

EDC PROGRAM YEAR 7 ANNUAL REPORT

Program Year 7: June 1, 2015 – May 31, 2016

Presented to:

PENNSYLVANIA PUBLIC UTILITY COMMISSION

Pennsylvania Act 129 of 2008
Energy Efficiency and Conservation Plan

Prepared for:

Pennsylvania Electric Company

Docket No. M-2012-2334392
November 15, 2016

Prepared by:

**ADM Associates,
TetraTech MA, and
Pennsylvania Electric
Company**

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ACRONYMS

C&I	Commercial and Industrial
CFL	Compact Fluorescent Lamp
Phase II Verified / (Phase II-VG)	Verified/ Ex Post Cumulative Program/Portfolio Phase II Inception to Date
Phase II Reported	Reported/ Ex Ante Cumulative Program/Portfolio Phase II Inception to Date
Phase II+CO	Cumulative Program/Portfolio Phase II Inception to Date including Carry Over Savings from Phase I (this is cumulative Phase II verified savings)
CSP	Conservation Service Provider or Curtailment Service Provider
DR	Demand Response
EDC	Electric Distribution Company
EE&C	Energy Efficiency and Conservation
EM&V	Evaluation, Measurement, and Verification
GNI	Government, Nonprofit, and Institutional
HVAC	Heating, Ventilating, and Air Conditioning
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light Emitting Diode
LEEP	Low-Income Energy Efficiency Program
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and Verification
MW	Megawatt
MWh	Megawatt-hour
NTG	Net-to-Gross
PUC	Pennsylvania Public Utility Commission
PY5	Program Year 2013, from June 1, 2013 to May 31, 2014
PY6	Program Year 2014, from June 1, 2014 to May 31, 2015
PY7	Program Year 2015, from June 1, 2015 to May 31, 2016
PY8	Program Year 2016, from June 1, 2016 to May 31, 2017
PYX QX	Program Year X, Quarter X
PYTD	Program Year to Date
SEER	Seasonal Energy Efficiency Rating
SWE	Statewide Evaluator
TRC	Total Resource Cost
TRM	Technical Reference Manual

REPORT DEFINITIONS

Note: Definitions provided in this section are limited to terms that are critical to understanding the values presented in this report. For other definitions, please refer to the Act 129 glossary in Appendix E.

REPORTING PERIODS

Phase I

Refers to the Act 129 programs implemented prior to June 1, 2013. Phase I carryover references verified gross Phase I savings in excess of Act 129 Phase I targets.

Phase II

Refers to the period of time from the start of Phase II Act 129 programs on June 1, 2013 through May 31, 2016. Phase II savings are calculated by totaling all program year results, including the current program year-to-date results and subtracting any Phase II savings that expired during the current program year. For example, Phase II results for PY7 Q3 is the sum of PY5, PY6, PY7 Q1, PY7 Q2, and PY7 Q3 results, minus any Phase II savings that expired during PY5, PY6 or PY7.

Program Year-to-Date (PYTD)

Refers to the current reporting program year only. Activities occurring during previous program years are not included. For example, PYTD results for PY7 Q3 will include only results that occurred during PY7 Q1, PY7 Q2, and PY7 Q3; they will not include results from PY5 or PY6.

SAVINGS TYPES

Preliminary

Qualifier used in all reports, except the final annual report, to signify that evaluations are still in progress and that results have not been finalized. Most often used with realization rate or verified gross savings.

Reported Gross

Refers to results of the program or portfolio, determined by the program administrator (e.g., the electric distribution company [EDC] or the program implementer). Also known as ex ante, or “before the fact” savings (using the annual evaluation activities as the reference point for the post period).

Adjusted Ex Ante Gross

References to Adjusted Ex Ante Gross (or Adjusted Ex Ante) savings in this report refer to reported gross savings from the EDC’s tracking system that have been adjusted, where necessary, to reflect differences between the methods used to record and track savings and the methods in the Technical Reference Manual (TRM), or to correct data capture errors. These corrections are made to the population, prior to EM&V activities. The adjusted ex ante gross savings are then verified through EM&V activities.

Verified Gross

Refers to the verified gross savings results of the program or portfolio determined by the evaluation activities. Also known as ex post, or “after the fact” savings (using the annual evaluation activities as the reference point for the post period).

Verified Net

The total change in load that is attributable to an energy efficiency program. This change in load may include, implicitly or explicitly, the effects of spillover, free-riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand. Net savings are calculated by multiplying verified savings by a net-to-gross (NTG) ratio.

TOTAL RESOURCE COST COMPONENTS¹

Administration, Management, and Technical Assistance Costs

Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.

EDC Costs

Per the Pennsylvania PUC 2013 Total Resource Cost (TRC) Test Order, the total EDC costs refer to EDC-incurred expenditures only. This includes, but is not limited to, administration, management, technical assistance, design & development of EE&C Plans and programs, marketing, evaluation, and incentives.

Participant Costs

Participant Costs as defined by the 2013 Total Resource Cost Test Order.

Total TRC Costs

Total TRC Costs as defined by the 2013 Total Resource Cost Test Order.

Total TRC Benefits

Benefits as defined by the 2013 Total Resource Cost Test Order.

¹ All Total Resource Cost definitions are subject to the Pennsylvania PUC 2013 Total Resource Cost Test Order.

1 OVERVIEW OF PORTFOLIO

Pennsylvania Act 129 of 2008, which was signed on October 15, 2008, mandated energy savings and demand reduction goals for the largest electric distribution companies (EDCs) in Pennsylvania for Phase I (2008 through 2013). In 2009, each EDC submitted energy efficiency and conservation (EE&C) plans pursuant to these goals, which were approved by the Pennsylvania Public Utility Commission (PUC). Each EDC filed new EE&C plans with the PUC in 2012 for Phase II (June 2013 through May 2016) of the Act 129 programs. These plans were approved by the PUC in 2013.

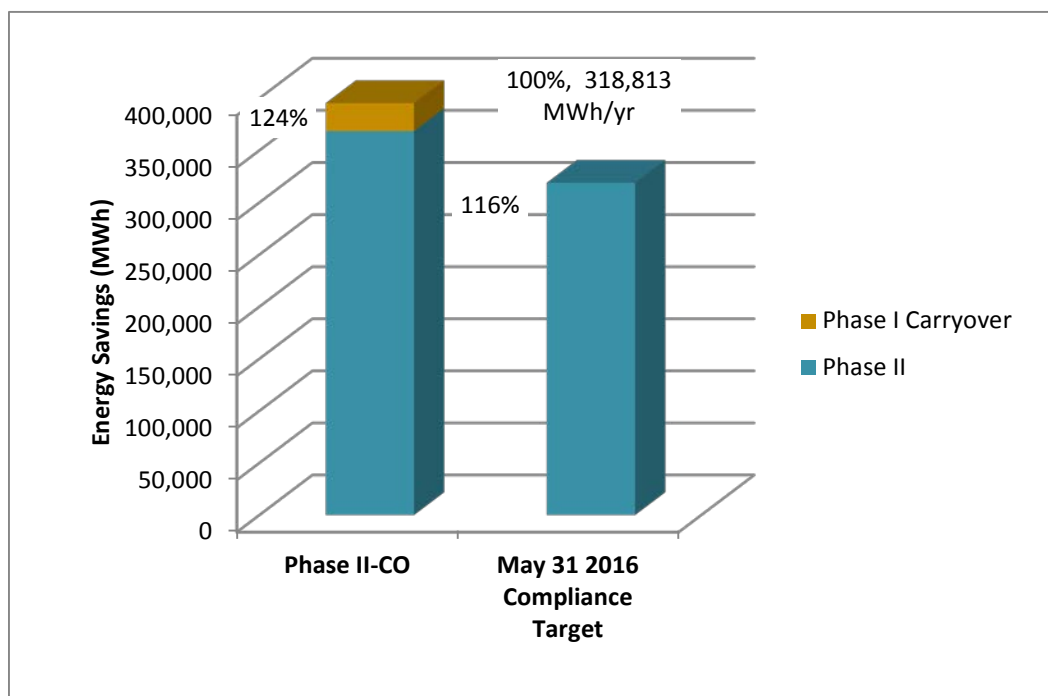
Implementation of Phase II Act 129 programs began June 1, 2013. This report documents the progress and effectiveness of the Phase II EE&C accomplishments for Pennsylvania Electric Company (Penelec) in Program Year 7 (PY7), defined as June 1, 2015 through May 31, 2016, as well as the cumulative accomplishments of the programs since inception of Phase II. This report additionally documents the energy savings carried over from Phase I. The Phase I carry-over savings count toward EDC savings compliance targets for Phase II.

ADM Associates evaluated the programs, which included measurement and verification of the savings.

1.1 SUMMARY OF PROGRESS TOWARD COMPLIANCE TARGETS

Penelec has achieved 124 percent of the energy savings compliance target, based on cumulative portfolio Phase II inception to date including carryover savings from Phase I (“Phase II+CO”) verified gross energy savings, as shown in Figure 1-1.

