2013 Residential Direct Load Control Program

Prepared for FirstEnergy Ohio Companies:

The Cleveland Electric Illuminating Company

Ohio Edison Company

The Toledo Edison Company

2013

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Prepared by:

ADM Associates, Inc.

3239 Ramos Circle, Sacramento CA 95827
916.363.8383

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Executive Summary

For 2013, the Ohio Operating Companies The Cleveland Electric Illuminating Company (CEI), Ohio Edison Company (OE), and The Toledo Edison Company (TE) (collectively "Companies") offered the Residential Direct Load Control (DLC) program. Under contract with the Companies, ADM Associates, Inc. (ADM) performed evaluation, measurement and verification (EM&V) services to confirm the savings (kWh) and demand reduction (kW) realized through the energy efficiency programs that the Companies implemented in Ohio in 2013. This report presents and discusses results from an evaluation of the Companies' 2013 Direct Load Control Program ("DLC").

This evaluation focuses on determining the achieved peak demand reduction and energy savings attributed to the DLC program in 2013. The evaluation included one-way UtilityPro Programmable Control Thermostats (PCTs). These devices functioned to restrict central air conditioner (CAC) runtime to a specified percentage of the runtime that would have transpire in the absence of the curtailment event.

Program participation levels, Ex Ante and Ex Post values are listed in the following table. Demand (kW) and energy (kWh) savings calculations are detailed in Chapter 4. Demand (kW) savings represents average hourly kW reduction during Load Control Events, while energy (kWh) savings represents the product of average hourly kW and duration (hours) of Load Control Events.

Table ES-0-1 Program Savings Summary

Utility	*Participating Residential Households with DLC Device*	*Ex Ante Expected Savings*		*Ex Post Savings*		*kW Realization Rate*
		kWh	*kW*	*kWh*	*kW*	
OE	10,109	68,704	4,809	55,278	5,499	114%
CE	5,697	31,300	1,519	41,419	2,761	182%
TE	1,333	10,911	662	11,947	988	149%
Total Program	17,139	110,916	6,991	108,643	9,248	132%

DLC program savings have a measure life of one year, which is the program year itself; in other words, savings do not persist beyond the 2013 calendar year.

1. Introduction and Purpose of Study

Under contract with the Companies, ADM Associates, Inc. (ADM) performed evaluation, measurement and verification (EM&V) services to confirm the savings (kWh) and demand reduction (kW) being realized through the energy efficiency programs that the Companies implemented in Ohio in 2013. ADM prepares an EM&V report for each program for which EM&V is required. This document is the EM&V report for the 2013 Direct Load Control (DLC) Program in Ohio.

1.1 Objectives of the Study

The scope of ADM's EM&V work for the DLC project includes the following activities.

- Develop a load reduction research plan, including a measurement and sampling strategy to establish kW per unit impacts.
- Perform analysis of load data collected in 2013.
- Determine the program level kWh Savings
- Determine the system wide MW Impacts at the EDC level
- Perform analysis of DLC events in the summer of 2013 to assess hourly load reductions

1.2 Overview of Study Methodology

Data for the study was collected and analyzed through the following procedures.

1.2.1 Data Collection

ADM, as the M&V Contractor, was not responsible for physically collecting data on runtime of controlled Central Air Conditioners (CAC) or whole-house meter data. However, as part of the evaluation, ADM did consult on sample design, in order to ensure that all sampling meets program requirements of 90% confidence and 10% precision (90/10). ADM obtained Wattnode logger data at 2 minute intervals for the entire summer cooling season (May-Oct). ADM performed checks on each logger to ensure that the data being recorded was accurate.

2. Description of Program

The Companies have designed the (DLC) Program to reduce peak demand for electricity during the summer months. Customers who opt into the program will have a radio-controlled thermostat installed that will allow the Company to reduce CAC compressor operation by a variable load control percentage (e.g., 50%) during load control "events". The demand control events began in the summer of 2013. The events themselves were initiated to reduce electric energy consumption during peak hours. This program is strictly for residential customers, and was targeted at customers with CAC units who are willing to accept reduced cooling capacities during event hours.

Honeywell is contracted with the Companies to provide DLC services. Load curtailment is enabled through special programmable thermostats that can receive radio frequency signals and curtail CAC unit usage by reducing compressor operation during load control events.

Devices are equipped with an adaptive algorithm that will cut the runtime of the CAC compressor to 50% (or alternate percentage) of what it would have been otherwise, based on the normal operation of the unit. During a 70% Cycling event for example, if a particular unit would have normally run 40 minutes during a given hour, the program will limit that unit to only 12 minutes of run time in that hour. Given that an event will likely last a number of consecutive hours, that same control limit will be applied to each hour of the event. The actual usage schedule that achieves the desired control limit will be unique for each program participant and will depend upon the physical characteristics of the home and behavioral patterns during conditions similar to the actual events.

During the 2013 Cooling Season the Companies ran the following whole-system events:

(1) July 15th, 5 – 7 PM, 50% Cycling
(2) July 16th, 2 – 6 PM, 50% Cycling
(3) July 17th, 5 - 6 PM, 70% Cycling
(4) July 18th, 4 – 7 PM, 70% Cycling
(5) July 19th, 5 - 6 PM, 70% Cycling
(6) September 10th, 5 – 7 PM, 70% Cycling
(7) September 11th, 5 – 7 PM, 70% Cycling

From these event days, ADM calculated the average kW Factor by Company and number of enrolled participants. The device count was measured just before the first curtailment event on July 15th, 2013. Any participant who requested to be removed from the program before that date was not included.

3. Evaluation Methodology

This chapter discusses the M&V approach for designing the sampling plan, calculating the kW impact per unit, program level kWh savings and MW impacts.

3.1 Impact Evaluation Methodology

The impact evaluation addressed the following questions:

- Determine the kW reduction per event and snapback hour, for all program participants.
- Determine the operability rate of devices in the field through field inspections.

3.2 Sampling Strategy

The sample size is determined to 10% error at a 90% confidence level using a two-tailed test. For M&V purposes, the minimum sample size (MSS) which meets Ohio's regulatory requirements can be achieved by applying the 90/10 requirements at the program level. The MSS for a particular group is determined as the number of sample points required to meet the 90/10 requirements times a factor of 1.10 for contingency purposes. This sample size will provide adequate confidence and precision levels to exceed Ohio SWE requirements.

The equation for determining MSS is as follows:

$$n_0 = \frac{z^2 cv(y)^2)}{p^2}$$

where n is required sample size (i.e., number of devices); z is the x value from a standard normal curve for a specified confidence level (e.g., 1.645 for 90% confidence level); CV(y) is coefficient of variation for CAC compressor kW draw during a typical control event time-frame; and p is required precision. The conditions under which the CV will be estimated are as follows:

- Between the hours of 10AM – 7PM
- Weighted Temperature-Humidity Index (WTHI[1]) Index is above 78 for each hour

[1] The THI and WTHI are explained in Appendix C.

- Day is a non-Event Day, non-holiday and non-weekend

Given the confidence interval and precision requirements, the size of the sample depends primarily on the coefficient of variation (CV) for runtime reduction in the population of devices to be sampled. Using the 2013 meter data, ADM calculated the CV using the population Standard Deviation (Stdev), Mean, and CV = Stdev/Mean.

Table 3-1 Required Sample Size Calculations

Standard Deviation	*Mean*	*Coefficient of Variation*	*Required Sample Size (90% Confidence, 10% Precision)*	*Required SS with 10% Contingency*	*Actual 2013 Sample of Logger Data*
0.15	0.19	0.78	165	182	225

To ensure that the sample adequately covered each of the three Operating Companies' territories, a sub-sampling procedure was conducted as detailed in the following table, i.e., the total of 225 sites was allocated equally across the three Operating Companies. The sample was divided between the two major cities in each Operating Company.

