

Home Performance Program Evaluation, Measurement, and Verification Report 2015 Participants

Prepared for FirstEnergy Ohio Companies:

*Ohio Edison Company
The Cleveland Electric Illuminating Company
The Toledo Edison Company*

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1. Executive Summary

During 2014, The Cleveland Electric Illuminating Company (CEI), Ohio Edison (OE), and The Toledo Edison Company (TE) (collectively Companies) implemented the demand side management (DSM) Home Performance Program for the Companies' residential customers in their respective service territories.

Under contract with the Companies, ADM Associates, Inc. (ADM) performed evaluation, measurement and verification (EM&V) activities for the Home Performance Program. The procedures used to perform the EM&V activities described in this report were informed by the approved State of Ohio Energy Efficiency Technical Reference Manual ("TRM")¹ and ADM's previous experience performing EM&V activities for the Companies' DSM programs. In addition, the procedures chosen built on information collected during a project initiation meeting and succeeding discussions with Company staff.

The program was suspended in 2015 pursuant to the Companies filing and Commission approval of an amended Plan for the 2015-2016 program years.² In order to honor outstanding commitments to Home Performance Program participants from 2014, the Companies allowed participants to submit applications for 2014 rebates during the first quarter of 2015 (2015 Participants).

During 2015, ADM performed measurement and verification activities for the Home Performance Program 2015 participants. ADM conducted M&V activities for the subprograms of the Home Performance Program as outlined below:

- Audits
 - Comprehensive Audit and All Electric Homes Audit
 - Online Audits³
- Energy Efficiency Kits
 - Energy Conservation Kits (Standard and All Electric)
 - School Education Kits
- New Homes
- Behavioral Modification (Opower)

¹ Vermont Energy Investment Corporation (VEIC), *State of Ohio Energy Efficiency Technical Reference Manual*, Prepared for Public Utilities Commission of Ohio, Draft of August 6, 2010.

² See *In the Matter of the Application for Approval of Energy Efficiency and Peak Demand Reduction Program Portfolio Plans for 2013-2015*, Case Nos. 12-2190-EL-POR *et al.*, November 20, 2014 Finding and Order.

³ For Online Audits, no 2014 participants received online audits during PY2015; thus, ADM did not evaluate activity for the Online Audits component of the Audits subprogram during 2015.

This report describes the methodologies, procedures and data tracking systems utilized to conduct program evaluation activities, including data gathering, sampling and analysis methods.

1.1 Residential Energy Audit

The target market for the Residential Energy Audit (REA) is residential single-family homeowners. The REA subprogram provides residential customers a comprehensive home energy audit with air infiltration testing through the use of a blower door diagnostic test for improving the thermal integrity of the building envelope. The REA subprogram also evaluates home appliance, lighting and HVAC system efficiencies. In the REA subprogram, customers paid a fee of up to \$350 for the audit, and then submitted a rebate application form for up to \$250 once they had achieved a minimum of 350 kWh in energy savings. Customers could elect to have energy efficiency measures installed at the time of the audit and/or home improvement measures installed later by participating home improvement contractors.

In PY2014, the rebates for additional recommended measures changed from a specific dollar amount per measure to a specific dollar amount dependent upon kWh saved: with the addition of a bonus rebate of either \$100 for saving over 2,000 kWh or \$150 for saving at least 3,000 kWh.

The Companies contracted with Honeywell to be the Conservation Service Partner or Provider (CSP) to administer the REA subprogram.

The energy audit includes:

- An evaluation of the home's heating and cooling system, insulation levels, windows, doors, appliances, and lighting;
- A blower door diagnostic test to detect air leaks in the home's building envelope; and
- An energy audit report that recommends specific energy-saving measures appropriate for the home. Customers who choose to implement the recommended measures are entitled to rebates available from the Companies.

Energy efficiency measures that can be direct installed at the time of the home energy audit include:

- ENERGY STAR Compact Fluorescent Lamps (CFLs)
- LED Nightlights
- Low Flow Showerheads
- Energy Smart Strips
- Faucet Aerators (kitchens and bathrooms)
- Pipe Wrap insulation

- Furnace Whistles

Additional home improvement measures that may be recommended at the time a residential energy audit is performed include the following items:

- Roof and Ceiling Insulation
- Wall Insulation
- ENERGY STAR qualified Windows
- Duct Sealing
- Air Sealing
- HVAC Early Replacement

Participation by operating company is shown in Table 1-1 for the Companies' 20 customers that received rebates from the 2014 REA subprogram during 2015.⁴

Table 1-1: Residential Energy Audit Participation by Operating Company

<i>Operating Company</i>	<i>Participating Households</i>
CEI	7
OE	5
TE	8
2015 Total	20

The overall subprogram level verified gross kWh energy savings and kW peak demand reductions for the 2015 participants of the 2014 REA subprogram are summarized in Table 1-2.

⁴ Unique account numbers were used to determine the participant count.

Table 1-2: Residential Energy Audit Energy Impacts

Operating Company	Ex Ante kWh	Ex Ante kW	Ex Post kWh	Ex Post kW	kWh Realization Rate	kW Realization Rate
CEI	3,065	0.8	3,017	0.7	98%	88%
OE	2,997	0.3	2,963	0.4	99%	133%
TE	4,367	0.5	4,279	0.5	98%	100%
2015 Total	10,429	1.6	10,259	1.6	98%	100%

Table 1-2 yields a realization rate for kWh savings of approximately 98%, as determined by the ratio of verified gross kWh savings to expected gross kWh savings. The realization rate for kW reductions was 100%.

Taken together, the various types of CFLs directly installed through the REA subprogram accounted for 81% of the total verified kWh savings, rebated measures for 6%, and all other measures for the remaining 13%.

1.2 Energy Conservation Kits

During 2015, the Energy Conservation Kits subprogram delivered energy efficiency kits to the Companies' customers who had requested an energy conservation kit during 2014 and had not yet been shipped an energy conservation kit. During 2015, the Energy Conservation Kits subprogram delivered energy conservation kits requested through the following two distribution channels:

- Energy Conservation Kit Program
- Schools Education and Kit Program

Power Direct Energy implemented the Energy Conservation Kit Program with a target demographic of residential single-family homeowners. The Companies provided residential customers with an energy conservation kit containing energy saving products. The energy conservation kits were distributed through a direct mail distribution channel and consisted of the following components:

- ENERGY STAR Compact Fluorescent Lamps (CFLs)
- Smart Power Strips
- LED Night Lights
- Furnace Whistles
- Faucet Aerators (for customers with electric water heaters only)
- Low Flow Showerheads (for customers with electric water heaters only)

The Schools Education and Kit Program implemented by AM Conservation Group in collaboration with National Theatre Company (NTC) delivered "live performances" for students in kindergarten thru 5th grade to learn about energy conservation during 2014.

Students were supplied with a permission slip to receive a schools energy conservation kit. Students that returned the permission slip were sent through the mail a Schools Kit that consisted of the following components:

- ENERGY STAR Compact Fluorescent Lamps (CFLs)
- Faucet Aerators
- LED Night Light

The total number of kits distributed by the Companies during 2015 for the 2014 Energy Conservation Kits subprogram by type and operating company is shown in Table 1-6.⁵

Table 1-6: Count of Kit Types Delivered by Operating Company

Kit Type	Operating Company			
	CEI	OE	TE	Total
Electric	65	145	55	265
Standard	494	463	287	1,244
Schools	-	148	31	179
2015 Total	559	756	373	1,688

Ex post verified electric savings for the Energy Conservation Kits delivered during 2015 was 794,159 kWh annually (a realization rate of 112%). *Ex post* verified peak demand reduction was 88 kW. *Ex post* gross energy savings (kWh) and peak demand reduction (kW) for the 2015 participants of the 2014 Energy Conservation Kits subprogram in the three service territories are reported in Table 1-7.

Table 1-7: Energy Conservation Kits Energy Impacts

Operating Company	Ex Ante kWh	Ex Ante kW	Ex Post kWh	Ex Post kW	kWh Realization Rate	kW Realization Rate
CEI	248,149	26	278,012	31	112%	119%
OE	303,187	32	338,433	37	112%	116%
TE	158,846	17	177,714	20	112%	118%
2015 Total	710,181	75	794,159	88	112%	117%

1.3 New Homes

For 2015 Participants, the Companies provided incentives to home builders that construct their homes to be at least 15% better than the minimum building code standards (IECC 2009⁶) and receive ENERGY STAR® Version 3.0 certification. Eligibility was determined

⁵ Unique project numbers were used to tally the total number of kits distributed.

⁶ 2009 IECC and 2009 International Residential Code were incorporated into the Residential Code of Ohio effective January 1st, 2013.

by certified Home Energy Rating System (HERS) Raters in accordance with RESNET standards. Participants received a rebate based on the calculated energy savings related to the home's construction as reported on the FirstEnergy Ohio Report in REM/Rate software or similar. Rebates for appliances, lighting and other plug loads were aggregated within the Residential New Homes Program. The Companies contracted with Performance Systems Development (PSD) to provide supporting program components including builder recruiting, verification of building plans and documentation to qualify for the incentives, provision of on-site notification of receipt of award under the program, as well as for marketing and outreach services to the builder community.

A total of 119 homes in the Companies' service territories received rebates through the 2014 Residential New Homes Program in the first three months of 2015. The number of incentivized homes by operating company and completion year is shown in Table 1-8.⁷

Table 1-8: Participating Homes by Operating Company

Operating Company	2015 Participating Homes
CEI	49
OE	70
TE	0
All Companies	119

Between the three operating companies, 13 builders participated in the program and there were two new builders that participated during the first three months of 2015 that had not participated in the program during 2014. The number of participating builders by operating company is shown in Table 1-9.

Table 1-9: Builder Participation by Utility

Operating Company	Number of Builders Reported in 2015
CEI	5
OE	8
TE	0
All Companies	13

Ex post gross electric savings were determined through detailed analysis of program reporting and tracking data. ADM verified program savings through REM/Rate by

⁷ Unique project numbers were used to tally the total number of participating homes.

comparing the user-defined reference home as specified in the TRM to the as-built home model generated by the HERS rating company from plan sets and field data.

The total 2015 subprogram *ex post* verified electric savings was determined to be 270,147 kWh annually (a realization rate of 102%). *Ex post* verified peak demand reduction was 55 kW. *Ex post* gross energy savings (kWh) and peak demand reduction (kW) for the subprogram in the three service territories are reported in Table 1-10.

Table 1-10: New Homes Energy Impacts

Operating Company	Ex Ante Expected Gross Savings		Ex Post Verified Gross Savings		Realization Rates	
	kWh	kW	kWh	kW	kWh	kW
CEI	94,227	20	95,173	18	101%	90%
OE	171,394	41	174,973	37	102%	90%
TE	0	0	0	0	-	-
2015 Total	265,621	61	270,147	55	102%	90%

1.4 Behavioral Modification

The Companies had previously contracted with OPower during 2013 and 2014 to administer a Behavior Modification (Behavioral) Program targeted at residential customers. An impact evaluation was conducted to measure persistence of savings in 2015 associated with the previous efforts. The energy savings of the Behavioral program were examined using regression analysis of monthly billing data for customers who participated in the program and for a control sample of non-participants.

Participants in the 2013 Behavioral programs had received monthly usage reports which contained information about their energy use, compared the household's energy use to that of a group of similar households (both average and most efficient neighbors), and educated them on low-cost measures, practices or behaviors to reduce their energy use. Participants in the 2014 Behavioral programs were a subset of the 2013 participant group who continued to receive reports during 2014. The reports were delivered via the United States Postal Service with the option of also receiving the reports through e-mail.

Persistence savings were measured for a total of 61,612 customers who participated in the Behavioral program in 2013 (42,028) and 2014 (19,584). Table 1-11 below details participant counts by operating company.⁸

Table 1-11: Participation Levels for Behavioral Program by Utility

Utility Company	2013 Participants	2014 Participants
CEI	14,127	6,666
OE	23,265	9,460
TE	4,636	3,458
Total	42,028	19,584

As shown in Table 1-12, verified annualized ex post electric savings in 2015 were 12,246,299 kWh. The realization rate for electric savings was 90.4%. The realization rate equals the ratio of ex post annual savings from ADM to ex ante annual electricity savings from OPower in 2015 for participants in the previous years' Behavioral programs. Table 1-12 also shows that verified average demand reduction was 1,398 kW.

Table 1-12: Summary of Annualized Energy and Demand Savings in 2015 for 2014 Customers Impacts

	Ex Ante Savings		Ex Post Savings		Realization Rates	
	kWh	kW	kWh	kW	kWh	kW
Savings by Utility Company						
CEI	4,513,910	851	4,077,657	465	90%	55%
OE	7,546,586	1,194	6,335,877	723	84%	61%
TE	1,479,244	676	1,832,764	209	124%	31%
Total	13,539,740	2,721	12,246,299	1,398	90%	51%

⁸ Ex Ante participant counts provided by OPower in monthly savings summary sheet. Ex post participant counts based on billing data filtered as follows: Bills were grouped by a key consisting of the account and premise information and filtered to meet the following all requirements:

- First bill occurred prior to June 2012
- Last bill occurred after November 2015
- Count of bills received greater than 30 (this allows for up to approximately 10% to 20% of bills to be missing for a given account/premise)

2. Introduction and Purpose of Study

The purpose of this report is to present the results of the impact evaluation effort undertaken by ADM to verify the energy savings and peak demand reductions that resulted from the implementation of the Home Performance Program during 2015.

During 2015, ADM modified the scope of the M&V effort to reflect that the Companies' DSM activity during 2015 was intended to fulfill outstanding obligations from the 2014 DSM programs and not reflective of fully operating 2015 programs

2.1 Residential Energy Audit

The research questions for the REA subprogram are presented below:

- What are the energy savings and peak demand reduction impacts for the measures installed as a result of the energy audits and rebated retrofit jobs completed in response to audit recommendations?

2.2 Energy Conservation Kits

The research questions for the Efficiency Kits subprogram are presented below:

- How many kits were delivered during 2015?
- What are the total number of measures installed by customers and the location of installed lighting measures?
- How much energy savings can be attributed to the Program?
- How much peak demand reduction can be attributed to the Program?

2.3 New Homes

The impact evaluation component estimated gross energy savings (kWh) and peak demand reduction (kW) was framed by the following research questions:

- How many builders participated in the program and how many homes were constructed per plan type per builder?
- What was the correct baseline energy code for each permitted home?
- Do the sample homes modeled in the energy modeling software reflect the as-built homes in the field? Do they reflect the architectural details shown on the city approved plan set?
- What were the savings generated per model home for each sample home?