Figure 1-1: Cumulative Portfolio Phase II Inception to Date Verified Gross Energy Impacts



According to the Phase II Implementation Order, Penelec is allowed by the PUC to “carry over” into Phase II the Phase I verified energy savings that exceeded the Phase I compliance target. Table 1-1 shows the

incremental annual MWh savings from Phase I that Penelec is carrying over into Phase II. Table 1-2 shows the lifetime MWh savings from Phase I that Penelec is carrying over into Phase II.

Table 1-1: Phase II Verified Gross Savings and Verified Gross Savings from PY4 Carried Into Phase II

Sector	PYTD Verified Gross Savings (MWh)	Phase II Verified Gross Savings (Cumulative Phase II MWh/Yr)	Verified Gross Savings Carried Over from Phase I (Cumulative Annual MWh/Yr)	Phase II+CO Verified Gross Savings (Cumulative MWh/Yr)
Residential (non Low Income)	69,285	147,995	NA	147,995
Residential (Low Income)	18,368	55,255	NA	55,255
Total Residential (Non Low Income Plus Low Income)	87,654	203,250	8,042	211,292
Commercial and Industrial	62,923	133,294	8,042	141,336
GNI	13,821	31,964	10,721	42,685
Total	164,398	368,508	26,805	395,313

Table 1-2: Phase II Verified Gross Lifetime Savings and Verified Gross Lifetime Savings from PY4 Carried Into Phase II

Sector	PYTD Verified Gross Savings (Lifetime MWh)	Phase II Verified Gross Savings (Lifetime MWh)	Verified Gross Savings Carried Over from Phase I (Lifetime MWh)	Phase II+CO Verified Gross Savings (Lifetime MWh)
Residential (non Low Income)	369,658	1,051,380	NA	1,051,380
Residential (Low Income)	113,955	337,354	NA	337,354
Total Residential (Non Low Income Plus Low Income)	483,613	1,388,733	104,506	1,493,239
Commercial and Industrial	786,250	1,707,672	104,506	1,812,178
GNI	179,657	395,617	139,320	534,937
Total	1,449,520	3,492,022	348,332	3,840,354

Table 1-3: Phase I and Phase II Cumulative Annual Savings

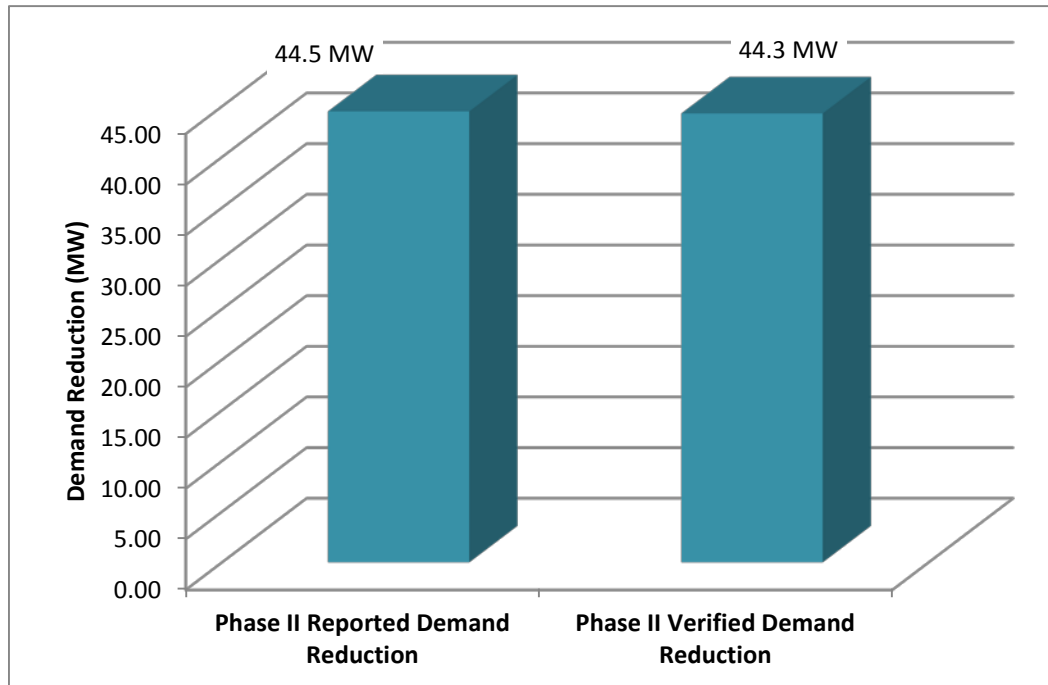
Sector	Phase I Cumulative Annual Savings (MWh)	Phase II Cumulative Annual Savings (MWh)	Act 129 Cumulative Annual Savings (MWh) Through Phase II
Residential (non Low Income)	247,102	147,995	395,098
Residential (Low Income)	7,375	55,255	62,631
Total Residential (Non Low Income Plus Low Income)	254,478	203,250	457,728
Commercial and Industrial	150,387	133,294	283,681
GNI	53,919	31,964	85,883
Total	458,784	368,508	827,292

Table 1-4: Phase II Verified Net First-Year and Lifetime Savings

Sector	PYTD Verified Net Savings (MWh/year)	Phase II Verified Net Savings (Cumulative Phase II MWh/Yr)	PYTD Verified Gross Savings (Lifetime MWh)	Phase II Verified Net Savings (Lifetime MWh)
Residential (non Low Income)	53,861	100,087	369,658	662,610
Residential (Low Income)	14,116	41,208	113,955	228,838
Total Residential (Non Low Income Plus Low Income)	67,978	141,295	483,613	891,448
Commercial and Industrial	48,030	101,814	786,250	1,299,627
GNI	10,674	22,760	179,657	299,287
Total	126,682	265,868	1,449,520	2,490,361

In addition, Penelec has achieved 44.3 MW of gross verified demand reduction during Phase II². See Figure 1-2 below. Additional detail on achieved demand reduction by program can be found in Table 1-11 and Table 1-12 of this section.

Figure 1-2: Phase II Portfolio Reported and Verified Demand Reduction



There are six broad groups of measures available to the low-income sector at no cost to the customer, compared to a total of 40 broad measure categories included in the Company's EE&C Plan. These groups of measures offered to the low-income sector therefore comprise 15.0% of the total measures offered. As required by the Phase II goal, this exceeds the fraction of the electric consumption of the utility's low-income households divided by the total electricity consumption in the Penelec territory by 6.2%.³ These values are shown in Table 1-5 and Table 1-6.

² Unlike Phase I, there is no compliance target for demand reduction in Phase II. The Commission, however, requires that demand reduction savings in Phase II be reported including line losses, as was done in Phase I.

³ Act 129 includes a provision requiring electric distribution companies to offer a number of energy efficiency measures to low-income households that are "proportionate to those households' share of the total energy usage in the service territory." 66 Pa.C.S. §2806.1(b)(i)(G).

Table 1-5: Phase II Low-Income Sector Compliance (Number of Measures)

	Low-Income Sector	All Sectors	% Low-Income	Goal
# of Measures Offered	6	40	15%	8.8%

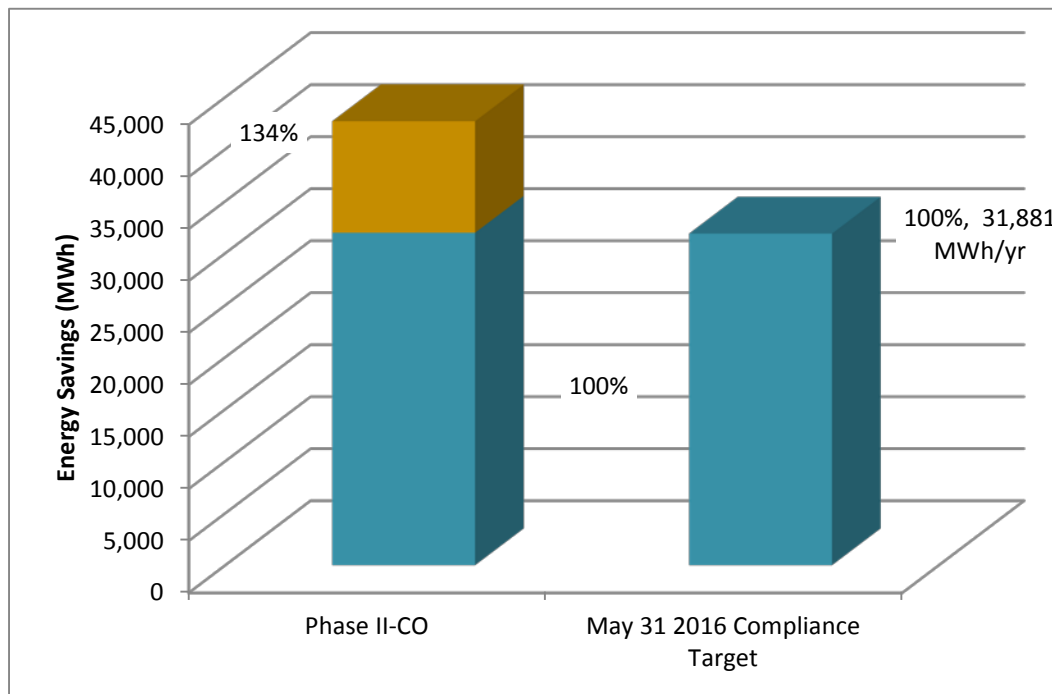
Table 1-6: Phase II Low-Income Sector Compliance (Percentage of Savings)

	Phase II Gross Verified
Low Income Verified Gross Savings from Low Income Programs (Cumulative Annual MWh/Yr)	10,633
Low Income Verified Gross Savings from Other Residential Programs (Cumulative Annual MWh/Yr)	44,622
All Low Income Verified Gross Savings [Sum of First Two Rows]	55,255
Progress Towards Low Income Goal [Previous Row divided by Phase II MWh Target]	385%
Goal (MWh/Yr)	14,347

The Phase II verified gross energy savings achieved through programs specifically designed for income-eligible customers are 10,633 MWh/yr and 44,622 MWh/year through other programs; this is 385 percent against the 4.5% Phase II total portfolio verified gross energy savings target for the low-income sector.

