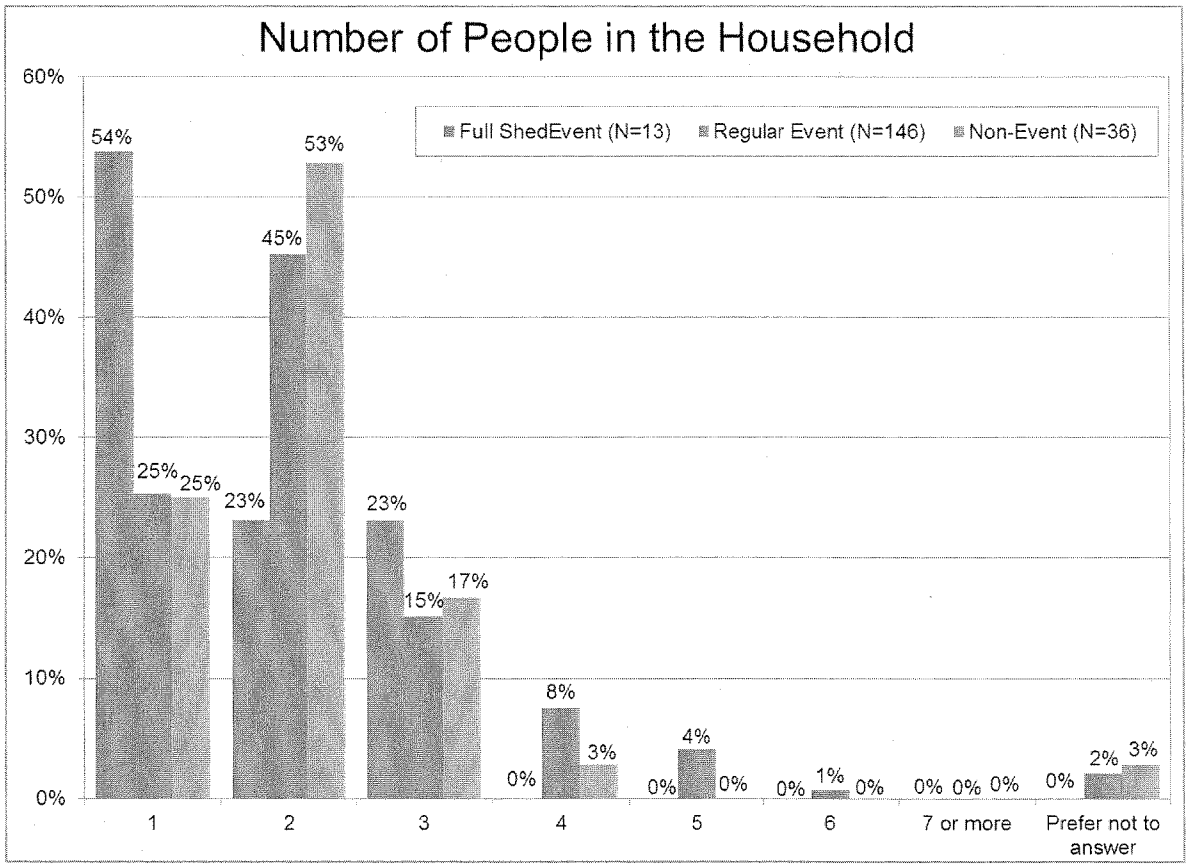

Figure 52. Population Distribution of Event and Non-Event Participants

I/H

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Final Report

Impact Evaluation and Review of the 2013 Power Manager® Program in the Carolina System

Prepared for
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May 30, 2014

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Executive Summary

Summary of Findings

In preparing the impact evaluation for the 2013 Duke Energy Power Manager® program, the Company has employed essentially the same evaluation methodology and analytical procedures as it has used over the past few years. In our review, we find that the assessment methodology and the analytical procedures followed by Duke Energy for estimating the load impacts from the Power Manager program are reasonable, analytically reliable, and defensible. One strength of the approach is the use of an extensive history for model estimation. Instead of relying on an approach used by many utilities which compares only a few days deemed to be similar (a less rigorous and less reliable approach because it limits the comparison to a few pre-event days), Duke Energy employs a multivariate regression model to estimate the load impacts. The application of the multivariate regression model allows for more precise estimates instead of relying on assumptions about a limited set of comparable type days.

In our opinion, after reviewing the overall analysis, Duke Energy's impact evaluation is thorough and employs a state-of-the-art methodology which provides accurate and reliable estimates of event impacts and the summer load reduction capacity under peak normal weather conditions, as summarized in Table 7 on page 14.

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Introduction and Purpose of Study

This document presents the evaluation report for Duke Energy's Power Manager Program as it was administered in the Carolina System.

The evaluation was conducted by Duke Energy and the TecMarket Works evaluation team. Duke Energy conducted the impact analysis, and Integral Analytics (a TecMarket Works subcontractor) conducted the review of the methodology and results.

Summary Overview

This document presents a review of the impact evaluation for the Power Manager (PM) program conducted by Duke Energy as it was administered in the Carolina System.

Summary of the Evaluation

Power Manager is a voluntary residential program, available to homeowners with qualified central air conditioning (AC). On days where energy demand and/or energy costs are expected to be high, Power Manager participants have agreed to allow Duke Energy to cycle their air conditioning off and on for a period of time.

The impact evaluation conducted by Duke Energy developed an air conditioner (AC) duty cycle model based on information from a sample of PM participants. This duty cycle was then used to simulate the expected natural duty cycle during the PM event days and under peak normal weather conditions for different PM program options and load control technologies to produce estimates of the potential load reduction. These estimates were then de-rated by the results of operability studies to give estimates of the realized load reductions.

Evaluation Objectives

The purpose of this evaluation was two-fold. The first objective is to summarize the actual kW and expected peak normal kW impacts determined by Duke Energy for 2013. The second objective is to determine if the approach used by Duke Energy in estimating these impacts is consistent with commonly accepted evaluation principles.

Summary of Review

From our review, we find that the methodology as well as the application used by Duke Energy for estimating the load impacts from the Power Manager program are reasonable, reliable, and defensible. One strength of the approach is the use of an extensive history for model estimation. Instead of relying on only a handful of days deemed to be similar, Duke Energy employs a multivariate regression model to estimate the load impacts. The application of the multivariate regression model allows for more precise impact estimates instead of relying on assumptions about a few comparable type days.

After reviewing the overall analysis, in our opinion, Duke Energy's impact evaluation is thorough and employs a state-of-the-art methodology which provides accurate and reliable estimates of event impacts and the summer load reduction capacity under peak normal weather conditions, as summarized in Table 7 on page 14. The information supplied by Duke Energy and

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reviewed by the evaluation team included written documentation as well as spreadsheets covering summer capability, M&V summary, and P&L Calculations.

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Description of Program

Power Manager is a voluntary residential program, available to homeowners with qualified central air conditioning (AC). On days where energy demand and/or energy costs are expected to be high, Duke Energy has permission from Power Manager participants to cycle their air conditioning off and on for a period of time.

When customers enroll, Duke Energy installs a switch that allows the AC unit to be cycled off and on in response to signals sent over Duke Energy's paging system.

Within Duke Energy's portfolio, Power Manager is currently the only residential demand response program[1]. The Power Manager program plays a key role in capacity planning; every year, Power Manager provides an estimate as to how much capacity it can provide during the summer season, and this information is taken into account by the capacity planners.

Program Participation

Program	Participation Count for 2013 (number of switches)
Power Manager Carolina System	EOM Sept. 2013 = 183,402

[1] Not including pilot programs.

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Methodology

Overview of the Evaluation Approach

The Duke Energy Power Manager (PM) program impact evaluations were performed by Duke Energy staff. Furthermore, the impacts presented in this report include a review by Integral Analytics (IA) of the impact evaluation methodology and results. The methodology and approach used by Duke Energy staff are nearly identical to that used in prior evaluations reviewed by the TMW team.

To begin, the impact evaluation involves an air conditioner (AC) duty cycle model developed from an analysis of a sample of PM participants. This duty cycle model was then used in two ways: (1) to simulate the expected natural duty cycle during the PM event days to produce estimates of event-related load reductions and (2) to produce estimates of the potential load reduction expected on a peak normal day using peak normal weather conditions for different PM program options and load control technologies. These load impact estimates were then de-rated to account for the results of operability studies and thus provide estimates of the realized load reductions.

Overall, the general approach employs a state-of-the-art methodology which is well established in the industry. The performance of the actual analysis was thorough and the resulting load impact estimates are accurate and reliable. The information supplied by Duke Energy and reviewed by IA included written documentation as well as spreadsheets covering participation and impacts.

Data collection methods, sample sizes, and sampling methodology

The 2013 PM M&V sample in the Southeast consists of 161 households with 205 air-conditioner (AC) units. This includes 120 households from North Carolina and 41 households from South Carolina, closely reflecting the relative numbers of PM participants in each state. There are 59 holdovers from North Carolina 2012 M&V sample and 25 holdovers from South Carolina 2012 M&V sample that were randomly selected in either 2011 or 2012. The Southeast sample is designed to target at 10% relative precision at 90% confidence level plus extra households to compensate for potential loss of sample due to data issues or removal of the switch during the summer.

At households selected for the M&V sample, any older load control switch was replaced by a Cannon load control switch. Our purpose in this study is to determine the load reduction achieved when the load control switch functions as expected, so this switch replacement does not introduce bias into our results. Completely separate operability studies are conducted to determine deviation from expected performance (the de-rating factor) for each load control technology. The M&V samples were used for both fixed and target cycling, as well as full shed impact analysis.

PM M&V sample is stratified into high and low groups according to premise monthly kWh usage from the previous summer. The Dalenius-Hodges technique for selecting strata boundary (high strata: >= boundary; low strata: < boundary) and the Neyman method for optimum sample

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allocation were employed to achieve reduced sample variance of load reduction estimates. Stratification analysis was performed for the Southeast PM population. The resulting stratification of PM M&V sample is shown in Table 1.

Table 1. M&V Sample Stratification

	Strata Boundary	Sample allocation		Population weight	
	(kWh)	High	Low	High	Low
NC & SC	1785	80	81	34.8%	65.2%

Hourly run-time of AC units in the M&V sample was collected during 2013 summer months (May through September). This was accomplished with the Cannon load control switches, which record hourly run-time (in minutes) of the AC unit to which they are attached. In addition to hourly run-time, the Cannon switch scan data includes hourly shed minutes and the contents of many other switch registers. Information about the AC unit is also recorded, including rated amps for the compressor and fan.

Households in the M&V sample are equipped with load research interval meters, and 15-minute premise interval usage (kWh) was collected for 2013 summer months.

Number of completes and sample disposition for each data collection effort

See "Table 1. M&V Sample Stratification" above.

Expected and achieved precision

The 2013 M&V sample is representative of the PM population and is designed to target at 10% relative precision at 90% confidence level.

Description of baseline assumptions, methods and data sources

The baseline is developed from the duty-cycle of the sampled AC units based upon the observed AC usage during non-holiday, non-weekend, and non-control days.

Description of measures and selection of methods by measure(s) or market(s)

The PM program is an AC cycling program, so the only measure in question is the AC units.

Use of TRM values and explanation if TRM values not used

The analysis provides estimate of the savings that were achieved by participating households, thus there was no need to use TRM values.

Threats to validity, sources of bias and how those were addressed

The approach used in the evaluation relied upon actual measurement of AC usage, and is therefore not subject to any reporting or self-selection bias.

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Evaluation Findings

Validation of AC Duty Cycle Data

Hourly air conditioner (AC) run-time collected from Cannon M&V switches is compared to corresponding premise interval kWh to verify that it accurately reflects operation of the attached AC unit. The validation process is accomplished through a sequence of computer programs that: 1) convert the hourly AC run-time data into hourly duty cycle; 2) display time series plots of premise kWh and duty cycle with control over time resolution enabling visual comparison of plot detail; 3) calculate cross-correlation between hourly kWh and hourly duty cycle and display cross-plots of kWh vs. duty cycle. Each run-time data file collected for an AC in the 2013 M&V sample is reviewed in this fashion, and the AC duty cycle is added to the model database if it passes the validation process.

Duke Energy could not obtain the 2013 data for 12 ACs due to: unable to retrieve scan data (11), and customer dropped off the program (1). The run-time data was rejected for 15 ACs through the validation process. These cases appear to be due to equipment sensitivity issues, where the AC is reported to have no run-time or to be always running. Overall, hourly duty cycle data was added to the model database for 141 households with 178 ACs. Table 2 summarizes the 2013 M&V sample.

Table 2. M&V Sample

	Southeast	
	NC	SC
Households	120	41
Total AC Units	205	
Missing data	12	
Invalid Data	15	
Final AC Sample	178	
Final Households	141	

AC Duty Cycle Models

Impact estimates during PM load control periods are based upon models developed for the natural duty cycle of M&V AC units. These models are developed from 2013 duty cycle data described above, and similar duty cycle data from the two prior summers (2011, 2012) for AC units that are holdovers from previous M&V samples. Weekends and holidays are not used in the models, and hours during load control and for the remainder of the day are not used. As addressed above, Duke Energy staff was able to develop duty cycle models for AC units at 141 households in the Southeast M&V sample.

Natural duty cycle models are specified and estimated individually for M&V AC units to better capture the unique dependence of duty cycle on the temperature and humidity characteristics of each AC unit. A limited dependent variable model specification is adopted for hourly duty cycle, the dependent variable in the models. Candidate specifications for independent variables in the

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models include temperature averaged over the prior 2-hour, 4-hour, and 6-hour intervals, and a weighted temperature average with declining weights over the previous six hours. Candidate specifications also include similar sets of averages based on temperature-humidity index (THI) and heat index (16-element polynomial). Models are estimated with the SAS procedure QLIM[2]. The dependent variable specification selected for an AC unit is based on fit diagnostics from hourly model fits over the typical load control hours, 2:00–6:00 PM. For the selected model, distinct parameters are estimated in each hour of interest, resulting in a set of hourly natural duty cycle fits for each M&V AC.

PM Load Control Strategies

The PM program employs two generic types of load control switches which require somewhat different treatment for load impact evaluation. The newer switch type, Cannon LCR 4700, in NC and SC, operates with an adaptive control strategy called Target Cycle (TC). For each hour of load control, the Target Cycle switch calculates a unique shed time (or percentage) based on characteristics of the attached AC unit. The older switch type, Comverge, uses traditional fixed cycling (FC) control, where all switches on the same program shed the same amount of time during the control period.

Cannon switches in NC and SC are configured with a load reduction target of 1.3 kW (TC 1.3) constrained by the maximum shed time of 22.5 minutes per 30-minute control period, and Comverge fixed cycling switches limit the AC run-time to 5 minutes of each 15-minute control period. Equivalently, PM Comverge switches in the Southeast are operated with a fixed cycling percentage of 67% (FC 67%). Another control strategy in the Southeast is full shed of the AC; in which the AC is completely turned off during the control periods. This strategy is only employed in the Southeast for emergency load shed events. Note that PLC (Power Line Carrier) switches in the Southeast are full shed only switches. Table 3 summarizes PM load control technology and strategy used in the Carolinas.

Table 3. PM Load Control Switches and Strategies

Switch	Period	Strategy	
		NC / SC	
	(min)	Cycling	Full Shed
Cannon	30	TC 1.3	FC 100%
Comverge	15	FC 67%	FC 100%
PLC	NA		FC 100%

The Target Cycle control strategy puts more functionality in the switch itself. Rated amps of the attached AC unit is entered into the switch at installation, and used to determine connected load for the unit. The switch also records hourly duty cycle of attached AC unit when instructed and builds a profile (historical profile) of the expected hourly duty cycle under weather conditions typical for load control. The historical profile can be scaled (globally) by adjusters included in the commands sent to switches for load control. The connected load and adjusted historical

[2] QLIM: qualitative and limited dependent variable model.

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profile are used to calculate hourly cycling percentages for the attached AC unit expected to achieve the load reduction target of 1.3 kW.

An alternate adaptive cycling approach called True Cycle was developed before the summer of 2012 to address a firmware issue in some of the switches. For the True Cycle approach, a cycling percentage called a gear is determined using duty cycle model results and is sent to switches for load control. This gear and the scaled historical profile are then used to calculate hourly shed percentages for the attached AC unit to achieve the load reduction target of 1.3 kW.

Factors that determine Target Cycle and True Cycle shed percentages for M&V AC units during control periods are known, except for contents of hourly historical profile registers on those days. Values in these registers change frequently during the summer as they are updated with the AC hourly run-time on "saved" days, which are selected with weather conditions sufficiently close to a typical load control day. Hourly run-time profiles on 2013 control days for M&V AC units are determined from the contents at the end of the 2013 control season (when available), and the unit run-time on 2013 saved days. The impact for both of the cycling strategies are estimated and the proportions of True Cycle and Target Cycle switches are used to determine the overall shed per switch attributable to Cannon switches.