2.4 Behavioral

The impact evaluation component estimated energy savings (kWh) and peak demand reduction (kW) as framed by the following research questions.

- To what extent has the previous Behavioral Modification program resulted in electric energy savings for participating customers (compared to similar non-participating customers) in each of the three Ohio utilities, as measured by annualized reductions in kilowatt hours (kWh) per customer?

3. Program Description

This chapter presents a description of each of the subprograms in the Home Performance Program that had subprogram activity during 2015.

3.1 Residential Energy Audit

The REA subprogram, which was administered by Honeywell, had three main elements:

- Residential customers paid the full price of the audit (not to exceed \$350), then submitted a rebate application form for up to \$250 once they had achieved a minimum of 350 kWh in energy savings.
- At the time of the energy audit, several direct install measures were available at no additional charge to the customer.
- Also, energy auditors recommended additional, rebate eligible, improvements that could be installed by a participating home improvement contractor.

The energy audits were performed by contractors certified through the Building Performance Institute (BPI). The audit service included the following:

- Evaluation of the home's heating and cooling system, insulation, windows, doors, appliances, and lighting;
- Diagnostic testing with a blower door to detect air leaks in the home's building envelope; and
- Providing an energy audit report that recommends energy-saving projects and measures appropriate to the home.

As part of an audit, the auditor could install, for no additional charge, several types of measures. These direct install measures included:

- ENERGY STAR® compact fluorescent lamps (CFLs).
- Water reduction measures (low flow showerheads, faucet aerators)
- Pipe rap insulation
- LED night lights
- Furnace whistle
- Smart power strip

In addition, energy auditors might also recommend other measures to improve energy efficiency that could be installed by a participating home improvement contractor. The Companies offered rebates for having the following types of measures installed by a contractor:

- Attic insulation
- Wall insulation
- Duct sealing
- Air sealing

- ENERGY STAR qualified windows
- Early replacement of HVAC equipment

3.2 Energy Conservation Kits

The Energy Conservation Kit Program provides the Companies' customers with energy efficiency measures and educational materials to encourage residential energy usage reduction. The target market for the Program is residential single-family homeowners.

Kits are provided to customers upon request, and the contents of kits vary slightly depending on the customers' water heating fuel source. Participants receive measure descriptions and installation guidelines with their kits, and are able to choose which measures to install. The conservation kits also contain educational materials regarding residential energy saving behaviors, which encourage kit recipients to further reduce their electricity usage.

The Energy Conservation Kit Program requires customers to request kits via the electronic application on the Ohio Energy Kit website or by calling a toll-free telephone number. The Companies verify that the prospective participant is a customer of one of the participating EDCs, and that they have not already received a kit during the program year. Kits are typically shipped to customers within a few weeks of the request date. The conservation kits include a help line telephone number that allows participants to report measure defects or ask questions regarding the program and specific measures.

Energy Conservation Kits

Energy conservation kits requested from the Companies and distributed by Power Direct included the following energy saving measures:

- 23W CFL
- 20W CFL
- 13W CFLs
- 3-Way CFL
- Globe CFL
- LED night lights
- Furnace whistle
- Energy smart strip
- Faucet aerators (for customers with electric water heaters only)
- Low flow showerhead (for customers with electric water heaters only)

School Education Kits

The School Education and Kit Program provide an opportunity for parents or guardians of students in grades kindergarten thru 5th grade to request an Energy Conservation Kit

after the school has participated in the program. The program includes a 25-minute performance on energy conservation and corresponding curriculum for the classroom. Parents are able to request a kit through an electronic application on the Student Energy Kit website or request a kit through permission slip with their teacher. Kits are shipped to the student's homes within a few weeks of the request.

School education kits included the following energy saving measures:

- 13W CFLs
- 18W CFL
- Faucet aerators
- LED night light

3.3 New Homes

The New Homes subprogram encourages the building of energy efficient homes for increased comfort, enhanced energy performance and savings, and increased marketability of the home. Homes must meet third-party verification standards for energy efficiency to qualify for incentives. A full remodel of an existing home (gutting the home down to the studs) also qualifies under this program.

The Companies offer rebates for builders of new, energy efficient homes. Each newly built home is eligible for a rebate of \$400, plus an additional \$0.10/kWh saved over the reference home, as calculated by the modeling software, REM/Rate. The ENERGY STAR® rating or equivalent Home Energy Rating System Program (HERS) score is used to determine eligibility. Participants can receive a rebate based on the calculated energy savings related to the home's construction as reported on the "fuel summary report" or similar modeling software output. Qualifying homes will be built to ENERGY STAR® Version 3.0 requirements, be at least 15 percent more efficient than the 2009 IECC, and be located within the service areas of one of the Companies.

Builders will typically bring a rater in during the design phase of the building. It is here where the rater would suggest modifications to become ENERGY STAR Version 3.0 compliant. Some raters will present more than one proposal for builders to choose from, outlining different upgrades and the potential savings they would achieve. This is effective for an incentive-based program because builders can essentially choose their investment and corresponding incentive amount. All of the raters we spoke with said they actively promote the program to builders.

Once a building has been completed, a certified HERS rater will conduct a blower-door test and other visual checks to determine whether or not it meets the requirements of the program. If so, the rater submits the results in Performance Systems Development's (PSD) COMPASS software and uploads the REM/Rate results.

After submission by raters, the PSD QA manager reviews 100 percent of the entries using pre-programmed mathematical checks in the system to catch any simple data entry errors, such as a wall not being documented. Once approved by the QA manager, arrangements are made for an on-site QA check. Ten percent of all submissions will require an on-site QA—8 percent will receive a full comprehensive review with a blower-door test and other mechanisms, and 2 percent consist of only a visual review, ensuring the correct number of bulbs is installed, the right equipment models are reported, etc. Similar to last year, there were no issues reported by builders or raters regarding the onsite QA process.

If the calculated savings between the raters' reports and the QA's results are within a 15 percent difference, the rating is accepted and a check is issued to the builder. If the savings difference is greater than 15 percent or PSD's QA review results in a failed rating, PSD will go back to the rater and either have them correct the rating or give them the opportunity to work with the builder to become compliant.

In addition to paying cash incentives, this program also represents a market transformation program, aimed at reducing multiple barriers to this higher level of construction standards. Builders can attend training sessions which highlight the improved energy performance of the homes, promote the program, and communicate the associated benefits of buying a program-qualified home. The following are examples of the types of training opportunities that are provided:

- Sales staff training sessions on how to use the program and energy efficiency as a strong selling point
- Technical training sessions on building to program specifications and energy-efficient construction practices

Program participation is contingent upon an internal eligibility review and verification process conducted by PSD. This process provides a first layer of assurance to the Companies and the participating builders that the homes will meet program specifications and be at least 15% more efficient than required by code (IECC 2009). The first level of quality control is implemented through HERS (Home Energy Rating System) Raters who implement the RESNET (Residential Energy Services Network) testing processes and procedures or the equivalent. All participating builders must meet the quality control requirements of the approved HERS Providers including the use of certified HERS Raters to perform inspections of the home during construction and just prior to occupancy. The second level of quality control involves plan reviews for each plan type and for all participants. The plan review is conducted by PSD. All participating homebuilders are assigned an Account Manager to help them maximize their benefits from participation and leverage available incentives and opportunities for market differentiation.

3.4 Behavioral Modification

The Companies contracted with OPower in the prior program years to administer a behavioral based program targeted at residential customers. The Behavioral program is designed to generate greater awareness of energy use and of how to manage energy use through energy efficiency education in the form of Home Energy Reports (HERs). The program provided customers with information about their energy use, compared the household's energy use to that of a group of similar households (both average and most efficient neighbors), and educated them on low-cost measures, practices or behaviors to reduce their energy use. It was expected that through this education, customers implemented measures or adopted practices that lead to more efficiency energy use in their homes.

4. Methodology

This chapter provides a description of the methodology applied by ADM in the evaluation of the Home Performance Program activity during 2015. ADM did not undertake any process evaluation tasks related to the 2015 program activity and savings that were reported during 2015.

4.1 Residential Energy Audit Impact Evaluation Methodology

ADM used an evaluation audit strategy in performing an impact evaluation of the program. The audit strategy involved four major activities:

- Ex ante review
- Performing impact analysis calculations using the TRM algorithms

Using the audit strategy, ADM estimated energy savings and demand reduction for each program measure using the TRM algorithms with data obtained from the program's tracking database and augmented as necessary from site visits, surveys, and contractor job invoices. The evaluation audit strategy is discussed in more detail in the following sections.

Ex Ante Review

During 2015, Honeywell provided all necessary data points required for energy savings calculation per the algorithms in the TRM in a supplemental data set. The list below outlines the necessary data provided by Honeywell.

Insulation Improvement

- Baseline R-value of the pre-existing ceiling and/or wall insulation
- New R-value after ceiling or wall insulation has been added
- Square footage of insulated area
- SEER of Air Conditioning equipment
- COP of Heat Pump

Window Retrofits

- Average U factor value of the windows installed (manually verified by Honeywell)
- Number of ENERGY STAR windows installed
- Square footage of the windows installed

Water Measures

- GPM ratings of installed aerators and showerheads
- R-Value of pipe wrap installed

- Verification of water heater as electric or gas

The Companies provided the tracking system data for the program and Honeywell provided the additional technical information required to verify savings. ADM reviewed these data sets and performed data cleaning for the measures reported in the first quarter of 2015. The data cleaning steps were as follows:

- Verification of rebate status as completed
- Verification of measure rebate requirements (e.g. ENERGY STAR qualified windows) for completed rebate applications
- Identification of duplicate data entries
- Identification of cases with incomplete data (e.g. no model number provided)

As part of the ex ante data review, ADM compared the per unit ex ante estimates of kWh savings and kW reduction that were reported for the 2015 participants to the ex ante estimates of kWh savings and kW reduction for that were reported during 2014. ADM determined there was not a substantial difference between the distribution of measures or ex ante savings reported in 2015 and those reported in 2014. Table 4-1 shows the average kWh and kW savings reported for REA measures during 2014 and in the first quarter of 2015.

Table 4-1: Ex Ante Estimates of per Unit Annual kWh Savings and kW Reduction for Home Energy Audit

Measure	kWh	kw
12/22/33W 3-way CFL	64	0.008
13W CFL (60 watt equivalent)	38	0.005
14W Globe CFL	45	0.005
20W CFL (75 watt equivalent)	59	0.007
25W CFL (100 watt equivalent)	67	0.008
7W Candelabra CFL	23	0.003
9W Candelabra CFL	29	0.005
LED Nightlight	26	0.000
Smart Power Strips	59	0.006
Kitchen Aerator	31	0.004
Bath Aerator	53	0.007
Low Flow Showerhead	194	0.025
Pipe Insulation	22	0.003
Furnace Whistle	149	0.000
Attic Insulation*	126	0.060
Wall Insulation*	100	0.051
ENERGY STAR Windows*	233	0.103
Air Sealing*	23	0.026
Duct Sealing*	0.01	0.000
*Due to the many variables involved in the savings calculations, the values presented are the average savings per site.		

Sampling Plan

The sampling plan for site visits by operating company for the REA subprogram is shown in Table 4-2 through Table 4-4. To determine the sampling necessary to verify savings reported for 2015 participants, ADM added the 2015 ex ante data to the sampling plan that was created for the 2014 REA evaluation. ADM then recalculated precision for the totality of 2014 participants. No additional sites were required during 2015 to meet precision and sampling requirements; however, ADM completed four site visits and 2 telephone interviews.

Table 4-2: Sampling Plan for CEI

Strata	Count of kWh (annual)	Minimum kWh	Average kWh (annual)	Maximum kWh	Sum of Ex Ante kWh	Standard Deviation, Annual kWh	CV	Uncertainty	Sample
CEI1	29	4	56	95	1,638	30	0.527	847.48	2
CEI2	134	105	190	297	25,492	50	0.261	6,721.70	2
CEI3	67	304	550	946	36,858	171	0.311	9,314.06	3
CEI4	27	1,037	1,458	1,866	39,378	220	0.151	5,814.23	2
CEI5	15	2,051	2,540	3,153	38,105	330	0.130	4,685.91	2
Total									11
Precision at 90% confidence interval:									9.70

Table 4-3: Sampling Plan for OE

Strata	Count of kWh (annual)	Minimum kWh	Average kWh (annual)	Maximum kWh	Sum of Ex Ante kWh	Standard Deviation, Annual kWh	CV	Uncertainty	Sample
OE1	62	3	56	99	3,475	28	0.501	1,742.79	2
OE2	102	101	186	299	18,993	53	0.287	4,458.46	3
OE3	96	306	514	786	49,352	132	0.257	10,385.70	3
OE4	43	800	1,229	2,288	52,851	439	0.357	9,398.37	7
OE5	13	2,526	4,039	5,523	52,503	1,076	0.266	8,378.54	4
Total									19
Precision at 90% confidence interval:									9.60

Table 4-4: Sampling Plan for TE

Strata	Count of kWh (annual)	Minimum kWh	Average kWh (annual)	Maximum kWh	Sum of Ex Ante kWh	Standard Deviation, Annual kWh	CV	Uncertainty	Sample
TE1	25	2	44	94	1,099	30	0.694	744.65	2
TE2	53	102	179	290	9,502	50	0.280	2,656.75	2
TE3	43	302	468	985	20,141	151	0.322	3,231.94	7
TE4	10	1,062	1,719	2,220	17,191	476	0.277	3,313.04	3
TE5	3	2,631	3,296	4,589	9,889	1,120	0.340	1,974.57	2
Total									16
Precision at 90% confidence interval:									9.92

Impact Analysis Methods

Senate Bill 310 (SB 310), passed in 2014, states that the following count toward compliance requirements:

Energy efficiency savings and peak demand reduction achieved on and after the effective date of S.B. 310 of the 130th general assembly shall be measured on the higher of an as found or deemed basis, except that, solely at the option of the electric distribution utility, such savings and reduction achieved since 2006 may also be measured using this method.

The incremental savings resulting from using the existing equipment as the baseline were calculated for the program activity during the first quarter of 2015. The existing equipment baselines were taken from the Ohio TRM. Some measure baselines have been adjusted as applicable based on the savings provisions of Ohio Senate Bill 310 and are reflected in the sections below.