Penelec achieved 134 percent of the May 31, 2016 energy reduction compliance target for the government, nonprofit, and institutional sector based on cumulative program/portfolio savings from Phase II+CO verified gross energy savings achieved from the inception of Phase II through PY7 and including carry-over savings from Phase I as shown in Figure 1-3.

Figure 1-3: Government, Nonprofit, and Institutional Sector Phase II Verified Gross Energy Impacts



A summary of the number of participants, Phase II verified gross energy savings (MWh/Yr), Phase II demand reduction (MW), and incentives paid (\$1,000) are shown in Table 1-7.

Table 1-7: Summary of Phase II Performance by Sector

Sector	Participants	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Verified Gross Demand Reduction (MW)	Incentives Paid (\$1,000)
Residential	890,916	147,995	13.53	12,032
Low-Income	290,111	55,255	2.77	0
Small Commercial and Industrial	9,434	54,347	10.45	3,057
Large Commercial and Industrial	416	78,947	11.65	4,190
Government, Nonprofit, and Institutional	2,286	31,964	5.93	1,846
Phase II Total	1,193,163	368,508	44.31	21,126

A summary of the energy savings from Phase I programs that remain in Phase II is shown in Table 1-8 below for both the beginning and the end of Phase II.

Table 1-8: Summary of Phase I Verified Gross Savings Remaining Through Phase II

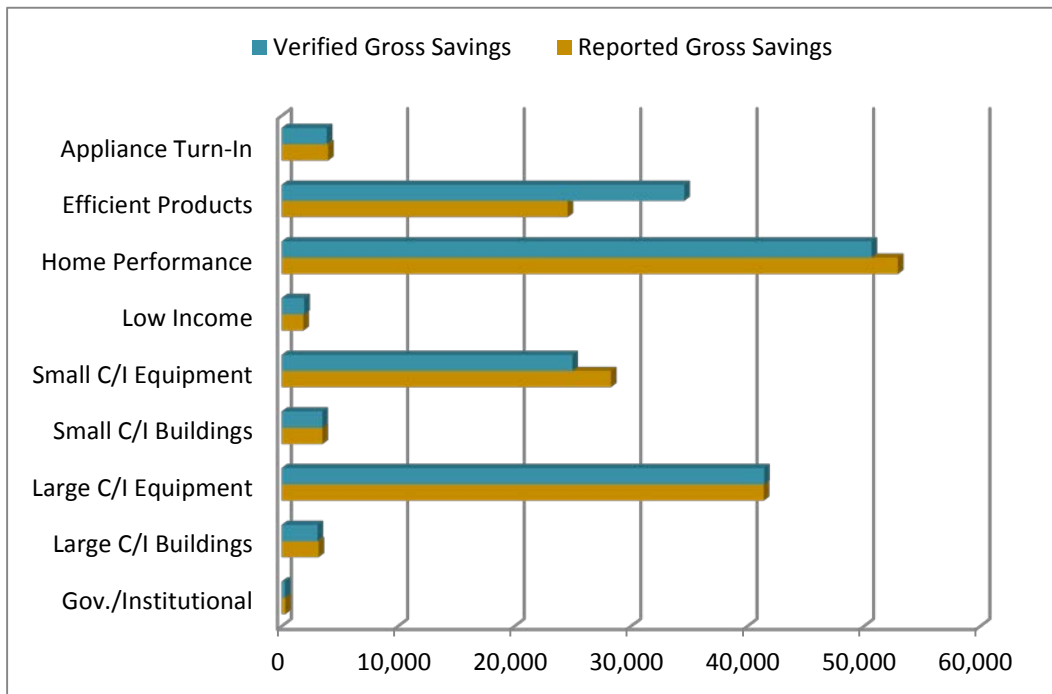
Sector	Phase I Carryover (MWh)	Phase II Cumulative Annual Savings (MWh)	Phase I Carryover Savings + Phase II Cumulative Annual Savings (MWh)	Phase II Targets (MWh)	Phase II Carryover Savings (MWh)*
Residential	NA	147,995	147,995	N/A	13,913
Low-Income	NA	55,255	55,255	14,347	7,872
Small Commercial and Industrial	8,042	203,250	211,292	N/A	13,913
Large Commercial and Industrial	8,042	133,294	141,336	N/A	13,913
Government, Nonprofit, and Institutional	10,721	31,964	42,685	31,881	82
Total	26,805	368,508	395,313	318,813	49,695

*To be eligible for Phase II carryover, all of the Phase II target must have been met and exceeded by Phase II program spending. For example, if the Phase II target was 1,000 MWh and 500 MWh was carried over from Phase I, the EDC would have had to show verified savings of at least 1,501 MWh to realize a Phase II carryover of 1 MWh. The low-income carryover is calculated according to the allocation factor methodology explained on page 85 of Phase III Implementation order.

1.2 SUMMARY OF ENERGY IMPACTS

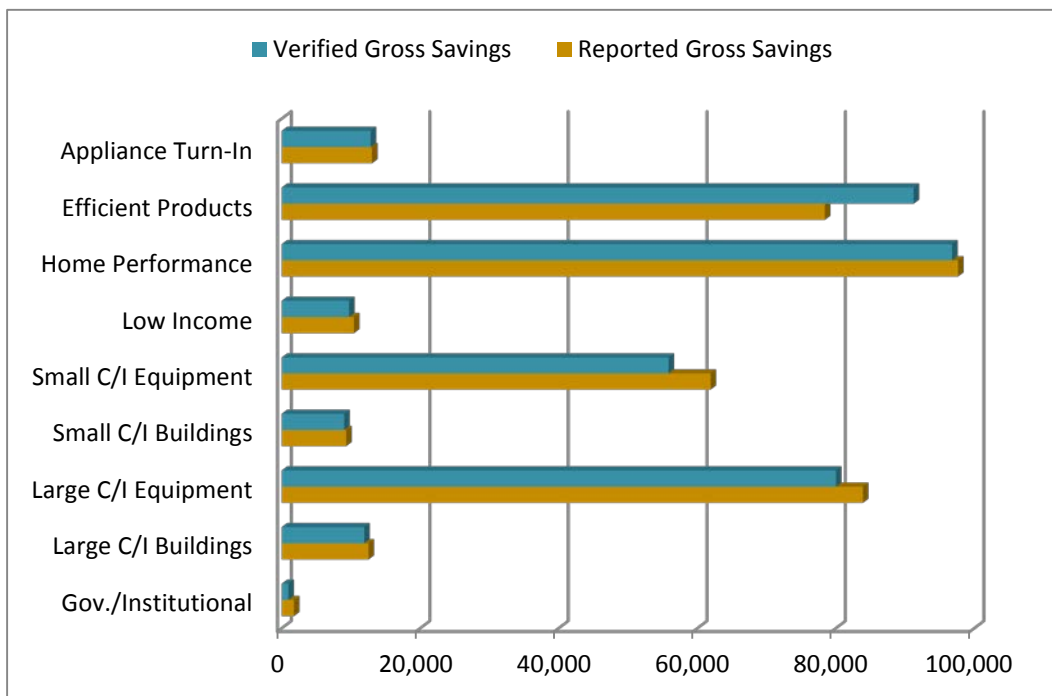
A summary of the reported and verified energy savings by program for PY7 is presented in Figure 1-4.

Figure 1-4: PYTD Reported and Verified Gross Energy Savings by Program (MWh/yr)



A summary of the Phase II reported and verified energy savings by program is presented in Figure 1-5.

Figure 1-5: Phase II Reported and Verified Gross Energy Savings by Program (MWh/yr)



Summaries of energy impacts by program through PY7 are presented in Table 1-9 and Table 1-10.