AC Connected Load

Connected load is the average power demand (kW) of a running AC unit over a full cycle. It determines the load reduction (kWh) achieved when AC run-time is reduced. Connected load is specified for M&V AC units through the basic engineering formulas:

*Apparent Power (kVA) = (Compressor Amps + Fan Amps) * 230 Volts / 1000*

*Connected Load (kW) = Power Factor * Apparent Power*

Rated amps for the compressor (FLA) and fan (RLA) are typically listed on the AC faceplate.

Power factor in this formula is actually different for different AC units, and even varies somewhat for different cycles of the same unit, increasing at high temperature and humidity. We have analyzed synchronous AC run time and premise interval kWh collected for the M&V sample to determine an appropriate overall power factor within the sample and the result is 0.83. This power factor value is used to calculate connected loads for impact evaluation.

Simulation Method for PM Impact Evaluation

Simulation with M&V natural duty cycle models is used to determine average load reduction per household within high and low M&V strata during each hour of load control and for each PM load control strategy. These strata results are combined with the population weights given in Table 1 to estimate average load reduction per household in the PM populations in NC and SC. The potential load impacts estimated in this manner represent the load reduction which would be achieved if all switches controlled as expected.

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The simulation procedure is very similar for the three basic PM control strategies, Target/True cycle, fixed cycling, and full shed. In a fixed cycling or full shed (100% cycling) simulation, the same specified shed percentage is applied to all AC to evaluate load impact. In a Target/True cycle simulation for a particular load reduction target during a specified hour (and day) of load control, a customized shed percentage is calculated for each AC unit from information specific to that unit. The resulting unit-specific shed percentages remain fixed in all simulated realizations for that load reduction target and load control hour.

A single realization in the simulation is generated by a random draw of residuals for each of the M&V natural duty cycle model fits, which are evaluated at the temperature and humidity independent variable applicable to the control hour (and day). This gives a set of simulated natural duty cycles appropriate for the control hour. Load reduction for each M&V AC is calculated as follows:

Duty cycle reduction = MAX[Duty cycle - (1 – Shed percentage), 0]

*Load reduction = Connected load * Duty cycle reduction*

For households with multiple AC, realized load reduction is aggregated to the household level by summing load reduction from all household AC. These realized load reductions are averaged within the strata, to produce single realizations of average load reduction per household within both high and low strata. These two sample averages constitute the result from one pass through the simulation corresponding to one draw of model residuals.

Two thousand simulation trials are performed for each hour of load control to adequately capture the variation in average load reduction within strata that is consistent with our duty cycle models and M&V sample size. The results accumulate into distributions of sample averages for both high and low strata. The grand means of these distributions are the most significant output from a simulation run. They are the estimates of average load reduction per household in each stratum for the specified control hour and cycling strategy. The spread of these distributions (e.g., variance) characterizes the uncertainty in the load reduction estimates, and is inversely related to the M&V sample sizes.

Load Impact Results

Load impacts described in this section are computed with population estimates of load reduction per switch, rather than load reduction per household. Simulation results are converted to load reduction per switch using the factor of 1.191 switches per household. Population estimates of load reduction per household are divided by this factor to get corresponding population estimates of load reduction per switch. The estimate of switches per household is determined from the M&V sample.

PM hourly impact results for all 2013 load control days in NC and SC are given in Table 5. These results are adjusted for distribution and transmission line losses. Table 4 shows de-rating factors used for 2013 impact evaluation. The Comverge factor in Southeast was determined by an operability study conducted in 2010. It would normally be our approach to perform another operability study for Comverge switches in the Southeast but these switches are rapidly being

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replaced and therefore another study is not expected. Cannon factor in the Southeast was determined by the operability study conducted in 2011.

Table 4. De-rating Factors for Impact Evaluation

Switch Type	NC / SC
Cannon	0.945
Comverge	0.399
PLC	0.399

Table 5. PM Impact Results for NC and SC

Event Date	Hour	PM Impact (MW)		Southeast Total
		NC	SC	
7/17/2013	15	83.3	30.1	11.4
	16	208.8	73.1	281.9
7/18/2013[3]	16	116.3		116.3
	17	115.4		115.4
7/19/2013	15	106.2		106.2
	16	118.4		118.4
7/24/2013	15	104.7	37.3	142.0
	16	117.1	41.7	158.8
8/12/2013	15	110.4	39.3	149.7
	16	121.9	43.5	165.4
8/29/2013	15	109.6	38.8	148.4
	16	122.9	43.5	166.4
9/10/2013	16	101.5	35.9	137.4
	17	108.9	38.6	147.5
9/11/2013	16	106.3	37.6	143.9
	17	111.5	39.5	151.0
	18*	54.7	19.4	74.1

*Note: The event on 9/11was ended at 5:30 pm. So the impact number for hour ending 18 is estimated as half of the impact for the whole hour calculation.

PM economic events were activated in NC on 7 days and in SC on 5 days during the summer of 2013. Both Cannon and Comverge switches were controlled on all days. Table 5 gives hourly impact results adjusted for line losses in NC and SC for each control day. The last column of Table 5 gives total PM impact in the Southeast. A test event was activated on July 17 from 2:00 to 4:00 pm in NC and SC. The first hour of the event was cycling event including both Cannon

[3] There were no events in South Carolina on July 18 and July 19 due to storm restoration activities being conducted by Duke Energy.

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and Comverge switches, and the last hour of the event was full shed including Cannon, Comverge and PLC switches. The total impact was 113.4 MW for cycling hour and 281.9 MW for full shed hour after adjusting for line losses.

Table 6 gives estimated load reduction per switch not adjusted for line losses under peak normal weather conditions and load control technologies. **Table 7 shows the summer monthly load reduction adjusted for line losses under peak normal weather conditions.** Table 8 shows the peak normal weather conditions used to calculate the results in Table 6. The system peak in the Southeast is assumed to occur in the hour 4:00 – 5:00 pm EDT (identified as hour 17 in this report).

Table 6. Shed kW/switch with Peak Normal Weather

Switch Type	Control Strategy	Potential Impact	De-rated Impact
Cannon	TC 1.3	1.27	1.20
	Full Shed	2.35	2.22
Comverge	FC 67%	1.38	0.55
	Full Shed	2.35	0.94
PLC	Full Shed	2.35	0.94

Table 7. Monthly Peak Normal Weather Load Reduction De-rated Impact Adjusted for Line Losses for Cycling and Full Shed

State	Control Strategy	June	July	August	September	Summer Capability
Carolinas	Cycling	175.7	177.1	178.9	180.9	177.5
Carolinas	Full Shed	324.5	327.2	330.3	334.0	327.8

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Table 8. Peak Normal Weather

Hour	NC / SC	
	Temp	Dewpt
11	89.0	69.0
12	91.0	69.0
13	92.0	68.0
14	94.0	68.0
15	93.0	69.0
16	95.0	67.0
17	95.0	66.0
18	95.0	67.0

The last column of Table 7 shows the weighted average capability of the Power Manager program across the summer months in 2013 in the Carolinas. These weighted average values are calculated using the summer monthly values and weighting them based on the probability of experiencing an annual peak load in that month in each state. However, for revenue recovery purposes, Duke Energy also calculates a value called a P&L value. The P&L value is calculated from monthly capability values in each state. The P&L value is the value proposed by Duke Energy to be used for revenue recovery since it is consistent with accounting guidelines. The P&L value for 2013 is 329.0 MW. A further explanation of the P&L value is provided below.

P&L Value (Revenue Recovery Value) – the process can be summarized as follows.

- Using the processes described above and the program participants (number of switches) for a particular month, calculate the monthly capability of those participants using summer peak normal weather. For Power Manager, these values, for the summer months, are the same values as provided above in Table 7.
- The monthly values receive accounting adjustments if applicable.
- The revised monthly values are averaged across the months during which the program is available for curtailment, June through September.

Review Results

The Duke Energy Power Manager (PM) program impact evaluations were performed by Duke Energy staff. Furthermore, the impacts presented in this report include a review by Integral Analytics of the impact evaluation methodology and results. The methodology and approach used by Duke Energy staff are nearly identical to that used in prior evaluations reviewed by the TMW team.

From our review, we find that the methodology as well as the application used by Duke Energy for estimating the load impacts from the Power Manager program are very reasonable and defensible. One strength of the approach is the use of an extensive history for model estimation. Instead of relying on only a handful of days deemed to be similar (an approach used by many utilities which is less rigorous since it just compares average usages from a pre-event period), Duke Energy employs a multivariate regression model to estimate the load impacts. The

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application of the multivariate regression model allows for more precise estimates instead of relying on assumptions about comparable type days.

After reviewing the overall analysis, in our opinion, Duke Energy's impact evaluation is thorough and employs a state-of-the-art methodology which should provide accurate and reliable estimates of event impacts and the summer load reduction capacity under peak normal weather conditions, as summarized on page 14 in Table 7.

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Final Report

Process Evaluation of the 2013-2014 PowerShare® Program and Impact Evaluation for the 2013 PowerShare® Program in the Carolina System

Prepared for
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Executive Summary

Impact Evaluation Findings

TecMarket Works conducted a review of the analytical approach used by Duke Energy to estimate energy impacts from the Carolina System PowerShare program.

Duke Energy conducted the impact evaluation analysis, while Integral Analytics (a TecMarket Works' Subcontractor) reviewed the methodology and results.

From our review of Duke Energy's evaluation of the Duke Energy Carolinas' PowerShare® 2013 Program, the methodology employed, including the application used to estimate the load impacts, is very reasonable and defensible. Besides being innovative, the approach is thorough which should provide accurate estimates of Event impacts (i.e., for settlement with customers, impact results for an event, capability values, and P&L values).

In general, the model specifications in all the processes include key determinates of energy usage, which minimizes the likelihood of any bias in the results from omitted variables. One additional strength of the approach is that Duke Energy uses an extensive history to estimate the model, rather than relying on only a handful of days deemed to be similar (an approach used by many utilities which is less rigorous since it just compares average usages from a pre-event period). In addition, using a multivariate regression model in the Capabilities, P&L, and M&V processes is generally preferred over approaches that are based on average loads from a pre-event period.

The technical approach used by Duke Energy in developing settlement calculations for the customer day-ahead Pro forma load (PFL) and the M&V event impacts are detailed and very thoroughly developed. The use of multiple methods to determine the Best of Breed (BoB) in the PFL is noteworthy in that it assures that the most accurate approach will be used in developing the PFL – a step which, to the best of our knowledge, is not used by any other entity.

Finally, in the previous review of Duke Energy's analytical process for determining Capabilities and conducting M&V, Integral Analytics recommended that Duke Energy should review the need for each of the processes to see if they are truly required and look for ways to combine them. In that previous review, Integral Analytics recommended that Duke Energy investigate a mechanism that will produce all the required reports for customers, internal management and operational uses, and regulatory requirements, using a single, unified process for the PFLs and the other reports.

Since the last review, Integral Analytics has determined that while Duke Energy has not yet implemented actions in accordance with the recommendations, Duke Energy is taking steps to combine the processes.

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Summary of Findings

The PowerShare program as operated in the Carolina System is a well-structured and expertly managed program serving a diverse market of customer types and with varying levels of knowledge about how the program works. The program is complex, in that there are multiple types of load reduction call events relying on different customers to achieve the load reduction objectives depending on the nature of the call event and grid-based load reserves. The program is operated on an evolutionary platform in which the program has evolved over the years to its current configuration. This evolution continues today, with new challenges brought about as a result of recent severe winter conditions that required mid-winter calls for load reductions during a period when most participants were unprepared for that call. In addition, regulatory changes which have allowed customer to opt-in or opt-out of the program have created marketing, load reduction, timing and cost control challenges for the program. These challenges are currently being addressed by the program and are described in this report.

The regulatory structure under which the program must operate needs to be examined to determine the extent to which regulatory conditions are impacting the ability of the program to acquire needed load while maintaining the highest possible levels of customer satisfaction and relationships. The program is going through a customer targeting and market interaction change phase as program managers develop new marketing strategies to attract smaller customers who may have reduced knowledge of their energy use and their ability to reduce load and who have lower levels of load reduction capabilities. The success of these changes will be determined over the next couple of years as program managers launch new marketing initiatives, establish strong methods of custom communications, and reexamine the reliably acquirable load that can be cost effectively captured under different economic, supply, and regulatory conditions. Duke Energy's managers and topic experts are among the best we have seen in this industry. The focus of these managers is to not only on meeting these challenges, but designing and operating a program that takes advantage of the challenges in ways that improve the program and the participation experience.

Recommendations From The Management Interviews

1. **Establish Both Summer and Winter Peak Program and Participant Goals**
    a. We recommend that Duke Energy investigate the potential for restructuring the program to address the ability of customers to respond to demand reduction calls at different times of the year (winter and summer events) and determine if alternative regulatory and program operational conditions are needed to meet different customer conditions associated with different seasonal peak demand call events. If those changes are needed, Duke Energy should work with state regulators if necessary to restructure those conditions to meet the need for winter and summer program designs and contract conditions.
2. **Examine Opt-in Timelines and Requirements and Determine if Changes are Needed**
    a. We recommend that Duke Energy assess this issue and the effects of program timelines in view of the regulatory structure and the potential for winter calls and work to design timelines in which the opt-in and opt-out decision timelines are supportive of the customer's decision-making requirements, provide a positive

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decision experience for the customer, and which allow the program to effectively achieve both winter and summer load reductions.

b. We recommend that Duke Energy examine the timing and duration of the opt-in commitment requirements and determine if those requirements are over-restricting participation or resulting in potential load not being acquired because of the flexibility and risk avoidance needs of the target customers. If such a condition is warranted, Duke Energy should work with the Commission to structure a schedule that is more supportive of customer requirements to the extent this can be accomplished under North Carolina regulatory constraints.

Recommendations From The Participant Surveys

1. **Track CallOption Refusal Reasons**
   a. If Duke Energy wishes to better understand the reasons customers are not enrolling in CallOption, they should consider asking the account managers to document on the PowerShare contract the reasons why CallOption is not suitable for a particular company's situation and assess the responses to determine if programmatic changes are needed. This will allow Duke Energy to distinguish between lack of interest in CallOption from lack of suitability.

2. **Educate Customers on Responsibility for Call Determinations**
   b. Duke Energy should consider investigating the source of customers' expectations that Duke Energy can control the frequency of demand response events. This may reveal opportunities for Duke Energy to educate customers on the full benefits of participating in PowerShare.

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Introduction and Purpose of Study

This document presents the process evaluation report for Duke Energy's PowerShare Program as it was administered in the Carolina System for calendar year 2013.

The process evaluation covers 2013 and 2014 through April. The evaluation was conducted by TecMarket Works with Carol Yin of Yinsight as a subcontractor. All surveys were conducted by TecMarket Work's staff.

Duke Energy conducted the impact evaluation analysis for the 2013 program year, while Integral Analytics (a TecMarket Works' subcontractor) reviewed the methodology and results.

Summary Overview

This document presents the process and impact evaluation and review for the PowerShare program as it was administered in the Carolina System.

Summary of the Evaluation

For the process evaluation, the evaluation team conducted in-depth interviews with three Duke Energy managers and program staff members at different levels of responsibility for the program. The evaluation team also conducted 15-minute interviews with 42 commercial and industrial customers who participated in the 2013-2014 PowerShare Carolina System program.

The 2013 impact analysis of the PowerShare program was conducted by Duke Energy. The basic approach for determining the impacts, capabilities, and profit and loss (i.e., the MW values used for revenue recovery and P&L) involves combining actual weather data with hourly load data from all enrolled customers, collected for the previous month(s), as appropriate. A regression model is developed using the combined data to provide an estimate of what the load would have been for the customer, absent an event. This is compared to the actual customer load to determine the impacts from an event.

Evaluation Objectives

The process evaluation of the 2013-2014 PowerShare program has several purposes. First, this process evaluation is intended to help identify areas where the program may be improved, drawing upon the insights of Duke Energy staff across different divisions and upon the insights of a sample of participating customers. Second, this report will document program operations for future reference, including ways in which the program has addressed and overcome past program challenges.

The purpose of the impact evaluation is two-fold. The first objective is to summarize the actual kW and expected peak normal kW impacts determined by Duke Energy for 2013. The second objective is to determine if the approach used by Duke Energy in estimating these impacts as well as the capacity values are consistent with commonly accepted evaluation principles.

Researchable Issues

This participant survey addressed several research issues that were identified collaboratively by Duke Energy and the TecMarket Works team:

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- Investigate the operations of the program to document current operations and identify issues relative to effective operations and customer interaction and participation.
- Identify recommendations that can be expected to improve the operations of the program or increase effectiveness or customer satisfaction.
- Report on program and market events and changes that are impacting the ability of the program to provide cost effective load reduction.
- Identify issues related to recent winter events and discuss their implications on program operations and customer participation.