For measures installed through the REA subprogram, total energy (kWh) savings and total peak demand (kW) reduction for that measure were determined as a function of the number of measures verified as being installed and the energy savings determined per measure. The algorithms utilized by ADM to determine total energy savings and total peak demand reduction are reviewed in this section for the following measures:

- CFLs categorized by type and wattage
- Kitchen and bathroom faucet aerators
- Low flow showerheads
- Pipe wrap
- Attic and wall insulation
- Duct sealing
- Air sealing
- ENERGY STAR qualified windows

The calculation of energy savings for the following measures which were also included in the REA subprogram are reviewed in 4.2.1 of this report:

- Furnace whistles
- LED nightlights
- Energy smart strips

The data elements needed to verify per-unit savings for the program's energy audit measures, as described below, were either obtained from Honeywell's tracking database or the Companies' reporting database.

Compact Fluorescent Lamps (CFL)

Energy and demand savings for CFLs were calculated using the TRM algorithms for residential direct installation of ENERGY STAR CFLs using an early replacement scenario.⁹

Equation 1: CFLs Calculation of Annual Energy Savings

$$\text{kWh Savings} = (\Delta\text{Watt}/1,000) * \text{ISR} * \text{Hours} * \text{WHFe}$$

Where:

$\Delta\text{Watts for CFLs} = \text{CFL watts} * \text{delta watts multiplier};$

$\text{CFL watts} = \text{wattage of installed CFL, as verified}$

$\text{Delta watts multiplier (factor to account for baseline conditions)}$

$= 3.25 \text{ (from TRM)}$

$\text{ISR} = \text{In Service Rate}$

$= .81 \text{ (From TRM)}$

$\text{Hours} = \text{Average hours of use per year}$

$= 1040 \text{ (From TRM)}$

$\text{WHFe} = \text{Waste Heat Factor for energy}$

$= 1.07 \text{ (From TRM)}^{10}$

Equation 2: CFL Calculation of Summer Coincident Peak Demand Savings

$$\Delta\text{kW} = ((\Delta\text{Watts})/1000) * \text{ISR} * \text{WHFd} * \text{CF}$$

⁹ 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 17-21.

¹⁰ Parameter to account for effects on heating/cooling from efficient lighting

The delta watts multiplier utilized for calculating energy savings is the same as that used for calculating demand savings.

Where:

WHFd = Waste Heat Factor for Demand¹¹

= 1.21

CF = Summer Peak Coincidence Factor

= 0.11

Smart Power Strips

Energy and demand savings for are deemed based on the plug size (5-plug or 7-plug) of the smart strip. Table 4-5 shows the deemed savings values specified in the TRM (p. 76).

Table 4-5: Deemed Savings Values for Smart Strips

<i>Plug Size</i>	<i>Annual kWh Savings per Unit</i>	<i>Peak Demand kW Reduction per Unit</i>
5-Plug	56.5	0.0063
7-Plug	102.8	0.012

Low Flow Showerheads

Energy and demand savings for low flow showerheads were calculated using the TRM algorithms for residential low flow showerheads in which the Program intends for auditors to implement a direct installation/early replacement¹² policy. Only savings pertaining to electric hot water heating were calculated.

Equation 3: Low Flow Showerheads Calculation of Annual Energy Savings

$$\Delta kWh = ISR * (GPM_{base} - GPM_{low}) * kWh/GPM_{reduced}$$

Where:

ISR = verified In Service Rate as verified by ADM onsite visits and surveys.¹³

GPM_{base} = Gallons per minute of baseline showerhead

¹¹ Parameter to account for cooling savings from efficient lighting

¹² 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 93-96.

¹³ Assumed value is 1.0, based on direct install Program policy.

$$= 2.87 \text{ (From TRM)}^{14}$$

$$\text{GPM}_{\text{low}} = \text{Gallons per minute of low flow showerhead}^{15}$$

$$\text{kWh/GPM}_{\text{reduced}} = \text{Assumed kWh savings per GPM reduction}^{16}$$

$$= 173$$

Equation 4: Low Flow Showerheads Calculation of Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh / \text{Hours} * CF$$

Where:

$$\text{Hours} = 29$$

$$CF = \text{Summer Peak Coincidence Factor}$$

$$= 0.00371$$

Faucet Aerators

Energy and demand savings for faucet aerators were calculated using the TRM algorithms for residential low flow faucet aerators in which the program intends for auditors to directly install.¹⁷ Only savings pertaining to electric hot water heating were calculated. The auditor may install aerators for either kitchen or bathroom faucets, or both.

Equation 5: Faucet Aerators Calculation of Annual Energy Savings

$$\Delta kWh = \text{ISR} * (((\text{GPM}_{\text{base}} - \text{GPM}_{\text{low}}) / \text{GPM}_{\text{base}}) * \# \text{ people} * \text{gals/day} * \text{days/year} * \text{DR}) / \text{F/home}) * 8.3 * (\text{T}_{\text{ft}} - \text{T}_{\text{mains}}) / 1,000,000 / \text{DHW Recovery Efficiency} / 0.003412$$

Where:

$$\text{ISR} = \text{verified In Service Rate as verified by ADM onsite visits and surveys.}^{18}$$

$$\text{GPM}_{\text{base}} = \text{Gallons per minute of baseline faucet}$$

$$= 2.2^{19}$$

Ohio TRM for a baseline standard showerhead; see footnote 236 on p. 93 of the Ohio TRM.

¹⁵ This rate was captured by ADM through install verification visits and participant surveys.

¹⁶ Ohio TRM with VEIC replies to Joint utility comments

¹⁷ 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 89-92.

¹⁸ Assumed value is 1.0, based on direct install Program policy.

¹⁹ Ohio TRM; see footnote 227 on p.90 of the Ohio TRM.

GPM_{low} = Gallons per minute²⁰ of low flow faucet²¹
 # people = Average number of people per household
 = 2.46²²
 Gals/day = Average gallons per person per day used by all faucets in the home = 10.9²³
 Days/year = 365
 DR = Percentage of water flowing down the drain
 = 63%²⁴
 F/home = Average number of faucets in the home
 = 3.5²⁵
 8.3 = Constant to convert gallons to pounds
 T_{ft} = Assumed temperature of the water used by faucet
 = 80²⁶
 T_{mains} = Assumed temperature of water entering house
 = 57.8²⁷
 DHW Recovery Efficiency = Recovery efficiency of electric hot water heater
 = 0.98
 0.003412 = Constant to convert MMBtu to kWh

Equation 6: Faucet Aerators Calculation of Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh / \text{Hours} * CF$$

Where:

$$\text{Hours} = 21$$

²⁰ This rate was captured by ADM through install verification visits and participant surveys.

²¹ Assumed value is 1.5 for kitchen faucets and 1.0 for bathroom faucets, based on Program installation policy.

²² Ohio TRM; see footnote 228 on p.90 of the Ohio TRM.

²³ Ohio TRM; see footnote 229 on p.90 of the Ohio TRM.

²⁴ If water is collected in a sink, a faucet aerator will not result in any saved water.

²⁵ Ohio TRM; see footnote 231 on p.90 of the Ohio TRM.

²⁶ Ohio TRM; see footnote 232 on p.90 of the Ohio TRM.

²⁷ Ohio TRM; see footnote 233 on p.90 of the Ohio TRM.

CF = Summer Peak Coincidence Factor
= 0.00262

Pipe Wrap

Energy and demand savings for adding insulation to un-insulated domestic hot water pipes were calculated using the TRM algorithms for domestic hot water pipe insulation in which the program intends for auditors to directly install.²⁸ Only savings pertaining to electric hot water heating were calculated. Care was taken to insure that savings are not over reported due to interactive effects.

Equation 7: Pipe Wrap Calculation of Annual Energy Savings

$$\Delta kWh = (1/R_{exist} - 1/R_{new}) * (L * C) * \Delta T * 8,760 / \eta_{DHW} / 3413$$

Where:

R_{exist} = R-value of un-insulated pipe =
1.0²⁹

R_{new} = R-value of hot water pipe after being wrapped with insulation.

L = Length of pipe wrapped by insulation from water heater up to the first elbow

C = Circumference of pipe wrapped by insulation in feet

ΔT = 65° F ³⁰

8,760 = Number of hours in a year.

η_{DHW} = Recovery efficiency of electric hot water heater
= 0.98³¹

3,413 = Conversion from Btu to kWh.

Equation 8: Pipe Wrap Calculation of Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh / 8760$$

Where:

²⁸ 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 97-99.

²⁹ See Ohio TRM, p. 97, footnote 250.

³⁰ Average temperature difference between supplied water and outside air temperature = (see Ohio TRM, p. 97, footnote 251).

³¹ See Ohio TRM, p.97, footnote 252.

ΔkWh = Savings from pipe wrap installation
8760 = Number of hours in a year

Insulation

Energy and demand savings for improving the insulation of attics, ceilings, and walls were calculated using a single set of algorithms in the TRM that apply equally to retrofitting the insulation in attics, roofs, ceilings, and walls.³² Savings were calculated for both cooling and heating if an electric heat pump is used by the customer. The program accomplishes domestic insulation retrofits through participating home improvement contractors hired by customers who decide to implement recommendations made by the home energy auditors.

Equation 9: Insulation Calculation of Annual Energy Savings

$$\Delta kWh = ((1/R_{exist} - 1/R_{new}) * CDH * DUA * Area / 1000 / \eta_{Cool}$$

Where:

R_{exist} = R-value of baseline insulation
 R_{new} = R-value of improved insulation
CDH = Cooling Degree Hours
DUA = Discretionary Use Adjustment³³
Area = Square footage of insulated area
 η_{Cool} = SEER of air conditioning equipment

Equation 10: Insulation Calculation of Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh / FLH_{cool} * CF$$

Where:

FLH_{cool} = Full load cooling hours³⁴
CF = 0.5³⁵

³² 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 36-39 and pp. 100-103.

³³ This is a parameter to account for the fact that people do not always operate air conditioning systems when the outside temperature is greater than 75° F = 0.75 (see Ohio TRM, p. 37, footnote 74).

³⁴ This is a location dependent variable which depends on customer's location (defined by zip code) and corresponding FLH value in look-up table.

³⁵ See Ohio TRM, p. 38, footnote 76.

Equation 11: Insulation Calculation of Annual Energy Savings for Electric Heating

$$\Delta\text{kWh} = ((1/R_{\text{exist}} - 1/R_{\text{new}}) * \text{HDD} * 24 * \text{Area}/1000/\eta_{\text{Heat}}$$

Where:

HDD = Heating Degree Days³⁶

η_{Heat} = COP of electric heating equipment (resistance or heat pump)

Duct Sealing

Energy and demand savings for duct sealing retrofits will be calculated using Evaluation of Distribution Efficiency algorithms in the Ohio TRM.³⁷ Savings will be calculated for cooling and electric heating (resistance or heat pump). The subprogram accomplishes duct sealing retrofits through home improvement (market) contractors hired by customers who decide to implement recommendations made by the Honeywell auditors.

Equation 12: Duct Sealing (Air Conditioning) Calculation of Energy Savings

$$\Delta\text{kWh} = ((\text{CFM50}_{\text{DLbefore}} - \text{CFM50}_{\text{DLafter}}) * 60 * \text{CDH} * \text{DUA} * 0.018/1000/\eta_{\text{Cool}}$$

Where:

- $\text{CFM50}_{\text{DLbefore}}$ = baseline blower door test results³⁸
- $\text{CFM50}_{\text{DLafter}}$ = blower door test results after duct sealing³⁹
- 60 = Constant to convert cubic feet per minute to cubic feet per hour
- CDH = Cooling Degree Hours⁴⁰
- DUA = Discretionary Use Adjustment⁴¹
- 0.018 = The volumetric heat capacity of air (Btu/ft³ °F) invoices
- η_{Cool} = SEER of air conditioning equipment⁴²

³⁶ This is a location dependent variable which depends on customer's location (defined by zip code) and corresponding HDD value in look-up table.

³⁷ 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 108-114.

³⁸ Based on ADM review of contractor invoices

³⁹ Ibid.

⁴⁰ This is a location dependent variable which depends on customer's location (defined by zip code) and corresponding CDD value in look-up table.

⁴¹ This is a parameter to account for the fact that people do not always operate air conditioning systems when the outside temperature is greater than 75° F = 0.75 (see Ohio TRM, p. 37, footnote 74).

⁴² Based on ADM review of contractor invoices

Equation 13: Duct Sealing (Air Conditioning) Calculation of Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh / FLH_{cool} * CF$$

Where:

- FLH_{cool} = Full load cooling hours⁴³
- CF = 0.5⁴⁴

Equation 14: Duct Sealing (Air Conditioning) Calculation of Energy Savings for Electric Heating

$$\Delta kWh = ((CFM50_{DLbefore} - CFM50_{DLafter}) * 60 * 24 * HDD * 0.018 / 1000 / \eta_{Heat}$$

Where:

- $CFM50_{DLbefore}$ = as previously defined.
- $CFM50_{DLafter}$ = as previously defined.
- HDD = as previously defined.
- η_{Heat} = Coefficient of Performance of heating equipment⁴⁵

Air Sealing

Energy and demand savings for air sealing retrofits will be calculated using Evaluation of Distribution Efficiency algorithms in the Ohio TRM.⁴⁶ Savings will be calculated for cooling and electric heating (resistance or heat pump). The subprogram accomplishes air sealing retrofits through home improvement (market) contractors hired by customers who decide to implement recommendations made by the Honeywell auditors.

Equation 15: Air Sealing Calculation of Energy Savings

$$\Delta kWh = (((CFM50_{Exist} - CFM50_{New}) / N\text{-factor}) * 60 * CDH * DUA * 0.018 / 1000 / \eta_{Cool}$$

Where:

- $CFM50_{Exist}$ = baseline blower door test results⁴⁷
- $CFM50_{New}$ = blower door test results after duct sealing⁴⁸

⁴³ As previously defined

⁴⁴ See Ohio TRM, p. 112, footnote 282.

⁴⁵ Based on ADM review of contractor invoices.

⁴⁶ 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 104-107.

⁴⁷ Based on ADM review of contractor invoices

⁴⁸ Ibid.