Table 1-9: Reported Participation and Gross Energy Savings by Program

Program	Participants		Reported Gross Impact (MWh/Yr)	
	PYTD	Phase II	PYTD	Phase II
Appliance Turn-In	3,914	16,454	3,990	13,056
Efficient Products	309,501	731,677	24,568	78,421
Home Performance	295,881	408,491	52,921	97,658
Low Income	4,176	24,405	1,868	10,439
Small C/I Equipment	793	1,681	28,292	61,918
Small C/I Buildings	3,948	9,804	3,509	9,313
Large C/I Equipment	162	401	41,406	83,921
Large C/I Buildings	8	212	3,173	12,546
Gov./Institutional	14	38	319	1,771
TOTAL PORTFOLIO	618,397	1,193,163	160,046	369,044

Table 1-10: Verified Gross Energy Savings by Program

Program	PYTD Reported Gross Energy Savings (MWh/Year)	PYTD Energy Realization Rate	PYTD Verified Gross Energy Savings (MWh/Year)	PYTD Achieved Precision ^[1]	Phase II Verified Gross Energy Savings (MWh/Year)	Phase II Achieved Precision ^[2]
Appliance Turn-In	3,990	97.3%	3,881	8.4%	12,857	7.2%
Efficient Products	24,568	140.7%	34,573	1.8%	91,250	1.2%
Home Performance	52,921	95.7%	50,660	3.8%	96,807	7.8%
Low Income	1,868	103.8%	1,982	9.1%	9,789	5.1%
Small C/I Equipment	28,292	88.3%	24,980	14.2%	55,842	10.0%
Small C/I Buildings	3,509	99.7%	3,499	8.9%	9,037	9.1%
Large C/I Equipment	41,406	100.1%	41,451	12.9%	80,030	8.9%
Large C/I Buildings	3,173	97.2%	3,084	13.7%	11,923	6.1%
Gov./Institutional	319	90.2%	288	15.0%	974	13.5%
TOTAL PORTFOLIO	160,046	102.7%	164,398	4.1%	368,508	3.2%
Phase I Carryover	n/a	n/a	n/a	n/a	26,805	n/a
Total Phase II+CO	n/a	n/a	n/a	n/a	395,313	n/a

1.3 SUMMARY OF FUEL SWITCHING IMPACTS

Per Commission Order, the EDCs are to report on the amount of electric to non-electric fuel switching in their annual reports. The following measure categories are those the Fuel Switching working group identified as potential “fuel switching measures”:

- Water Heating
- Heating and Air Conditioning
- Clothes Drying
- Combined Heat and Power Distributed Generation
- Residential Micro Combined Heat and Power.

Solar Water Heaters are the only electric to non-electric fuel switching measure offered in the Company’s approved EE&C Plan for the residential sector. One solar water heaters were rebated in PY7, with a total savings of 1,598 kWh and \$500 in associated incentives. Absorption chillers and combined heat and power projects may also be eligible under the approved commercial and industrial equipment programs. One combined heat and power project was rebated in PY7, with a total savings of 11,462,920 kWh and an associated incentive of \$401,202.

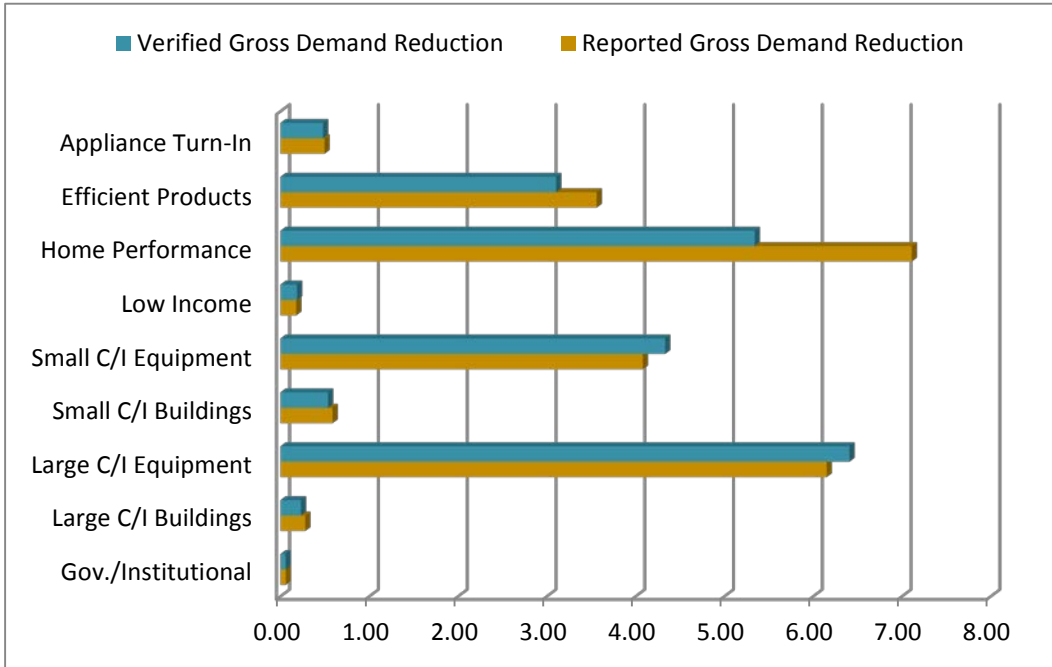
Measures that could possibly involve gas to electric fuel switching are Water Heating, Heating and Air Conditioning and Clothes Drying. The Company only provides incentives under its EE&C Plan for the purchase and installation of efficient electric heat pump water heaters and heat pumps which could involve customers switching from non-electric to electric technologies. The following summarizes participant responses to questions related to natural gas availability and possible non-electric to electric fuel switching during PY7:

- The reported availability of natural gas was limited for the heat pump water heater and heat pump HVAC participants.
- A total of 68 efficient electric water heaters were rebated in PY7. Of the customers surveyed for M&V purposes, 11% reported replacing a gas water heater (22% non-electric).
- A total of 928 electric heat pumps were rebated in PY7. Of the customers surveyed for M&V purposes, 21% reported replacing a gas furnace or boiler.

1.4 SUMMARY OF DEMAND IMPACTS

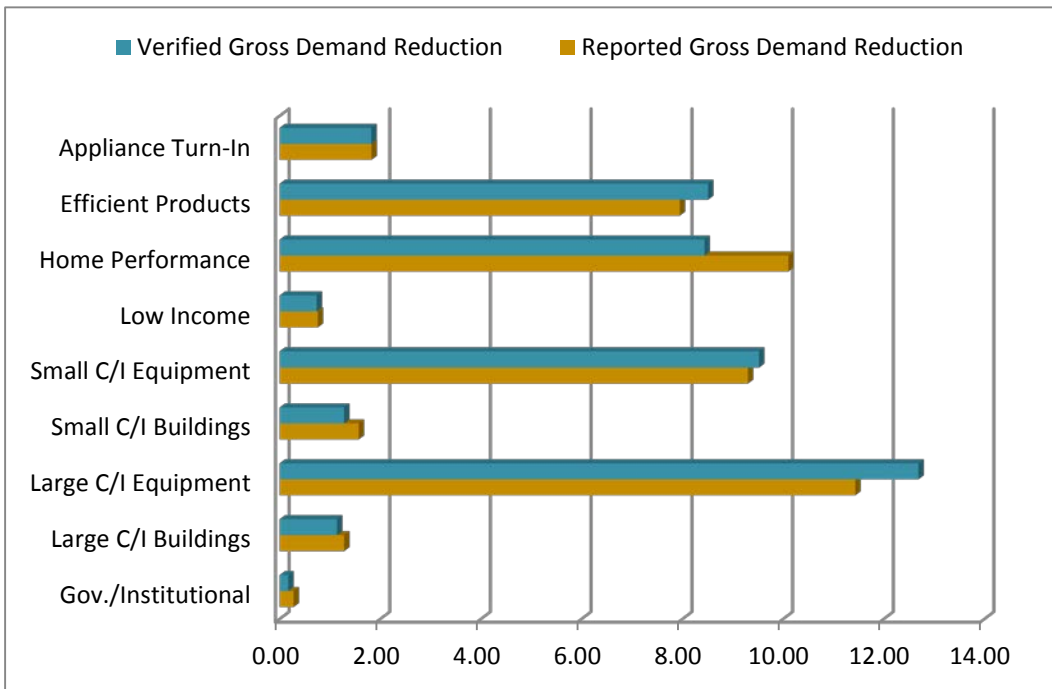
A summary of the reported and verified demand reduction by program for PY7 is presented in Figure 1-6. The impacts below reflect the line loss factors shown in Table 1-15.

Figure 1-6: PYTD Reported and Verified Gross Demand Reduction by Program



A summary of the cumulative reported and verified demand reduction by program is presented in Figure 1-7.

Figure 1-7: Phase II Reported and Verified Gross Demand Reduction by Program



A summary of demand reduction impacts by program through PY7 is presented in Table 1-11 and Table 1-12.