Table 3-2 Sample Sites by City and Company

City/EDC	*Sample Sites*
CEI	
Cleveland	36
Strongsville	39
OE	
Akron	39
Youngstown	36
TE	
Sylvania	36
Toledo	39
Total	**225**

Although the sample size was 225, there were 215 logger installations in total. Not all 215 sites yielded useful data for analysis. Of the 215 data loggers, a total of 194 logger files remained eligible for analysis[2].

[2] The 10% attrition rate is not unusual given that the loggers are installed for extended periods. In planning data acquisition activities ADM oversampled by 10% in anticipation of potential data losses.

3.3 Data Collection and Conversion Procedures

For the households recruited for the sample, data was collected to measure changes in the energy use of the AC unit. The fields of interest to the evaluation collected by Honeywell are listed below:

- 2-minute interval kWh reading
- Unit tonnage
- Install date
- Event dates
- Event Type (Cycling Strategy)

Having the unit tonnage from the sample allows there to be a control mechanism to account for any difference in the average tonnage by Operating Company versus the entire program population. This procedure will be explained in the next section.

Honeywell conducted the Wattnode Logger installation and data retrieval during 2013. 50 amp current transformers (CTs) were used with the Wattnode loggers. ADM received data files for each of the 215 Wattnode loggers with 2-Minute Interval Pulse data for the entire summer cooling season (May-Oct). Wattnode loggers sum the number of pulses over the measurement period to determine the recorded interval reading. The measurements from the Wattnode loggers were converted into kW by employing the following formula:

$$kW = Pulses \div 800(Pulses/kWh) \times 30(kW/kWh)$$

The 800 Pulse/kWh factor comes from the Wattnode reference manual documentation based on the 50 amp CT used. Multiplying by 30 simply converts from kWh to kW.

3.3.1 Data Quality Checks

As an integral part of the M&V effort, ADM investigated each customer's logger data to ensure that their usage profile was being accurately described by the Wattnode devices.

Of the194 data files available for analysis, 177 ultimately were modeled and informed savings[3], while 17 failed goodness of fit criteria and were excluded from analysis. In order to determine the capacity of each individual AC unit, ADM calculated the capacity as the average of the 99th percentile of all 2-minute kW readings. The data are then converted to an hourly load shape by averaging the kW readings for all 30 readings within each hour. This procedure was conducted in SAS/SQL with the following program:

[3] The final logger counts are 64 for TE, 53 for CE, 60 for OE.

```
*Converting from Pulses to kW;
Data OHDLC.Combined3;
set OHDLC.combined2;
kW = (pulses/800*30);
kW_Ton = kW/tons;
Drop Data_Logger_SN Pulses city var6;
Run;

*Aggregating from 2Min Interval Data to Hourly Data;
Data OHDLC.Combined5;
set OHDLC.combined4;
IDSASDate2 = cats(of ID SASdate2);
drop kW_Ton tons age;
run;
Proc SQL;
  Create table OHDLC.Combined6 as
  Select *, Mean(kW) Label = "Hourly Average" as HourlykW
  From OHDLC.Combined5
  group by IDSasdate2;
Quit;
Data OHDLC.Combined7;
Set OHDLC.Combined6;
Drop kW kW_ton;
run;
Proc sort nodupkey data=OHDLC.Combined7;
by ID SasDate2;
run;
```

3.3.2 Program-Level Tracking Database

ADM received the following information on each program participant from the Companies including:

- Full Name
- Address
- Install Date
- Account Number
- System Size (Tons)
- System Type (Conventional, Package Unit, Heat Pump, 2-Stage Unit)
- Removal Date (If Applicable)

The following table provides a comparison of participation tonnage values and unit age for the program versus the sample. Any participant who requested a removal date before 7/17/2013 (The first called event) was removed from the enrolled participant count and the average tonnage calculation.

Table 3-3 Participation and Average Tonnage Summary

Company	Number of Installs	Number of Removals	Program Pop. Size	Average Tonnage (Program Pop.)	Average Tonnage (Sample)	P-Value For Tonnage Diff	Average Age (Program Pop.)	Average Age (Sample)	P-Value for Age Diff
CEI	10,338	229	10,109	2.92	2.82	0.10	13.5	12.67	0.31
OE	5,846	149	5,697	2.77	2.51	0.29	12.07	12.38	0.38
TE	1,364	31	1,333	2.69	2.83	0.37	13.34	16.13	0.00
Total	**17,548**	**409**	**17,139**	**2.81**	**2.69**	**0.24**	**12.64**	**13.72**	**0.10**

3.3.3 Weather Data

ADM compiled historical weather data from NOAA for each Company in Ohio from May 15th – Sept 30th for the following cities:

- Youngstown (OE)
- Cleveland (CEI)
- Toledo (TE)

3.4 Baseline Determination

ADM employed a regression-based baseline methodology to estimate the amount cooling demand that would have been observed had no load control event been called. $Ajustment\ factor = kW_{event\ day} - kW_{baseline}$ Regression analysis relies on historical information about customer loads and focuses on understanding the relationship between loads, or load impacts, during hours of interest and other predictor variables.

The Weather-Sensitive Model (WSM) is a regression model that describes the CAC unit's power (the dependent variable) as a response to outdoor temperature, humidity[4], time of day, and the previous hour's predicted usage. This is known as an auto-regressive model, in that the model is based upon previous observations of the dependent variable (kW usage). The WSM defines a relationship between outdoor ambient conditions and CAC kW that is piecewise continuous depending on the temperature range. This model will be specified for each hour of the day. It has two distinct ranges for each hour:

(1) Temperatures below the set-point (~70 degrees) should have minimal or no call for cooling.

[4] Weather data is specific to customer zip code. For details on the WSA, see PJMDOCS #621890.

(2) Temperatures above the set-point up to a certain temperature (~95 degrees) will be modeled by a linear regression with increasing power consumption at higher temperatures.

In order to calculate the demand reduction for each hour of a particular event, we calculate the model's predicted value and subtract the actual kW draw during that hour to determine the kW reduction value. The regression model is specified below:

$$Hourly\ kWh = \beta_0 + \beta_1 Lag1kWh + \beta_2 THI + \varepsilon$$

As a graphical illustration of the methodology Figure 1 through Figure 3 show how the WSM simulates the baseline usage during the 7/18/13 event for each of the EDCs, using the lower-usage group (less than 3.5 kW).