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Description of Program

PowerShare is a demand response program designed to reduce non-residential customers' energy use (kW demand) during periods of high energy prices or during periods when high energy usage would cause energy supplies across the transmission and distribution system to drop to near-critical levels. In both these situations, the PowerShare program allows Duke Energy to purchase capacity from their customers by paying their commercial and industrial customers to reduce their energy demand, thus increasing the available energy supply. The program achieves a demand reduction from participants via multi-approach customer notification system notifying customers that a demand response event is needed, causing participants to reduce their electric usage to a level consistent with their program participation agreements. The reduction period is a specific period of time set to match the period of time in which the critical supply condition is expected to occur, but not beyond the timing period specified in the participation agreements.

In the past this program has focused on participants with enough demand and operational flexibility that each participant is capable of providing substantial load reduction to meet Duke Energy's PowerShare supply reduction needs. This focus has resulted in a program in which the typical participants have been and continue to be high demand industrial customers or large commercial customers. However, the opt-out provisions associated with the Carolina's program is resulting in an erosion of the larger customers as they elect to opt-out of the financial and demand reduction requirements of participation and instead move to the ability to implement demand reduction and energy efficiency initiatives on their own, without participation in Duke Energy's programs. As this trend continues it is expected that the program will move to lower levels of demand reduction per participating customer, requiring a larger participation base from which savings goals can be achieved.

PowerShare® is the brand name covering several Duke Energy Carolina's commercial and industrial (C&I) demand response program tariffs. In North Carolina, PowerShare includes NC Rider PS (NC Rider PS) and Rider PowerShare CallOption (NC Rider PSC). In South Carolina, PowerShare includes Rider PowerShare Non-Residential Load Curtailment (SC Rider PS in this document; note that this is only for this document since there exists a separate, unrelated Rider PS in South Carolina) and Rider PowerShare CallOption Non-Residential Load Curtailment (SC Rider PSC) and collectively as the PS Riders. These programs were implemented on or after June 1, 2009. The PowerShare programs are voluntary and offer customers the opportunity to reduce their electric costs by managing their electric usage during the Company's peak load periods. Customers and the Company will enter into a service agreement under the parameters established in the PS Riders.

There are four product options offered under PowerShare®; Mandatory, Generator, Voluntary, and CallOption®:

- Mandatory
  - A customer served under the Mandatory product agrees, upon notification by the Company, to reduce its demand to a pre-specified firm service level.
  - Each time the Company exercises its option under the agreement, the Company will provide the customer a credit for the energy reduced.
  - PowerShare Mandatory is an emergency only program. Emergency events are

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implemented due to reliability concerns as determined by the DEC System Operations Center (SOC). Participants are required to reduce load during emergency events.
  - In addition to the energy credit, customers on Mandatory receive a monthly capacity credit.
  - Mandatory is a year around program that permits 100 hours of event time as needed. There are not a defined maximum number of events for this program.
  - Only customers able to provide a minimum of 100 kW load reduction qualify for Mandatory.
- Generator
  - A customer served under the Generator product agrees, upon notification by the Company, to reduce its demand from the Company by starting an on-site generator to supply all or a portion of the customer's electric needs.
  - Each time the Company exercises its option under the agreement, the Company will provide the customer a credit for the energy self-supplied.
  - PowerShare Generator is an emergency only program. Emergency events are implemented due to reliability concerns as determined by the DEC System Operations Center (SOC). Participants are required to transfer load to their generators during emergency events.
  - In addition to the energy credit, customers on Generator receive a monthly capacity credit based upon load transferred to the generator during events and test periods.
  - Generator is a year around program that permits 100 hours of event time as needed. There are not a defined maximum number of events for this program.
  - Only customers able to provide a minimum of 100 kW load response/self-supply qualify for Generator.
  - The Generator program requires participants to start their generators monthly for a 1-hour test period.
- Voluntary
  - Under the Voluntary product, the Company may notify the customer of a Voluntary event and provide a Price Quote to the customer for each event hour.
  - The customer will decide whether to reduce demand during the event period. If they decide to do so, the customer will notify the Company and provide a firm service level for the event hours.
  - Each time the Company exercises the option, the Company will provide the participating customer who reduces load an energy credit.
  - There is no capacity credit for the Voluntary product since customer load reductions are voluntary.
  - Only customers able to provide a minimum of 100 kW load response qualify for Voluntary.
  - Customers may participate in PowerShare Mandatory and Voluntary concurrently.
- CallOption®
  - A customer served under a CallOption® product agrees, upon notification by the Company, to reduce its demand.

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  - Each time the Company exercises its option under the agreement, the Company will provide the customer a credit for the energy reduced.
  - There are two types of events.
    - Economic events are primarily implemented to capture savings for customers and not necessarily for reliability concerns. Participants are not required to curtail during economic events. However, if participants do not curtail, they must pay a marginal energy cost based price for the energy not curtailed. This is called "buy through energy."
    - Emergency events are implemented due to reliability concerns. Participants are required to curtail during emergency events.
  - If available, the customer may elect to buy through the event at a marginal energy cost-based price. The buy through option is not always available as specified in the PowerShare® Agreements. During system emergency events, customers are not provided the option to buy through.
  - In addition to the energy credit, customers on the CallOption® will receive a capacity credit.
  - For the 2013 PowerShare® CallOption program (note that NC participation years are January – December while SC participation years are June – May), there were four different enrollment choices for customers to select among in NC and SC and 1 additional choice in NC. All five choices require curtailment availability for up to five emergency events. The number of economic events varies among the choices. Customers can select exposures of zero, five, ten, or fifteen economic events or, in NC, they can choose an option that allows for 200 hours of economic events with no specific maximum number of events specified. This option is called PS 200/5 and events must be a minimum of 2 hours in duration.
  - Only customers able to provide a minimum of 100 kW load response qualify for CallOption®.
- Other
  - Note that other large commercial and industrial demand response programs are offered in DEC through Riders IS and SG. These programs are not part of PowerShare and are not included in this report.

The PowerShare programs have different enrollment periods and participation periods. This report covers the participation year of 2013. However, for some programs (e.g., CallOption in South Carolina), customers enroll for 1 year periods from June through May. Therefore, one set of customers could participate in PowerShare from January through May, 2013, while a different set of customers are enrolled for June through December, 2013. Likewise, with Mandatory, Generator, and Voluntary, customers can enroll for multiple year terms starting in any month of the year. Only PowerShare CallOption in North Carolina has a specified participation period that starts on January 1 and goes through December 31. Duke Energy Carolinas (DEC) is a summer peaking system and therefore, the most relevant participation period is the summer months of June through September and this report concentrates on those months.

The table below compares account participation levels for summer 2012 and summer 2013, as well as MWs enrolled in the program. The MW values are DEC's estimate of the curtailment

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capability across the summer months. Additional information is presented below on the different calculations performed for the program including summer capability, revenue recovery values, Measurement & Verification (M&V) values, and day-ahead projected load reduction (PFLs).

Carolinas PowerShare® Participation Update by State

Enrolled Customers†

	North Carolina			South Carolina		
Program	2012	2013	Change	2012	2013	Change
CallOption® PS	0	0	0	1	1	0
Generator® PS	4	4	0	5	5	0
Mandatory®β	96	110	14	71	69	-2
Total	100	114	14	77	75	-2

†Counts coincide with summer month of maximum participation
β Includes Mandatory HP participants

Summer Curtailment Capability (MWs)*

	North Carolina			South Carolina		
	2012	2013	Change	2012	2013	Change
CallOption® PS	0.0	0.0	0.0	0.2	0.0	-0.2
Generator® PS	9.4	7.1	-2.3	4.0	3.9	-0.1
Mandatory®β	181.3	185.8	4.5	185.1	177.4	-7.7
Total	190.7	192.9	2.2	189.3	181.3	-8.0

*Numbers reported are adjusted for losses
β includes Mandatory HP capabilities

PowerShare® 2013-2014 Program Activity

During the winter of 2012/2013, there were no PowerShare® events. During the summer of 2013, there were no PowerShare® events. The relatively mild weather and low marginal energy prices resulted in no PowerShare® event activity in 2013.

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Methodology

Overview of the Evaluation Approach

The process evaluation for the PowerShare program was conducted by TecMarket Works. The results presented in this report include management interviews and participant surveys.

The impact analysis for the PowerShare programs was conducted by Duke Energy staff. The results presented in this report include a review by Integral Analytics of the impact evaluation methodology and results. This can be found under the *Review of Impact Evaluation Approach* section later in this report.

Management Interviews

TecMarket Works developed the interview protocol for the PowerShare Program management that was implemented in April and May of 2014. The full interview guide can be found in *Appendix A: Management Interview Protocol.*

One-to-two-hour long management interviews were conducted with a Duke Energy product and services manager for PowerShare in the Carolina System. A shorter summary interview was conducted with a program manager who held the management responsibility prior to the period in which the new manager assumed operational control of the program. In addition, a more focused interview was conducted with the Duke Energy manager who supports the program's marketing and outreach campaigns and who provides supporting outreach support to the managers and account executives that have first line contact with the customer.

Two additional interviews were conducted with Carolina System account executives to discuss the program's interactions with participating customers.

Participant Interviews

TecMarket Works and Yinsight developed a customer survey for the PowerShare Program participants. The survey can be found in *Appendix B: Participant Survey Protocol.*

Data collection methods, sample sizes, and sampling methodology

- Data collection method: Questionnaires were administered via short telephone interviews with the contact person identified to receive PowerShare alerts on behalf of the company.
- Sample sizes: The evaluation team attempted a census.
- Sampling methodology: The evaluation team attempted interviews with a census of the 71 current PowerShare Carolina participants for the 2013-2014 program year (42 in North Carolina and 29 in South Carolina). Forty-two interviews were completed by phone between 3/10/14 – 3/18/14[1].

[1] Note that an Emergency event was called in Carolina on March 4, from 6:30 to 8:30 am, which likely affected participant responses.

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Forty-two companies (26 from North Carolina, 16 from South Carolina) were randomly selected from current Carolina System participants in PowerShare, and asked to take part in this survey.[2] These 42 companies comprise 10 textile manufacturers, 6 water plants, 5 furniture manufacturers, 12 manufacturers of other products with the rest being sole representatives of assorted other non-manufacturing sectors. Thirteen of the respondents also manage more than one site that currently participates in PowerShare. Of these companies, 41 are enrolled in the Mandatory program, with six on the Generator option. Thirty-two of the companies are enrolled in the Voluntary Curtailment Option, and one enrolled in CallOption. On average, these companies have been participating in PowerShare for 3 to 4 years.

Number of completes and sample disposition for each data collection effort

For this process evaluation, the evaluation team conducted in-depth interviews with three Duke Energy product managers and program staff members at different levels of responsibility for the program. The evaluation team also conducted 15-minute interviews with 42 commercial and industrial customers who participated in the 2013-2014 PowerShare Carolina program.

Expected and achieved precision

The sample is representative of the PowerShare population and is designed to target at 10% relative precision at 90% confidence level.

Description of baseline assumptions, methods and data sources

Not applicable.

Description of measures and selection of methods by measure(s) or market(s)

Not applicable.

Use of TRM values and explanation if TRM values not used

Not applicable.

Threats to validity, sources of bias and how those were addressed

No causal relationships were being investigated, so threats to validity are not a concern. Participants may have exhibited the social desirability bias when answering a question relating to the customer's main motive for participating in the PowerShare program, and when answering questions about satisfaction with the PowerShare program. To counter this bias, these questions used neutral language wherever possible. When probing customer's motivations for participating, customers were probed for additional motivations so that socially desirable biases would hopefully only affect one response, if at all.

[2] Not all companies provided responses to all questions.

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Impact Evaluation

Overview of the Evaluation Approach

There are many different numbers calculated by the DSM Analytics group for PowerShare. A large portion of the effort surrounding analytics for PowerShare falls into four different calculation areas. These calculations can be grouped into 2 categories. These categories and calculation areas are listed below and then described in more detail.

a. Hourly Event Day Impact Estimates
   i. *Pro-forma Load Estimations (PFLs)* – estimates of participant's hourly electric consumption for the next day. These baseline projections are used to determine potential load reduction for a potential event the next day.
   ii. *Measurement and Verification Load Reduction Estimates (M&V)* – estimates of actual load reduction provided by participants on an event day.
b. Peak Available Load Reduction Estimates
   i. *Load Reduction Capability (LRC)* – estimates of load reduction under peak normal weather conditions, if applicable, over a specified period of time such as a month or the entire summer for participants during the period of time in question.
   ii. *Revenue Recovery Load Reduction Estimates (P&L)* – monthly estimates of summer load reduction enrolled in the program under peak normal weather conditions, if applicable, for all participants enrolled in the program during the calendar year. A single value is obtained by averaging the monthly values over the period when the program can be implemented (i.e., all year).

As the categories above imply, the impact evaluation of the PowerShare program must meet a diverse set of goals. Specifically, after each event, the level of load reduction must be calculated for each participant. If the participant is on a firm service level reduction agreement, the determination is made if they reduced load from wherever their load would have been absent the event, a baseline, to their actual load during the event period. Another key feature of a firm service level agreement is to determine if the customer's actual load is at or below the firm service level during the event hours, regardless of the amount of load reduction provided.

If the customer is on a fixed reduction agreement (CallOption only), the evaluation calculates the difference between the baseline and the actual load during the control period to see if the agreed amount of reduction was achieved.

[Note that PS Generator has a completely different approach from all the other programs. Generators are required to be metered and impacts are derived from the generator output metered during events. Likewise, for other calculations, the 12 test hours of metered data is utilized and therefore embeds a forced outage rate into the capability of the generators.]

Credits or penalties for participants for events, using PFL baselines, are calculated within the Energy Profiler Online (EPO) system for PowerShare and recorded on the customer's utility bill.

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In addition, the results of the various calculations mentioned above are used to develop reports for the system operator, load reduction projections, summer curtailment projections for state level planning, and event load reduction analysis.

An additional requirement related to PFLs is that an event can be called on any day and therefore, the PFL calculation must be available every day. The control season runs all year for emergency events; however, economic events, although possible outside the summer season, tend to be during the summer season. Regardless of the date, the evaluation needs to be able to assess the load data of all participants so that Duke Energy can calculate a projected amount of load reduction that could be achieved during any hour.

The above requirements have resulted in an extensive impact evaluation procedure as described above. This impact evaluation procedure consists of the following:

Table 1. PowerShare Impact Evaluation Procedures

Process	Purpose	Frequency
PFLs	Settlement with customers and emergency event load reduction projections	Every weekday
LRCs	Internal & external reporting and input into P&L process	Monthly
P&L	Internal reporting and revenue recovery requests	Monthly as needed for internal reporting and a year-end true-up for revenue recovery
M&V	Reporting actual impacts of events to regulatory bodies.	Monthly if an event occurred in the prior month

A high-level overview of each process in Table 1 is given below. [Again, note that these processes are not applicable to PowerShare Generator which uses the metered generator output from events and test events to calculate the values needed.]

Day-Ahead PFLs

This process, as the name implies, creates the day-ahead pro forma (i.e., estimated assuming no control events) load shapes (PFL) specific to each customer. This process applies to PowerShare Mandatory and CallOption.

The estimation of the PFL involves using 12 weeks (84 days) of historical load and weather data (eliminating or accounting for NERC holidays, event days, and any days identified as quiet periods from the analysis) to produce hourly predicted load shapes for the next thirty days based upon forecasted weather, if applicable, for the region. A PFL is estimated for each account individually.

The estimation of the PFL involves using five different estimation approaches:

- Hourly regression,
- PJM average method,
- MISO average method,
- Last two days average, and a

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- Hybrid method.

A summary of each approach is presented below.

Hourly Regression

In this method, hourly energy is regressed on a set of Fourier variables, weather variables and monthly dummies (if appropriate). An autoregressive (AR) process is fit to the error terms. The same model is re-fit except that weather variables are excluded. Then an F-test is performed to see if weather is a significant explanatory factor and the appropriate model results are used for further calculations.

PJM Method

This method is based on the default method PJM uses to calculate CBLs for settlement. It calculates an average load shape based on the high 4 of 5 days selected by the method. Those 5 days are selected from a 45 day window of days. Only non-NERC holiday weekdays are considered that are not event days. The initial set of days is the most recent 5 days in the window. If the average usage over the exposure hours on any day in the 5 days is less than 25% of the overall average level over the exposure hours for the 5 days, that day is dropped and a replacement selected. This loop is repeated until there are 5 days, none of whose average usage over the exposure hours is less than 25% of the overall average usage level over the exposure hours. The 4 days with the highest usage are selected from this group and the average load shape is calculated using those 4 days.

MISO Method

The MISO method is similar to the PJM method. The differences are the MISO method uses 10 days, there are no exclusions for low usage and all 10 days are used to calculate the load shape.