Table 1-11: Reported Participation and Gross Demand Reduction by Program

Program	Participants		Reported Gross Impact (MW)	
	PYTD	Phase II	PYTD	Phase II
Appliance Turn-In	3,914	16,454	0.50	1.83
Efficient Products	309,501	731,677	3.56	7.95
Home Performance	295,881	408,491	7.11	10.11
Low Income	4,176	24,405	0.18	0.76
Small C/I Equipment	793	1,681	4.08	9.30
Small C/I Buildings	3,948	9,804	0.59	1.57
Large C/I Equipment	162	401	6.15	11.43
Large C/I Buildings	8	212	0.28	1.28
Gov./Institutional	14	38	0.06	0.28
TOTAL PORTFOLIO	618,397	1,193,163	22.50	44.50

Table 1-12: Verified Gross Demand Reduction by Program

Program	PYTD Reported Gross Demand Savings (MW)	PYTD Demand Realization Rate	PYTD Verified Gross Demand Savings (MW)	PYTD Achieved Precision ^[1]	Phase II Verified Gross Demand Savings (MW)	Phase II Achieved Precision ^[2]
Appliance Turn-In	0.50	96.6%	0.48	7.9%	1.82	6.4%
Efficient Products	3.56	87.2%	3.11	2.4%	8.51	2.3%
Home Performance	7.11	75.1%	5.34	3.8%	8.44	16.8%
Low Income	0.18	105.1%	0.19	9.1%	0.74	5.3%
Small C/I Equipment	4.08	106.2%	4.33	14.9%	9.52	10.3%
Small C/I Buildings	0.59	91.3%	0.54	8.5%	1.28	9.0%
Large C/I Equipment	6.15	104.2%	6.41	12.9%	12.69	9.5%
Large C/I Buildings	0.28	82.4%	0.23	12.9%	1.14	3.0%
Gov./Institutional	0.06	97.9%	0.06	18.5%	0.17	12.5%
TOTAL PORTFOLIO	22.50	91.9%	20.68	5.2%	44.31	4.8%
Phase I Carryover	n/a	n/a	n/a	n/a	n/a	n/a
Total Phase II+CO	n/a	n/a	n/a	n/a	44.31	n/a

1.5 SUMMARY OF PY7 NET-TO-GROSS RATIOS

Per the 2013 TRC Order, EDCs are required to conduct net-to-gross (NTG) research. NTG ratios are not used for compliance purposes, but are used for cost effectiveness reporting and future program planning purposes and should be applied to gross savings in order to calculate net verified energy and demand savings. NTG should be estimated for all programs, including low-income and programs that distribute measures at no cost to participants. The only exception is if an EDC (or its evaluation consultant) provides an explanation, acceptable to the SWE, that estimating NTG for a given program would be inappropriate or unfeasible. Table 1-13 presents a summary of NTG ratios by program. The NTG ratios in Table 1-13 are determined through stratified sampling, and are weighed according to lifetime gross verified MWh achieved in Phase II⁴.

Table 1-13: PY7 NTG Ratios by Program.

Program Name	Free Ridership (%)	Spillover (%)	NTG Ratio PY7	PY7 Verified Net Energy Savings (MWh/Yr)	PY7 Verified Net Demand Savings (MW/Yr)	NTG Categories Included ⁵
Appliance Turn-In	66%	0%	34%	1,081	0.14	FR
Efficient Products	38%	2%	64%	22,554	2.01	FR,PSO
Home Performance	34%	4%	70%	44,521	4.84	FR,PSO
Low Income	26%	9%	82%	1,864	0.18	FR
Small C/I Equipment	38%	12%	75%	18,600	3.24	FR,PSO
Small C/I Buildings	36%	0%	64%	2,377	0.38	FR,PSO
Large C/I Equipment	26%	7%	81%	33,934	5.24	FR,PSO
Large C/I Buildings	50%	0%	50%	1,542	0.12	FR,PSO
Gov./Institutional	38%	11%	73%	210	0.04	FR,PSO
(Weighted by program savings for programs reporting NTG Ratios)	34%	6%	71%	126,682	16.19	N/A

⁴ For this reason, the net MW values in this table cannot be reconstructed as simple products of the NTG ratios here and the gross MW values reported in Table 1-12.

⁵ For example, free-ridership (FR), nonparticipant spillover (NPSO), and participant spillover (PSO).

1.6 SUMMARY OF PORTFOLIO FINANCES AND COST-EFFECTIVENESS

A breakdown of the portfolio finances is presented in Table 1-14.

Table 1-14: Summary of Portfolio Finances

Row #	Cost Category	Actual PYTD Costs	Actual Phase II Costs
		(\$1,000)	(\$1,000)
1	Incremental Measure Costs (Sum of rows 2 through 4)	\$29,899	\$64,023
2	EDC Incentives to Participants	\$7,872	\$21,126
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$22,026	\$42,897
5	Program Overhead Costs (Sum of rows 6 through 10)	\$8,616	\$30,019
6	Design & Development	\$128	\$308
7	Administration, Management, and Technical Assistance ^[1]	\$6,465	\$24,099
8	Marketing ^[2]	\$690	\$2,447
9	EDC Evaluation Costs	\$1,267	\$2,143
10	SWE Audit Costs	\$65	\$1,022
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$11,439	\$11,439
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$49,953	\$105,480
13	Total NPV Lifetime Energy Benefits	\$70,434	\$164,053
14	Total NPV Lifetime Capacity Benefits	\$7,810	\$18,235
15	Total NPV TRC Benefits ^[4]	\$78,244	\$182,288
16	TRC Benefit-Cost Ratio ^[5]	1.57	1.73
NOTES			
<i>Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.</i>			
[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.			
[2] Includes the marketing CSP and marketing costs by program CSPs.			
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.			
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.			
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.			

1.7 SUMMARY OF COST-EFFECTIVENESS BY PROGRAM IN PY7

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. Table 1-15 shows the TRC ratios by program and other key factors used in the TRC ratio calculation for Phase II programs.

Table 1-15: PYTD TRC Ratios by Program⁶

Program	TRC NPV Benefits (\$1000)	TRC NPV Costs (\$1000)	TRC Benefit-Cost Ratio	Discount Rate	Energy Line Loss Factor	Demand Line Loss Factor
Appliance Turn-In	1,854	685	2.71	7.92%	9.45%	9.45%
Efficient Products	16,750	5,257	3.19	7.92%	9.45%	9.45%
Home Performance	9,804	3,982	2.46	7.92%	9.45%	9.45%
Low Income	905	2,224	0.41	7.92%	9.45%	9.45%
Small C/I Equipment	16,435	13,601	1.21	7.92%	7.20%	7.20%
Small C/I Buildings	1,084	2,162	0.50	7.92%	7.20%	7.20%
Large C/I Equipment	29,084	20,529	1.42	7.92%	7.20%	7.20%
Large C/I Buildings	2,128	1,021	2.08	7.92%	7.20%	7.20%
Gov./Institutional	200	493	0.41	7.92%	7.20%	7.20%
TOTAL	78,244	49,953	1.57	7.92%	8.06%	7.86%

1.8 COMPARISON OF PY7 PERFORMANCE TO APPROVED EE&C PLAN

Table 1-16 below shows PY7 expenditures compared to the budget estimates set forth in the EE&C plan.

Table 1-16: Comparison of PY7 Program Expenditures to PY7 EE&C Plan

Program	PY7 Budget from EE&C Plan	PY7 Actual Expenditures	% Difference from PY7 EE&C Plan [(Planned – Actual)/Planned]
Appliance Turn-In	\$1,189,042	\$680,153	43%
Efficient Products	\$3,421,004	\$2,513,679	27%
Home Performance	\$6,734,178	\$4,000,364	41%
Low Income	\$3,707,523	\$2,206,429	40%
Small C/I Equipment	\$3,784,879	\$2,880,791	24%
Small C/I Buildings	\$1,417,973	\$636,572	55%
Large C/I Equipment	\$2,321,598	\$2,748,721	-18%
Large C/I Buildings	\$983,470	\$547,805	44%
Gov./Institutional	\$536,906	\$208,347	61%
TOTAL	\$24,096,572	\$16,422,862	32%

⁶ For reporting purposes, PYTD TRC Ratios by Program should be reported based on the gross verified energy and demand savings.

Table 1-17 shows PY7 program savings compared to the energy and demand savings estimates filed in the EE&C plan.

Table 1-17: Comparison of PY7 Actual Program Savings to EE&C Plan for PY7

Program	PY7 MWh Savings Projected in EE&C Plan	Actual Reported PY7 MWh Savings	% Difference [(Planned – PY7 Actual)/PY Planned]	PY7 MW Savings Projected in EE&C Plan	Actual Reported PY7 MW Savings	% Difference [(PY7 Actual)/Planned]
Appliance Turn-In	4,164	3,990	4%	0.39	0.50	-26%
Efficient Products	21,373	24,568	-15%	0.82	3.43	-317%
Home Performance	17,714	52,921	-199%	5.24	7.11	-36%
Low Income	3,590	1,868	48%	0.69	0.18	74%
Small C/I Equipment	29,099	28,282	3%	2.74	4.08	-49%
Small C/I Buildings	4,483	3,509	22%	0.55	0.59	-7%
Large C/I Equipment	15,056	41,406	-175%	2.02	6.15	-204%
Large C/I Buildings	3,379	3,173	6%	0.37	0.28	24%
Gov./Institutional	630	319	49%	0.09	0.06	31%
TOTAL	99,489	160,036	-61%	12.90	22.37	-73%

The results in PY7 are within expectations for Phase II implementation. The relatively large apparent differences between the planned and achieved incremental impacts for the Home Performance Program are due to the fact that the plan included the impacts of the Home Energy Reports sub-program in PY5 only, due to the assumed one-year measure life. PY7 includes actual reported and verified impacts for that sub-program, however. This accounts for most of the apparent over-achievement for that program. The nonresidential programs over performed in part due to the Company's efforts to increase participation among Government, Non-Profit, and Institutional customers. The reduced cost-effectiveness in PY7 for the Low-Income program relative to prior years is in large part due to the absence of LILU.