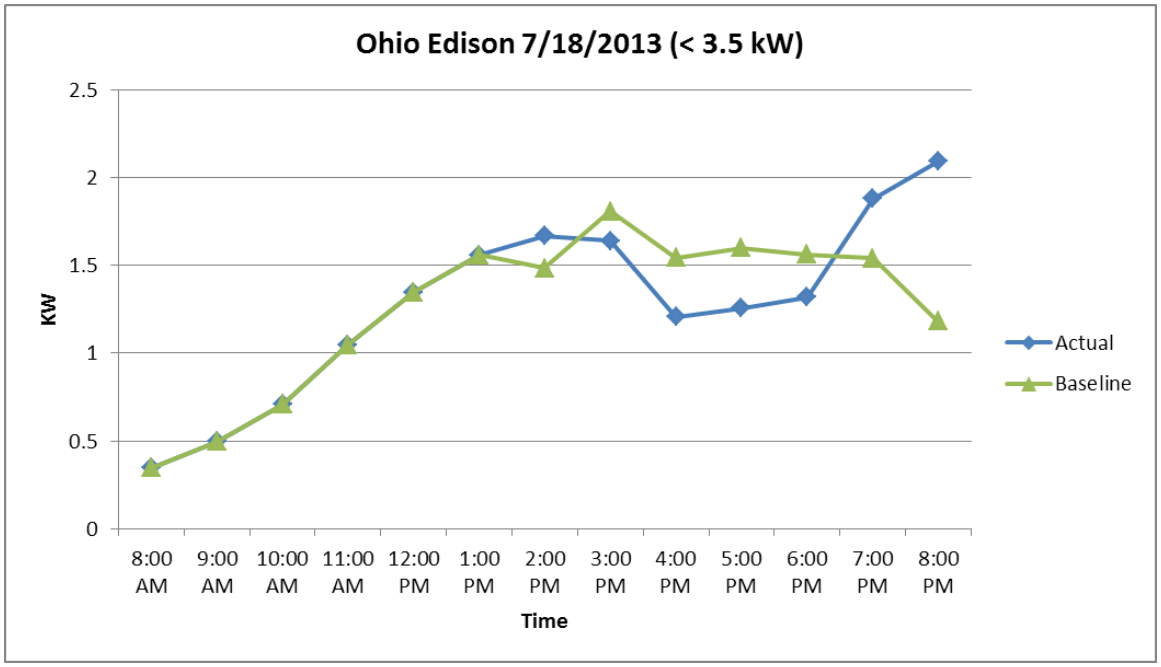

Figure 1: Ohio Edison Baseline and Actual Load Comparison

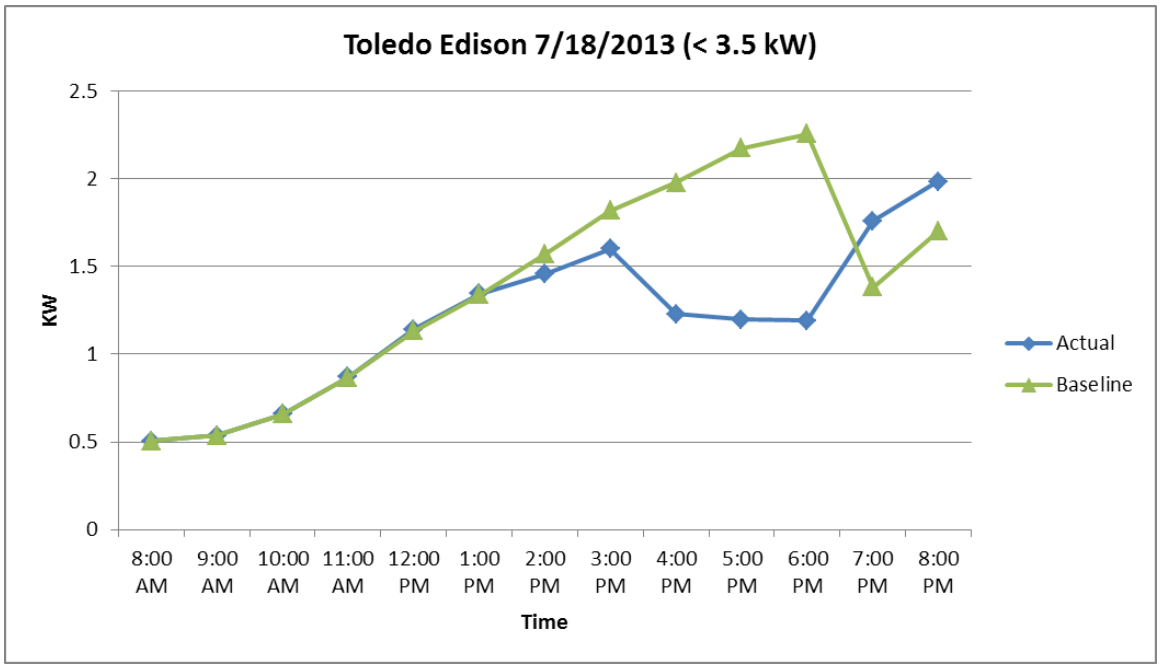

Figure 2: Toledo Edison Baseline and Actual Load Comparison

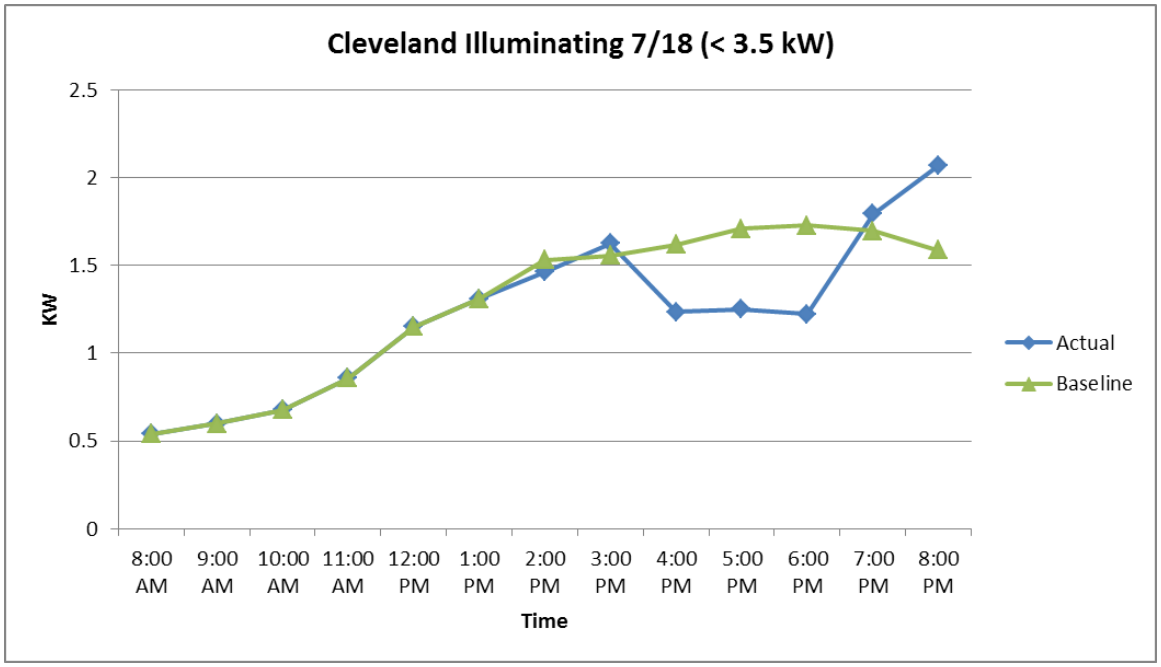

Figure 3: Cleveland Illuminating Co. Baseline and Actual Load Comparison

3.4.1 Error analysis of baseline method

To quantify the accuracy of the WSM, the relative root mean-squared error (RRMSE) was computed for the WSM when applied to non-event days.

$$RRMSE = \sqrt{\frac{1}{N}\sum_{t=1}^{N}\left(\frac{Baseline_t - Actual_t}{Actual_t}\right)^2}$$

Where N is the number of test hours, which are defined as the hours of 12-6 PM on-M&V event days, non-weekend and non-holiday. Because usage is bounded below by zero, test hours where actual usage was less than 0.5 kW were omitted to avoid division by small numbers in the calculation of the RRMSE.

These calculations were conducted individually by Operating Company and usage group (peak load above or below 3.5 kW). Before presenting the results of the comparison, each of the baseline methodologies will be explained in detail.