- N-factor = Conversion factor to convert 50-pascal air flows to natural airflow
= 29.4
- 60 = Constant to convert cubic feet per minute to cubic feet per hour
- CDH = Cooling Degree Hours⁴⁹
- DUA = Discretionary Use Adjustment⁵⁰
- 0.018 = The volumetric heat capacity of air (Btu/ft³ °F) invoices
- η_{Cool} = SEER of air conditioning equipment⁵¹

Equation 16: Air Sealing Calculation of Summer Coincident Peak Demand Savings

$$\Delta kW = \Delta kWh / FLH_{cool} * CF$$

Where:

- FLH_{cool} = Full load cooling hours⁵²
- CF = 0.5

Equation 17: Air Sealing Calculation of Energy Savings for Electric Heating

$$\Delta kWh = ((CFM50_{Exist} - CFM50_{Exist}) * 60 * 24 * HDD * 0.018 / 1000 / \eta_{Heat}$$

Where:

- CFM50_{Exist} = as previously defined.
- CFM50_{Exist} = as previously defined.
- HDD = as previously defined.
- η_{Heat} = Coefficient of Performance of heating equipment⁵³

ENERGY STAR Windows

Energy and demand savings for the purchase of ENERGY STAR windows were calculated using a deemed savings approach, as specified in the TRM for electric heating

⁴⁹ This is a location dependent variable which depends on customer's location (defined by zip code) and corresponding CDD value in look-up table.

⁵⁰ This is a parameter to account for the fact that people do not always operate air conditioning systems when the outside temperature is greater than 75° F = 0.75 (see Ohio TRM, p. 37, footnote 74).

⁵¹ Based on ADM review of contractor invoices.

⁵² As previously defined

⁵³ Based on ADM review of contractor invoices.

and cooling savings.⁵⁴ The TRM specifies that all deemed savings values for ENERGY STAR windows are per 100 square feet of windows and depends on the type of heating and cooling equipment in the home, as shown in Table 4-6.

Table 4-6: Deemed Savings Values for ENERGY STAR Qualified Windows

Type of Energy Savings	Average Annual kWh Savings (per 100 square feet of ENERGY STAR windows)	Average Summer Coincident Peak kW Savings (per 100 square feet of ENERGY STAR windows)
Heating Savings (Electric Resistance)	302	NA
Heating Savings (Heat Pump)	237	NA
Cooling Savings (Central AC)	126	0.063

ADM visited a sample of customer homes to verify that the windows installed were ENERGY STAR qualified and met U factor requirements for Ohio’s northern climate zone. Energy and demand savings for ENERGY STAR qualified windows were computed as the product of the deemed savings values associated with the heating and cooling equipment in the home and the square footage of ENERGY STAR windows installed.

Impact Analysis Summary

Table 4-7 summarizes the impact analysis approach and relevant evaluation question to be determined for each energy savings audit measure.

Table 4-7: Impact Analysis Summary of Impact Evaluation Questions and Methods

Evaluation Question	Data Collection Methods	Data Analysis Method
Energy savings per rebated audit measure?	Desk review; customer survey; on-site visits; tracking database.	TRM algorithms
Demand savings per rebated audit measure?	Desk review; customer survey; on-site visits; tracking database.	TRM algorithms

⁵⁴ 2010 Ohio Technical Reference Manual, August 6, 2010. Vermont Energy Investment Corporation, pp. 115-117.

4.2 Energy Conservation Kits

4.2.1 Impact Evaluation Methodology

The impact evaluation strategy was identical for Energy Conservation Kits and School Education Kits. Three major activities were performed in the evaluation of the Energy Conservation Kits subprogram:

- Ex ante review of program data
- Participant survey to determine measure specific in-service rates
- Performing impact analysis calculations using measure specific TRM algorithms

Ex Ante Review

During the 2014 evaluation of the Energy Conservation Kits subprogram, the Companies' sent ADM a spreadsheet that showed each of the distribution of Energy Conservation Kits and their components. During the 2015 evaluation, ADM verified with the Energy Conservation Kits project manager there was not a substantial difference in the distribution of kit types, the measures included in the kits, and the ex ante savings values assigned between the kits reported in 2014 and those reported in 2015.

ADM audited a census of the energy conservation kits data and found the data to be adequate for impact evaluation. The average ex ante estimates of kWh savings and kW reduction for the Energy Conservation Kits and the School Education Kits are shown in Table 4-8. The table displays average ex ante savings values across kits delivered in 2014 and those kits requested in 2014 delivered in the first quarter of 2015.

Table 4-8: Ex Ante Estimates of per Unit Average Annual kWh Savings and kW Reduction per Kit Type

Kit Type	Ex Ante kWh	Ex Ante kW
<u>CEI</u>		
Electric	621	0.063
Standard	546	0.056
Schools	188	0.022
<u>OE</u>		
Electric	626	0.063
Standard	559	0.057
Schools	172	0.021
<u>TE</u>		
Electric	571	0.058
Standard	467	0.048
Schools	168	0.021

The measures distributed in each kit and the source of the method utilized by ADM to determine energy and demand savings are presented in Table 4-9 and Table 4-10.

Table 4-9: Lighting Measures Distributed by Kit Type

Kit Type	13W CFL	18W CFL	20W CFL	23W or 26W CFL	3 Way CFL	9W or 11W Globe CFL
Electric	4 or 5	-	1 or 2	1 or 3	0 or 1	0 or 1
Standard	4 or 5	-	1 or 2	1 or 3	0 or 1	0 or 1
Schools	3	1	-	-	-	-
Source for Analysis Method	Ohio TRM	Ohio TRM	Ohio TRM	Ohio TRM	Ohio TRM	Ohio TRM

Table 4-10: Non-Lighting Measures Distributed by Kit Type

Kit Type	Smart Power Strip	LED Night Lights	Furnace Whistle	Aerators	Showerhead
Electric	1	2 or 3	1	2	1
Standard	1	2 or 3	1	-	-
Schools Kits	-	1	-	2	-
Source for Analysis Method	Ohio TRM	Pennsylvania TRM	Pennsylvania TRM	Ohio TRM	Ohio TRM

Customer Survey and Sampling Plan

To verify delivery of energy conservation kits and to determine measure level in-service rates, ADM collected data through a telephone survey implemented by VuPoint Research. ADM analyzed the survey data and through comparison to the ISRs that were verified during the 2014 subprogram evaluation determined that there was no substantial difference in measure level ISRs for customers whom were sent an Energy Conservation Kit or School Education Kit during 2014 and customers whom were sent a kit during 2015.

Energy Conservation Kits

In 2015, ADM delivered a survey to customers who received an energy conservation kit during the first quarter of 2015. The sampling plan for the 2015 energy conservation kit survey effort is shown in Table 4-11; the sample was drawn at random from participants from each EDC pooled together.

Table 4-11: Sampling Plan for Survey of 2015 Energy Conservation Kits Recipients

Utility Company	Sampling Proportion	Sample Size (Completes)
CEI, OE, TE	1.0	n=70

School Education Kits

To verify delivery of School Education Kits in 2015, School Education Kits participants were delivered a survey by VuPoint Research; the sampling plan for the 2015 school education kits survey effort is shown in Table 4-12.

Table 4-12: Sampling Plan for Survey of 2015 School Education Kits Recipients

Utility Company	Sampling Proportion	Sample Size (Completes)
Sampling Plan for 2014 Kits Distributed in 2015		
OE, TE	1.00	n=20

Impact Analysis Methods

For each energy conservation kit measure installed in 2015, total energy (kWh) savings and total peak demand (kW) reduction for that measure were determined as a product of the number of measures verified as being installed and the savings estimated per measure. ADM used the algorithms specified in the Ohio TRM or as revised based on recommendations contained in the Ohio TRM Joint Utility Comments and approved by

the Vermont Energy Investment Corporation. In the case of furnace whistles and LED nightlights, the TRM does not specify an algorithm; the savings for these measures were calculated according to industry best practices. The calculations for the following measures are reviewed in previous sections of this plan:

- CFLs
- Kitchen and bathroom faucet aerators
- Low flow showerheads

The calculations for measures not previously specified in this document are presented here.

Furnace Whistles

The TRM does not specify an algorithm for furnace whistles, so energy savings were calculated using the Pennsylvania TRM algorithm as follows:⁵⁵

Equation 18: Furnace Whistle Calculation of Energy Savings

$$\Delta kWh = MkW \times EFLH \times EI \times ISR$$

Where:

- | | |
|------|--|
| MkW | = Average motor full load electric demand (kW)
= 0.5 kW |
| EFLH | = Estimated Full Load Hours (Heating and Cooling) ⁵⁶
= Will be taken from Ohio TRM |
| EI | = Efficiency Improvement
= 15% |
| ISR | = In-service Rate ⁵⁷ |

According to the PA TRM, there are no measureable peak demand savings attributed to furnace whistles.

LED Nightlights

The TRM does not specify an algorithm for LED night lights, so energy savings were calculated using the Pennsylvania TRM (PA TRM) algorithm as follows:

Equation 19: LED Nightlights Calculation of Energy Savings

⁵⁵ Pennsylvania Public Utility Commission, *Technical Reference Manual*, June 2013

⁵⁶ This is a location dependent variable which depends on customer's location (defined by zip code) and corresponding EFLH value in look-up table.

⁵⁷ This rate was captured by ADM through participant surveys.

$$\Delta\text{kWh} = ((\text{Watts}_{\text{base}} - \text{Watts}_{\text{NL}}) \times (\text{NL}_{\text{hours}} \times 365)) / 1000 \times \text{ISR}$$

Where:

Wattsbase = Wattage of baseline nightlight

WattsNL = Wattage of LED nightlight

NLhours = Average hours of use per day per Nightlight

ISR = In-service rate

According to the PA TRM, there are no measureable peak demand savings attributed to LED night lights.

Seven Plug Smart Power Strips

The energy savings for seven plug smart power strips are deemed in the TRM as 102.8 kWh per year.⁵⁸

Equation 20: Smart Power Strip Calculation of Summer Coincident Demand Savings

$$\Delta\text{kW} = \text{kWh/Hours} \times \text{CF}$$

Where:

Hours = Annual number of hours during which the controlled standby loads are turned off by the Smart Power Strip.

CF = Summer Peak Coincidence Factor for measure
=0.8

4.3 New Homes

4.3.1 Impact Evaluation Methodology

The M&V approach for the Residential New Homes subprogram included:

- Determining quantity of homes in population by builder
- Performing engineering calculations and desk reviews of energy modeling data

The impact evaluation component in 2015 estimated gross energy savings (kWh) and peak demand reduction (kW) as framed by the following research questions:

- How many builders participated in the program and how many homes were constructed per builder?

⁵⁸ Deemed value for seven plug smart power strips based on NYSERDA measure characterization for advanced power strips.

- Do the sample homes modeled in the energy modeling software reflect the as-built homes in the field?
- What were the savings generated per home for each sample home?

Data Collection and Sampling Plan

The first aspect of conducting measurements of program activity was to verify the number of homes participating in the program. Our verification work was based on using program tracking data. To begin the verification effort, we reviewed the tracking system data on reported homes to determine that all homes were eligible for the program. Additionally, the tracking system was reviewed to ensure that the proper data fields required to support this evaluation as well as future evaluations were included. The tracking system was reviewed for completeness, accuracy, and efficiency.

To determine the number of sites to sample for 2015 participants, ADM added the Residential New Homes ex ante savings data reported during 2015 to the sampling plan that was created for the 2014 Residential New Homes evaluation. ADM then recalculated precision for the totality of 2014 participants. Table 4-12 below shows the stratified sampling plan based on ex ante data reported during 2014 and 2015. During 2015, ADM completed the evaluation of six homes in addition to the homes that were sampled for the 2014 evaluation to meet statistical precision requirements.

Table 4-12: New Homes Energy Impacts by Strata

Strata	Ex Ante Total (kWh)	Ex Ante Sampled (kWh)	Sites Included in Sample
CEI			
CEI 1	253,897	17,765	7
CEI 2	189,045	11,916	4
CEI 3	147,011	12,720	5
OE			
OE 1	653,298	24,480	9
OE 2	346,141	7,455	3
OE 3	68,339	7,080	7
OE 4	347,210	5,353	3
OE 5	353,906	34,149	6
OE 6	17,313	17,313	1
OE 7	23,398	23,398	1
TE			
TE	123,294	19,365	10
Program Totals	2,522,852	180,994	56

Engineering Review

For homes that were selected to be included in the M&V sample, ADM first reran each of the provided models to reproduce the *ex ante* savings estimates. This step served as an initial check to evaluate potential reasons for discrepancy between the *ex ante* and *ex post* savings (i.e. data entry error or variant models). All *ex post* savings were calculated using the same version of REM/Rate as the *ex ante* estimates (version 14.3, 14.4.1, or 14.5.1).

ADM used either data provided or data collected during field visits during the 2014 evaluation to determine if the REM/Rate models accurately represented that of the incentivized homes. Each of the builders was also interviewed with regards to construction practices and material selection. Then, ADM leveraged the data collected from visits to partially constructed homes to verify that the construction techniques and materials being modeled were appropriate. ADM then verified each home's orientation using satellite mapping techniques and/or on-site verification.⁵⁹ Finally, ADM verified the builder provided lighting and appliances by interviewing home builders and home owners over the phone.

Gross Savings Estimates

The performance of each prototype home was verified by obtaining the original electronic data file from the builder's simulation software and updating it to match the as-built conditions observed during the on-site data collection and monitoring visit. To account for natural variation in building orientation and to verify major equipment efficiencies of the homes, a simple random sample from the tracking system data was taken. An on-site verification of this sample determined if the home was constructed or not, if it is occupied or not, and the home's actual cardinal orientation. While on-site during 2014, ADM also verified heating fuel type and outside unit air conditioner/heat pump efficiency. Updates to the prototype REM/Rate models may have included:

- HVAC systems (capacity and efficiencies)
- Window square footage
- Duct leakage
- House infiltration
- Actual window orientations
- Efficient Appliances, lighting, appliance, and other plug loads

The energy savings and demand reductions for any energy efficiency components not incorporated into the comprehensive building simulation model, and any measures

⁵⁹ With respect to the four Cardinal points (North, South, East, and West)

installed through the other residential rebate programs, were determined based upon the methods outlined in those programs.

ADM used the REM/Rate “Fuel Summary” report to evaluate both the as-built and baseline simulated home’s annual energy use. An example of this report is given in Figure 4-1.