1.9 SUMMARY OF COST-EFFECTIVENESS BY PROGRAM FOR PHASE II

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. Table 1-18 shows the TRC ratios by program and other key factors used in the TRC ratio calculation for Phase II programs.

Table 1-18: Phase II TRC Ratios by Program

Program	TRC NPV Benefits (\$1000)	TRC NPV Costs (\$1000)	TRC Benefit-Cost Ratio	Discount Rate	Energy Line Loss Factor	Demand Line Loss Factor
Appliance Turn-In	5,993	2,848	2.10	7.92%	9.45%	9.45%
Efficient Products	40,383	14,801	2.73	7.92%	9.45%	9.45%
Home Performance	31,268	16,947	1.85	7.92%	9.45%	9.45%
Low Income	4,021	6,848	0.59	7.92%	9.45%	9.45%
Small C/I Equipment	34,025	25,023	1.36	7.92%	7.20%	7.20%
Small C/I Buildings	3,031	3,602	0.84	7.92%	7.20%	7.20%
Large C/I Equipment	54,379	32,074	1.70	7.92%	7.20%	7.20%
Large C/I Buildings	8,571	1,965	4.36	7.92%	7.20%	7.20%
Gov./Institutional	617	1,371	0.45	7.92%	7.20%	7.20%
TOTAL	182,288	105,480	1.73	7.92%	8.21%	8.21%

1.10 COMPARISON OF PHASE II PERFORMANCE TO APPROVED EE&C PLAN

Table 1-19 below shows Phase II expenditures compared to the budget estimates set forth in the EE&C plan.

Table 1-19: Comparison of Phase II Program Expenditures to Phase II EE&C Plan

Program	Phase II Budget from EE&C Plan (\$1000)	Phase II Actual Expenditures	% Difference from Phase II EE&C Plan [(Planned – Actual)/Planned]
Appliance Turn-In	\$3,536,199	\$2,776,001	21%
Efficient Products	\$9,566,456	\$7,331,649	23%
Home Performance	\$19,833,050	\$16,757,328	16%
Low Income	\$9,900,593	\$6,576,497	34%
Small C/I Equipment	\$10,521,922	\$6,733,483	36%
Small C/I Buildings	\$4,316,904	\$1,846,960	57%
Large C/I Equipment	\$6,757,717	\$5,893,213	13%
Large C/I Buildings	\$2,866,688	\$1,585,845	45%
Gov./Institutional	\$1,595,555	\$622,105	61%
TOTAL	\$68,895,084	\$50,123,081	27%

Table 1-20 shows Phase II program savings compare to the energy and demand savings estimates filed in the EE&C plan.

Table 1-20: Comparison of Phase II Actual Program Savings to EE&C Plan for Phase II

Program	Phase II MWh Savings Projected in EE&C Plan	Actual Reported Phase II MWh Savings	% Difference [(Planned – Phase II Actual)/Phase II Planned]	Phase II MW Savings Projected in EE&C Plan	Actual Reported Phase II MW Savings	% Difference [(Phase II Planned – Phase II Actual)/Phase II /Planned]
Appliance Turn-In	12,492	13,056	-5%	1.18	1.83	-55%
Efficient Products	62,079	78,421	-26%	2.18	7.82	-259%
Home Performance	92,596	97,658	-5%	15.82	10.11	36%
Low Income	10,625	10,439	2%	2.06	0.76	63%
Small C/I Equipment	77,620	61,908	20%	7.50	9.30	-24%
Small C/I Buildings	13,450	9,313	31%	1.65	1.57	5%
Large C/I Equipment	44,394	83,921	-89%	5.97	11.43	-92%
Large C/I Buildings	9,751	12,546	-29%	1.06	1.28	-21%
Gov./Institutional	1,913	1,771	7%	0.26	0.28	-6%
TOTAL	324,921	369,034	-14%	37.67	44.37	-18%

Most program impacts, when aggregated for Phase II, were reasonably close to the initial planning estimates. The smaller programs in the commercial and industrial sector had the most volatility, but this is expected due to the size of the programs. The demand reductions were generally much higher than those in the initial planning assumptions. This is particularly true in the residential sector, and is primarily due to a conservative coincidence factor assumption for residential lighting. The overall portfolio level cost effectiveness is close to planning estimates. The Gov./Institutional program had a lower than planned TRC score, and this is largely because the program did not scale to the level needed to overcome fixed administrative costs. A second reason for the low program TRC is that the rate classes that are eligible to participate do not have enough energy usage to bring forth very large savings projects. As such, the ICSP's level of effort, per kWh saved, is much higher than the average for other nonresidential programs.

1.11 PORTFOLIO LEVEL/CROSS-CUTTING PROCESS AND IMPACT EVALUATION SUMMARY FOR PY7

Much of the Phase II process evaluation activities occurred in PY5 and PY6. Phase II Process evaluation activities are summarized below⁷, with PY7 activities distinguished in bold lettering.

1. Interviews and surveys with trade allies to assess program operations and effectiveness (including influence on stocking practices and recommendations), and their experiences with the programs.
 - a. Large and Small C/I Buildings program contractor interviews, n=12
 - b. Residential New Construction Builders in-depth interviews, n=6
 - c. Residential New Construction non-participant Builders in-depth interviews, n=4
 - d. Residential New Construction HERS Rater in-depth interviews, n=4
 - e. Upstream retailer and corporate contact semi-structured interviews, n=16
 - f. Residential HVAC trade ally semi-structured interviews, n=4

⁷ The numbers of surveys or interviews are inclusive of all four FirstEnergy PA Operating Companies.

- g. Residential HVAC trade ally surveys, n=51
- h. Residential Low-Income Contractor and Auditor In-Depth Interviews, n=5
- 2. Participant surveys to assess program experiences and the influence of programs on energy efficiency decisions.
 - a. Small Commercial Efficient Equipment Programs, n=205
 - b. Large Commercial Efficient Equipment Programs, n=160
 - c. Small Commercial Efficient Buildings Programs, n=112
 - d. Large Commercial Efficient Buildings Programs, n=26
 - e. Government and Institutional Programs, n=18
 - f. Residential Low-Income Programs, n=660
 - g. Energy Efficient Products Downstream Rebates, n=500
 - h. Upstream Lighting – Cross Sector Sales and Low-Income Surveys, n=1,000
 - i. Appliance Turn-In Programs, n=172
 - j. Home Performance Program – In Home Audits, n=95
 - k. Home Performance Program – Online Audits, n=156
 - l. Home Performance Program – Opt In Conservation Kits, n=136
 - m. Home Performance Program – Schools Conservation Kits, n=156
- 3. Program documentation and website reviews, including rebate forms and marketing materials.
- 4. In-depth interviews with FirstEnergy Energy Efficiency and Conservation Program staff
- 5. Additional Process Evaluation and Net Impact Evaluation for Upstream Program
 - a. General Population Survey, n=500
 - b. Shelf Stocking Study of participating retailers, n=9
 - c. Shelf Stocking Study of non-participating retailers, n=4

Table 1-21: Phase II Process and Impact Evaluation Recommendations from PY7 Evaluations

Applicability	Recommendations
Portfolio Level	Maintain close communications between the measurement and verification team and the tracking and reporting team. The process, initiated by FirstEnergy, has resulted in significant administrative efficiencies related to data requests and reporting.
C/I Programs	Share M&V related memorandums and “institutional knowledge” gained in Phase II with the new C/I vendor in Phase III.
Home Performance Program	Share M&V related memorandums and “institutional knowledge” gained in Phase II with the new whole house audit vendor in Phase III.
Appliance Turn-In Program	The program will have a new vendor, and a new measure (Dehumidifier recycling) in Phase III. Conduct NTG surveys regularly in PY8, with slight variations in survey phrasing and methodology, to obtain timely and well-rounded feedback regarding the program.
Low-Income Program	Conduct desk reviews and verification surveys monthly to closely track program achievement toward the Phase III low-income target.

1.12 SITE INSPECTIONS SUMMARY

Table 1-22 below summarizes site inspections conducted during PY7. It is important to note that on-site inspections generally do not result in categorical “pass” or “fail” scores, but rather provide quantitative feedback that is on a continuum. This feedback can take the form of in-service rates for direct-install measures in the residential sector, to hours of use associated with a nonresidential lighting upgrade. ADM Associates reviews data collected from QA/QC on-site inspection for both impact and process evaluation purposes for the following programs:

- Home Performance – Audit and Direct Install
- Home Performance – New Construction
- Low-Income Program – Direct Install

For these programs, the in-service rates, as found by the QA/QC inspectors, are used to develop the gross verified impacts. As an example, the in-service rates in Table 5-5 are reflected in the PY7 realization rates for the low-income program. The New Construction program's QA/QC visits do not result in strict in-service rates, but rather an independent whole-house characterization that is used to construct REM/Rate simulation models, as required by the PA TRM. ADM uses data from these inspections, along with data collected by our own field techs during "ride-along" joint inspections with the ICSP Performance Systems Development (PSD), to develop independent REM/Rate simulation models for all homes in our gross impact evaluation sample. As a process evaluation step, ADM informs FirstEnergy when potentially significant or otherwise interesting discrepancies are discovered as we review on-site inspections.