Table 3-4 RRMSE by Company and Usage Group

Company	*Regression model RRMSE*
CEI (< 3.5 kW)	15.97%
CEI (> 3.5 kW)	13.54%
OE (< 3.5 kW)	22.77%
OE (> 3.5 kW)	25.41%
TE (< 3.5 kW)	29.44%
TE (> 3.5 kW)	30.94%

3.5 kW Factors by Company

Using the regression baseline model specified in Section 3.4, ADM calculated hourly kW factors for the following event days:

(1) July 15th, 5 – 7 PM, 50% Cycling

(2) July 16th, 2 – 6 PM, 50% Cycling

(3) July 17th, 5 - 6 PM, 70% Cycling

(4) July 18th, 4 – 7 PM, 70% Cycling

(5) July 19th, 5 - 6 PM, 70% Cycling

(6) September 10th, 5 – 7 PM, 70% Cycling

(7) September 11th, 5 – 7 PM, 70% Cycling

The formula for calculating hourly kW factors is as follows:

$$kW\ Factor = Regression\ Baseline\ kWh - Actual\ Event\ kWh$$

3.6 Snapback Factor

It is commonly observed in the data that after the curtailment ends, AC usage rises to a level higher than observed in the same hour on baseline days. Even after applying the Offset Factor, there is a negative kW factor for these hours following curtailment, a factor

referred to as the Snapback Factor. Note that in general, snapback does not affect the program demand reductions since it occurs after the curtailment event. However, it is important to quantify snapback to better anticipate the magnitude and duration of kW increases immediately following the event, and also to inform energy savings calculations.

In determining Snapback Factor, the data for the one or two hours following curtailment were examined for residential and commercial participants depending on the length of the event. Based on analysis of indoor temperature data, ADM concluded that the Snapback Period lasts for at least two hours following a two-hour or longer curtailment event, in other words, two hours is the length of time required for indoor temperature to return to the pre-curtailment level.

In some cases, snapbacks were not observed, which may be due to weather conditions or the timing of the event's conclusion, and would have implied continued savings following the event. In such cases, the snapback is considered to be zero.

3.7 Energy Savings

Annual energy (kWh) savings for the 2013 DLC Program can be calculated as a function of kW reductions, Snapback, Total Devices, and the number and length of curtailment events. Energy savings for an individual event is calculated as:

$$kWh\ Savings = \sum_{j}^{M} \sum_{i}^{N} kW_{i,j} \times Total\ Devices_{i,j}$$

Where:

i = the event/snapback hour

j = the Company

$kW_{i,j}$ = the kW factor for Company *i* during hour *j*.

And M, N denote the total number of device populations (i.e. three, one for each Operating Company) and DR event hours, respectively. The quantity $kW_{i,j}$ is calculated for every event hour, every snapback hour, and every Company. All events are evaluated with a two-hour snapback period.

3.8 Process Evaluation Methodology

The process evaluation for the Direct Load Control program assessed the following program components to determine initial and post program implementation effectiveness:

- program awareness;

- participating customer characteristics;
- the customer participation experience;
- and customer satisfaction.

A detailed presentation of the process evaluation can be found in Appendix A.

4. Detailed Evaluation Findings

This chapter presents the results of the 2013 DLC Program, including kW factors, Snapback Factors, kWh Savings and process evaluation findings.

4.1 kW Factors and Snapback All Companies

The kW factors were calculated independently by Company as detailed in Chapter 3. Each set of kW factors are reported separately in the following six tables.

Table 4-1 OE Event kW Factors < 3.5kW

Date	*Event Hour 1*	*Event Hour 2*	*Event Hour 3*	*Event Hour 4*	*Snapback 1*	*Snapback 2*	*Max WTHI*
7/15/201	0.19	0.1	na	na			74.19
7/16/201	-0.07	0.28	0.55	0.61	0.48	-0.11	74.9
7/17/201	0.3	na	na	na			75.03
7/18/201	0.45	0.46	0.36	na	-0.17	-0.72	76.91
7/19/201	0.53	na	na	na	-0.08		77.29
9/10/201	0.41	0.72	na	na	-0.2	-0.6	81.31
9/11/201	0.41	0.77	na	na	0.07	-0.29	79.64

Table 4-2 OE Event kW Factors > 3.5kW

Date	*Event Hour 1*	*Event Hour 2*	*Event Hour 3*	*Event Hour 4*	*Snapback 1*	*Snapback 2*	*Max WTHI*
7/15/201	0.75	0.6	Na	na			74.19
7/16/201	0.5	1.13	1.77	1.73	1.28	-0.11	74.9
7/17/201	1.2	na	Na	na			75.03
7/18/201	1.81	1.66	1.44	na	0.13	-0.85	76.91
7/19/201	1.43	na	Na	na			77.29
9/10/201	1.15	1.12	Na	na	-0.53	-0.59	81.31
9/11/201	1.22	1.86	Na	na	0.1	-0.59	79.64

Table 4-3 CEI Event kW Factors < 3.5kW

Date	Event Hour 1	Event Hour 2	Event Hour 3	Event Hour 4	Snapback 1	Snapback 2	Max WTHI
7/15/2013	0.13	0.26	na	na			74.84
7/16/2013	0.08	0.09	0.17	0.21			74.87
7/17/2013	0.47	Na	na	na			74.89
7/18/2013	0.52	0.6	0.64	na	-0.03	-0.41	76.35
7/19/2013	0.65	Na	na	na			77.83
9/10/2013	0.52	0.88	na	na	0.07	-0.3	79.18
9/11/2013	0.58	0.98	na	na	0.2	-0.23	80.23

Table 4-4 CEI Event kW Factors > 3.5kW

Date	Event Hour 1	Event Hour 2	Event Hour 3	Event Hour 4	Snapback 1	Snapback 2	Max WTHI
7/15/2013	0.25	0.38	na	na			74.84
7/16/2013	0.24	0.24	0.07	-0.15			74.87
7/17/2013	0.89	Na	na	na			74.89
7/18/2013	0.82	0.91	0.98	na	-0.26	-1.18	76.35
7/19/2013	0.95	Na	na	na			77.83
9/10/2013	1.11	1.89	na	na	0.53	-0.74	79.18
9/11/2013	0.78	1.73	na	na	0.38	-0.14	80.23

Table 4-5 TE Event kW Factors < 3.5kW

Date	Event Hour 1	Event Hour 2	Event Hour 3	Event Hour 4	Snapback 1	Snapback 2	Max WTHI
7/15/2013	0.45	0.77	na	na			77.98
7/16/2013	0.3	0.34	0.44	0.61			78.36
7/17/2013	0.54	Na	na	na			77.98
7/18/2013	0.75	0.98	1.06	na	-0.38	-0.28	80.11
7/19/2013	0.67	Na	na	na	-0.21		78.94
9/10/2013	0.75	1.12	na	na	-0.48	-0.21	78.56
9/11/2013	0.6	1.11	na	na	-0.46	-0.07	79.17

Table 4-6 TE Event kW Factors > 3.5kW

Date	Event Hour 1	Event Hour 2	Event Hour 3	Event Hour 4	Snapback 1	Snapback 2	Max WTHI
7/15/2013	0.74	0.97	na	na			77.98
7/16/2013	0.3	0.51	0.86	1.33			78.36
7/17/2013	0.18	Na	na	na			77.98
7/18/2013	1.04	1.55	1.61	na	-0.64	-0.26	80.11
7/19/2013	0.93	Na	na	na	-0.18		78.94
9/10/2013	0.99	1.41	na	na	-0.97	-0.32	78.56
9/11/2013	1.65	1.89	na	na	-0.21	-0.05	79.17

In order to capture the impact of the DLC program during event hour, the kW factors for each EDC were aggregated and scaled up by the total number of active DLC devices in the field (17,139) measured as of July 15th, 2013. This value removes customers that had exited the program as of that date. These results are captured in *Table 4-7*.