Last Two Days Method

For this method, the load shape is calculated based upon the most recent past two non-NERC holiday and non-event day weekdays.

Hybrid Method

This method first performs a regression of the daily energy usage for a customer. The explanatory variables are binary variables for day of the week, a daily weather variable, monthly dummies (if appropriate) and interactions between the weather variables and binary variables. The model is fit using an AR(7) process. As with the hourly regression, the model is re-fit without the weather variables and an F-test performed to determine the appropriate model. Once the predicted daily energy has been determined it is spread over the hours of the day using the load shape from the PJM method after that load shape has been normalized by the total energy under the shape.

Best-of-Breed (BoB)

For each customer, the "best" method is chosen to produce the final day-ahead baseline estimates. This is done by comparing the predicted load from each method to the actual load for the five days that went into the PJM method at an hourly, daily, and total level. Specifically:

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- For the hourly value, the absolute value of each hourly difference between the predicted and actual load is summed across all five days.
- For the daily value, the difference for each hour is summed for each day, then the absolute value is summed across the five days.
- For the total the difference in each hour for all five days is calculated for all five days, then summed and the absolute value is taken.

The best method is chosen based on each methods relative performance of these differences. If a method is the best for at least two values, then the PFL from that method is used. Otherwise, the PFL from the method which produced the lowest hourly variance is used

Measurement and Verification (M&V)

The steps involved in the calculation of the monthly LRC, P&L, and M&V are all similar but not exactly the same. In addition, for PowerShare Voluntary, the LRC and P&L processes are not performed since they are not relevant to the program. For the M&V process for PowerShare Mandatory, CallOption, and Voluntary, hourly load data from all enrolled customers is collected for a particular month. Data is treated similarly among the processes but with a few exceptions such as the modeling of quiet periods. In the M&V process, event days are excluded as they are in all the processes. However, Quiet Periods, such as days where participants have reduced load due to a maintenance period, and included but accounted for in the model. If an event occurs during a period when the customer is on a maintenance shutdown, the information used in the analysis concentrates only on the information during their shutdown period and requires special handling. This is a rare event though and the typical procedure is described below.

The data is combined with the actual weather for that month. Regression models (one with and one without weather terms) are developed using the combined data similar to the hourly regression model discussed in the day-ahead PFL calculations discussed above. Specifically, the regression equation relates the customer's hourly electricity load to:

- A Fourier transform of hour of the day
- A Fourier transform of hour of the week
- A Fourier transform of hour of the month
- Temperature Humidity Index
- Binary variables for holidays and quiet periods, if appropriate
- Interactions between the Fourier transforms and the other variables

An F-test is calculated for each customer to determine if weather is a significant explanatory variable (unless weather is explicitly excluded for customers known not to be weather sensitive). If so, then the estimated parameters are used to create predicted loads using actual weather conditions on the event days. Thus, the baselines from the M&V process are representative of the actual load the customer would have consumed absent an event. These baselines from event days are then used with actual load data from the event hours and a load reduction is calculated.

However, note that all results are reviewed by DSM Analytics. If regression results are clearly not representative of a specific participants load absent the event, an adjustment to the baseline

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may be applied. In addition, small variances around the baseline expected from typical model variance, above and below, are set to zero and therefore not considered load reduction.

M&V results are shown above in the Introduction section. Please note that the PFL event load reduction estimates are used for settlement with customers due to their quicker availability and the fact that the baselines are available for customer review for load reduction decisions. However, M&V load reduction estimates are Duke Energy's best estimate of the load reduction impacts and these impacts are used for regulatory reporting purposes.

Load Reduction Capability (LRC)

Similar to the M&V regression process described above, Load Reduction Capability (LRC) is calculated on a monthly basis for PowerShare Mandatory and CallOption. [Note that for PowerShare Generator, capability is defined by the metered performance during test hours and events.] For the LRC process, hourly load data from all enrolled customers is collected for a particular month. Event day information is eliminated from the analysis. Quiet periods, for example due to a maintenance shutdown, are included and modeled in the analysis. The regression methodology is the same as the M&V regression described above. The differences between the M&V process and the LRC process are:

A. Event day information is eliminated from the analysis similar to the M&V process. However, Quiet Periods, which are eliminated in the M&V process, are included and modeled in the LRC analysis.
B. Once the regression equation is specified as described above in the M&V section, the estimated parameters are used to create predicted loads using peak normal weather conditions for all days of the month, if weather is applicable. Thus, the baselines from the LRC process are representative of the peak normalized load the customer would have consumed throughout the month.
C. The weekday, non-holiday baselines are then used with the customer's specified fixed reduction amount or firm load level to calculate the load reduction available each hour. By hour, these values are averaged across the month.

However, monthly LRC by participant is typically not of interest for most reporting purposes. Of primary interest is the summer LRC given that DEC is a summer peaking utility. Therefore, by hour and by participant, a weighted average of the summer monthly LRC values is calculated. Then, the hour ending (HE) Eastern Daylight Time (EDT) 17 is captured to determine the summer LRC of each participant. Summing across all participants provides the Summer LRC of the program.

Revenue Recovery Load Reduction Estimates (P&L)

Similar to the LRC regression process described above, P&L is calculated based on capability calculations for all 4 summer months for PowerShare Mandatory and CallOption. For the P&L process, hourly load data from June through September is collected for all enrolled customers during the year regardless of whether they actually participated in the program during the summer months. Event day information is eliminated from the analysis. Quiet periods, for

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example due to a maintenance shutdown, are included in the analysis but are not explicitly modeled.

The data is combined with actual weather data. Monthly, a regression model is developed using the combined data similar to the hourly regression models discussed above. Specifically, the regression equation relates the customer's hourly electricity load to:

- A Fourier transform of hour of the day
- A Fourier transform of hour of the week
- A Fourier transform of hour of the month
- Temperature Humidity Index
- Binary variables for holidays
- Interactions between the Fourier transforms and the other variables

An F-test is calculated for each customer to determine if weather is a significant explanatory variable (unless weather is explicitly excluded for customers known not to be weather sensitive). If so, then the estimated parameters are used to create predicted loads using peak normal weather conditions for all days of the month. Thus, the baselines from the P&L process are representative of the peak normalized load the customer would have consumed throughout the month for all customers; even if the customer wasn't actually participating in one or more of the summer months.

> *[This is where the LRC and P&L processes differ. In LRC, the monthly value for June for a participant who joined the program in July would be 0. However, in P&L, the calculated value for the customer would be used for June. The fact that the customer did not participate in June is captured below, not here.]*

Continuing, the weekday, non-holiday baselines are then used with the customer's specified fixed reduction amount or firm load level to calculate the load reduction available each hour. By hour, these values are averaged across the month.

Then, by hour and by participant, a weighted average of the four monthly values is calculated. Then, by participant, the hourly value for hour-ending (HE) Eastern Daylight Time (EDT) 17 is captured to determine the summer P&L of each participant. This is where the LRC process would terminate after summing across all participants. However, the P&L process now calculates monthly values by taking the sum of the summer values described above for each month for only the participants in a particular month. These monthly values are then delivered to Product Analytics for final calculations of the P&L results. Accounting adjustments are made as needed including the application of a line loss factor.

Summary

As discussed above, each calculation PFL, M&V, LRC, and P&L has a specific purpose. Primarily, PFLs are used for customer settlements where applicable for event incentives and operational projections of load reduction available the following day. M&V is used for regulatory and internal reporting of load reduction during events. LRC is used for internal and external reporting of load reduction available during each monthly period and for the summer.

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P&L is used for revenue recovery requests to demonstrate the enrolled summer load reduction capacity each month. For DEC PowerShare Mandatory, Generator, and CallOption, the LRC and P&L values including adjustments for line losses for 2013 are provided in Table 2below.

Table 2. LRC & P&L Program Summary

Program	Summer LRC (MWs)			P&L (MWs)
	NC	SC	Total	System Total
PS CallOption 0/5	0.0	0.0	0.0	0.0
PS CallOption 5/5	0.0	0.0	0.0	0.0
PS CallOption 10/5	0.0	0.0	0.0	0.0
PS CallOption 15/5	0.0	0.0	0.0	0.1
PS CallOption 200/5	0.0	0.0	0.0	0.0
Total PS CallOption	0.0	0.0	0.0	0.1
PS Generator	7.1	3.9	11.0	11.1
PS Mandatory	185.8	177.4	363.2	366.8
Total PowerShare	192.9	181.3	374.2	378.0

Review of Impact Evaluation Approach

Integral Analytics reviewed the analysis as well as information contained in the files covering participation and impacts.

From our review of Duke Energy's evaluation of the Duke Energy Carolina's PowerShare® 2013 Program, the methodology employed, including the application used to estimate the load impacts, is reasonable and defensible. Besides being innovative, the approach is thorough and provides accurate estimates of Event impacts (i.e., for settlement with customers, impact results for an event, capability values, and P&L values).

In general, the model specifications in all the processes include key determinates of energy usage, which minimizes the likelihood of any bias in the results from omitted variables. One additional strength of the approach is that Duke Energy uses an extensive history to estimate the model, rather than relying on only a handful of days deemed to be similar (an approach used by many utilities which is less rigorous since it just compares average usages from a pre-event period). In addition, using a multivariate regression model in the Capabilities, P&L, and M&V processes is generally preferred over approaches that are based on average loads from a pre-event period.

The technical approach used by Duke Energy in developing settlement calculations for the customer day-ahead Pro forma load (PFL) and the M&V event impacts are detailed and very thoroughly developed. The use of multiple methods to determine the Best of Breed (BoB) in the PFL is noteworthy in that it assures that the most accurate approach will be used in developing the PFL – a step which, to the best of our knowledge, is not used by any other entity.

Finally, in the previous review of Duke Energy's analytical process for determining Capabilities and conducting M&V, Integral Analytics recommended that Duke Energy should review the need for each of the processes to see if they are truly required and look for ways to combine them. In that previous review, Integral Analytics recommended that Duke Energy investigate a mechanism that will produce all the required reports for customers, internal management and

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operational uses, and regulatory requirements, using a single, unified process for the PFLs and the other reports.

Since the last review, Integral Analytics has determined that while Duke Energy has not yet implemented actions in accordance with the recommendations, Duke Energy is taking steps to combine the processes.

Overall, based on our review, Duke Energy's impact evaluation is a complete and innovative approach, and provides accurate estimates of event impacts.

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Process Evaluation

Management Interviews

This section of the report presents the results from the management interviews with program managers, marketing support managers, and account executives. These interviews focused on the operations of the programs and the interactions with the customers who must be able to reduce load for the program to achieve its goals.

Program Goals

According to the Carolina System Program Manager, the PowerShare Program has the following program goals.

1. Maximize program resource in terms of mega-watt to support grid reliability and deal with power supply grid restraints when we have grid or demand supply issues.
2. Deliver a cost effective program.
3. Design and operate a program that is easy for customer to understand and participant.
4. Have very clear customer commitments; make sure the customers fully understand the commitments associated with their participation.

The interviewed manager noted that this last goal is not as easy as it sounds and noted that because the demand reduction events are few, and in some cases a year or more can pass without an event, the customers may forget their commitments and need to be reminded of those commitments and in some cases brush-up on how they intend to meet those kW reduction commitments. The manager noted that they need to continually deal with the issue of participant information and education and are adding new information resources to the program (see section "*Marketing Challenges*") to help participants understand the program and their commitments and how they can respond. Duke Energy has examined and continues to examine message consistency across the various messaging approaches to make sure the program-related information provided by Duke Energy is accurate, reliable, and consistent with respects to the customer and the program obligation and requirements.

Program Structure and Operations

While there are few program staff specifically assigned to the PowerShare program in the Carolina System, the program is supported by a wide and diverse set of professionals across Duke Energy that form the PowerShare operational team. The Carolina System PowerShare program is supported by Duke Energy professionals, including, but not limited to, professional engineers who understand customer kW load levels who project participant kW resources; professional grid experts who understand the conditions that drive market resources and prices; program tool development professionals that help design program management and operational tools; marketing and messaging experts who help with customer interface opportunities; customer notification support team that helps with notifying customers of event warnings, watches and calls; energy demand tracking experts that help determine if and when calls are going to be needed; response analysts that help interpret customer and program demand reduction achievements, and others.

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Duke Energy has developed system and grid monitoring capabilities that help support the Carolina System supply planning and monitoring function, but who also help program managers understand current and anticipated demand conditions. As peak demand conditions appear to be critical the Duke Energy Carolina System managers work with the system operators to gauge the probability of an event call during that period, and determine when warnings, watches, and calls are needed. This formation and use of topic experts to serve as the PowerShare operational team helps assure that the right skills are available to the program and minimizes the potential for under-performance of the program. It also means that Duke Energy has established a team of experts to support the program design or redesign function as well as support the program's implementation and operational processes not just in the Carolina System, but across the Duke Energy territories.

Need for the Program

An interviewed manager noted that Duke Energy needs to plan for a wide range of supply and weather-associated needs and noted that the PowerShare program serves as one of the key tools in both planning for expected and unexpected supply constrained conditions. The program is considered as a valuable part of the Duke Energy supply resource mix.

The manager also noted that call events are not conducted for the sole purpose of economically benefiting Duke Energy, but are called when capacity relief is needed to meet demand or when a call can benefit all customers by acting to lower supply costs. It is a demand-related event that is typically required for supply requirements.

Change in Marketing Approach

The program's marketing efforts have undergone a substantial change over the last year. In the past, the marketing efforts of the programs have been initiated and maintained by the account executives with limited support from Duke Energy's marketing professionals. The marketing support in the past has focused on brochure development and web-page design support. These efforts have been designed to support the one-on-one program presentations to large customers by the account executives and program managers. However, over the past year, the program's marketing efforts have moved and continue to move to a more segment-based marketing approach. In the new marketing efforts, Duke Energy develops a marketing plan in conjunction with input from the PowerShare managers and the other energy efficiency program managers. Those PowerShare aspects of the marketing plan are then implemented as they have been in the past by the account executives that have direct contact with the larger customers. However, in addition to these efforts Duke Energy is in the process of developing segment-based strategies that can be directed at groups of customers, rather than single customers. In the past years, the account executives shouldered the majority of the marketing and outreach responsibilities, including outreach to specific customers, presentation of the program to these individually targeted customers, going over the program benefits and responsibilities with the customers, and negotiating the participation contracts with these customers. The targeting of customer was largely a function of the account managers who know their customers well and understand their assigned customer's operations to the extent that they can target customers who may have demand shedding potential that can be utilized by Duke Energy and at the same time benefit the customer. The Duke Energy marketing support managers described the marketing approach as "one-on-one" marketing.

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This approach is changing with the addition of a segment-based approach to capture customers who cannot opt-out. The customers who were (and remain) the primary targets for this program are also the customers who can now opt-out of being eligible for participation in Duke Energy's energy efficiency and demand response programs. The opt-out provision allows customers to avoid paying for the energy efficiency and demand response programs via the additional charge on their electric bills. However, if they exercise the opt-out option, they are no longer eligible to receive participation incentives (payments) for their load reduction or energy savings actions. As a result, some of the larger customers who make excellent PowerShare participants can now opt-out of these programs. The opt-out option is currently eroding the eligible high-priority (larger customers) participation population for the PowerShare Carolina System program, requiring the program to move to smaller segment-based customers. Duke Energy is now in the process of developing a new approach for marketing to these smaller customers. The success of this effort will be tested over the next couple of years as the program attempts to gain a larger number of smaller customers who will need to set up kW reduction agreements which result in less load reduction per customer which will need to be off-set by increasing the number of participants if the program kW levels are to be maintained.

According to the interviewed managers, the opt-out provision and the resulting change in the per-customer kW reduction potential is resulting in increased cost for the program per unit of kW reduction achieved. The opt-out provision is impacting costs per kW reduction in the following ways:

1. A new marketing approach is being developed to target and attract the smaller customers who do not qualify for the direct support of an account executive and will need to acquire program information and participation decision support information from program information sources that are more market based and that do not directly require the engagement of the account executives.
2. The average kW reduction per customer is expected to go down as smaller customers enroll in the program, at the same time that the cost to obtain a participant are moving up.

The goal of the program, with regards to the marketing efforts, are to maintain as much of the kW load reduction as possible, while controlling marketing and program operations costs that are resulting from the need to acquire larger numbers of smaller, segment-based customers that are offering less kW reduction. It is a significant challenge. According to one interviewee, "*The costs are not going down at a rate to match the opt-out rate, resulting in increasing cost per kW acquired. As a result we need better more effective marketing approaches to supplement our one-on-one approaches.* "

The change in the opt-out condition was a challenge for Duke Energy in that it occurred over a short period of time, compressing the need to develop new marketing strategies. As a result, early changes focused on updating the web site and in the development of new program brochures more appropriate for the smaller customer. In addition, Duke Energy updated the large customer website and provided a link to the program page that helped customers get to the PowerShare site resulting in an increase in web traffic to the site. Additional improvements to the marketing efforts included the use of a new web-trackable e-mail approach that allows program

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managers to see which customer are opening the mail and are visiting the website. The first use of this approach was sent to 1,800 customers of whom 25% opened the e-mail and viewed it.