Figure 4-1: Example REM/Rate Fuel Summary Report

FUEL SUMMARY			
Date:	November 24, 2008	Rating No.:	2437
Building Name:	1202	Rating Org.:	Energy Inspectors
Owner's Name:		Phone No.:	(702)365-8080
Property:	Newcastle	Rater's Name:	
Address:	Las Vegas, NV	Rater's No.:	
Builder's Name:	American West Homes	Rating Type:	Based on Plans
Weather Site:	Las Vegas, NV	Rating Date:	9/2/08
File Name:	Plan 1202 ES Base.blg		
1202			
Annual Energy Cost (\$/yr)			
Natural gas	\$	397	
Electric	\$	1110	
Annual End-Use Cost (\$/yr)			
Heating	\$	251	
Cooling	\$	584	
Water Heating	\$	116	
Lights & Appliances	\$	556	
Photovoltaics	\$	-0	
Service Charges	\$	156	
Total	\$	1663	
Annual End-Use Consumption			
Heating (Therms)		326	
Heating (kWh)		428	
Cooling (kWh)		6614	
Water Heating (Therms)		177	
Lights & Appliances (Therms)		104	
Lights & Appliances (kWh)		5514	
Annual Energy Demands (kW)			
Heating		0.2	
Cooling		3.4	

REM/Rate calculates simulated energy use on an annual basis (not hourly) and reports maximum peak demand reduction instead of coincident peak demand. Therefore, ADM used the methodology defined in the TRM to calculate coincident peak demand reduction. Per the TRM, the coincident peak demand is calculated by multiplying the maximum demand reduction by 0.5.

4.4 Behavioral

The primary impact question addressed in the 2015 evaluation was:

- To what extent has the previous Behavioral Modification program resulted in electric energy savings for participating customers (compared to similar non-participating customers) in each of the three Ohio utilities, as measured by annualized reductions in kilowatt hours (kWh) per customer?

4.4.1 Impact Evaluation Methodology

Analysis of the impact of the Behavioral Modification program on energy savings was conducted using regression analysis of billing data. The main objective of the analysis was to quantify the impact of program participation on energy consumption, after controlling for the effects of weather and other factors.

To determine the savings resulting from the Behavioral program, a “difference in differences” method was used for the analysis, consistent with prior year evaluations.

With a “difference in differences” method, changes in energy use for customers receiving HERs are compared to changes in energy use for customers in a comparison group who did not participate in the program, with both groups being compared against a baseline “pre” period occurring prior to the participants’ receipt of their first energy usage report.

This quasi-experiment utilizes a randomized control trial. The Companies targeted high energy users⁶⁰ as the target population for the Behavioral Modification program. After the initial target population was selected, OPower randomly allocated (in a manner that is not related to usage patterns, geography, house size, etc.) each household into either the treatment (household receives HER) or the control group (household receives no communication from OPower). This method creates two groups that are statistically equivalent, except for one group’s receipt of HERs.

The changes in energy use for different groups were determined using the results from regression analysis of the energy usage data for the treatment and control groups. ADM used regression analysis to estimate the amounts of electricity used and to quantify the impacts of receiving an energy usage report on energy consumption after controlling for the effects of weather and other factors. The regression analysis isolated and quantified the effects of different factors on the changes in energy usage.

⁶⁰ It is important to note that the targeting of high-use customers in the treatment and control groups in this program will produce savings estimates that apply only to similarly high-use customers. The savings of lower-usage customers will not be seen in the same proportion as exists in the full customer population.

Because of the large size of the dataset, the idiosyncrasies of electricity usage among households, and the limited number of independent variables available (mainly weather-related variables), inference on the effect of HERs is noisy, but robust, given the large size of the sample. Because this principle holds regardless of model complexity, a parsimonious (i.e. using a minimal number of variables) model was selected to estimate the effect of HERs on the treatment group. The following linear model was used to fit the data:

Equation 21: Behavioral Management Base Regression Model

$$kWh_{i,t} = a_1 \cdot CCD_{i,t} + a_2 \cdot HDD_{i,t} + a_3 \cdot post_{i,t} + a_4 \cdot treat_i + a_5 \cdot treat_i \times post_{i,t} + \epsilon_{i,t}.$$

Where, i indexes individual accounts, and $t = 1, \dots, T(i)$ is a time index, denoting the distinct bills originating from that account. The terms in the model are

- $kWh_{i,t}$, which is the total consumption (billing_usage) divided by the number of days in the billing period (billing_duration), to normalize the bills to the average daily usage during the billing period.
- $CDD_{i,t}$ and $HDD_{i,t}$, which is the average number of cooling degree days (base 75) and heating degree days (base 64), respectively, during the billing period, as measured at a local weather station (KAKR for OE, KCLE for CEI, and KTOL for TE).
- $post_{i,t}$, which is an indicator variable, equal to 1 when the bill is received after the date listed in first_generated_date, and 0 otherwise (this field is also defined for accounts in the control group, and signifies when their treatment group counterparts begin receiving HERs). The value of a_3 is an estimate of the average change in usage (for both treatment and control groups) between the pre-HER and post-HER periods. This change is assumed to be independent of the effect of the HERs themselves.
- $treat_i$, which is an indicator variable, equal to 1 if an account's recipient_status field is equal to "RECIPIENT," and equal to 0 otherwise. The value of a_4 is an estimate of the average difference in usage between the treatment and control groups, when the bills are taken as a whole.
- The interaction term $treat_i \times post_{i,t}$, is an indicator, which equal to 1 when a bill originates from a treatment account during the post-HER period, and 0 otherwise. Its coefficient a_5 is an estimate in daily energy use reduction among the treatment group during the post period, after controlling for the same pre-post change in the control group, and the systematic differences between treatment and control groups.

It should be noted, that the main quantity of interest, a_5 , is an average over the entire treatment group and does not distinguish between differences in, for example, date at

which the first HER was generated. While it does not stratify the savings estimated among all possible groupings of the treatment group, the value of a_5 is general, so it can be uniformly applied to all participants.

Estimating Coefficients of the Regression Models

The coefficients of the regression models were estimated by applying estimation procedures that take into account both the cross-sectional and the time-series dimensions of the data. In particular, regression models were estimated by pooling cross-sectional observations (i.e., customers) with time-series observations (i.e., daily consumption).

A “mixed-effects” specification was used for the panel regression modeling. The purpose of this specification is to control for those determinants of a household’s electricity use that are constant over time. The model specification is identical to that displayed in Equation 18, except that the error term is decomposed as:

Equation 22: Error Term Decomposition

$$\epsilon_{i,t} = u_i + v_{i,t}.$$

That is, the noise in the data is assumed to be accounted for by random differences (u_i) from the average usage among different accounts, and irreducible noise ($v_{i,t}$), which is due to the limitations of the model. Accounting for this noise structure in the data allows one to get better and less-biased inferences on the value of the model coefficients, as well as their uncertainties.

Method for Calculating Program Level Savings

Once the regression model is estimated, the regression results were used in the calculation of per-participant and program-level kWh savings and kW savings.

Method for Calculating kW Reduction

For the estimation of demand impacts, it is assumed that the demand reductions achieved with HERs have a flat hourly profile (i.e. the same for all hours). Under this assumption, the demand reductions are derived from the daily energy savings estimates by dividing by 24 (which is equivalent to dividing the annual energy savings by 8760).

Dual Enrollment Effect

To control for energy savings associated with participation in other FirstEnergy residential energy conservation programs or subprograms, ADM obtained lists of program participants from 2013 and 2014 for the following programs and subprograms and

conducted a data merge on the customer account field to flag participants with dual enrollments. The residential conservation programs that were checked against are as follows:

- Easy Cool Rewards Program (incentives for programmable thermostats)
- Appliance Turn-In
- Appliance Rebates (part of the Energy Efficient Products Program)
- CFL Retail Program (part of the Energy Efficient Products Program)
- HVAC Tune-ups and Rebates (part of the Energy Efficient Products Program)
- Community Connections (Low-Income) Program
- Behavioral Modification

The multiple enrollment rate between Behavioral Modification and the other programs was very low (0.6%) and in representative proportions across the different program years and treatment and control groups. As such, no adjustments were made in the data preparation process to flag or exclude the small amount of cross participants.

Data Elements for Billing Analysis

The following data elements were provided the Companies for customers randomly selected into the treatment and control group samples.

- Utility customer ID (Account Number)
- Customer Name
- Service Address Zip Code
- Meter Type
- Beginning and end dates of monthly electric bills, and number of days billed.
- Monthly kWh consumption billed for each customer from mid-2012 through December 2015
- Billing Period Usage
- Dates of receipt of energy HERs for each customer
- Treatment and control group home characteristic data

Data was provided for the 12 months prior to the first recorded energy usage report receipt date and then for all subsequent months up to the latest available date (e.g., through December 2015). Table 4-19 summarizes the focus of the impact evaluation questions along with their associated methods of data collection and analysis.

The billing data for each operating company were screened for the following data points:

- Bills recording fewer than 7 days of usage, and more than 37 days were dropped.
- Bills recording fewer than 250 kWh of usage, and more than 7000 kWh of usage were dropped.

Given the long range of time included in the regression model (“pre” period starting in 2012 and “post” period of 2015), billing data was also filtered with the goal of confirming that the homes included had the same occupants during the entirety of the modeling date range. Bills were grouped by a key consisting of the account and premise information and filtered (needing to meet all requirements) as follows:

- First bill occurred prior to June 2012
- Last bill occurred after November 2015
- Count of bills received greater than 30 (this allows for up to approximately 10% to 20% of bills to be missing for a given account/premise)

Table 4-19: Summary of Impact Evaluation Questions and Methods

Evaluation Question	Data Collection Method	Data Analysis Method
Is there a Behavioral Program effect?	~42 months of billing records	Linear Multiple Regression
How do savings vary by weather and home characteristics?	Program tracking data and certified weather data	Linear Multiple Regression

Sampling Plan

ADM received a near census of data for the Behavioral impact evaluation.

5. Detailed Evaluation Findings

This chapter provides the findings of the impact evaluation component of this report.

5.1 Detailed Evaluation Findings: Residential Energy Audit

5.1.1 Verification of Residential Energy Audit Program Population

Table 5-1 shows the quantities of qualified energy efficient measures that were rebated per operating company by the REA subprogram during 2015.

Table 5-1: Quantities of REA Measures Rebated During 2015 by Operating Company and Type of Measure

<i>Operating Company</i>	<i>CEI</i>	<i>OE</i>	<i>TE</i>	<i>Total</i>
<u>Direct Install Measures</u>				
12/22/33W 3-way CFL	2	7	-	9
13W CFL (60 watt equivalent)	33	47	98	178
20W CFL (75 watt equivalent)	3	-	4	7
25W CFL (100 watt equivalent)	3	5	-	8
LED Nightlight	-	1	2	3
Smart Power Strip	5	4	1	10
Low Flow Showerhead	2	-	-	2
Pipe Insulation	1	-	-	1
Total Quantity of Direct Install Measures	49	64	105	218
<u>Rebate Measures</u>				
Attic Insulation	3	1	-	4
Wall Insulation	2	1	-	3
ENERGY STAR Windows	-	-	1	1
Air Sealing	3	-	-	3
Duct Sealing	1	-	-	1
Total Quantity of Rebate Measures	9	2	1	12
Grand Total for Quantity of Measures	58	66	106	230

5.1.2 Residential Energy Audit Gross Annual kWh Savings

The program-level estimates of energy savings reported in this subsection and the peak demand reductions reported in the following subsection were developed by applying the methods described in Chapter 4. On a measure-by-measure basis, savings per unit were developed by applying TRM values and/or algorithms combined with in-situ data.

Annual kWh savings by measure and operating company for the 2015 participants REA subprogram are shown in Table 5-2 through Table 5-4. The verified kWh savings resulted in a program level realization rate of approximately 98%. The direct install measures had a realization rate of approximately 100%. The rebated measures varied from 100% because of greater verified savings for wall insulation and duct sealing; also, lower verified savings were found for attic insulation, ENERGY STAR windows, and air sealing measures.

- Total ex post kWh savings during 2015 for the REA program were 10,259 kWh.
 - Among the three service territories, CEI accounted for 29 percent of total kWh savings, OE for 29 percent, and TE for 42 percent.
 - Of the total kWh savings, 75 percent resulted from direct install measures and 25 percent from rebate measures.
 - Taken together, the various types of CFLs directly installed through the REA subprogram accounted for 81% of the total verified kWh savings, rebated measures for 6%, and all other measures for the remaining 13%.

Table 5-2: Ex Post Annual kWh Savings by REA Measures
Reported in 2015 for CEI

<i>Measure</i>	<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>
<i>Direct Install Measures</i>			
12/22/33W 3-way CFL	129	129	100%
13W CFL (60 watt)	1,257	1,257	100%
20W CFL (75 watt)	176	176	100%
25W CFL (100 watt)	202	220	109%
LED Nightlight	-	-	-
Smart Power Strip	283	283	100%
Low Flow Showerhead	388	384	99%
Pipe Insulation	266	266	100%
Total	2,701	2,714	100%
<i>Rebate Measure</i>			
Attic Insulation	296	117	40%
Wall Insulation	0.02	8	40941%
ENERGY STAR Windows	-	-	-
Air Sealing	68	60	88%
Duct Sealing	0.01	118	1175208%
Total	364	303	83%
Grand Total			
	3,065	3,017	98%

Table 5-3: Ex Post Annual kWh Savings by REA Measures Reported in 2015 for OE

<i>Measure</i>	<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>
<i>Direct Install Measures</i>			
12/22/33W 3-way CFL	451	451	100%
13W CFL (60 watt)	1,791	1,790	100%
20W CFL (75 watt)	-	-	-
25W CFL (100 watt)	337	366	109%
LED Nightlight	26	26	100%
Smart Power Strip	226	226	100%
Low Flow Showerhead	-	-	-
Pipe Insulation	-	-	-
Total	2,831	2,859	101%
<i>Rebate Measure</i>			
Attic Insulation	72	4	5%
Wall Insulation	94	100	106%
ENERGY STAR Windows	-	-	-
Air Sealing	-	-	-
Duct Sealing	-	-	-
Total	166	104	63%
Grand Total			
	2,997	2,963	99%

Table 5-4: Ex Post Annual kWh Savings by REA Measures Reported in 2015 for TE

<i>Measure</i>	<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>
<i>Direct Install Measures</i>			
12/22/33W 3-way CFL	-	-	-
13W CFL (60 watt)	3,734	3,732	100%
20W CFL (75 watt)	234	234	100%
25W CFL (100 watt)	-	-	-
LED Nightlight	53	53	100%
Smart Power Strip	57	57	100%
Low Flow Showerhead	-	-	-
Pipe Insulation	-	-	-
Total	4,077	4,076	100%
<i>Rebate Measure</i>			
Attic Insulation	-	-	-
Wall Insulation	-	-	-
ENERGY STAR Windows	290	204	70%
Air Sealing	-	-	-
Duct Sealing	-	-	-
Total	290	204	70%
Grand Total			
	4,367	4,279	98%

5.1.3 Residential Energy Audit Gross Peak Demand (kW) Reduction

The verified kW reductions resulted in a program level realization rate of 103%. The direct install measures had a realization rate of 100%, and rebated measures had a realization rate of 109%. Estimates of annual kW reductions by measure and operating company for the PY2014 REA subprogram are shown in Table 5-5 through Table 5-7:

- Total ex post kW reductions for the REA program in 2015 were 1.65 kW.
- Among the three service territories, CEI accounted for 42 percent of total kW reductions, OE for 27 percent, and TE for 31 percent.
- Of the total kW reductions, direct install measures accounted for 69 percent of kW demand reductions and rebate measures for 31 percent.
- Taken together, the various types of CFLs directly installed through the program accounted for 60 percent of the total kW reductions, rebated measures for 31 percent, and all other measures for the remaining 9 percent.