Table 4-7 Hourly Load Impact All Companies in MW

Date	Event Hour 1	Event Hour 2	Event Hour 3	Event Hour 4	Snapback 1	Snapback 2	Max WTHI
7/15/2013	4.03	4.20	na	na			77.98
7/16/2013	0.91	4.90	8.52	9.34	5.77	-1.11	78.36
7/17/2013	7.68	Na	na	na			77.98
7/18/2013	10.31	11.04	10.24	na	-1.92	-7.80	80.11
7/19/2013	11.22	Na	na	na	-0.99		78.94
9/10/2013	9.38	14.94	na	na	-3.12	-6.35	78.56
9/11/2013	9.47	16.70	na	na	0.17	-3.37	79.17

4.2 MWh Savings

MWh Savings are calculated as the sum of the kW factors for each Company and event and snapback hour multiplied by quantity of devices in the field. Total program savings for the 2013 season are 108.64 MWh. Results per event are listed in Table 4-8 below.

Table 4-8 MWh Savings by Event

Date	kWh TE	kWh CEI	kWh OE	kWh Combined
7/15/2013	1.70	2.38	4.15	8.23
7/16/2013	2.45	3.04	22.83	28.32
7/17/2013	0.67	2.95	4.07	7.68
7/18/2013	3.02	10.64	8.22	21.88
7/19/2013	0.66	3.90	5.68	10.23
9/10/2013	1.56	9.01	4.28	14.85
9/11/2013	1.89	9.50	11.58	22.97
Total	**11.95**	**41.42**	**60.81**	**114.17**

4.3 Per-unit kW factors versus WTHI

In order to plan for future program years and determine how to improve the program it is important to note what factors may increase or decrease the kW factor during an event. Two main impact variables are time of day and Weighted Temperature-Humidity Index (WTHI[5]). In the following table, ADM presents the average kW factors by Hour and by WTHI bin, which can be interpreted as the results at a 60% cycling strategy. As expected the kW factors increase as the event stretches later in the day and as the temperature increases (higher WTHI). As a recommendation for higher kW factors in future program years, ADM suggests targeting later hours in the day when the temperature is highest.

Table 4-9 kW Factors by Hour, Temp Bin, and Cycling Strategy

	Load Study kW Factors (<3.5 kW)		**Load Study kW Factors (>3.5 kW)**	
	50% Cycling	*70% Cycling*	*50% Cycling*	*70% Cycling*
WTHI	**5PM**	**5PM**	**5PM**	**5PM**
76	0.22	0.42	0.77	0.40
77	0.31	0.54	0.81	0.46
78	0.38	0.66	0.85	0.51
79	0.46	0.78	0.88	0.57
80	0.55	0.90	0.90	0.63
80.6	0.59	0.97	0.92	0.69

4.4 Process Evaluation Findings

Below are the key findings from the Process Evaluation.

Direct mailings are the most effective method of marketing the program to potential participants. Over 70 percent of respondents indicated they first learned of the Easy Cool Rewards program through either a utility bill insert (45.8 percent) or a utility direct mailing (28.2 percent). While maybe not their first method of awareness, 64.3 percent of respondents recalled hearing about the program through a utility bill insert at some point.

[5] The THI and WTHI are explained in Appendix C.

Table 4-10. How Learned About Easy Cool Rewards Program

	The Illuminating Company (n=77)			Ohio Edison (n=80)			Toledo Edison (n=81)		
Response	*First*	*Else*	*Total*	*First*	*Else*	*Total*	*First*	*Else*	*Total*
Utility bill insert	46.8%	23.4%	70.1%	45.0%	26.3%	71.3%	45.7%	6.2%	51.9%
Utility direct mailing	28.6%	11.7%	40.3%	30.0%	11.3%	41.3%	25.9%	8.6%	34.6%
Word of mouth	3.9%	7.8%	11.7%	6.3%	5.0%	11.3%	7.4%	3.7%	11.1%
Telephone call	9.1%	0.0%	9.1%	7.5%	1.3%	8.8%	7.4%	3.7%	11.1%
Newspaper	3.9%	1.3%	5.2%	0.0%	3.8%	3.8%	0.0%	0.0%	0.0%
Utility website	1.3%	0.0%	1.3%	5.0%	2.5%	7.5%	3.7%	1.2%	4.9%
Other event (home and garden show, earth day)	1.3%	0.0%	1.3%	0.0%	1.3%	1.3%	0.0%	0.0%	0.0%
Other	1.3%	0.0%	1.3%	1.3%	2.5%	3.8%	2.5%	2.5%	4.9%
Radio advertisement	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Door hanger	0.0%	0.0%	0.0%	0.0%	1.3%	1.3%	0.0%	0.0%	0.0%

Customers prefer to receive information about this and other energy efficiency programs directly from the utility via bill insert or direct mail. Over half of all respondents indicated they prefer receiving information about programs similar to Easy Cool Rewards via utility bill inserts (52.5 percent), while 41.6 percent noted direct mail as a preferred method. Conversely, very few respondents want to learn about the Companies' energy efficiency programs through newspapers (1.3 percent).

The established methods of communication between the Companies' staff and Honeywell staff continue to work well. The Companies' staff noted that *"Honeywell has been fantastic in terms of everything they've done through this point to manage the program. I'm very pleased with the staff they have involved; their process and procedures, and their reports are very professional."* Additionally, the Companies' staff noted that there are no outstanding implementation issues with the 2013 Easy Cool Rewards program. Honeywell staff reiterated comments from 2013, noting that managers at the Companies and Honeywell continue to have an excellent working relationship.

Program participants expressed very high levels of satisfaction with the Companies' Easy Cool Rewards program. Participant satisfaction with the overall experience with the program was high across Operating Companies, ranging from 4.4 in CEI and TE territory to 4.5 in the OE service area (using a scale of 1 to 5, with 1 being very dissatisfied and 5 being very satisfied). Other program aspects such as the enrollment process, receipt and installation of the programmable thermostat as compensation for participation, and the service professional who installed the Easy Cool

Rewards device score equally high, ranging from average scores of 4.1 to 4.9 across Operating Companies.

Table 4-11. Mean Satisfaction with Specific Aspects of Easy Cool Rewards Program

Program Aspect	The Illuminating Company		Ohio Edison		Toledo Edison		Total	
	Avg	Std. Dev	Avg	Std. Dev	Avg	Std. Dev	Avg	Std. Dev
The service professional who installed the device	4.6	0.9	4.7	0.9	4.8	0.6	4.7	0.8
Receipt and installation of a new thermostat as compensation for participation in program	4.6	1.0	4.7	0.8	4.8	0.6	4.7	0.8
The enrollment process	4.6	0.8	4.6	0.9	4.6	0.8	4.6	0.8
Overall experience with program	4.4	1.0	4.5	1.0	4.4	1.1	4.4	1.1
The program information provided	4.3	1.0	4.3	1.1	4.2	1.1	4.3	1.1
Overall experience during energy reduction events	4.2	1.0	4.2	1.0	4.1	1.3	4.2	1.1

Current participants are likely to participate in the program in subsequent years. More than 85 percent of customers indicated their likelihood of participating in the Easy Cool Rewards program in future years was 8 or higher (using a scale of 1 to 10, with 1 being not at all likely and 10 being very likely). Additionally, 68.2 percent of respondents rated the likelihood at 10.