Both ADM and CLEAResult performed on-site inspections for the nonresidential programs. CLEAResult maintained all photos, reports, and logger data from these inspections. The existence of on-site inspection data did not influence ADM's sampling plan (our sample was "blind" to the presence of such data). However, if such data were found to be representative, and adequate for M&V, they were included along with ADM's primary data. Note that the number of sites with discrepancies from reports is not estimated for nonresidential projects because the variance between reported and verified impacts can have multiple causes. In many cases, the primary causes of variance involve differences between assumed and measured operational parameters such as lighting or HVAC hours of use or part-load factors on motors.

Table 1-22: Summary of PY7 Site Visits

Program	Measure	Inspection Firm	Number of Inspections Planned	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
Efficient Products	HVAC	Honeywell	5% of all applications	5% of all applications	< 5% of inspected sites	Incentive modification or rejection of application
Home Performance	Direct Install	PSD	10% of all applications	10% of all applications	< 10% of inspected sites	In-service rates reflected in gross verified impacts
Home Performance	New Construction	PSD	10% of all applications	10% of all applications	< 10% of inspected sites	Modeling discrepancies reflected in gross verified impacts
Low-Income	Direct Install	Pure Energy Coach, LLC	585	585	< 5% of inspected sites	All discrepancies reflected in gross verified impacts
Commercial and Industrial Programs	All Measures	CLEAResult	5% of applications	5% of applications	Less than 2%	Amendments to ex ante calculations
Gov./Institutional	C/I Custom	ADM	0	0	n/a	All discrepancies reflected in gross verified impacts
Gov./Institutional	C/I Lighting	ADM	7	7	n/a	All discrepancies reflected in gross verified impacts
Large C/I Buildings	C/I Custom	ADM	3	3	n/a	All discrepancies reflected in gross verified impacts
Large C/I Equipment	C/I Custom	ADM	6	6	n/a	All discrepancies reflected in gross verified impacts
Large C/I Equipment	C/I Lighting	ADM	11	11	n/a	All discrepancies reflected in gross verified impacts
Small C/I Buildings	C/I Custom	ADM	4	4	n/a	All discrepancies reflected in gross verified impacts
Small C/I Equipment	C/I Custom	ADM	13	13	n/a	All discrepancies reflected in gross verified impacts
Small C/I Equipment	C/I Lighting	ADM	24	22	n/a	All discrepancies reflected in gross verified impacts
Total			n/a	n/a	n/a	

2 RESIDENTIAL APPLIANCE TURN-IN PROGRAM

Residential customers are eligible for a cash incentive and disposal of up to two large older inefficient appliances (refrigerators or freezers); and two Room Air Conditioners (RAC) per household per calendar year. All units must be working and meet established size requirements

2.1 PROGRAM UPDATES

JACO Environmental, the CSP for Penelec's Phase II Appliance Turn-In Program, unexpectedly ceased operations on November 23, 2015. The Company worked with customers impacted by the unexpected closure and paid customers any rebates owed. Customers with existing appointments were also contacted by KEY Recycling and given the opportunity to reschedule.

2.1.1 Definition of Participant

The participant counts are based on the number of unique account numbers, while measure counts correspond to the number of removed refrigerators, freezers, and RACs

2.2 IMPACT EVALUATION GROSS SAVINGS

2.2.1 Evaluation Methodology

The reported impacts for this program are based on the energy savings associated with the permanent removal of working refrigerators, freezers and RACs from service. The gross impact evaluation method includes the following steps:

1. Through customer verification surveys, determine the fraction of refrigerators, freezers and RACs that were drawing power from the grid prior to retirement.
2. Through customer surveys and data reported by the ICSPs, determine all other TRM parameters for gross savings estimation.

The first step above is a basic verification step: Zero savings are credited if an appliance was reported to be non-functional (unable to draw power from the grid) prior to pick-up.

The second step provides data to calculate average values of each parameter used in the TRM calculation of energy savings and demand reduction.

For refrigerator and freezers, the appliance age, volume, and configuration (e.g. single-door, side-by-side, or chest freezer) were derived from program tracking data recorded by the ICSP as they picked up the appliance. The location of the appliance within the home (as it relates to conditioned or unconditioned space) along with associated heating or cooling degree days, are also required parameters for the unit energy consumption calculation. The values for these parameters were derived from participant surveys. The basic verification of appliance operability prior to pick up, and the part-use factors were also determined from participant surveys. The energy impacts are calculated with the aforementioned parameters, according to the 2015 PA TRM. The demand impacts are calculated as the product of the annual energy savings and the Energy to Demand factor from section 2.4.3 of the 2015 PA TRM.

The impact calculation for RACs utilized the default capacity and efficiency from the 2015 PA TRM, and the cooling equivalent hours of use based on the participating home's zip code to one of the seven weather zones listed in the 2015 PA TRM. The basic verification of appliance operability prior to pick up was determined from participant surveys.

The combined gross impact evaluation effort for refrigerators, freezers, and RACs is described as a combination of calculation review and surveys (CR,S in Table 2-2).

The Company updated the reported per-unit savings for refrigerators, freezers, and RACs by using the default values for all TRM parameters. The realization rate for refrigerators and freezers is attributable almost entirely to the differences between the ex-ante and ex-post values of the “appliance was operational” and the “part-use factor” variables, while the realization rate for RACs is driven primarily by the average equivalent full load hours derived by mapping customer zip codes to the seven weather-zones in the PA TRM.

Table 2-1: Phase II Residential Appliance Turn-In Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives Paid (\$1,000)
Residential	16,034	13,056	1.83	871
Low-Income	0	0.0	0.00	0
Small Commercial and Industrial	0	0.0	0.00	0
Large Commercial and Industrial	0	0.0	0.00	0
Gov., Non-Profit, and Institutional	0	0.0	0.00	0
Phase II Total	16,034	13,056	1.83	871

2.2.2 Program Sampling

The sampling strategy for the PY7 evaluation is shown below. Approximately 3% of the total reported program impacts are attributable to the interim program ICSP, KEY Recycling, rather than JACO Environmental. Given that the overall impacts associated with the KEY pickups are small, we did not initiate an additional round of surveys to capture data from participants that scheduled appliances to be collected by JACO, but were ultimately picked up by KEY. This should not cause any bias in our results given the small fraction of impacts associated with KEY, coupled with the fact that the primary drivers of the realization rate (e.g. part-use factor, appliance characteristics, and operability) are likely to be independent of who picked up the appliance⁸.

Table 2-2: Residential Appliance Turn-In Sampling Strategy for PY7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Refrigerator	2,962	9.5%	56	57	CR,S
Freezer	753	19.8%	13	15	CR,S
Room AC	199	71.8%	1	11	CR,S
Program Total	3,914	8.6%	70	83	

Table 2-3: PY7 Residential Appliance Turn-In Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
Refrigerator	3,276	95.7%	3,134	0.5	9.4%
Freezer	692	105.1%	727	0.5	18.4%
Room AC	23	91.6%	21	0.5	21.1%
Program Total	3,990	97.3%	3,881		8.4%

⁸Furthermore, KEY Recycling used the same utility tracking data reporting procedure, and the same ex ante impacts per measure as JACO Environmental.

Table 2-4: PY7 Residential Appliance Turn-In Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
Refrigerator	0.37	95.6%	0.35	0.5	9.4%
Freezer	0.08	105.1%	0.08	0.5	18.4%
Room AC	0.05	90.9%	0.05	0.5	21.1%
Program Total	0.50	96.6%	0.48		7.9%

2.2.3 On-Site Inspections

No on-site inspections were performed for this program in PY7 because the appliances are removed from customers' homes. ADM performs telephone verification surveys with program participants. Variations between reported and verified impacts are due primarily to differences between ex-ante assumptions and ex-post survey responses of the part-use factor, and secondarily to the fraction of appliances that were still working at the time of retirement.

2.3 IMPACT EVALUATION NET SAVINGS

The evaluation team assessed free ridership using the protocol outlined in SWE's Guidance Memo GM-026. The data collection effort for this evaluation was done in conjunction with the ADM verification survey for impact evaluation in PY7. The resulting free ridership values, 65% on average between the four FirstEnergy PA Companies, were significantly higher than historical program results. The high free ridership as estimated in PY7 is not due to growth in appliances being removed by retailers - this mode accounts for a small fraction of all counterfactual discard scenarios. The main driver of the high free ridership is that a large number of customers reported that they would have discarded the old units, but without questions about the reliability of that response including how they would dispose of the units. These scenarios are assigned 100% free ridership in the protocol. We suspect that many customers may not be fully informed about the availability or cost of such services which could be a source of bias in the survey. For example, prominent "junk removal" franchises do not have full coverage in the Company's service territory. A second potential issue is that the PY7 survey protocol does not ask the customer whether the program accelerated their plans to dispose of the old appliance, which is the objective of the turn-in program. A question asking about the *timing* of the appliance removal may be added in Phase III to measure the extent that the program removed the appliance off the grid before a customer's anticipated removal date. We anticipate this adjustment will provide a more accurate estimate of net savings. This will be addressed early in Phase III to provide FirstEnergy with timely feedback.