Improvements to the marketing efforts are continuing as the outreach efforts for 2014-2015 are being developed at the time of the process evaluation interviews. While these new approaches are still in development, the early results from the e-mail tracking look promising. Duke Energy is also working on the development of case studies that are tailored to show the smaller segment-based customers examples of how the program has benefited specific customers that are like those being targeted. These efforts will be launched in the 2014 fall campaign and will be assessed in future evaluations. There are about 4,000 of these newly targeted segment-based customers in the Carolina System that will be targeted in the fall campaign.

Marketing Challenges

When asked about the primary challenge to the marketing effort caused by the need to go after smaller participants, customer education was noted as an increasingly problematic challenge. Managers noted that the smaller customers do not understand kW use or their ability to control their energy use as well as the larger customers. While the account executives can work directly with the largest customer, the smaller customers cannot be assigned to an account executive. This means that the marketing and educational materials will need to be effective not only at informing the customer about the program, but in helping them understand how they might benefit from the program. The marketing approaches will need to educate the customer about what kinds of things (event actions) they can take to achieve a kW reduction over the event period that is consistent with their kW reduction participation agreements. According to the interviewed managers, the program is going to need to help these customers understand the kW reductions they can acquire and the time periods or operational conditions during which those resources can be acquired. They noted that flexibility of operations and equipment use will be important to the success of their participation experience.

Marketing, Supply, and the Polar Vortex

The extreme winter of 2013-2014 caused Duke Energy to experience higher demand levels not typically experienced in the Carolina System and drove electric prices higher while limiting access to additional energy supplies. During the period of time in which a polar vortex was channeling a southerly push of frigid air over the United States, utilities such as Duke Energy were experiencing a substantially higher winter peak as customers used more electricity to heat their homes and businesses. This event drove consumption to peak levels within the Duke Energy distribution system and substantially increased the cost of market acquired power as demand substantially increased within a limited supply condition. The weather extremes were noted by the PowerShare team and caused program managers and their marketing support teams to consider adjusting the marketing materials and program designs to reflect the potential for future winter peak events or structuring new components of the program to consider winter emergency peak program events. Managers also noted that the polar vortex caused participants to become more aware of their commitments to the program because of the unexpected kW load on the Duke Energy system and the potential for winter peak call events. Duke Energy will continue to assess the degree to which the program or its marketing materials may need to be adjusted, especially if the winter peaking events repeat in future winters.

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The managers noted that they are going to need to develop case studies and other materials and approaches that convey the kind of information that will be read by the customer, and more importantly, allow them to understand that material well enough to make a decision to consider participation. Managers also noted that Duke Energy is developing a Medium-Sized Business Advisor Group that will help Duke Energy develop materials that are effective at educating these customers, and also assist with helping educate businesses about the program and the program requirements, but also help educate them about what they can expect to gain as a result of their participation. Duke Energy has begun the development of these materials and will put them into use this year.

Understanding the Impact of the Program on Customer

Duke Energy managers noted that the program can have a very substantial impact on customers and needs to be used with care. It was noted that participants can be substantially harmed by a load reduction call if that reduction is not well planned and implemented by the participating company. The manager noted that there are risks as well as rewards of participation for the customers. For most of the participants the rewards are greater than the risks, especially when the customers have a well-structured kW reduction plan that they are comfortable implementing. However, as the managers noted, because the call for a kW reduction may not occur for a year or more, it is important for participants to review their participation agreement periodically and be comfortable with their kW reduction response. The managers noted that while it is common for the account executives to help participants understand their commitments and responsibilities, and for these managers to help them identify ways to respond to a call event, most participants understand the program and their obligations well. The manager noted that participants are better educated about the program now than in the past, and that the program's improved communications with the customers supported by internal communications training, as well as the use of contact check-lists have helped improve customer understanding and ability to respond. The manager noted that the program has adopted a check-list communications approach that helps to assure that each customer is exposed to key information designed specifically to help improve an understanding of the program and their commitments. The check list is an online internal management tool that tracks all contacts with the participants and documents the information discussed with the customer.

Follow-up with the Customer

Following each event, the monitoring assessments of the program, the event and the response of the participating customers are conducted and examined. The monitoring is examined for performance and to assess the performance-against-costs and to determine if penalties are required for specific customers. This information is provided to the account executives so that the account executives can work with and report performance to the participating customer. In addition, customer reports are generated so that individual customers can see how well they did on that call event. However, this report is not provided in real time (nor do we think it needs to be unless it can be automated), but is provided after a few days when the Duke Energy internal analysis is complete. Once performance is assessed the payments are calculated for each customer and the credit amount is incorporated into an export file to be sent to the billing department. However, prior to the sending of the credit file for billing, the program manager confirms that the amounts to each customer are accurate. Once the confirmation is made, the file is provided to the billing department for incorporating into the next utility bill.

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Once the credit is incorporated into the utility bill, it is checked and confirmed to be the correct amount before the bill is sent to the customer. Errors in billing or credit amounts are corrected at one or more of the multiple pre-release quality control checks. As customers elect to continue or drop-out of the program, or as new customers are enrolled in the program, the program records are updated so that they can be confirmed to be a part of the performance assessment monitoring stream for future events.

Event Monitoring

The Duke Energy program manager monitors the performance of the Carolina System program through the use of analytical tools in which the manager examines the historical load contract commitment and compares that to the daily performance metrics reports that show the kW load profiles of the participants within a called event. In addition, the manager uses Energy Profiler OnLine, a tool that allows the manager to examine daily performance of the participating event customers. These tools provide the information to monitor both program performance and customer performance to assess and confirm kW reductions but do not provide real-time monitoring.

Incentive Levels

Managers were asked about the incentive levels and if there was a need to adjust those levels in view of the smaller customers being approached for participation or to consider winter peaking conditions. Managers noted that the incentives are set to reflect the market price of acquired power in order for the program to be cost effective. They noted that increased incentives can drive the program to be non-cost effective. They also noted that incentive levels are not considered substantial barriers to participation for the larger legacy participants or for the newly targeted smaller customers. Managers noted that the program is experiencing higher cost per acquired kW pressures as gaps created by the participants who opt-out are requiring the program to go after participants that can offer lower kW levels. Managers noted that adjustments may be required to the incentive levels in the future once the full impact of the opt-out provisions and the addition of smaller customers are more fully understood, but they do not think that incentives should be changed (increased or lowered) at this time.

Winter and Summer Peak Need Different Pricing and Load Reduction Plans

Interviewed account executives noted that customer responses and response conditions to demand reduction calls need to be different in winter than they are in the summer. The interviewed account executives noted that these are very different types of load events and noted that load reduction pricing and demand reduction plans appropriate for summer may not work in winter. It was noted that many customers have load reduction plans to drop summer air conditioning loads that do not apply in winter. Likewise, reductions to manufacturing and processing plans, which apply to summer contracts and work schedules, do not always match what they do in the winter. Other managers noted that they had established reduction contracts with their customers based on summer conditions and a specific participant may have no reducible load for a winter call. The manager noted that these large customers were financially penalized for their lack of ability to reduce in the winter.

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The manager indicated that a winter event can cause a customer to give notice to opt-out, only to be told by Duke Energy that they are required to stay in for at least 12 months in accordance with their participation agreements and the program's regulated operational rules.

It was noted that many participants need seasonal flexibility in their reduction plans and have to implement different strategies that provide different load reductions and require a winter-structured incentive that is different than a summer incentive. As a result, according to the account managers, the planning and pricing agreements reached for anticipated summer demand reductions may need to be different than winter demand reduction calls. However, according to the account executives, the program does not need to be segregated into different seasonal focused programs (PowerShare Winter vs PowerShare Summer). These account executives noted the difficulty of their participants trying to meet a summer load reduction commitment during the winter when their operations and operational cost structures are different. Duke Energy's customers need to have PowerShare contracts and event calls that are specifically designed to the operational and pricing requirements of the load conditions at the time of the call events. This means that customers need to have program-approved reduction plans and incentive structures that may be different from season to season.

> Recommendation: Duke Energy may wish to investigate the potential for restructuring the program to address the ability of customers to respond to demand reduction calls at different times of the year and determine if alternative regulatory and program operational conditions are needed to meet different customer conditions associated with different seasonal peak demand call events.

Timing of the Customer Agreements and the Opt-out Provisions

According to the results of the management interviews, there is a need to reexamine the timelines associated with establishing customer agreements and the participation enrollment processes so that they are in agreement with the opt-in and opt-out timelines and decision events. Interviewed managers suggest that the opt-in opt-out rules and timelines are having an impact on customer participation decisions that are impacting Duke Energy's ability to maintain participation and reach program load reduction goals. Managers noted that the opt-in opt-out rules are not set up for winter event decisions and have long decision-change timelines that can cause customers to be forced to participate after they have made a decision to opt-out. For example, a customer who is penalized after they were unable to meet a winter reduction call because their reduction plan and incentive structure was established to achieve a summer load reduction must give a 12 month notice in order to opt-out. Managers also noted the opposite decision is problematic as well in which a customer can decide to be a participant, only to be told that they cannot join the program until the opt-in window is open. The managers noted that it can take months for the window to open, over which time the customer can change their mind because of the inability to implement their decision within the timeline that their operations need. Managers noted that regulatory and program decision timelines can act to alienate customers who must operate in real time and make decisions effectively.

> Recommendation: We recommend that Duke Energy assess these issues and the effects of program timelines in view of the regulatory structure and the potential for winter calls and work to design timelines in which the opt-in and opt-out timelines are supportive of

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the customer's decision making requirements, provide a positive decision experience for the customer and which allow the program to contract to effectively achieve both winter and summer load reductions.

Participation Decision Mechanisms and Regulated Opt-Out Provisions

Interviewed managers noted that there is a significant timing difference between the timing of a customer's participation decision and the regulated timing of the Opt-Out / Opt-In decision. Managers noted that a participant will consider participation within a decision frame that is appropriate for their operations and budgeting schedules, but noted that this timeline may be substantially different from what the opt-in regulatory timeline requires. It was noted that the opt-in decision was a 3-year decision over which substantial changes to a company's operations can occur which directly impact their ability to reduce load. The account managers noted that the 3-year opt-in requirement means that there is load that can be achieved but will not be contracted because of the operational and financial risk associated with a three-year decision within a business climate that is based on annual or in some cases seasonal needs and budgets. One manager noted, *"The three year commitment is hard for customers to do, it is a barrier to participation."*

We recommend that Duke Energy examine the timing and duration of the opt-in commitment requirements and determine if those requirements are over-restricting participation or resulting in potential load not being acquired because of the flexibility and risk avoidance needs of the targeted customers. If such a condition is warranted, Duke Energy should work with the Commission to structure a schedule that is more supportive of customer requirements to the extent this can be accomplished under Carolina System regulatory constraints.

EPA Regulations Impacting Program Design and Operations

The legacy PowerShare program has enrolled customers who have stand-by or older generators that can be used as alternative power supply options within these participant facilities. When there is a PowerShare control event called by Duke Energy, these generators could (in the past) be used by the customers to replace or offset the program-contracted PowerShare energy required from Duke Energy, thereby decreasing the short-fall of kW needed by Duke Energy to serve their customers. In the past, the participants and utility companies have had considerable flexibility in the use of these generators to support supply needs, however recent changes to the EPA regulations have resulted in prohibitions against relying on all of these generators to offset supplies under some emergency conditions unless they have passed the updated EPA emission regulations. This regulation change means that Duke Energy cannot call on all of these customers to provide load relief for events not defined by the EPA as an emergency unless the generators are certified to pass the new regulatory requirements. Beginning January 1, 2015, customer generators that do not meet the new EPA emissions standards will need to participate in the PowerShare Generator option.

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Recommendations from the Management Interviews

The evaluation identified a set of recommendations that we think Duke Energy should consider. These recommendations stem from an observation of how the current program operates relative to the winter peak events of 2013-2014 and the process associated with cost assessment. The recommendations are as follows:

1. **Establish Both Summer and Winter Peak Programs and Participant Goals**
    a. We recommend that Duke Energy investigate the potential for restructuring the program to address the ability of customers to respond to demand reduction calls at different times of the year (winter and summer events) and determine if alternative regulatory and program operational conditions are needed to meet different customer conditions associated with different seasonal peak demand call events. If those changes are needed Duke Energy should work with the North Carolina Commission to restructure those conditions to meet the need for winter and summer program designs and contract conditions.

2. **Examine Opt-in Timelines and Requirements and Determine if Changes are Needed**
    a. We recommend that Duke Energy assess these issues and the effects of program timelines in view of the regulatory structure and the potential for winter calls and work to design timelines in which the opt-in and opt-out decision timelines are supportive of the customer's decision-making requirements, provide a positive decision experience for the customer and which allows the program to contract to effectively achieve both winter and summer load reductions.

    b. We recommend that Duke Energy examine the timing and duration of the opt-in commitment requirements and determine if those requirements are over-restricting participation or resulting in potential load not being acquired because of the flexibility and risk avoidance needs of the target customers. If such a condition is warranted, Duke Energy should work with the Commission to structure a schedule that is more supportive of customer requirements to the extent this can be accomplished under Carolina System regulatory constraints.

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Participant Survey Results

Forty-two companies (26 from North Carolina, 16 from South Carolina) were randomly selected from current participants in PowerShare, and asked to take part in this survey[3]. These 42 companies comprise 10 textile manufacturers, six water plants, five furniture manufacturers, 12 manufacturers of other products with the rest being sole representatives of assorted other non-manufacturing sectors. Thirteen of the respondents also manage more than one site that currently participates in PowerShare. Of these companies, 41 are enrolled in the Mandatory program, with six on the Generator option. Of the respondents, thirty-two of the companies are enrolled in the Voluntary Curtailment Option and one enrolled in CallOption. On average, these companies have been participating in PowerShare for three to four years.

Marketing

The PowerShare program is marketed mainly by Duke Energy Account Managers, to their assigned large customers: 30 respondents (71%) reported they first became aware of PowerShare through a Duke Energy representative, with the rest learning about the program through previous experience with demand response programs or from colleagues. The respondents felt their sources provided almost everything they needed to decide whether or not to participate (a mean rating of 9.19, on a scale of 1 to 10, with 1 meaning "almost nothing I needed" and 10 meaning "everything I needed", S.E.=.28). In addition, when asked where they sought out additional information, 8 of 12 reported they went back to a Duke Energy representative or account manager. The remaining three respondents reported they sought out additional information from the Duke Energy website, engineers within their company, or a consulting engineer. The additional information ranged from more details on the benefits and opt-out procedure, to curtailment logistics for their company (3 of 10 responses mentioned this). All but two reported they got the information they needed.

Enrollment

By an overwhelming count, respondents said that their main reason for participating is financial (37 out of 42). Of the others, three respondents said their primary reason was to help prevent outages, and two said they had a need to test their generators. When prompted for any secondary reasons for participating, 22 of 39 respondents said that there was no secondary reason[4]. Of the others, eight said they wanted to help avoid outages, five said their secondary reason was financial, three said their company's processes made them a good fit for the program, and one respondent said their secondary reason was that they thought there would be no events called.

CallOption Awareness

At the time they were first learning about PowerShare, 22 of 30 respondents reported that they were also presented with information about the PowerShare CallOption program. However, Duke Energy's program participation data shows that only one company enrolled in CallOption. When companies were asked why they didn't enroll, four of eleven respondents said it wasn't their decision, three said they were not aware of CallOption, two said the incentives were too

[3] Not all companies provided responses to all questions.
[4] A social desirability bias would lead respondents to cite environmental or corporate citizenship as a primary or secondary reason for participating. The fact that very few cited these reasons assures that very little social desirability bias is affecting our findings

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low, one explained they used an emergency generator, and one said it was difficult for their company to curtail energy. When asked what Duke Energy could do to make CallOption more attractive to their company, six said they would need more information about CallOption, four said their production needs took priority, and only one mentioned that Duke Energy could increase the incentive. Taken all together, while the sample size for this set of questions is small, these data suggest that there may be a need for consistent marketing of CallOption. An alternative explanation for these findings may be that CallOption was indeed presented to all companies, but found to be an unsuitable option for these companies due to their production priorities or other constraints. Once ruled out as unsuitable, it is possible that respondents simply forgot about CallOption, because it became irrelevant. From these responses, it also seems that PowerShare incentives were priced well, with very few respondents citing low incentives as a reason for not participating.