Table 4-12. Likelihood of Participating in Easy Cool Rewards Next Year

*Likelihood**	*The Illuminating Company (n=76)*	*Ohio Edison (n=79)*	*Toledo Edison (n=81)*	*Total (n=236)*
1	5.3%	5.1%	4.9%	5.1%
2	-	1.3%	-	0.4%
3	-	-	2.5%	0.8%
4	-	-	1.2%	0.4%
5	5.3%	2.5%	1.2%	3.0%
6	1.3%	2.5%	3.7%	2.5%
7	1.3%	3.8%	2.5%	2.5%
8	6.6%	6.3%	9.9%	7.6%
9	9.2%	10.1%	8.6%	9.3%
10	71.1%	68.4%	65.4%	68.2%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

*1=very unlikely; 10=very likely

Customers were extremely satisfied with the service they received when calling the toll-free number. While half of all respondents (n=119) were aware of the Companies' toll-free number for the Easy Cool Rewards program, only 17 respondents contacted the Companies' call center. Customers reported very high levels of satisfaction when calling the toll-free number, with 16 of 17 respondents indicating that their questions about enrollment were sufficiently answered.

Participants were uncertain about when energy reduction events occurred. In 2013, customers found it difficult to determine when the Companies called energy reduction events. Each of the Operating Companies called seven energy reduction events during the summer of 2013; however, only one survey respondent recalled experiencing seven events. Most respondents (54.2 percent) could not recall the number of events the Companies called during summer, while 18.0 percent of participants believe no energy reduction events occurred.

Table 4-13. Number of Energy Reduction Events Recall FirstEnergy Issuing this Past Summer

Number of Events	The Illuminating Company (n=74)	Ohio Edison (n=72)	Toledo Edison (n=81)	Total (n=227)
Don't know	48.6%	58.3%	55.6%	54.2%
0	25.7%	15.3%	13.6%	18.1%
1	4.1%	5.6%	6.2%	5.3%
2	2.7%	2.8%	6.2%	4.0%
3	4.1%	4.2%	6.2%	4.8%
4	2.7%	4.2%	4.9%	4.0%
5	2.7%	2.8%	4.9%	3.5%
6	1.4%	2.8%	0.0%	1.3%
7	1.4%	0.0%	0.0%	0.4%
10	1.4%	1.4%	0.0%	0.9%
12	1.4%	0.0%	1.2%	0.9%
20	1.4%	0.0%	0.0%	0.4%
40	1.4%	1.4%	0.0%	0.9%
100	1.4%	1.4%	1.2%	1.3%

5. Recommendations

Overall, the program appears to be functioning without major issues, a finding reiterated by a Honeywell staff member's statement that all three Operating Companies' programs had attrition rates of less than four percent. Interviewees reported that channels of communication between the Companies and Honeywell remained open and that meetings and telephone calls were productive throughout the program year. However, we provide the following recommendation for consideration.

Provide participating customers periodic reminders and updates regarding how the Companies will communicate when an energy reduction event will occur. Understanding when and how they will receive notification that an event is occurring was the single aspect of the program that participants found most difficult to understand. Providing additional information, perhaps utilizing more frequent online communication (e.g., email and/or instant messaging services), may improve customers' understanding of events and may also enhance customers' abilities to manage their comfort during events.

6. Appendix A: Required Savings Table

DLC program savings have a measure life of one year, which is the program year itself; in other words, savings do not persist beyond the 2013 calendar year.

Table 6-1. Required Savings Table

Utility	*Annual Ex Post Savings*		*Measure Life*	*Lifetime Ex Post Savings*	
	kWh	*kW*		*kWh*	*kW*
OE	55,278	5,499	1	55,278	5,499
CEI	41,419	2,761	1	41,419	2,761
TE	11,947	988	1	11,947	988
Total Program	108,643	9,248		108,643	9,248

7. Appendix B: Survey Instrument

FirstEnergy Ohio Edison, Cleveland Electric Illuminating, and Toledo Edison Companies Residential Direct Load Control Survey

Q1. Hello, my name is [INTERVIEWER NAME], and I am calling on behalf of [EDC]. May I speak with [RESPONDENT NAME]?

1. Yes [CONTINUE]
2. No [SCHEDULE CALLBACK AND/ OR ATTEMPT TO CONVERT]

Q2. I'm with ADM, an independent research firm. We have been hired to assist [EDC] with review of their energy savings services by speaking with households that have signed up to participate in the Easy Cool Rewards (Thermostat) program. You should have received a postcard a couple of days ago explaining the purpose of this call. I'm not selling anything; I'd just like to ask you some questions about your decision to sign up for the Easy Cool Rewards (Thermostat) program offered by [EDC]. I'd like to assure you that your responses will be kept confidential and your name will not be revealed to anyone other than the evaluation team members. For quality and training purposes this call will be recorded.

The Easy Cool Rewards (Thermostat) program helps [EDC] to save energy during peak demand periods. As a part of this program, your central air conditioning system is remotely controlled by [EDC] by increasing the temperature setting to reduce energy usage when [EDC] predicts that electricity demand will be high. Do you recall enrolling for this program?

1. Yes [SKIP TO Q5]
2. No

Q3. Is there someone else in the household who may be familiar with the program?

1. Yes [ASK TO SPEAK TO THEM AND RECYCLE TO Q1]
2. No [THANK AND TERMINATE]

[DISPLAY Q4 IF Q3 = 1]
Q4. May I speak to that person?

1. Yes [RECYCLE TO Q2]
2. No [THANK AND TERMINATE]

Q5. Are you an employee of [EDC] or FirstEnergy?

1. Yes [THANK AND TERMINATE]
2. No
98. Don't Know
99. Refused

1. How did you FIRST learn about Easy Cool Rewards (Thermostat) program offered by [EDC]? (Do not read list; Record response]
    1. Utility bill insert
    2. Utility direct mailing
    3. Telephone call from [EDC] telemarketer
    4. Utility website
    5. Radio advertising
    6. Newspaper
    7. Door hanger
    8. Word of mouth: Friend/ Relative/ Neighbor/ Co-worker
    9. Other event: Home and Garden show/ Earth day
    10. Easy Cool Rewards email
    97. Other (Specify)
    98. Don't know
    99. Refused

2. How would you prefer to receive information from [EDC] about programs like this in the future? (Do not read; select all that apply)
    1. Utility direct mailing such as a letter or postcard
    2. Telephone call from [EDC]
    3. Program website
    4. Email from [EDC]
    97. Other (Specify)
    98. Don't know
    99. Refused

3. For what reason or reasons did you decide to participate in the Easy Cool Rewards (Thermostat) program? (Do not read; Select all that apply)
    1. Concerned about saving energy in my home
    2. The opportunity to participate in an energy savings program
    3. Concerned about protecting the environment
    4. The program was recommended to me by [EDC]
    5. Reduce need for building new power plants
    6. Help [EDC] avoid power shortages (or brownouts or buying power at high prices)
    7. To get a new thermostat
    8. Not home when the AC is cycled
    97. Other (Specify)
    98. Don't know
    99. Refused

[DISPLAY Q5 IF > 1 SELECTED FOR Q4]

4. Of all the things that interested you about the program (Read list), what was the most compelling reason you decided to enroll in the program?
    1. Record verbatim response:
    98. Don't know
    99. Refused

5. Did you have concerns about participating in the Easy Cool Rewards (Thermostat) program?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q6 IF Q5 = 1]

6. What concerns did you have? (Do not read; Select all that apply)
    1. Concerned about being uncomfortable during energy reduction events
    2. Concerned about the load control device damaging my air conditioning equipment
    3. Concerned about the utility being able to shut off my AC
    97. Other (Specify)
    98. Don't know
    99. Refused

[DISPLAY Q7-Q13 FOR DROPOUTS ONLY]