Table 5-5: Ex Post Annual kW Reduction by REA Measures Reported in 2015 for CEI

<i>Measure</i>	<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>
<i>Direct Install Measures</i>			
12/22/33W 3-way CFL	0.015	0.015	103%
13W CFL (60 watt)	0.152	0.150	99%
20W CFL (75 watt)	0.021	0.021	100%
25W CFL (100 watt)	0.024	0.026	109%
LED Nightlight	-	-	-
Smart Power Strip	0.032	0.032	98%
Low Flow Showerhead	0.050	0.049	98%
Pipe Insulation	0.030	0.030	101%
Total	0.324	0.324	100%
<i>Rebate Measure</i>			
Attic Insulation	0.347	0.138	40%
Wall Insulation	-	0.010	0%
ENERGY STAR Windows	-	-	0%
Air Sealing	0.079	0.070	89%
Duct Sealing	-	0.146	0%
Total	0.426	0.364	85%
Grand Total	0.750	0.688	92%

Table 5-6: Ex Post Annual kW Reduction by REA Measures Reported in 2015 for OE

<i>Measure</i>	<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>
<u>Direct Install Measures</u>			
12/22/33W 3-way CFL	0.054	0.054	100%
13W CFL (60 watt)	0.216	0.214	99%
20W CFL (75 watt)	-	-	-
25W CFL (100 watt)	0.040	0.044	109%
LED Nightlight	-	-	-
Smart Power Strip	0.024	0.025	105%
Low Flow Showerhead	-	-	-
Pipe Insulation	-	-	-
Total	0.334	0.337	101%
<u>Rebate Measure</u>			
Attic Insulation	0.002	0.004	199%
Wall Insulation	-	0.105	0%
ENERGY STAR Windows	-	-	-
Air Sealing	-	-	-
Duct Sealing	-	-	-
Total	0.002	0.109	5450%
Grand Total	0.336	0.446	133%

Table 5-7: Ex Post Annual kWh Reduction by REA Measures Reported in 2015 for TE

<i>Measure</i>	<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>
<i>Direct Install Measures</i>			
12/22/33W 3-way CFL	-	-	-
13W CFL (60 watt)	0.451	0.446	99%
20W CFL (75 watt)	0.028	0.028	100%
25W CFL (100 watt)	-	-	-
LED Nightlight	-	-	-
Smart Power Strip	0.006	0.006	105%
Low Flow Showerhead	-	-	-
Pipe Insulation	-	-	-
Total	0.485	0.481	99%
<i>Rebate Measure</i>			
Attic Insulation	-	-	-
Wall Insulation	-	-	-
ENERGY STAR Windows	0.038	0.036	0.935
Air Sealing	-	-	-
Duct Sealing	-	-	-
Total	0.038	0.036	93%
Grand Total	0.523	0.516	99%

5.2 Detailed Evaluation Findings: Energy Conservation Kits

This section presents the findings of the impact evaluation of the Energy Conservation Kits subprogram.

5.2.1 Verification of Energy Conservation Kits Subprogram Population

ADM delivered a survey to a random sample of program participants drawn from the participant data contained in the SSRS database. The purpose of the survey was:

- To verify delivery of energy conservation kits
- To verify that the ISR for measures delivered in 2015 was substantially similar to the ISR for the same measures that were delivered during 2014.

Table 5-8 shows the delivery totals by kit type by operating company.

Table 5-8: Count of Kit Types Delivered by Operating Company

<i>Kit Type</i>	<i>Operating Company</i>			
	<i>CEI</i>	<i>OE</i>	<i>TE</i>	<i>Total</i>
Electric	65	145	55	265
Standard	494	463	287	1,244
Schools	-	148	31	179
2015 Total	559	756	373	1,688

For each measure in the Energy Conservation Kit, the ISR, as determined from the 2014 participant survey and verified by the 2015 participant survey, is shown in Table 5-9.

*Table 5-9: Impact Evaluation ISRs Verified by Survey:
Energy Conservation Kits*

<i>Measure</i>	<i>Measure In-Service Rate (ISR)</i>
13W CFL	74%
20W CFL	88%
23W and 26W CFL ⁶¹	78%
3 Way CFL	76%
Globe CFL	67%
LED Night Lights (2)	Replacement for existing night light: 27% Directly installed night light: 50%
LED Night Lights (3)	Replacement for existing night light: 21% Directly installed night light: 40%
Furnace Whistle	14%
7 Plug Smart Strip	73%
Faucet Aerator ⁶²	32%
Showerhead ⁶³	20%

The ISR for each measure in the School Education Kit is shown in Table 5-10. The ISR for faucet aerators for School Education Kits accounts for how many of the aerators were installed in homes with electric water heaters as a percentage of the total number of School Education Kits distributed.

*Table 5-10: Impact Evaluation ISRs Verified by Survey:
School Education Kits*

<i>Measure</i>	<i>Measure In-Service Rate (ISR)</i>
13W CFL	84%
18W CFL	84%
LED Night Light	Replacement for existing night light: 45% Directly installed night light: 50%
Faucet Aerator	14%

5.2.2 Energy Conservation Kits Gross Annual kWh Savings

For Energy Conservation Kits delivered during 2015, Table 5-11 below shows the Ex Post Annual kWh savings by kit type for each EDC. The subprogram level kWh realization rate was 112%. The greater than 100% realization rate for the subprogram was due to variances of in-service rates. The ex ante estimates utilized in-service rates determined

⁶¹ 100W incandescent equivalent.

⁶² This measure only contained in the all-electric kits.

⁶³ Ibid.

by ADM's 2013 evaluation while ADM utilized in-service rates determined from the 2014 participant surveys and verified by the 2015 participant surveys.

Table 5-11: Ex Post Annual kWh Savings by Kit Type for Energy Conservation Kits Distributed in 2015

<i>Kit Type</i>	<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>
<u>CEI</u>			
Electric	36,242	38,524	106%
Standard	211,907	239,488	113%
Schools	-	-	-
Total	248,149	278,012	112%
<u>OE</u>			
Electric	80,789	85,938	106%
Standard	198,628	224,459	113%
Schools	23,769	28,036	118%
Total	303,187	338,433	112%
<u>TE</u>			
Electric	30,741	32,706	106%
Standard	123,126	139,136	113%
Schools	4,979	5,872	118%
Total	158,846	177,714	112%
Grand Total			
	710,181	794,159	112%

5.2.3 Energy Conservation Kits Gross Peak Demand (kW) Reduction

Table 5-12 below shows the Ex Post Annual kW demand savings by kit type for each EDC. The subprogram realization rate for demand savings was 118%. The greater than 100% realization rate, in similar fashion to the variance in kWh savings, was due to ex ante demand reduction estimates that used different in-service rates than those utilized by ADM.

Table 5-12: Ex Post Annual kW Reduction by Kit Type for Energy Conservation Kits Distributed in 2015

<i>Kit Type</i>	<i>Ex Ante kW</i>	<i>Ex Post kW</i>	<i>Realization Rate</i>
<u>CEI</u>			
Electric	4	4	113%
Standard	22	27	120%
Schools	-	-	-
Total	26	31	119%
<u>OE</u>			
Electric	8	9	113%
Standard	21	25	120%
Schools	3	3	103%
Total	32	37	116%
<u>TE</u>			
Electric	3	4	113%
Standard	13	15	120%
Schools	1	1	103%
Total	17	20	118%
Grand Total	75	88	118%

5.3 Detailed Evaluation Findings: New Homes

This section presents the findings of the impact evaluation of the New Homes Program.

5.3.1 Verification of New Homes Program Population

As a first step toward determining program level kWh and kW impacts, ADM reviewed program tracking data provided by PSD as well as the final SSRS database information.

5.3.2 New Homes Gross Annual kWh Savings

Gross annual kWh savings were calculated as described in Chapter Four of this report. The details and results of these calculations are reported in this section. For the final sampling plan, M&V sites were selected by EDC and by builder. Selecting sites by builder ensured a valid sample was taken across the complete population for each EDC. For each EDC, the builders were separated into strata based on number of homes built as well as size of homes. Data was combined for the homes in 2014 and 2015 to calculate precision and sampling requirements. For both Cleveland Illuminating Company and Ohio

Edison all homes completed in 2015 were included in the strata developed during the 2014 evaluation. Toledo Edison had no homes completed in 2015.

For 2015 participants, the final program ex post verified energy savings were 270,147 kWh resulting in a subprogram level realization rate of 102%.

Table 5-13 shows the variance of energy savings and realization rates by Company.

During the ex post analysis, ADM adjusted model parameters to match the information found during site visits, QA/QC checks, or other sources of data used for verification. The most common change to model parameters was the percentage of energy efficient lighting for each sampled site. If the percentage of lighting differed between the available data and the model, ADM would make the necessary changes to the Rem/Rate model as required. Other less common causes of variation between ex ante and ex post savings were SEER values on AC units, system efficiencies of water heaters, and higher tested duct leakages than modeled.

Table 5-13: Variance of Energy Savings and Realization Rate

EDC	<i>Ex Ante Annual Energy Savings (kWh)</i>	<i>Ex Post Annual Energy Savings (kWh)</i>	<i>Realization Rate</i>
CEI	94,227	95,173	101%
OE	171,394	174,973	102%
TE	0	0	n/a
2015 Total	265,621	270,147	102%

5.3.3 New Homes Gross Peak Demand (kW) Savings

Gross peak demand savings were calculated per the TRM. The difference in electricity demand for the user defined reference home (UDRH) and the rated home was calculated and multiplied by a coincidence factor of 0.5 (based on the Energy Center of Wisconsin, May 2008 metering study). ADM generated fuel savings reports for the rated home's RemRate model in the version of RemRate the home was originally modeled. This eliminated any possibility of savings discrepancies due to RemRate version changes. Gross peak demand verified for homes reported during 2015 was 649 kW.

5.4 Detailed Evaluation Findings: Behavioral

The sections below outline the results for the OPower Behavioral Program. Results are provided separately for the two persistence groups:

- Customers who participated in the Behavioral program solely in 2013 (referred to herein as “2013 Participants”)
- Customers who received additional treatment beginning in late fall 2014 (referred to herein as “2014 Participants”)

5.4.1 Results of Regression Analysis

The estimated coefficients associated with the regression analyses for the mixed effect models used for determining kWh savings are reported in Table 5-29. Definitions for the variables in the model are provided in Table 5-30.

Table 5-29: Results of Regression Analysis of Billing Data for Models Used to Estimate kWh Savings for Participants in the Behavioral Program

Coefficient	2013 Participants			2014 Participants		
	OE	CEI	TE	OE	CEI	TE
Intercept	39.0	32.3	33.8	47.5	43.0	45.7
HDD	0.39	0.38	0.40	0.45	0.44	0.47
CDD	0.01	0.01	0.01	0.04	0.03	0.02
Post	-2.38	0.13	-0.45	-2.98	-0.51	-0.65
Treat	0.03	-0.12	0.05	0.29	0.14	0.62
Post x Treat	-0.45	-0.25	-0.18	-0.74	-1.14	-1.21

Table 5-30: Definitions for Variables in Regression Models

Variable Name	Variable Definition	Measurement Scale
kWh per day	Average daily kWh for customer during billing period	Continuous variable
Cooling degree-days per day	Cooling degree days, referenced to base temperature of 75°F during billing period	Continuous variable
Heating degree-days per day	Heating degree days, referenced to base temperature of 65°F during billing period	Continuous variable
Post	Post Audit indicator variable (0 = pre-HERS; 1 = post-HERS)	Binary variable
Treat	Recipient of HERs indicator variable	Binary variable
Post x Treat	Indicator variable that interacts Post and Treat variables	Binary variable

5.4.2 kWh Savings and kW Reductions for Participants in 2013 and 2014 Behavioral Program

The results from the regressions reported in Table 5-29 were used to determine annual kWh savings and kW reductions per participant for the Behavioral program.

As mentioned in the methodology section, the estimate of the “Post x Treat” coefficient gives the average change in daily energy consumption from pre-HER to post-HER. To arrive at an estimate of energy savings on an annual basis (365 days a year), the value of “Post x Treat” is multiplied by 365.

Table 5-31: Annual Savings and Reductions per Customer for Behavioral Participant by Utility

Savings Type	2013 Participants				2014 Participants			
	OE	CEI	TE	Average⁶⁴	OE	CEI	TE	Average
kWh Savings	162.7	91.9	67.0	128.3	269.7	416.9	440.2	349.9
kW Reduction	0.019	0.010	0.008	0.015	0.031	0.048	0.050	0.040

⁶⁴ Averages weighted by applicable participant counts.

5.4.3 Program-Level kWh Savings

Program-level savings for the 2014 Behavioral program were determined by multiplying the per customer savings results from Table 5-31 above by the number of participants who received HERs in the different service territories. The program-level kWh savings by utility are shown in Table 5-32 below. Total ex post kWh savings for the 2015 Behavioral program were determined to be 12,246,299 kWh.