Event Notification

Participants were asked if there were any other methods by which they would like to be notified about events, and they all said no. One customer did volunteer that they preferred the Automated Demand Response pilot that was offered in the Carolina System for a short period. Customers were also asked how useful it was for them to receive "day ahead" notices, which the program managers sometimes are able to provide. On a scale of 1 ("useless") to 10 ("useful"), 40 respondents gave a mean rating of 9.53 (S.D.=1.38). Respondents were asked to provide feedback on the event communications efforts. The top two most frequent responses from the 42 companies were that Duke Energy was already doing a good job (14 responses) and that there had no feedback (13 responses). Examples of responses include: "*Their event communication efforts are superb.*" And "*The event communication efforts are great. Sometimes our Duke rep even sends us a thank you letter afterwards.*" Of the other feedback, five respondents mentioned a desire to alter the event contact list, including the ability to do it online themselves. "*I would prefer being able to edit our event notification call list simply by logging onto my account. As is, I need to involve my Duke rep every time a number or name gets changed.*" And "*I would prefer during the annual [enrollment] period, to have the ability to reassess our event notification contact list. As is, Duke simply sends me a list I'm supposed to blanket-sign-off on and return. I need the ability to edit this list.*" Six other respondents mentioned that the more advance notice they can get, the better, with one specifically mentioning the need for more advance notice when there were winter events. Three customers mentioned that there were too many notifications, but we note that they were outweighed by those who appreciated the redundancy, "*Duke attempts to notify several of us in the case of events. This is actually pretty helpful, especially for early morning events. It ensures that we're all in the same communication loop.*"

Based on these data, we conclude that Duke Energy's communications efforts are effective and useful, and report that there is no need to change existing communications procedures. However, because interviews with Duke Energy managers suggest that some customers have to contact the account executive to learn of an event termination, there may be room for improvements to subsets of customers who are not now learning about the timing of the end of an event call. There does not now seem to be significant room for additional improvement beyond a small subset of participants who provided a few comments on event termination. We share two interesting comments about the content of the notifications for Duke Energy's consideration. One respondent remarked, "*Only thing that we've run into is that they're very vague as to when*

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we can start back up. They'll say like 11:00, but then say it may go past that. We don't know when to bring our people back in. It's hard to plan." Another mentioned, "*If Duke leaves me a phone message, that message should be informative. The message should not request that I call another number to find out what it's about.*" At this time, these singleton comments do not warranty any recommendations from the evaluation team.

Event Response

With the exception of three companies (of 30 respondents), all reported that their company declined at least one event since 2012. With the caveat that 32 of the 42 total companies in our sample are enrolled in Voluntary, this is not surprising, but provided an opportunity to explore their reasons for declining events. Of the 26 companies, almost three-quarters (19) cited production priorities. Four cited lack of cost effectiveness, with a few mentioning the cost of fuel to generate the electricity during the event, one mentioning that they had an emergency generator, and one more explaining that they didn't participate because of the burden of calculating cost-effectiveness: "*It's more trouble with our finance department than it's worth. It takes time to figure out the bidding.*" This is likely not new information for Duke Energy. However, for those events in which these companies do participate, 36 of 42 (86%) report that they successfully reduced their load.

Energy Profiler Online

Respondents also report some usage of Energy Profiler Online to review their load shape. Of those that use EPO, there is limited review of EPO after a bill arrives, with most of the review occurring during an event (see Figure 1).

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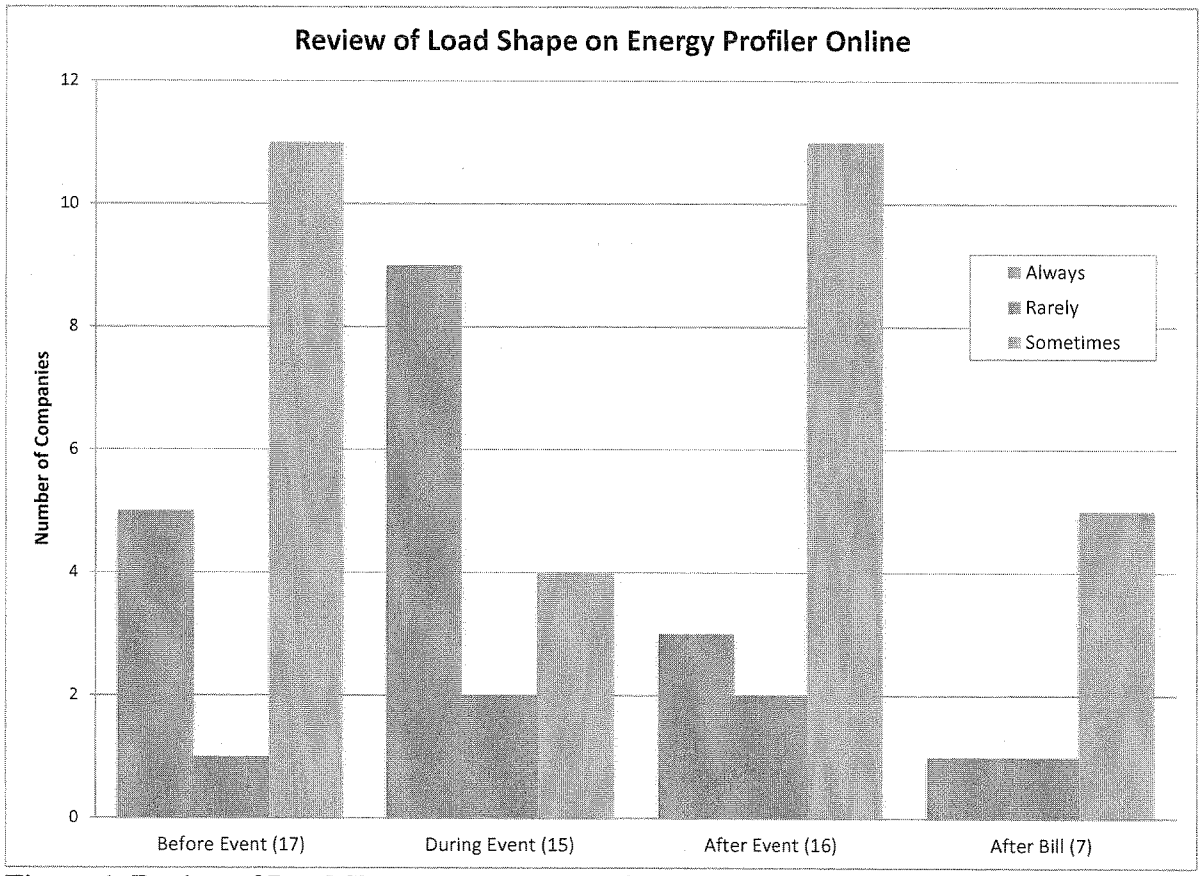

Figure 1. Review of Load Shape on Energy Profiler Online

EPO is seen by the respondents as being moderately easy to use, with 33 respondents rating it 6.91 (S.D.=2.5), with 1 meaning "very difficult" and 10 meaning "very easy". Those rating EPO with less than 8 reported a range of difficulties.

Two respondents asked for better usability features:

- *Duke could reduce the number of clicks required to log into EPO. It is currently quite cumbersome on the front end.*
- *Duke could make EPO easier to navigate.*

Three suggested that they would like more training

- *I'd like some training or examples.*
- *Duke could make the mechanics of EPO more intuitive by providing additional training resources and online tools.*
- *Have directions posted online, just something to clarify the whole process.*

Two others mentioned usability, as well as suggestions for more features:

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- *Duke could make EPO a little more user friendly by having less back & forth. Add the ability to redraw. Make it a more dynamic system.*
- *Duke could make EPO more user-friendly by allowing me to filter and then easily export data.*

Load Capacity Commitment

Most of the respondents report that their targeted level of load reduction is "about right for their company" (see Figure 2).

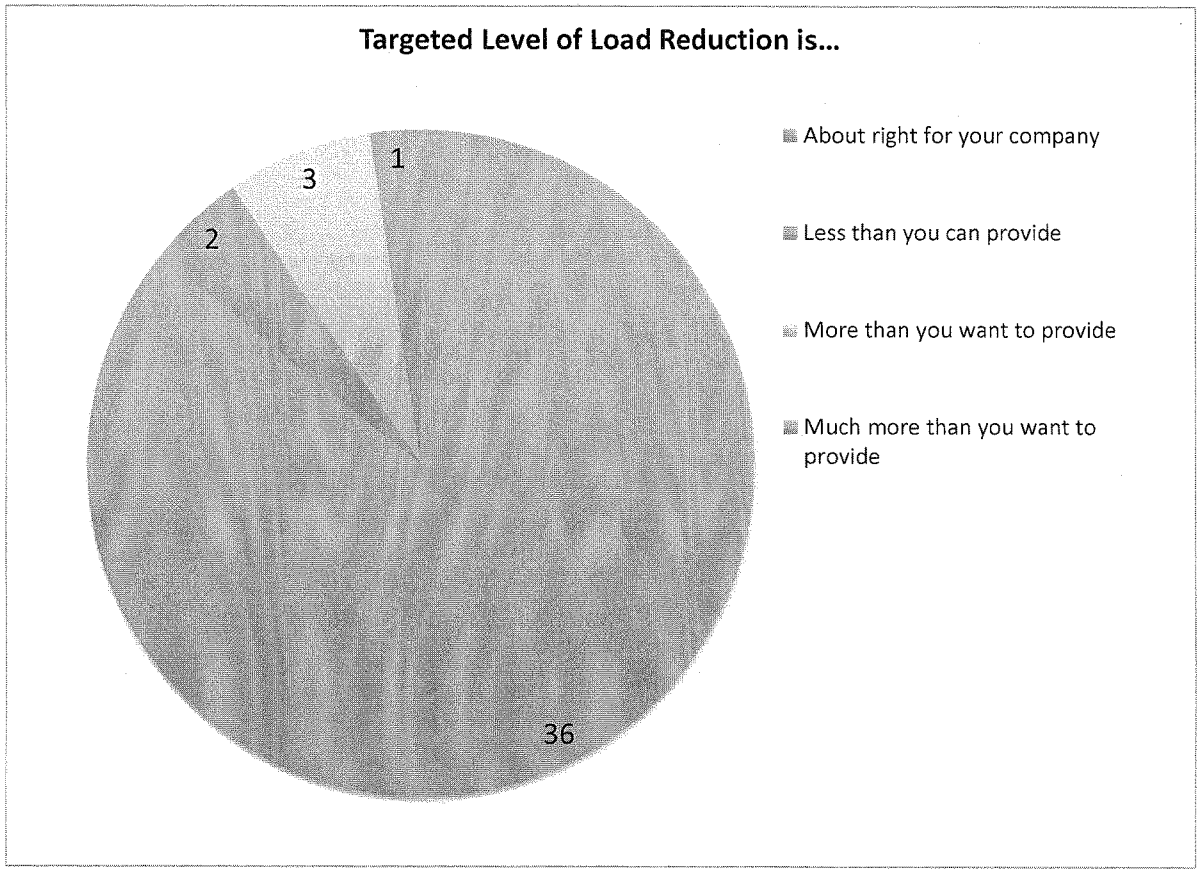

Figure 2. Targeted Level of Load Reduction

Generator

Fourteen of the respondents report that they do use generation as part of their load reduction strategy. Of these, seven report that they will continue to participate in Generator. However, four others are unsure, and two others are concerned about meeting the new EPA regulations, and one company reported "the cost to retrofit outweigh the cost benefit of the credits".

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PowerShare Concerns

We asked the respondents to share their biggest concern about PowerShare during their decision-making process[5]. Their primary concern was about interrupting production at their company (See Figure 3).

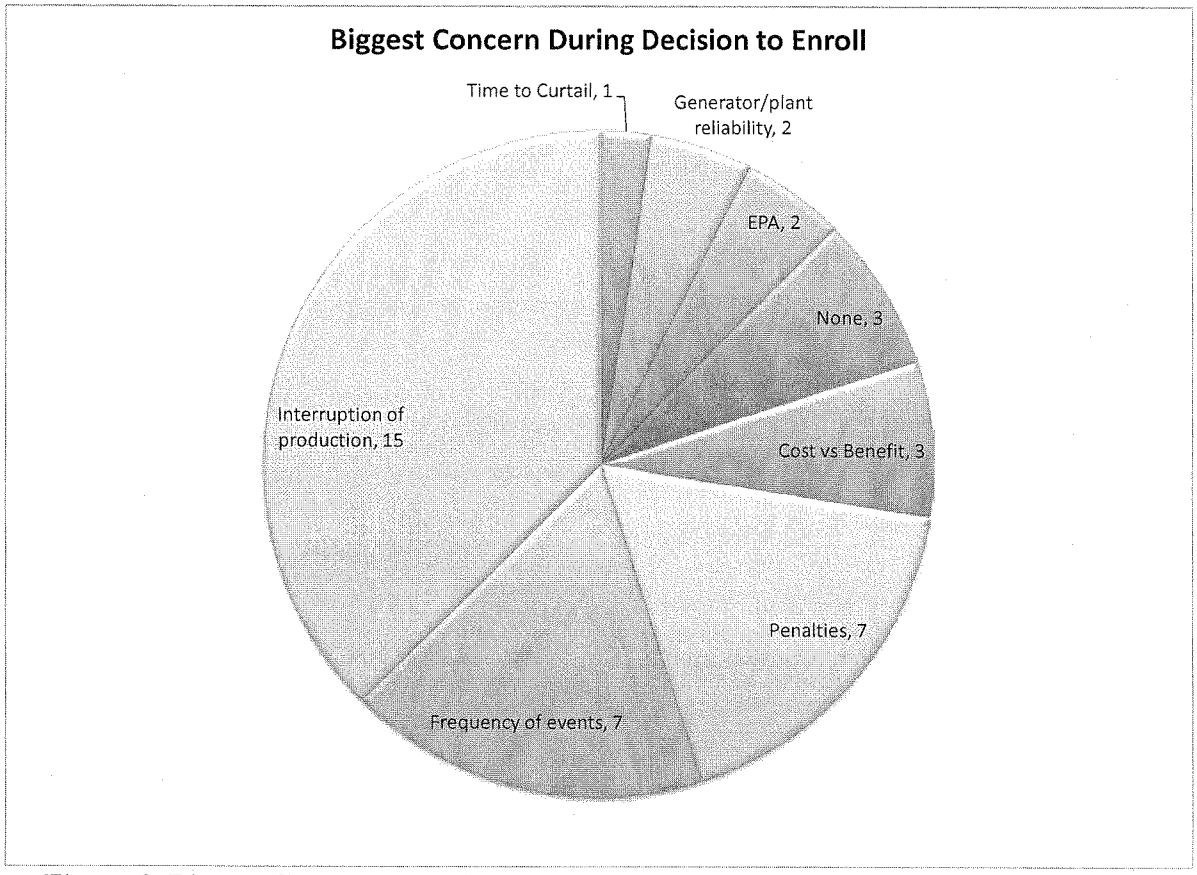

Figure 3. Biggest Concerns During Decision to Enroll

In seven cases, respondents reported that their experience with PowerShare this past event season decreased their concerns. When asked to elaborate, they gave these explanations:

- *History has shown us that the events occur infrequently.*
- *I don't think we've ever incurred a penalty.*
- *Since our enrollment began I think the longest shutdown we've experienced was 12 hours. Most events last only a couple hours, so we can make up for lost production later that same week if need be.*
- *We appreciate our continuing dialog between Duke Energy and various air quality organizations regarding the RICE NESHAP regulations.*

[5] Three respondents volunteered two additional "biggest" concerns, but the graph includes only the first "biggest" concern mentioned. The additional concerns that were mentioned were: Interrupting production (one mention), and penalties (two mentions).

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- *We didn't have any problems meeting any requirements.*
- *We finally experienced an event and everything went smoothly.*
- *We have received the incentives exactly as they were initially described.*

For 32 respondents, their experience this past season did not decrease their concerns. When asked for ways in which Duke Energy could decrease their concerns, 9 of 21 respondents wanted Duke Energy to control the events in some way. These ranged from suggestions to stop having events during peak hours, to several simplistic suggestions that "*Duke could eliminate the need for events altogether*" and "*eliminate them during the winter*", to one suggestion that Duke Energy could "*put more generators online so we don't have to worry about brownouts.*" While these attitudes may not affect the companies' ability or willingness to reduce load, and it may not be representative of the overall PowerShare participants in the Carolina System, it suggests that a segment of the participants may not understand the larger purpose of the PowerShare program, or that they perceive grid and power unreliability as due to Duke Energy's actions. Of the others, there were three suggestions to provide as much advance notice as possible. There were also three respondents who suggested more feedback would help, including one customer who wanted Duke to "offer us equipment that we can use to monitor ourselves to measure our load" and another who would like real time monitors. Two participants suggested that Duke split the program into a summer program and a winter program in some way, not including the respondent who wanted Duke to eliminate events during the winter. Of the remainder, there was one call each for increased incentives, decreased penalties, a request to increase one participant's targeted load, and two suggestions unrelated to PowerShare (to decrease rates, and stop power spikes.)