7. On a scale of 1 to 10, where 1 is very difficult and 10 is very easy, how easy or difficult did you find it to…(Read list; Record 1-10; 6 = Not applicable, 98 = Don't know, 99 = Refused)
    a. Understand the program requirements
    b. Sign up to participate in the program
    c. Schedule an appointment to have the Easy Cool Rewards device installed
    d. Interact with the program staff
    e. Understand how to operate the new thermostat

[DISPLAY Q8 IF Q7a-Q7e = 1, 2, 3, or 4]

8. What could the program have done differently to make it easier for you to [INSERT A-E WORDING]?
    1. Record verbatim response:
    98. Don't know
    99. Refused

9. I understand that your household decided to participate and dropped out of the program. Can you tell me why that is? (Do not read; Prompt if needed)
    1. The temperature increase was/ would be uncomfortable
    2. Didn't want [EDC] to control my energy use
    3. Didn't understand how the program worked
    4. Did not understand the energy reduction events
    5. Didn't understand what the program was trying to accomplish
    6. Afraid it might damage my central air conditioner
    7. Didn't like the time periods when the energy reduction events would happen
    8. Didn't like the number of days a year when energy reduction events would occur
    9. Health reasons
    10. Problems with Easy Cool Rewards device installation (Specify)
    97. Other (Specify)
    98. Don't know
    99. Refused

10. What could the program have done differently to encourage you to remain in the program? (Do not read; Prompt if needed)
    1. Nothing they could have done
    2. Better explained the program
    3. Increase the amount of the incentive/payment for participating (Specify Amount)
    4. Shorter event days
    5. Reduced the amount by which the temperature was increased
    97. Other (Specify)
    98. Don't know
    99. Refused

[DISPLAY Q11 IF Q8 > 1 RESPONSE]

11. Of all the reasons you mentioned for deciding not to participate in the program, which reason was the most important?
    1. Record verbatim response:
    98. Don't know
    99. Refused

12. Now I would like to understand how your experience with Easy Cool Rewards (Thermostat) program has affected your satisfaction with [EDC] as your utility. Did it…(Read list)
    1. Greatly improve your satisfaction
    2. Somewhat improve your satisfaction
    3. Make no difference in your satisfaction
    4. Somewhat decrease your satisfaction
    5. Greatly decrease your satisfaction

13. Will you please tell me why you responded [RESPONSE FROM Q12]?
    1. Record verbatim response
    98. Don't know
    99. Refused

[DISPLAY Q14-Q22 FOR ENROLLED PARTICIPANTS ONLY]

14. Next, I would like to ask you some questions about your enrollment in the program. Thinking about the information you have received about participating in the program, on a scale of 1 to 10, where 1 is very difficult and 10 is very easy, how difficult or easy did you find it to…(Read list; Record 1-10; 6 = Not applicable, 98 = Don't know, 99 = Refused)
    a. Understand the program requirements
    b. Sign up to participate in the program
    c. Schedule an appointment to have the Easy Cool Rewards device installed
    d. Understand when and how you will be notified of an energy reduction event
    e. Understand what you can do to reduce your electricity use when energy reduction events are occurring
    f. Interact with the [EDC] staff during enrollment

[DISPLAY Q15 IF Q14a-14f = 1, 2, 3, or 4]

15. What could the program have done differently to make it easier for you to [INSERT A-F WORDING]?
    1. Record verbatim response:
    98. Don't know
    99. Refused

16. Have you called the Easy Cool Rewards (Thermostat) toll free number with any questions about enrollment?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q17 IF Q16 = 1]

17. Were your questions sufficiently answered?
    1. Yes
    2. No (Record verbatim response: What was not answered?)
    98. Don't know
    99. Refused

[DISPLAY Q18 IF Q16 = 2, 98, or 99]

18. Were you aware that there is a toll free number you can call with questions about the program?
    1. Yes
    2. No
    98. Don't know
    99. Refused

19. Did you have any initial questions about the participating in the program?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q20 IF Q19 = 1]

20. What questions or concerns did you have? (Do not read ; Prompt if needed)
    1. Didn't know how to reduce my energy consumption during energy reduction events
    2. Didn't understand how the program worked
    3. Didn't like the potential time periods when the energy reduction events would happen
    4. Problems with installation of Easy Cool Rewards device (Specify)
    97. Other (Specify)
    98. Don't know
    99. Refused

21. Can you tell me in your own words your understanding of what occurs during an energy reduction event? (Record verbatim response)

22. What information did you find helpful? (Do not read; Select all that apply)
    1. Information about savings periods/events
    2. Information about rebate
    3. Information about how to save and/or reduce energy usage during savings periods
    4. Information about how savings period/event notifications will be sent
    5. Information about what to do when notification is received
    6. Information about penalties
    7. Information about how savings are calculated
    8. Information about how savings will be communicated
    9. Information about what number to call if there are questions
    10. Information about how to opt out of events
    97. Other (Specify)
    98. Don't know
    99. Refused

Next I would like to ask you some questions about your experience during the energy reduction events that occurred during the summer.

23. How many reduction events do you think [EDC] issued this past summer?
    1. Number of days
    2. Never
    98. Don't know
    99. Refused

24. Were you at home during any of the energy reduction events?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q25 IF Q24 = 1]

25. How could you tell that [EDC] AC was cycling during an event?
    1. The house got uncomfortably warm
    2. I didn't hear the air conditioner run as often
    3. I looked at the thermostat and saw that the temperature had been increased
    4. I called [EDC] to see if they had adjusted the temperature
    5. I received a notification via my thermostat
    97. Other (Specify)
    98. Don't know
    99. Refused

26. Thinking about the events that occurred when you were home, on a scale of 1 to 10, where 1 is very uncomfortable and 10 is very comfortable, how uncomfortable or comfortable was it for you?
    1. Record 1-10:
    98. Don't know
    99. Refused

27. Were you aware that energy reduction events had occurred when you were not at home?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q28 IF Q27 = 1]

28. How did you know that energy reduction events had occurred when you were not home during the event?
    1. The house was uncomfortably warm when I returned home
    2. The air conditioning ran more than usual
    3. I called [EDC] to see if they had adjusted the temperature
    4. I received a notification via my thermostat
    97. Other (Specify)
    98. Don't know
    99. Refused

29. Have you called the Easy Cool Rewards (Thermostat) toll free number with any questions about energy reduction events?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q30 IF Q29 = 1]

30. Were your questions sufficiently answered?
    1. Yes
    2. No (Record verbatim response: What was not answered?)
    98. Don't know
    99. Refused

[DISPLAY Q31 IF Q28 = 4]

31. You mentioned in a previous question that you had called [EDC] to ask if an energy reduction event had occurred. Were your questions answered?
    1. Yes
    2. No
    98. Don't know
    99. Refused

32. On a scale of 1-5 where, Very dissatisfied = 1, Somewhat dissatisfied = 2, Neither satisfied nor dissatisfied = 3, Somewhat satisfied = 4, Very satisfied = 5, Don't know = 98, and Refused = 99, how unsatisfied or satisfied are you with…
    a. The enrollment process?
    b. The program provided?
    c. The service professional who installed the Easy Cool Rewards device?
    d. The receipt and installation of a new thermostat as compensation for your participation in the program?
    e. Your overall experience during energy reduction events?
    f. Your overall experience with the program?