Table 5-32: Program-Level Electric Energy Savings (kWh) for 2015 Behavioral Program by Utility

OpCo	2013 Participants				2014 Participants				Total Combined kWh/year
	Estimated Savings		Program		Estimated Savings		Program		
	kWh/day	kWh/year	Count	Total kWh/year	kWh/day	kWh/year	Count	Total kWh/year	
OE	0.45	162.7	23,265	3,784,811	0.74	269.7	9,460	2,551,066	6,335,877
CEI	0.25	91.9	14,127	1,298,797	1.14	416.9	6,666	2,778,861	4,077,657
TE	0.18	67.0	4,636	310,596	1.21	440.2	3,458	1,522,168	1,832,764
Totals			42,028	5,394,204			19,584	6,852,095	12,246,299

5.4.4 Program-Level Critical Peak Demand Impacts

Program-level critical peak demand impacts for the 2015 Behavioral program were determined by applying the per customer kW reduction values. The program-level kW reductions by utility are shown in Table 5-33. Total ex post kW reductions for the 2015 Behavioral program were determined to be 1,398 kW.

Table 5-33: Program-Level kW Reductions During Critical Peak Hours by Utility

OpCo	2013 Participants			2014 Participants			Combined Demand Reduction (kW)
	Estimated Per-Participant Demand Reduction (kW)	Participant Count	Program Demand Reduction (kW)	Estimated Per-Participant Demand Reduction (kW)	Participant Count	Program Demand Reduction (kW)	
OE	0.019	23,265	432.1	0.031	9,460	291.2	723.3
CEI	0.010	14,127	148.3	0.048	6,666	317.2	465.5
TE	0.008	4,636	35.5	0.050	3,458	173.8	209.2
Totals		42,028	615.8		19,584	782.2	1,398.0

6. Conclusions

This chapter reports the conclusions resulting from the impact evaluation of the 2015 participants of the 2014 Home Performance Program.

6.1 Residential Energy Audit

The overall evaluation results for estimated gross kWh energy savings and kW peak demand reductions for the 2015 participants of the 2014 REA subprogram in the Companies' service territories are summarized in Table 6-1.

Table 6-1: Ex Ante and Ex Post Gross kWh and kW by Operating Company

Operating Company	Ex Ante kWh	Ex Ante kW	Ex Post kWh	Ex Post kW	kWh Realization Rate	kW Realization Rate
CEI	3,065	0.8	3,017	0.7	98%	88%
OE	2,997	0.3	2,963	0.4	99%	133%
TE	4,367	0.5	4,279	0.5	98%	100%
2015 Total	10,429	1.6	10,259	1.6	98%	100%

The gross kWh savings totals shown in Table 6-1 give a realization rate for kWh savings of approximately 98%, as determined by the ratio of verified gross kWh savings to expected gross kWh savings. The realization rate for kW reductions was 103%.

Of the total kWh savings, 94% resulted from direct install measures and 6% from rebate measures. Direct install measures accounted for 69% of kW demand reductions and rebate measures for 31%.

Taken together, the various types of CFLs directly installed through the REA subprogram accounted for 81% of the total verified kWh savings, rebated measures for 6%, and all other measures for the remaining 13%.

6.2 Energy Conservation Kits

The evaluation results for estimated gross kWh energy savings and kW peak demand reductions for the 2015 participants in the 2014 Energy Conservation Kits subprogram in the Companies' service territories are summarized in Table 6-2.

Table 6-2: Energy Conservation Kits Energy Impacts

<i>Operating Company</i>	<i>Ex Ante kWh</i>	<i>Ex Ante kW</i>	<i>Ex Post kWh</i>	<i>Ex Post kW</i>	<i>kWh Realization Rate</i>	<i>kW Realization Rate</i>
CEI	248,149	26	278,012	31	112%	119%
OE	303,187	32	338,433	37	112%	116%
TE	158,846	17	177,714	20	112%	118%
2015 Total	710,181	75	794,159	88	112%	117%

The gross kWh savings totals shown in Table 6-2 yield a program realization rate for kWh savings of 112%, as determined by the ratio of verified gross kWh savings to expected gross kWh savings. The realization rate for kW reductions was 117%. Of the total kWh savings and kW demand reduction, roughly 96% resulted from energy conservation kits measures delivered by Power Direct and 6% for School Education Kits measures.

6.3 New Homes

A total of 119 homes in the service territories of the three Companies received rebates through the Residential New Homes Program in 2015. The number of participating builders in each service territory is shown in Table 6-3.

Table 6-3: Builder Participation by Utility

<i>Operating Company</i>	<i>Number of Builders Reported in 2015</i>
CEI	5
OE	8
TE	0
All Companies	13

Verified electric impacts were 270,147 kWh saved annually, which represents a realization rate of 102%. Average on-peak demand reduction was verified to be 55 kW. Annual gross energy savings (kWh) and on-peak demand reductions (kW) for the program in the three Companies are reported in Table 6-4.

Table 6-4: New Homes Energy Impacts

Operating Company	Ex Ante Expected Gross Savings		Ex Post Verified Gross Savings		Realization Rates	
	kWh	kW	kWh	kW	kWh	kW
CEI	94,227	20	95,173	18	101%	90%
OE	171,394	41	174,973	37	102%	90%
TE	0	0	0	0	-	-
2015 Total	265,621	61	270,147	55	102%	90%

6.4 Behavioral

A total of 61,612 customers participated in the prior Behavioral Modification programs in Ohio during 2013 and 2014. Of these participants, 53% were in the OE service territory, 34% were from CEI and 13% were from TE.

6.4.1 Energy Impacts

For all participants in across all service territories during 2015, *ex ante* expected annual kWh savings were 13,539,740 kWh. The *ex post* verified annual electricity savings for all participants in 2015 were 12,246,299 kWh. The ratio of *ex post* to *ex ante* total electricity savings yields an overall realization rate of 90.4% for kWh savings for the 2015 Behavioral program.

For all participants combined across all service territories during 2015, *ex ante* expected critical peak demand kW reduction was 2,808 kW. The *ex post* verified critical peak kW reduction for all home energy audits in 2015 was 1,398 kW. The ratio of *ex post* to *ex ante* total demand reductions yields an overall realization rate of 49.8% percent for kW reductions for the 2015 Behavioral program.

Table 6-5 shows program-level results for kWh savings and kW reductions for the 2015 Behavioral program for each of the Companies.

Table 6-5: Program Level Results for 2015 Behavioral Modification Program

	Ex Ante Savings		Ex Post Savings		Realization Rates	
	kWh	kW	kWh	kW	kWh	kW
Savings by Utility Company						
CEI	4,513,910	851	4,077,657	465	90%	55%
OE	7,546,586	1,194	6,335,877	723	84%	61%
TE	1,479,244	676	1,832,764	209	124%	31%
Total	13,539,740	2,721	12,246,299	1,398	90%	51%

7. Appendix A: Required Savings Tables

Tables showing measure-level participation counts and savings for the Program were provided in various locations throughout this report. This appendix provides additional tables summarizing savings results. Lifetime savings were calculated as shown in

Equation 23: Calculation of Lifetime Savings

$$\text{Lifetime Savings} = \text{Measure Life} \times \text{Annualized Savings}$$

7.1 Audits

7.1.1 Residential Energy Audit

Table 7-1: Ex Post Annual kWh Savings by Measure and Operating Company for REA Measures Reported in 2015

Measure	Operating Company			
	CEI	OE	TE	Total
Direct Install Measures				
12/22/33W 3-way CFL	129	451	-	580
13W CFL (60 watt)	1,257	1,790	3,732	6,779
20W CFL (75 watt)	176	-	234	410
25W CFL (100 watt)	220	366	-	586
LED Nightlight	-	26	53	79
Smart Power Strip	283	226	57	565
Low Flow Showerhead	384	-	-	384
Pipe Insulation	266	-	-	266
Total	2,714	2,859	4,076	9,649
Rebate Measures				
Attic Insulation	117	4	-	121
Wall Insulation	8	100	-	108
ENERGY STAR Windows	-	-	204	204
Air Sealing	60	-	-	60
Duct Sealing	118	-	-	118
Total	303	104	204	611
Grand Total kWh Savings	3,017	2,963	4,279	10,259

Table 7-2: Ex Post Annual kW Reduction by Measure and Operating Company for REA Measures Reported in 2015

Measure	Operating Company			
	CEI	OE	TE	Total
Direct Install Measures				
12/22/33W 3-way CFL	0.015	0.054	-	0.069
13W CFL (60 watt)	0.150	0.214	0.446	0.811
20W CFL (75 watt)	0.021	-	0.028	0.049
25W CFL (100 watt)	0.026	0.044	-	0.070
LED Nightlight	-	-	-	-
Smart Power Strip	0.032	0.025	0.006	0.063
Low Flow Showerhead	0.049	-	-	0.049
Pipe Insulation	0.030	-	-	0.030
Total	0.324	0.337	0.481	1.142
Rebate Measures				
Attic Insulation	0.138	0.004	-	0.142
Wall Insulation	0.010	0.105	-	
ENERGY STAR Windows	-	-	0.036	
Air Sealing	0.070	-	-	0.070
Duct Sealing	0.146	-	-	0.146
Total	0.364	0.109	0.036	0.508
Grand Total kWh Savings	0.688	0.446	0.516	1.650

Table 7-3: Lifetime kWh Savings by Measure and Operating Company for
REA Measures Reported in 2015

Measure	Operating Company				
	EUL	CEI	OE	TE	Total
<i>Direct Install Measures</i>					
12/22/33W 3-way CFL	6.8	876	3,068	-	3,944
13W CFL (60 watt equivalent)	6.8	8,546	12,171	18,661	39,378
20W CFL (75 watt equivalent)	6.8	-	-	-	-
25W CFL (100 watt equivalent)	6.8	1,195	-	1,172	2,367
LED Nightlight	8.0	1,494	2,490	-	3,984
Energy Savings Surge Protector	4.0	-	-	-	-
Low Flow Showerhead	5.0	-	-	-	-
EHW Pipe Insulation	15.0	-	210	263	473
Total	6.1	1,130	904	283	2,317
<i>Rebate Measures</i>					
Attic Insulation	25.0	2,937	95	-	3,032
Wall Insulation	25.0	205	2,499	-	2,704
ENERGY STAR Windows	25.0	-	-	5,088	5,088
Air Sealing	15.0	901	-	-	901
Duct Sealing	20.0	2,350	-	-	2,350
Total	23.1	6,393	2,594	5,088	14,075
Grand Total for Lifetime kWh Savings	7.1	25,549	21,438	25,466	72,453

7.2 Energy Conservation Kits

Table 7-4: Ex Post Annual kWh Savings by Measure and Operating Company for Energy Conservation Kits Distributed in 2015

Measure	Operating Company			
	CEI	OE	TE	Total
<u>Non-Electric Kit Measures</u>				
13W CFL	86,168	80,760	50,061	216,989
20W CFL	31,605	29,622	18,362	79,588
23W/26W CFL	32,130	30,113	18,666	80,910
3 Way CFL	25,768	24,151	14,970	64,889
9W/11W Globe CFL	10,831	10,151	6,293	27,275
7 Plug Smart Strip	37,072	34,745	21,538	93,355
LED Nightlight	5,582	5,232	3,243	14,058
Furnace Whistle	10,333	9,684	6,003	26,020
Total for Standard Kit Measures	239,488	224,459	139,136	603,083
<u>Electric Kit Measures:</u> Energy savings only occur for these measures in homes with an electric water heater.				
13W CFL	11,338	25,292	9,568.907	46,199
20W CFL	4,159	9,277	3,574.783	17,010
23W/26W CFL	4,228	9,431	3,710.818	17,369
3 Way CFL	3,391	7,563	2,826.163	13,780
9W/11W Globe CFL	1,425	3,179	1,187.926	5,792
7 Plug Smart Strip	4,878	10,881	4,129.527	19,889
LED Nightlight	735	1,639	620.577	2,994
Furnace Whistle	1,360	3,033	1,150.967	5,543
Faucet Aerator*	5,993	13,369	5,073.588	24,436
Showerhead*	1,019	2,274	862.840	4,156
Total for All Electric Measures	38,524	85,938	32,706.0968	157,168
<u>Schools Kit Measures</u>				
13W CFL	-	17,512	3,668	21,180
18W CFL	-	8,082	1,693	9,775
LED Nightlight	-	1,426	299	1,725
Faucet Aerator	-	1,015	213	1,228
Total for Schools Kits Measures	-	28,036	5,872	33,908
Grand Total	278,012	338,433	177,714	794,159

Table 7-5: Ex Post Annual kW Reduction by Measure and Operating Company for Energy Conservation Kits Distributed in 2015

Measure	Operating Company			
	CEI	OE	TE	Total
<u>Non-Electric Kit Measures</u>				
13W CFL	10	10	6	26
20W CFL	4	4	2	10
23W/26W CFL	4	4	2	10
3 Way CFL	3	3	2	8
9W/11W Globe CFL	1	1	1	3
7 Plug Smart Strip	4	4	3	11
LED Nightlight	0	0	0	0
Furnace Whistle	0	0	0	0
Total for Standard Kit Measures	27	25	15	67
<u>Electric Kit Measures</u>				
13W CFL	1	3	1	6
20W CFL	0	1	0	2
23W/26W CFL	1	1	0	2
3 Way CFL	0	1	0	2
9W/11W Globe CFL	0	0	0	1
7 Plug Smart Strip	1	1	0	2
LED Nightlight	0	0	0	0
Furnace Whistle	0	0	0	0
Faucet Aerator	0	0	0	1
Showerhead	1	1	0	2
Total for All Electric Measures	4	9	4	17
<u>Schools Kit Measures</u>				
13W CFL	-	2	0	3
18W CFL	-	1	0	1
LED Nightlight	-	0	0	0
Faucet Aerator	-	0	0	0
Total for Schools Kits Measures	-	3	1	4
Grand Total	31	37	20	88

Table 7-6: Lifetime kWh Savings by Measure and Operating Company for Energy Conservation Kits Distributed in 2015