> Recommendation: Duke Energy should consider investigating the source of customers' expectations that Duke Energy can control the frequency of demand response events. This may reveal opportunities for Duke Energy to educate customers on the full benefits of participating in PowerShare.

Overall Satisfaction

Respondents were asked to rate their satisfaction, on a scale of 1 ("very dissatisfied") to 10 ("very satisfied") with various aspects of the PowerShare program. Overall, the PowerShare program garnered high ratings from the participants. These ratings can be seen in Figure 4.

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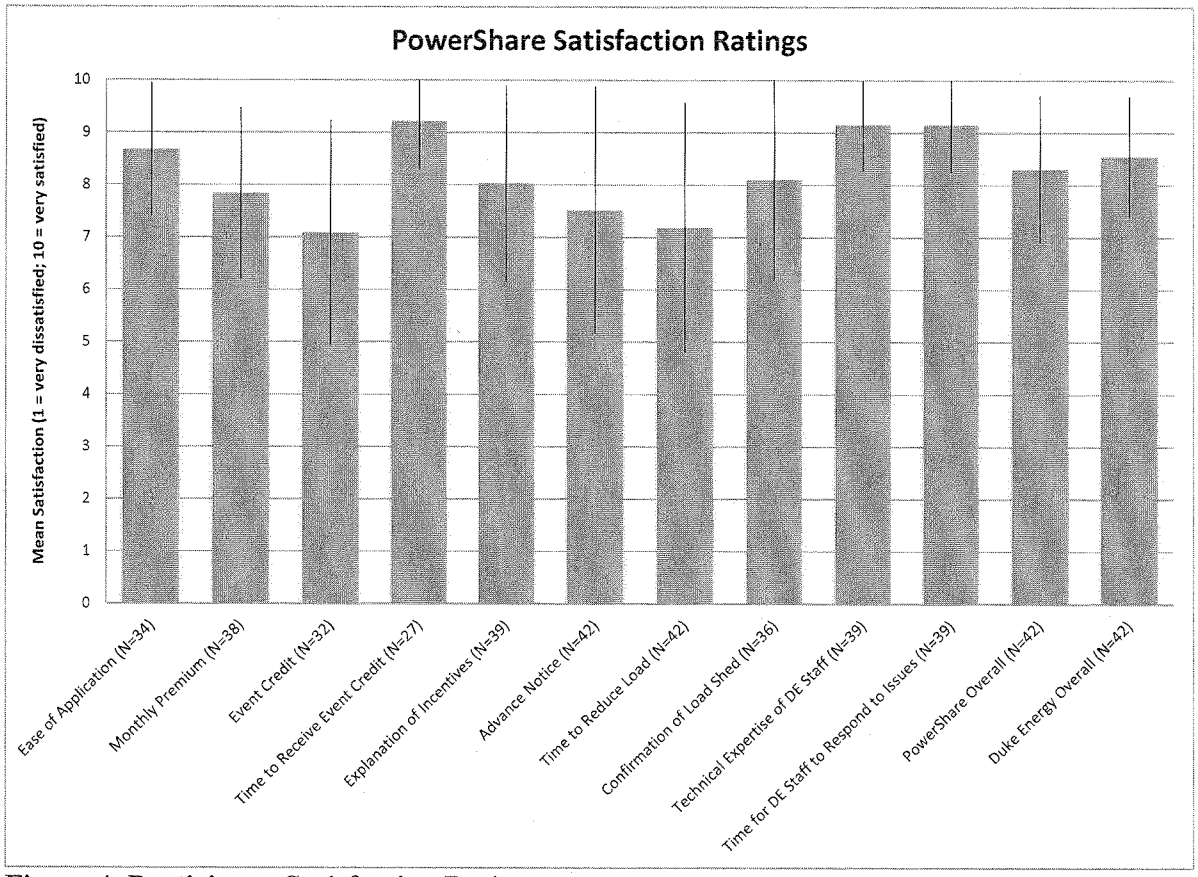

Figure 4. Participant Satisfaction Ratings

The highest satisfaction ratings were given to Duke Energy staff's technical expertise and the time it took for Duke Energy staff to respond to issues. Respondents were also highly satisfied with the time it took to receive event credits. Likewise, overall satisfaction with PowerShare and with Duke Energy itself were very high. Not unexpectedly, the financial incentives were some of the lowest ratings, but even these should be considered moderately high ratings: participants had higher satisfaction with the premium credits (average rating of 7.84) than with event credits (mean of 7.09). In the past, this evaluation team has heard participants say that they had difficulty understanding the calculation of the incentives. In 2013, participants rated their satisfaction with the incentive explanation at 8.03. Note that this evaluation team considers an "8"rating to be so high as to not warrant follow up questions.

While there is still room for improved satisfaction for the time that participants have to reduce load (7.19) and for the amount of advance notice (7.52), these two areas are historically where participants experience the most stress in response to an event call. Given the unavoidable stress associated with responding, the evaluation team considers these to be high ratings that may not have much room to be increased.

The most interesting finding, however, can be seen when comparing satisfaction with PowerShare in 2011 (the date of the last process evaluation survey) with current PowerShare satisfaction. As can be seen in Figure 5, there is a laudable overall increase in satisfaction.

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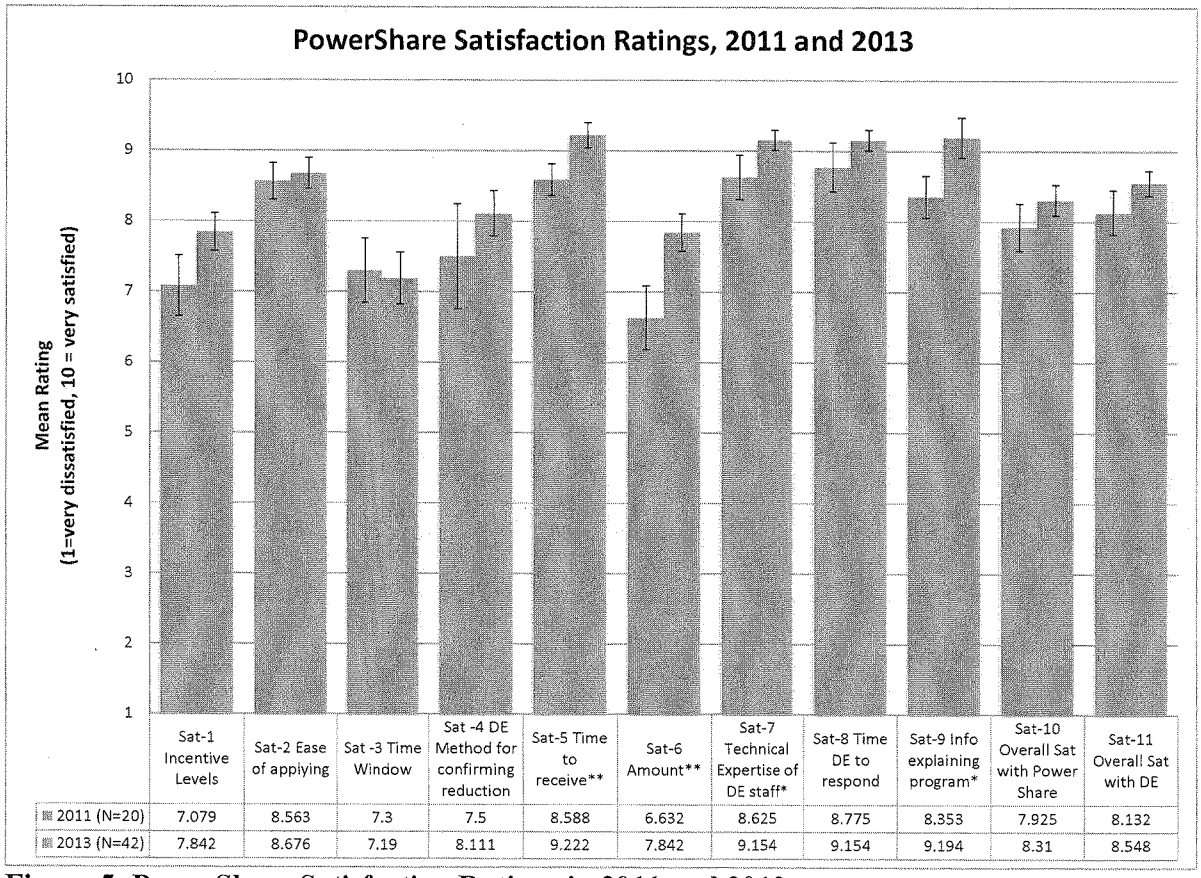
Further analyses show that this increase is statistically significant (with $p \leq .05$) for the time it took to receive the incentive, and with the amount of the incentive (marked with ** in the legend). Also notable is the increased satisfaction with the technical expertise of Duke Energy staff, and with the information explaining the program (marginally significant with $p \leq .10$, marked with * in the legend).



	Sat-1 Incentive Levels	Sat-2 Ease of appiying	Sat -3 Time Window	Sat -4 DE Method for confirming reduction	Sat-5 Time to receive**	Sat-6 Amount**	Sat-7 Technical Expertise of DE staff*	Sat-8 Time DE to respond	Sat-9 Info explaining program*	Sat-10 Overall Sat with Power Share	Sat-11 Overall Sat with DE
2011 (N=20)	7.079	8.563	7.3	7.5	8.588	6.632	8.625	8.775	8.353	7.925	8.132
2013 (N=42)	7.842	8.676	7.19	8.111	9.222	7.842	9.154	9.154	9.194	8.31	8.548

Figure 5. PowerShare Satisfaction Ratings in 2011 and 2013

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Appendix A: Management Interview Protocol

Interviewer: _____ Date of Interview: _____ Interview method: _____

Name: _____

Title: _____

Position description and general responsibilities:

_____

_____

_____

We are conducting this interview to obtain your opinions about and experiences with the PowerShare Program for the Carolina System. We'll talk about the Program and its objectives, your thoughts on improving the program and its participation rates. As you may know, due to regulatory requirements Duke Energy needs to conduct periodic evaluations whether they are needed or not. Today's interview will take about an hour to complete. May we begin?

Program Overview

1. In your own words, please briefly describe the PowerShare Program's objectives. Are there any objectives at the participant level? What are they?
   Are there any objectives at the state portfolio level?
   Are there any objectives at the company level, across all the PowerShare states?

2. In your own words please describe how the PowerShare Program works and go over its design, marketing and operational approaches. Walk us through the participatory steps starting with a customer who knows nothing about the program.

3. Please explain the different PowerShare options that are available to Duke Energy customers along with their incentives.

4. Please describe your role and scope of responsibility in detail. What is it that you are responsible for as it relates to this program? When did you take on this role?

5. Please describe for me the roles and responsibilities of vendors that are supporting Duke Energy's PowerShare program?

6. Are there any changes you would like to see in the vendors' roles or responsibilities that would improve the PowerShare program's operations?

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Objectives

7. Have the PowerShare's objectives changed in the last year or so, and if so how? Why?

8. In your opinion, which objectives do you think are being, or will be, met?

9. Since the program objectives were devised, have there been any changes in external influences (such as market conditions) or internal influences that have affected the PowerShare program's operations?

10. Should the current objectives be revised in any way because of these changes that developed since the program objectives were devised? What changes would you put into place, and how would it affect the objectives?

11. Are there any pre-existing conditions that are associated with the program or the market that are not being addressed or that you think should have more attention? If yes, which conditions are they? How should these conditions be addressed? What should be changed? How do you think these changes will increase program participation or impacts?

Incentives

12. Do you think the incentives offered through the PowerShare Program are adequate enough to entice the C&I community to enroll in the program? Why or why not?

13. Do you think the customers understand the incentive levels and how they are calculated? Have there been any issues relating to the customers understanding the incentive approach or confusion over what they are paid? What can be done to minimize this confusion?

14. If Duke were able to change the incentive level for each event, how do you think this would impact PowerShare's ability to acquire power reductions? In other words, do you think customers have additional ability to shed load that could be tapped if the incentives were increased?

Marketing

15. What kinds of marketing, outreach and customer contact approaches do you use to make your customers aware of the program? Are there any changes to the program marketing that you think would increase participation?

16. Do you think the materials and information presented to the C&I community about the PowerShare Program provides a complete enough picture for them to understand the potential importance of the program to them and their operations and the incentive or participatory benefits of the program?

17. In the state of [insert state], are there specific customer types (business types) or market segments that you think Duke Energy should focus more effort on enrolling? What are they? How should PowerShare approach them with this program?

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18. What market information, research or market assessments are you using to determine the best target markets or market segments to focus on?

19. What are the key market or operational barriers that impede a more efficient program operation or limit obtainable impacts?

20. What market information, research or market assessments are you using to identify market or segment-level barriers, and develop more effective or targeted operational mechanisms?

Overall PowerShare Management

21. Describe the use of any internal or outside program advisors, technical groups or organizations that have in the past or are currently helping you think through the program's approach or methods. How often do you use these resources? What do you use them for?

22. Do you think there should be changes made to the structure of the participation options?

Event calls

23. How do you track, manage, and monitor or evaluate customer response to the event calls?

24. For customers who do not shed as much load as anticipated, do you know why customers did not shed enough load?

25. Can you describe for me a picture of how customers react to a call? How fast do they learn of a call, what determines what they can do, how fast can they react?

26. Given that PowerShare customers have different capabilities to react to an event depending upon their work volumes, production schedules, etc., how does PowerShare capture needed savings within the different customer conditions and capabilities in the market?

27. How do you know if they reached their load shifting objectives?

28. What is the quality control, tracking and accounting process for determining how well control and control strategies work at the customer level and at the program level?

29. Are there any market segments or customer types that the program is now serving that are not able to provide the load shed within the timelines and notification systems used today? What would you suggest should be done about this customer segment?

30. Overall, what about the PowerShare Program works well and why?

31. What doesn't work well and why? Do you think this discourages participation?

32. In what ways can the PowerShare Program's operations be improved?

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33. If you could change any part of the program what would you change and why?

34. Are there any other issues or topics you think we should know about and discuss for this evaluation?

35. How did PowerShare respond to the following recommendations, that were made in the previous evaluation study?

    a) RECOMMENDATION: Duke Energy should consider conducting a conjoint analysis to obtain data on what value customers place upon the different PowerShare program offerings. Such a study would provide Duke Energy management with more information on which to base any reviews of the PowerShare incentive structure in the Carolina System. TecMarket Works further recommends that any conjoint analysis use a choice-based approach, such as discrete choice analysis. This would allow Duke Energy to mimic a real-life decision-making scenario and increase the predictive validity of the study. If Duke Energy does decide to conduct conjoint studies, TecMarket Works recommends that two conjoint studies with different participant samples be considered: One presenting the features of PowerShare Mandatory/Generator versus PowerShare CallOption (i.e., higher premium versus more lead time for events), and another that presents CallOption versus non-participation scenarios in which customers consider the costs of blackouts and of paying higher energy prices due to not curtailing energy use. The second study with non-participation scenarios would allow Duke Energy to compare the relative attractiveness of receiving lower CallOption premium credits versus not participating at all, removed from the context of PowerShare Mandatory/Generator's higher premium credits.
        a. Duke Energy's response and any actions taken:
            i. _____
               _____
               _____

    b) RECOMMENDATION: Because economic curtailment programs are new to customers in the Carolina System, Duke Energy may wish to provide a one-page reference to remind customers of the requirements for participating in Voluntary and CallOption economic events. This would allow new Voluntary participants to make more accurate decisions about whether or not they could participate in a Voluntary event, and when they could end their curtailment. This may also help remove any customer barriers to curtailment based upon a misunderstanding of program logistics and thus allow Duke Energy to focus on promoting the Voluntary program based upon its benefits.
        a. Duke Energy's response and any actions taken:
            i. _____
               _____
               _____

    c) RECOMMENDATION: It is not unexpected that PowerShare participants might forget details about the program in between the summer peak event seasons. To

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help remind customers, Duke Energy should consider providing customers with a summary sheet that highlights the program's key components, and their company's specific commitment in their agreement. If not already done, Duke Energy should also consider developing a process flow chart that illustrates the sequence of events during an event day, starting with the identification of event conditions, notification of customers, and the different paths to settlement should the customer choose to reduce load, generate, or buy through. This summary sheet could end with a reminder of where customers may find confirmation of their load reduction.

a. Duke Energy's response and any actions taken:
    i. _____
    _____
    _____

d) RECOMMENDATION: If the account managers are not already doing so, Duke Energy should consider following-up with first year PowerShare participants to review their load reduction commitments, whether or not those participants were compliant with the previous season's events. Duke Energy should also consider providing first year participants with the ability to adjust their commitments for the next event season, while their experience of the most recent event season is still fresh in their minds. This will allow these customers to provide feedback to Duke Energy on whether their load reduction commitments were easily achieved, just right, or too onerous. If a new participant has overcommitted and simply cannot deliver on that commitment, Duke Energy should identify them sooner rather than later, and stop paying on premiums on capacity that does not exist.