[DISPLAY Q33 IF Q32a-Q32f = 1, 2, 3, or 4]

33. What can the program do differently to make you more satisfied with [INSERT A-F WORDING]? (Record verbatim response)

34. On a scale of 1 to 10, where 1 is not at all likely and 10 is very likely, how likely are you to participate in an Easy Cool Rewards (Thermostat) program in the future?
    1. Record 1-10:
    98. Don't know
    99. Refused

[DISPLAY Q35 IF Q34 = 1, 2, 3, or 4]

35. What can the program do differently to make you more likely to participate in the future?
    1. Record verbatim response:
    98. Don't know
    99. Refused

36. On a scale of 1 to 10, where 1 is not at all likely and 10 is very likely, how likely are you to participate in an Easy Cool Rewards (Thermostat) program in the future if [EDC] did not offer an incentive (i.e. a free thermostat) to participate?
    1. Record 1-10:
    98. Don't know
    99. Refused

37. What effect, if any, has the program had on how you will use energy in the future?
    1. Record verbatim response:
    98. Don't know
    99. Refused

38. Now I would like to understand how your experience with Easy Cool Rewards (Thermostat) program has affected your satisfaction with **[**EDC] as your utility. Did it… (Read list)
    1. Greatly improve your satisfaction with [EDC]
    2. Somewhat improve your satisfaction with [EDC]
    3. Make no difference in your satisfaction with [EDC]
    4. Somewhat decrease your satisfaction with [EDC]
    5. Greatly decrease your satisfaction with [EDC]

39. Will you please tell me why you responded [RESPONSE FROM Q38]
    1. Record verbatim response:
    98. Don't know

99. Refused

I would now like to ask you some questions about how you would like to receive information about your electricity use and updates about the program from [EDC].

40. Do you have internet access?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q41 IF Q40 = 1]
41. Have you ever visited [EDC] or FirstEnergy's website?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q42 IF Q41 = 1]
42. Have you ever used the [EDC] or FirstEnergy Home Energy Analyzer to assess your home energy usage?
    1. Yes
    2. No
    98. Don't know
    99. Refused

43. Are there other methods that [EDC] should consider using to provide feedback information about your performance during energy reduction events? (Do not read; Select all that apply)
    1. Text message
    2. Email
    3. Cell phone call
    4. Home phone call
    5. Mail
    6. In home display
    97. Other (Specify)
    98. Don't know
    99. Refused

44. Have you been to the [EDC] website to review the energy savings tips they provide online?
    1. Yes
    2. No
    98. Don't know
    99. Refused

[DISPLAY Q45 IF Q44 = 1]

45. Please rate the usefulness of the energy efficiency information provided on the website using a scale of 1 to 10, where 1 is "not at all useful" and 10 is "very useful".
    1. Record 1-10:
    98. Don't know
    99. Refused

46. What types of additional information would you like on the website?

Next, I want to better understand the types of energy using equipment you have in your home.

47. How many plasma TV's do you have?
    1. Record response:
    98. Don't know
    99. Refused

48. How many LCD/LED TV's do you have?
    1. Record response:
    98. Don't know
    99. Refused

49. How many conventional (tube-based) TV's do you have?
    1. Record response:
    98. Don't know
    99. Refused

50. How many projection TV's do you have?
    1. Record response:
    98. Don't know
    99. Refused

51. How many other TV's do you have?
    1. Record response:
    98. Don't know
    99. Refused

52. What type of stove do you have?
    1. Natural Gas
    2. Electric
    3. Propane
    97. Other (Specify)
    98. Don't know
    99. Refused

53. What type of water heater do you have?
    1. Natural Gas
    2. Electric
    3. Propane
    97. Other (Specify)
    98. Don't know
    99. Refused

54. What type of clothes dryer do you have?
    1. Natural Gas
    2. Electric
    3. Propane
    97. Other (Specify)
    98. Don't know
    99. Refused

55. Which of the following best describes your home/residence?
    1. Single-family home, detached construction (Not a duplex, townhome, or apartment; attached garage is ok)
    2. Single family home, factory manufactured/modular
    3. Single family, mobile home
    4. Row House
    5. Two or Three family attached residence—traditional structure
    6. Apartment (4 + families)---traditional structure
    7. Condominium---traditional structure
    97. Other (Specify)
    98. Don't know
    99. Refused

56. Do you own or rent this residence?
    1. Own
    2. Rent
    98. Don't know
    99. Refused

57. Approximately when was your home constructed? (Do not read list)
    1. Before 1960
    2. 1960-1969
    3. 1970-1979
    4. 1980-1989
    5. 1990-1999
    6. 2000-2005
    7. 2006 or later
    98. Don't know
    99. Refused

58. How many square feet is the above-ground living space (If necessary, this excludes walk-out basements)?
    1. Numerical open end (Range 0-99,999)_____
    98. Don't know
    99. Refused

[DISPLAY Q59 IF Q58 = 98 or 99]

59. Would you estimate the above-ground living space is about:
    1. Less than 1,000 sqft
    2. 1,001-2,000 sqft
    3. 2,001-3,000 sqft
    4. 3,001-4,000 sqft
    5. 4,001-5,000 sqft
    6. Greater than 5,000 sqft
    98. Don't know
    99. Refused

60. How many square feet of conditioned living space is below- ground (If necessary, this excludes walk-out basements)?
    1. Numerical open end (Range 0-99,999)_____
    98. Don't know
    99. Refused

[DISPLAY Q61 IF Q60 = 98 or 99]

61. Would you estimate the below-ground living space is about:?
    1. Less than 1,000 sqft
    2. 1,001-2,000 sqft
    3. 2,001-3,000 sqft
    4. 3,001-4,000 sqft
    5. 4,001-5,000 sqft
    6. Greater than 5,000 sqft
    98. Don't know
    99. Refused

62. What kind of air conditioning does your home have? (Select all that apply)
    1. Central Air Conditioning
    2. Heat Pump
    3. Window A/C (Number)
    4. None
    98. Don't know
    99. Refused

63. How many window A/C units does your home have?
    1. Record response:
    98. Don't know
    99. Refused

Finally, I would like to ask you a few questions to better understand your household.

64. How many years have you lived at your current address? (Do not read list)
    1. 1 year or less
    2. 2 to 5 years
    3. 6 to 9 years
    4. 10 to 20 years
    5. More than 20 years
    98. Don't know
    99. Refused

65. I'm going to read several age groups. Please stop me when I come to the group in which your age belongs. (Read list)
    1. Under 24
    2. 25 to 34
    3. 35 to 44
    4. 45 to 54
    5. 55 to 64
    6. 65 to 74
    7. 75 or over
    98. Don't know
    99. Refused

66. How many people were living in your home during the summer of 2012?
    1. Number of people:
    98. Don't know
    99. Refused

[DISPLAY Q67IF Q66 > 0]

67. On average, how many of these people were home during week during the hours of [Savings period] during the summer?
    1. Number of people:
    98. Don't know
    99. Refused

END: Thank you, those are all the questions I have for you today.

8. Appendix C: Temperature Humidity Index

For the cooling season (June, July, August, and September), Temperature-Humidity Index (THI) is used as the weather variable:

If DB ≥ 58, THI = DB - 0.55 * (1 – HUM) * (DB – 58)

If DB < 58, THI = DB

Where: THI = Temperature humidity index;

DB = Dry bulb temperature (°F),

HUM = Relative Humidity (where 100% = 1).

For shoulder months (March, April, May, October and November), the average daily dry bulb temperature serves as the weather variable.

The weighted temperature-humidity index (WTHI) is constructed by incorporating "lag terms" in the THI. The WTHI as calculated as:

$WTHI = 1/14 \times (10 \times THI_n + 3 \times THI_{(n-24)} + THI_{(n-48)})$

Where: THI_n = Temperature humidity index for hour *n.*

$THI_{(n-24)}$ = THI for hour *n-24* (same hour from the previous day)

$THI_{(n-48)}$ = THI for hour *n-48* (same hour from the previous day)