Measure	Operating Company				
	EUL	CEI	OE	TE	Total
<u>Non-Electric Kit Measures</u>					
13W CFL	6.80	585,941	549,171	340,415	1,475,527
20W CFL	6.80	214,914	201,427	124,859	541,200
23W/26W CFL	6.80	218,482	204,771	126,932	550,185
3 Way CFL	6.80	175,222	164,226	101,799	441,248
9W/11W Globe CFL	6.80	73,651	69,030	42,789	185,470
7 Plug Smart Strip	4.00	148,287	138,981	86,151	373,419
LED Nightlight	8.00	44,659	41,857	25,946	112,462
Furnace Whistle	7.50	77,494	72,631	45,022	195,146
Total for Standard Kit Measures	6.42	1,538,650	1,442,095	893,912	3,874,656
<u>Electric Kit Measures</u>					
13W CFL	6.80	77,097	171,987	65,068.57	314,153
20W CFL	6.80	28,278	63,082	24,308.53	115,669
23W/26W CFL	6.80	28,748	64,129	25,233.56	118,110
3 Way CFL	6.80	23,056	51,432	19,217.91	93,705
9W/11W Globe CFL	6.80	9,691	21,618	8,077.89	39,387
7 Plug Smart Strip	4.00	19,511	43,526	16,518.11	79,555
LED Nightlight	8.00	5,876	13,108	4,964.62	23,949
Furnace Whistle	7.50	10,197	22,746	8,632.25	41,575
Faucet Aerator	5.00	29,965	66,845	25,367.94	122,178
Showerhead	5.00	5,096	11,368	4,314.20	20,778
Total for All Electric Measures	6.17	237,515	529,841	201,703.58	969,059
<u>Schools Kit Measures</u>					
13W CFL	6.80	0	119,082	24,943	144,025
18W CFL	6.80	0	54,961	11,512	66,473
LED Nightlight	8.00	0	11,409	2,390	13,799
Faucet Aerator	5.00	0	5,076	1,063	6,140
Total for Schools Kits Measures	6.80	0	190,528	39,908	230,436
Grand Total	6.39	1,776,165	2,162,464	1,135,523	5,074,152

7.3 New Homes

Table 7-7: New Homes Lifetime Savings by Operating Company

<i>Operating Company</i>	<i>Number of Participants</i>	<i>Annual ex Post kWh Savings</i>	<i>Annual ex Post kW Savings</i>	<i>Lifetime kWh</i>
CEI	5	95,173	18	1,427,602
OE	8	174,973	37	2,624,596
TE	0	0	0	0
Combined	13	270,147	55	4,052,199

7.4 Behavioral

Table 7-8: Behavior Modification Lifetime Savings by Operating Company

<i>Operating Company</i>	<i>Annual ex Post kWh Savings</i>	<i>Annual ex Post kW Savings</i>	<i>Lifetime kWh</i>
CEI	4,077,657	465	4,077,657
OE	6,335,877	723	6,335,877
TE	1,832,764	209	1,832,764
Total	12,246,299	1,398	12,246,299

8. Appendix B: Energy Conservation Kits Survey Instruments

8.1 Energy Conservation Kits Survey Instruments

Hello. My name is _____ and I am calling on behalf of **[INSERT UTILITY NAME]**'s Energy Conservation Kit Program. May I speak with **[INSERT CUSTOMER'S NAME]**?

(If not the right person) May I please speak to the person who would know the most about the energy conservation kit that was sent to your home?

REPEAT INTRODUCTION AND CONTINUE

(If the correct person) We are conducting a study to evaluate **[INSERT UTILITY NAME]**'s *Energy Conservation Kit Program*. **[INSERT UTILITY NAME]** will use the results of this study to determine the effectiveness of the program and to make improvements. We would appreciate it if you would take about 5 to 10 minutes of your busy schedule to complete a survey, and we are offering a \$10 Target gift card to people who complete the survey. The interview will take approximately 10 minutes. May I ask you a few questions?

1. Yes
2. No

[If Intro=2, terminate survey]

1. According to our records, you received an Energy Conservation Kit supplied by **[INSERT UTILITY NAME]**. Is that correct?

1. Yes
2. No [THANK AND TERMINATE INTERVIEW]

1. Does your home have an electric water heater?

1. Electric water heater
2. Non-electric water heater

2. Did you receive 13W (60W Equivalent) CFLs in your Energy Conservation Kit?

1. Yes
2. No

3. Did you receive a 20W (75W Equivalent) CFL in your Energy Conservation Kit?

1. Yes
2. No

4. Did you receive a 23W or 26W (100W Equivalent) CFL in your Energy Conservation Kit?

1. Yes
2. No

5. Did you receive a 14/19/32W 3-Way CFL in your Energy Conservation Kit?

1. Yes

2. No
6. Did you receive a 9W (40W equivalent) globe CFL in your Energy Conservation Kit?
1. Yes
 2. No
7. Did you receive LED Night Lights in your Energy Conservation Kit?
1. Yes
 2. No
8. Did you receive a furnace whistle in your Energy Conservation Kit?
1. Yes
 2. No
9. Did you receive a 7 Plug Smart Strip in your Energy Conservation Kit?
1. Yes
 2. No
10. Did you receive faucet aerators in your Energy Conservation Kit?
1. Yes
 2. No
11. Did you receive a showerhead in your Energy Conservation Kit in your Energy Conservation Kit?
1. Yes
 2. No
12. When you received the Energy Conservation Kit containing CFL light bulbs and other energy-efficient products, did you install any of these products?
1. Yes
 2. No

[DISPLAY Q14 IF Q10=1 and Q13=1]

13. Did you install the SMART POWER STRIP provided in the Energy Conservation Kit?
1. Yes
 2. No

[DISPLAY Q15 IF Q14=1]

14. What appliances did you connect to the Smart Power Strip?
- Outlet #1 – Master circuit
 - Outlet #2 – Controlled outlet
 - Outlet #3 – Controlled outlet
 - Outlet #4 – Controlled outlet
 - Outlet #5 – Controlled outlet

[DISPLAY Q16 IF ANY IN Q3-Q7=1 and Q13=1]

15. Did you install ANY of the CFL Light Bulbs provided in the Energy Conservation Kit?

1. Yes
2. No

[DISPLAY Q17 IF Q3=1 and Q16=1]

16. How many of the 13 Watt (60 Watt Equivalent) Spiral CFL Bulbs did you install (up to a maximum of 5 bulbs)?

[DISPLAY Q18 IF Q17>0]

17. For the 13W bulbs that you installed, where did you install these bulbs?

1. Living room
2. Bathroom
3. Kitchen
4. Outdoors
5. Family Room
6. Bedroom
7. Garage
8. Hallway
9. Office
10. Laundry Room
11. Dining Room
98. Don't know

[DISPLAY Q19 IF Q4=1 and Q16=1]

18. If you installed the 20W CFL, where did you install the bulb?

1. Living room
2. Bathroom
3. Kitchen
4. Outdoors
5. Family Room
6. Bedroom
7. Garage
8. Hallway
9. Office
10. Laundry Room
11. Dining Room
98. Don't know
99. I did not install the 20W CFL

[DISPLAY Q20 IF Q5=1 and Q16=1]

19. If you installed the 23W or 26W (100 Watt Equivalent) CFL, where did you install the bulb?

1. Living room
2. Bathroom
3. Kitchen
4. Outdoors
5. Family Room
6. Bedroom
7. Garage

8. Hallway
9. Office
10. Laundry Room
11. Dining Room
98. Don't know
99. I did not install the 23W or 26W (100W Equivalent) CFL

[DISPLAY Q21 IF Q6=1 and Q16=1]

20. If you installed the 3-Way CFL, where did you install this bulb?

1. Living room
2. Bathroom
3. Kitchen
4. Outdoors
5. Family Room
6. Bedroom
7. Garage
8. Hallway
9. Office
10. Laundry Room
11. Dining Room
98. Don't know
99. I did not install the 16/25/32W 3-Way CFL

[DISPLAY Q22 IF Q7=1 and Q16=1]

21. If you installed the Globe CFL, where did you install this bulb?

1. Living room
2. Bathroom
3. Kitchen
4. Outdoors
5. Family Room
6. Bedroom
7. Garage
8. Hallway
9. Office
10. Laundry Room
11. Dining Room
98. Don't know
99. I did not install the Globe CFL

[DISPLAY Q23 IF Q2=1, Q11=1 and Q13=1]

22. How many of the FAUCET AERATORS provided in the Energy Conservation Kit did you install?

1. Zero
2. One
3. Two

[DISPLAY Q24 IF Q23= 2 or 3]

23. Where in the home was the first Faucet Aerator installed?

	Kitchen	Laundry Room	Bathroom	Garage	Other
Faucet Aerator #1	()	()	()	()	()

[DISPLAY Q25 IF Q24=3]

24. Where in the home was the second Faucet Aerator installed?

	Kitchen	Laundry Room	Bathroom	Garage	Other
Faucet Aerator #2	()	()	()	()	()

[DISPLAY Q26 IF Q8 =1 and Q13 = 1]

25. How many of the NIGHT LIGHTS provided in the Energy Conservation Kit did you install?

1. None
2. One
3. Two
4. Three

[DISPLAY Q27 IF Q26= 2, 3, or 4]

26. Please describe where the FIRST (or only) Night Light was installed.

1. Where there was no night light before (new night light)
2. Where a standard night light was previously installed

[DISPLAY Q28 IF Q26= 3 or 4]

27. Please describe where the SECOND Night Light was installed.

1. Where there was no night light before (new night light)
2. Where a standard night light was previously installed

[DISPLAY Q29 IF Q26=4]

28. Please describe where the THIRD Night light was installed.

1. Where there was no night light before (new night light)
2. Where a standard night light was previously installed

[DISPLAY Q30 IF Q2=1, Q12=1 and Q13=1]

29. Did you install the SHOWERHEAD included in the Energy Conservation Kit?

1. Yes
2. No

[DISPLAY Q31 IF Q30=1]

30. Where did you install the Showerhead?

1. Master bathroom
2. Any other bathroom

[DISPLAY Q32 IF Q9=1 and Q13=1]

31. Did you install the FURNACE WHISTLE provided in the Energy Conservation Kit?

1. Yes
2. No

32. Thank you for your time in answering questions regarding the Energy Efficiency Kit in Ohio. We have finished with the questions we have for this survey. We would like to mail you a \$10.00 Target gift card for your participation. To do that I'll need to verify your mailing information at this time. You can expect to receive the gift card in 4-6 weeks.

First name:

Last name:

Mailing address:

City:

State:

Zip code:

If you have any questions regarding this survey or would like to check on the status of your \$10.00 gift card, please call 775-345-3031. Once again, thank you for participating in this survey. Have a great day.

8.2 School Education Kits Survey Instruments

Hello. My name is _____ and I am calling on behalf of **[INSERT UTILITY NAME]**. Your home was recently sent an Energy Conservation Kit through your child's school on or around **[INSERT REGULATORY REPORTING DATE]**. Are you the person who would be most familiar with your household's receipt of the Energy Conservation Kit?

(If not the right person) May I please speak to the person who would know the most about the Energy Conservation Kit that was sent to your home through your child's school?

REPEAT INTRODUCTION AND CONTINUE

(If the correct person) We are speaking with households that received through their children's school an Energy Conservation Kit from **[INSERT UTILITY NAME]**. We would appreciate it if you would take about 5 to 10 minutes of your busy schedule to complete a survey and we are offering a \$10 Target gift card to people who complete the survey.

1. Yes
2. No

[If Intro=2, terminate survey]

1. According to our records, you received an Energy Conservation Kit supplied by **[INSERT UTILITY NAME]** that was requested through your child's school. Is that correct?
 1. Yes
 2. No [THANK AND TERMINATE INTERVIEW]
1. Does your home have an electric water heater?
 1. Electric water heater
 2. Non-electric water heater
2. Did you receive 13W (60W Equivalent) CFLs in your Energy Conservation Kit?
 1. Yes
 2. No
3. Did you receive an 18W (75W Equivalent) CFL in your Energy Conservation Kit?
 1. Yes
 2. No
4. Did you receive an LED Night Light in your Energy Conservation Kit?
 1. Yes
 2. No
5. Did you receive faucet aerators in your Energy Conservation Kit?
 1. Yes
 2. No

[DISPLAY Q7 IF ANY IN Q3-Q6=1]

6. When you received the Energy Conservation Kit containing CFL light bulbs and other energy efficient products, did you install any of these products?

1. Yes
2. No

[DISPLAY Q8 IF ANY IN Q3-Q4=1 and Q7=1]

7. Did you install ANY of the CFL Light Bulbs provided in the Energy Conservation Kit?

1. Yes
2. No

[DISPLAY Q9 IF Q8=1]

8. How many of the 13 Watt (60 Watt Equivalent) Spiral CFL Bulbs did you install (up to a maximum of 3 bulbs)?

[DISPLAY Q10 IF Q9>0]

9. For the 13W bulbs that you installed, where did you install these bulbs?

1. Living room
2. Bathroom
3. Kitchen
4. Outdoors
5. Family Room
6. Bedroom
7. Garage
8. Hallway
9. Office
10. Laundry Room
11. Dining Room
98. Don't know

[DISPLAY Q11 IF Q8=1]

10. If you installed the 18W CFL, where did you install the bulb?

1. Living room
2. Bathroom
3. Kitchen
4. Outdoors
5. Family Room
6. Bedroom
7. Garage
8. Hallway
9. Office
10. Laundry Room
11. Dining Room
98. Don't know
99. I didn't install the 18W CFL

[DISPLAY Q12 IF Q2=1, Q6=1 and Q7=1]

11. How many of the FAUCET AERATORS provided in the Energy Conservation Kit did you install?

1. Zero

- 2. One
- 3. Two

[DISPLAY Q13 IF Q12= 2 or 3]

12. Where in the home was the first Faucet Aerator installed?

	Kitchen	Laundry Room	Bathroom	Garage	Other
Faucet Aerator #1	()	()	()	()	()

[DISPLAY Q14 IF Q12=3]

13. Where in the home was the second Faucet Aerator installed?

	Kitchen	Laundry Room	Bathroom	Garage	Other
Faucet Aerator #2	()	()	()	()	()

[DISPLAY Q15 IF Q5 =1 and Q7 = 1]

14. Did you install the NIGHT LIGHT provided in the Energy Conservation Kit?

- 1. Yes
- 2. No

[DISPLAY Q16 IF Q15= 1]

15. Please describe where the Night Light was installed.

- 1. Where there was no night light before (new night light)
- 2. Where a standard night light was previously installed

16. Thank you for your time in answering questions regarding the Energy Efficiency School Kit in Ohio. We have finished with the questions we have for this survey. We would like to mail you a \$10.00 Target gift card for your participation. To do that I'll need to verify your mailing information at this time. You can expect to receive the gift card in 4-6 weeks.

First name:

Last name:

Mailing address:

City:

State:

Zip code:

If you have any questions regarding this survey or would like to check on the status of your \$10.00 gift card, please call 775-345-3031. Once again, thank you for participating in this survey. Have a great day