a. Duke Energy's response and any actions taken:
    i. _____
    _____
    _____

e) RECOMMENDATION: Duke Energy is already aware that the calculation of capacity and incentives may be difficult for customers to understand, and results from these participant surveys confirm that there still is some confusion. If Duke Energy has not already done so, they should consider easily-accessible tools for helping customers understand these calculations. For example, Duke Energy may develop short tutorials on how customers could calculate their capacity, specifying how baselines are calculated and used, and how proformas are calculated and used. While Duke Energy currently does have marketing collateral explaining these processes, they may be difficult for customers to locate if they are embedded in a large document. Short tutorials that are available on the PowerShare website may be more convenient for customers who are trying to access specific information. Alternatively, if Duke Energy account managers are not already doing so, they could consider "showing their work" and leaving customers with documentation showing their company's specific incentive and baseline calculations. There are many other methods Duke Energy may be considering to improve the understanding of these technical issues.

a. Duke Energy's response and any actions taken:

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i. _____

f) RECOMMENDATION: Duke Energy should consider ways to reduce customer uncertainty about whether they can actually provide the amount of curtailment they have contracted (for both Mandatory and Voluntary events). Customers may have less uncertainty if they had a plan for curtailment and entered each event with an expectation that they will fulfill their curtailment commitment if they followed the entire plan. Such a plan may include a schedule specifying which pieces of equipment to turn off and which generators to turn on, and how much load would be curtailed with each of these actions if taken in the order specified. This schedule of curtailment would allow Voluntary participants to gauge how long they need to curtail and when they could return to normal operations. While developing such a plan would be the responsibility of the customer, Duke Energy might offer them some technical assistance. Duke Energy should obtain more data from customers on whether technical assistance with developing a curtailment plan and schedule would encourage more customers to participate in PowerShare. This may be accomplished informally by the Duke Energy account managers, or more formally with a telephone survey of customers whose main strategy is curtailment.

a. Duke Energy's response and any actions taken:

i. _____

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Appendix B: Participant Survey Protocol

Survey ID _____
Surveyor Name _____

State

( ) North Carolina
( ) South Carolina

Participant Info

Name: _____
Company: _____
Title: _____

Hello, my name is _____. I am calling on behalf of Duke Energy to conduct a customer satisfaction interview about the PowerShare Program. May I speak with _____ please?

We need your help. Duke Energy has given us your name as someone who might be able to share some of your experiences with the PowerShare Program. We are not selling anything. We would like to conduct a short interview that will take about 15 minutes and all your answers will be kept confidential. This information will enable Duke to make improvements to the program and the application process.

Message for voicemail
Hello, my name is _____ from TecMarket Works. I am calling on behalf of Duke Energy to conduct a customer satisfaction interview about the PowerShare Program. Duke Energy has given us your name as someone who might be able to share some of your experiences with the PowerShare Program. We are an independent evaluation firm and we are not selling anything. We would like to conduct a short interview that will take about 15 minutes. All your answers will be kept confidential. This information will enable Duke to make improvements to the program and the application process.
If you can help, please call me at _____. If there is someone at your company who would be more appropriate for us to speak to, we would appreciate if you could let us know that as well.

OPTIONAL - only If the customer wishes confirmation from Duke.
If you would like to verify this request, please contact your account manager. Or, you can contact ** ****, Manager of Measurement and Verification Ops, at Duke Energy. She can be reached at (***) ***-**** or *****@duke-energy.com.**

IN-1. Would you be able to help us?

( ) Yes
( ) No

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(If no)
IN-2. Can you please give me the name of someone else who might be the more appropriate person to tell us about your company's participation in PowerShare?

_____

ESTABLISHING QUESTIONS

ES-1. Would you please tell me what your company does and what your role is in your company? _____

ES-2a. Do you manage more than one site that participates in PowerShare for your company?
( ) Yes
( ) No

If yes,
ES-2b. How many sites?

_____

Most of the questions you will be answering today are about PowerShare in general, but if you manage sites that participate in PowerShare differently from one another, please answer for your company's facility that is listed as ...
[Please fill in facility name from info sheet].

_____

ES-4. In which option(s) did your company enroll?
Please select all that apply.
[ ] Mandatory Curtailment Option
[ ] Voluntary Curtailment Option
[ ] Generator Option
[ ] CallOption

ES-5. How long has your company been participating in the PowerShare ?

_____

INFORMATION-GATHERING PHASE

INFO-1. How did you first become aware of the PowerShare Program?
( ) Duke Energy sent me a brochure
( ) A Duke Energy representative told me about it
( ) Duke Energy website
( ) I saw an ad in: _____

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( ) Other: _____
( ) DK/NS

INFO-2. Please tell me how useful that source was in providing the information you needed to decide whether or not to participate. Please rate the usefulness of that source on a scale of 1 to 10, with 1 meaning "Almost nothing I needed", and 10 meaning "Everything I needed".

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

(If INFO-2 was less than 10, ask questions INFO-3a, 3b and 3c)

INFO-3a. Where else did you go to get information?

_____

INFO-3b. What additional information were you seeking?

_____

INFO-3c. Were you able to get the information you needed about the program's participation requirements and benefits?

( ) Yes
( ) No
( ) DK/NS

CALL OPTION

CO-1. I have some questions specifically about the PowerShare CallOption Program. When you were learning about the PowerShare Program, were you also presented with information about the PowerShare CallOption Program?
(CallOption is a combination of emergency and economic events)

( ) Yes
( ) No
( ) DK/NS

CO-2a. Did your company enroll in the CallOption ?

( ) Yes
( ) No
( ) DK/NS

If CO-2a was "No", ask CO-2b and 2c
CO-2b. Can you please tell me why you decided that the CallOption was not right for your company? _____

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CO-2c. What can Duke Energy do to make CallOption more attractive to your company?

_____

DECISION MAKING

DM-1. What was the primary reason that you decided to participate in the PowerShare Program?

_____

DM-2. Was there a secondary reason that your company decided to enroll?

_____

PARTICIPATION IN AN EMERGENCY OR ECONOMIC EVENT

EV-1a. How many PowerShare <u>emergency</u> events has your business been asked to respond to in 2012?

( ) 0
( ) 1 or more *(enter number)*: _____
( ) DK/NS
( ) NA

EV-1b. How many PowerShare <u>emergency</u> events has your business been asked to respond to in 2013?

( ) 0
( ) 1 or more *(enter number)*: _____
( ) DK/NS

EV-1c. How many PowerShare <u>emergency</u> events has your business been asked to respond to in 2014 (to date) ?

( ) 0
( ) 1 or more *(enter number)*: _____
( ) DK/NS

EV-2a. How many PowerShare <u>economic</u> events has your business been asked to respond to in 2012?

( ) 0
( ) 1 or more *(enter number)*: _____
( ) DK/NS
( ) NA

EV-2b. How many PowerShare <u>economic</u> events has your business been asked to respond to in 2013?

( ) 0

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( ) 1 or more *(enter number)*: _____
( ) DK/NS

EV-2c. How many PowerShare economic events has your business been asked to respond to in 2014 (to date)?
( ) 0
( ) 1 or more *(enter number)*: _____
( ) DK/NS

EV-3. In addition to phone calls, texts, and emails, is there another way in which you would like to be notified of events? _____

EV-3b. For some events, Duke Energy is able to send out a notice a day ahead of the event, to warn of the possibility that an event may occur. Can you please rate how useful it is for you to receive the "day ahead" notices, on a scale of 1 to 10, where 1 means "Useless" and 10 means "Useful".
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA

EV-3c. Do you have any other feedback for Duke Energy on their event communication efforts?

_____

(If EV-2 was 1 or more)
EV-4a. For the Economic events, did you decide to reduce energy use for every event, or did you decide to decline one or more events?
( ) Yes, I reduced energy for every event.
( ) No, I declined one or more events
( ) DK/NS

[If customer did reduce, EV4a=Yes]
EV-4b. Do you think you would have been able to reduce more? Why or why not?

_____

[If customer declined to reduce, EV4a=No]
EV-4c. Why did you decline to reduce energy usage?

_____

EV-5. What did you need to do at your facility to reduce load?

_____

EV-6a. Was your company successful in reducing load?
( ) Yes
( ) No
( ) DK/NS
( ) NA

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If No,
EV-6b. Were there any negative consequences of not reducing enough load?

_____

Note to Interviewer:
When reading answers to EV-7 aloud, if customers answers Yes, immediately ask follow-up "Rarely, Sometimes, Always". Then proceed with EV-7 answers, if appropriate.

EV-7. As you know, Duke Energy provides a forecasted load pattern to you on EPO (Energy Profiler Online) the day before an economic event to help in your decision making process for a Voluntary Event. Do you review that load shape....
(Read choices aloud.)

[ ] Never, I do not need to review the load shape before making the decision to participate or not.
[ ] Before participating in a Curtailment Event?
[ ] During or immediately after a Curtailment Event?
[ ] Sometime after a Curtailment Event but before the bill comes?
[ ] After the monthly bill comes?

EV-7b. How often "Before participating in a Curtailment Event"?
( ) Rarely
( ) Sometimes
( ) Always

EV-7c. How often "During or immediately after a Curtailment Event"?
( ) Rarely
( ) Sometimes
( ) Always

EV-7d. How often "Sometime after a Curtailment Event but before the bill comes"?
( ) Rarely
( ) Sometimes
( ) Always

EV-7e. How often "After the monthly bill comes" ?
( ) Rarely
( ) Sometimes
( ) Always

EV-8. Please rate how easy is it for you to use EPO, on a scale of 1 to 10, where 1 means very difficult and 10 means very easy.
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

(If rating was less than 8)
EV-9. What can be done to make using EPO easier for you?

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EV-10. Would you say the targeted level of load reduction you currently have with Duke Energy is ....

( ) **Much less than you can provide**
( ) **Less than you can provide**
( ) **About right for your company**
( ) **More than you want to provide**
( ) **Much more than you want to provide**
( ) DK/NS

EPA REGULATIONS

GEN-1. Do you turn on any generators as part of your load reduction strategy?

( ) Yes
( ) No
( ) DK/NS

If "Yes"

GEN-2. How has EPA's National Emissions Standards for Hazardous Air Pollutants that came into effect in January of 2013 affected your participation in the PowerShare ? Would you say that...

(Please read choices aloud).

( ) **My company has, or will, retrofit engines and continue participating in Mandatory and/or Voluntary.**
( ) **My company will stop participation in Mandatory and/or Voluntary, but continue to participate in the PowerShare Generator option.**
( ) **My company will stop participation in PowerShare entirely.**
( ) Other: _____

IMPROVEMENTS

IMPR-1. While your company was deciding whether or not to enroll, what was the biggest concern about participating in PowerShare?

IMPR-2a. During the past season, did anything happen to decrease your concern?

( ) Yes
( ) No

If YES

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IMPR-2b. What happened?

_____

If NO
IMPR-2c. What can Duke Energy do that would decrease your concern?

_____

IMPR-3. How interested would you be in aggregating your accounts together, for PowerShare purposes only, in order to optimize load curtailment strategies across several Duke Energy accounts? This would allow you to reduce a certain kilowatt across several sites, so that you could decide to curtail for one site and not for another, and still provide the agreed-upon load reduction. Would you be:

( ) **Not at all interested**
( ) **Slightly interested**
( ) **Somewhat interested**
( ) **Very interested**
( ) NA

IMPR-4. Is there anything about PowerShare you would say was working exceptionally well? It's fine if there isn't.

_____

IMPR-5. What doesn't work well and why?

_____

SATISFACTION

We would like to ask you a few questions about your satisfaction with various aspects of the program. For these questions, we would like you to rate your satisfaction using a 1 to 10 scale where a 1 means that you are very dissatisfied with that aspect and a 10 means that you are very satisfied.

SAT-1. How would you rate your satisfaction with: The ease of applying for the program?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-1a. How can this be improved?

_____

SAT-2. How would you rate your satisfaction with: The amount of the monthly premium credit provided by the program?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

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If rating was less than 8
SAT-2a. How can this be improved?

_____

SAT-3. How would you rate your satisfaction with: The amount of the load reduction credit for the events in which you participated?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-3a. How can this be improved?

_____

SAT-4. How would you rate your satisfaction with: The time it took for you to receive your load reduction credit?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-4a. How can this be improved?

_____

SAT-5. How would you rate your satisfaction with: How clear the explanation of the PowerShare incentive structure was?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-5a. How can this be improved?

_____

SAT-6. How would you rate your satisfaction with: The amount of advance notice you had about the events?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-6a. How can this be improved?

_____

SAT-7. How would you rate your satisfaction with: The time window in which you were required to reduce your load once you had received notification about the start of the event?
( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

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If rating was less than 8
SAT-7a. How can this be improved?

_____

SAT-8. How would you rate your satisfaction with: Duke Energy's method for confirming how much load you reduced?

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-8a. How can this be improved?

_____

SAT-9. How would you rate your satisfaction with: The technical expertise of Duke Energy staff?

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-9a. How can this be improved?

_____

SAT-10. How would you rate your satisfaction with: The time it took for Duke Energy staff to respond to any questions or address any issues?

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-10a. How can this be improved?

_____

SAT-11. Considering all aspects of the program, how would you rate your overall satisfaction with the PowerShare Program?

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8
SAT-11a. How can this be improved?

_____

SAT-12. How would you rate your overall satisfaction with Duke Energy?

( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ) NA ( ) DK/NS

If rating was less than 8

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SAT-12a. How can this be improved?

_____

SAT-13. Are there any other thoughts or comments you would like to share with Duke management about the PowerShare Program that we have not discussed already?

_____

Thank you for taking this time to share your thoughts! We appreciate it very much.

Morris, Paige

From: Jeter, Pat
Sent: Friday, June 12, 2015 1:57 PM
To: Cox, Jackie; Hodge, Tracy; McLamb, Maxine; Morales, John; Morris, Paige; Mount, Gail; Needham, Lisa; Peedin, Linda
Subject: Bug Tracker

Folks – As we decided initially, I am putting all the bugs in the system, but I want you to be able to know what is outstanding at all times; thus below is the link, userID and password to get into the bug tracker so you can see what is outstanding at any given time.

Let's start documenting issues using our online bug tracker.

https://apps.dorgersoft.com/bugtracker

Your login is to bugtracker is:

pjeter
NCUC@12345

E-mail correspondence to and from this address may be subject to the North Carolina Public Records Law and may be disclosed to third parties by an authorized state official.

Dorger ARCHITECTS

bugs search queries go to ID search text advanced logged in as pjeter logoff settings about help

add new bug | open bugs | print list | print detail | export to excel | download screen capture utility

clicking while holding Ctrl key toggles "NOT" in a filter: "NOT project 1"

id	flag	desc	project	organization	category	reported by	reported on	priority	assigned to	status	last updated by	last updated on
	[no filter]		[no filter]	[no filter]	[no filter]	[no filter]		[no filter]	[no filter]	[no filter]		
2629		Company/Contact/Invoice/Payment - issue as tried to test bug 2540	NCUC RegFees DB	NCUC		pjeter	2015-06-15 8:33 AM	low	pjeter	Client Verification	jsmith	2015-06-15 9:28 AM
2625		Adding Company and then Contact to same company - didn't auto assign as earlier tested and resolved	NCUC RegFees DB	NCUC	enhancement	pjeter	2015-06-12 1:08 PM	low	jsmith	In Queue	jsmith	2015-06-15 10:46 AM
2589		Refunding money on an account	NCUC RegFees DB	NCUC	bug	pjeter	2015-06-02 2:11 PM	low	jsmith	In Queue	pjeter	2015-06-15 11:45 AM
2588		In payments we need the ability to code a write off of balance	NCUC RegFees DB	NCUC	bug	pjeter	2015-06-02 2:07 PM	low	jsmith	In Progress	jsmith	2015-06-12 12:48 PM
2562		Question on the contacts displayed in test environment	NCUC RegFees DB	NCUC	question	pjeter	2015-05-29 10:28 AM	low	jsmith	In Queue	jsmith	2015-06-02 10:02 AM
2540		Recording a payment on the payments tab within a company after creating a recording	NCUC RegFees DB	NCUC	bug	pjeter	2015-05-27 1:09 PM	low	pjeter	Client Verification	jsmith	2015-06-08 3:25 PM
2480		Invoices numbering - will we be changing W-R987-2015-2 to WR-987-2015-2 since real entity number is WR-987?	NCUC RegFees DB	NCUC	bug	scot	2015-05-08 10:06 AM	low	jsmith	On Hold	jsmith	2015-05-18 12:57 PM

7 bugs returned by query