A spillover analysis was not attempted in PY7. We did note that the fraction of customers that reported purchasing EnergyStar refrigerators or freezers is much higher than the national EnergyStar market penetration rate for these appliances. However, we have noted in past program evaluations that most customers receive incentives for the efficient appliances through the Energy Efficient Products program, therefore this most plausible mode of spillover would likely be double-counted with gross impacts from the Energy Efficient Products program.

Although the program is anticipated to be cost effective, even with NTG as low as reported in PY7, we recommend that FirstEnergy monitor the Phase III net savings process evaluations and recommendations for this program closely and make adjustments to program delivery as needed to increase net savings⁹.

⁹ One option may be to market more heavily in more rural parts of the service territory, where NTG is expected to be higher due to the lack of robust secondary markets or appliance removal services.

Table 2-5: PY7 Residential Appliance Turn-In Sampling Strategy for NTG Research

Stratum	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ¹⁰ to Achieve Sample
Refrigerators	2,962	0.7	85/15	40	45	6.0%
Freezers	753	0.7	85/30	10	14	2.0%
RACs	199	n/a	85/100	0	0	0.0%
Program Total	3,914		85/15	50	59	5.1%

Table 2-6: Phase II Residential Appliance Turn-In Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Refrigerators	69.8%	0.0%	30.2%	0.9	19.3%
Freezers	53.2%	0.0%	46.8%	0.9	34.6%
RACs	50.0%	0.0%	50.0%	n/a	100.0%
Program Total ¹¹	69.8%	0.0%	33.8%		16.8%

2.4 PROCESS EVALUATION

A robust process evaluation was conducted for this program twice in Phase I. There were no issues identified in those efforts and the program design has not changed for Phase II. Additionally, the FirstEnergy staff in-depth interviews did not reveal any useful researchable topics or issues to pursue. Therefore, a limited process evaluation was conducted in PY6 to assess key participant interactions and to identify if additional research is warranted. This section summarizes the PY6 evaluation effort. There were no additional process evaluation activities conducted in PY7¹².

Participating Customer (Household) Surveys

ADM included questions on their impact verification survey to assess:

- Program awareness and marketing.
- Customer satisfaction.

Decision-making considerations (free-ridership) when recycling equipment

¹⁰ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

¹¹ NTG ratio at program level is developed using stratum weight and stratum NTG ratios. The weights are the Phase II verified MWh.

¹² The sample sizes and values in Table 2-7 correspond to the PY6 process evaluation effort.

Table 2-7: Residential Appliance Turn-In Sampling Strategy for PY6

Target Group or Stratum (if appropriate)	Stratum Boundaries (if appropriate)	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
Appliance Turn-In	All Measures	6,013	0.5	85/15	50	45	6%	Process, NTG
Program Total		6,013		85/15	50	45	6%	

Key Findings of the PY6 process evaluation are listed below.

1. Bill inserts continue to be the most common source of program information. Over 60 percent (106 out of 168) of respondents indicated bill inserts as a source of program information. For the self-identified low-income subgroup of respondents, almost three-quarters (34 out of 46) indicated bill inserts as a source of program information.
2. Program satisfaction remains high. Over 80 percent (138 out of 170) of respondents reported they were “Very Satisfied” with program overall, with a mean score of 4.7 out of 5.

2.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort.

Table 2-8: Residential Appliance Turn-In Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Reduce reported savings for RACs to 150 kWh per unit.	Implemented
Consider using bill inserts to address recycling concerns outside of the program.	Rejected – goes beyond scope of program
Consider adding a message to the rebate check that provides information about other FirstEnergy programs.	Accepted
Monitor free-ridership closely in PY8, with frequent surveys and additional questions to add details surrounding reported appliance discard and appliance transfer scenarios.	Accepted

2.6 FINANCIAL REPORTING

A breakdown of the program finances by program is presented in Table 2-9.

Table 2-9: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 through 4)	\$245	\$871
2	EDC Incentives to Participants	\$245	\$871
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$0	\$0
5	Program Overhead Costs (Sum of rows 6 through 10)	\$440	\$1,977
6	Design & Development	\$9	\$22
7	Administration, Management, and Technical Assistance ^[1]	\$311	\$1,435
8	Marketing ^[2]	\$71	\$380
9	EDC Evaluation Costs	\$45	\$69
10	SWE Audit Costs	\$5	\$72
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$685	\$2,848
13	Total NPV Lifetime Energy Benefits	\$1,679	\$5,348
14	Total NPV Lifetime Capacity Benefits	\$174	\$645
15	Total NPV TRC Benefits ^[4]	\$1,854	\$5,993
16	TRC Benefit-Cost Ratio ^[5]	2.71	2.10
NOTES			
<i>Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.</i>			
[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.			
[2] Includes the marketing CSP and marketing costs by program CSPs.			
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.			
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.			
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.			

3 RESIDENTIAL ENERGY EFFICIENT PRODUCTS PROGRAM

Through the Residential Energy Efficient Products Program, customers receive incentives for installing ENERGY STAR® qualified appliances, energy efficient HVAC equipment, and energy efficient water heaters. The program also provides incentives to retailers for point of sale price cuts for customers purchasing energy efficient light bulbs. Qualifying appliances include items such as clothes washers, dehumidifiers, and refrigerators. HVAC equipment qualifying as part of the program include central air conditioners, air source heat pumps, ground source heat pumps, and mini-split heat pumps. The program also provides incentives to customers for the maintenance (tune-ups) of existing HVAC equipment. Water heaters rebated under the program include heat pump water heaters, efficient electric water heaters, and solar water heaters.

3.1 PROGRAM UPDATES

No changes to this program during PY7.

3.1.1 Definition of Participant

The count of participants differs from the count of measures for this program. For downstream sub-programs, the participant count is the count of unique account numbers in the PY7 tracking and reporting data. The measure count typically exceeds the participant count as some participants complete multiple qualifying measures. For upstream lighting, the participant count is taken to be equal to the number of packages sold. For upstream electronics, each computer, monitor, television, or smart power strip is taken to represent one participant.

3.2 IMPACT EVALUATION GROSS SAVINGS

3.2.1 Evaluation Methodology

The program can be broadly divided in five components: Upstream Lighting, Upstream Electronics, Efficient HVAC Equipment, HVAC Tune-Ups, and Energy Star Appliances. The details of the methodologies are described in the subsections below.

Gross Impact Evaluation for Upstream Products

The lighting and consumer electronics program components are similar in structure. Both program components provide retailers incentives for point of sale purchases on energy efficient products. The efficient lighting products are discounted to the customers, while consumer electronics are not required to be discounted to the customers by program design. From a gross impact evaluation perspective, the salient shared characteristic between the two program components is that customer contact information is not available.

The similar nature of these programs allows for a similar evaluation approach for consumer electronics and efficient lighting products. The following verification elements were applied to these two program components:

Review of Sales Invoices

ADM conducted a review and obtained invoices for the CFLs, LEDs, LED holiday lights, desktop computers, smart strips, monitors, and televisions sold by participating retailers. These invoices are matched to the tracking and reporting (T&R) system to confirm proper counts and characteristics of the lighting and

consumer electronic equipment. For all of the measures discussed in this section, the information in the T&R system was found to be consistent with both the reviewed invoices.

General Review of Tracking and Reporting System

ADM reviewed the T&R system to assure there are no duplicate entries and that all equipment model types are eligible for being counted toward PY7 achievements based on sales dates.

Impact Calculations for Lighting Products

ADM developed an *ex-ante* wattage equivalency map for use by the ICSP. The wattage equivalency was not make/model specific, but was rather designed to facilitate accurate if somewhat conservative, reporting of MWh and MW impacts for the upstream program.

To calculate verified impacts, ADM developed a make/model specific wattage equivalency map. For each unique stock keeping unit (SKU) description, ADM determined the lamp type as one of the following:

- General Service.

- Reflector (with subcategories having different lumen to baseline wattage mappings),

- Globe,

- Decorative,

- 3-Way

For each category, the baseline wattage was determined, according to the TRM, as a function of the efficient lamp's lumen output. With the baseline and efficient watts determined, the impacts for all lamps are determined through TRM algorithms. Cross sector sales adjustments apply to residential lighting. Cross-sector sales determination and the associated adjustments to verified impacts and incentives are discussed in detail in Appendix D. In PY7, the realization for lighting was approximately 10% higher than in past years. The high realization rate is attributed primarily to low ex ante baseline watts estimates for certain lamps – particularly for LED reflector lamps. Honeywell uses lamp type and wattage specific wattage multipliers in ex ante calculations. As the luminous efficacy of LED lamps has improved, certain lamps are mapping to higher baseline wattages per the 2015 TRM. For example, a 10 Watt LED which in PY7 qualifies for a 43 Watt baseline was mapped to a 29 Watt baseline. Additionally, certain BR30 reflector lamps were assigned a baseline of 29 Watts as opposed to 65 Watts, possibly due to an implicit assumption that the lamps were general service lamps, rather than reflectors. A second reason for the high realization rate is that the additional contribution of cross-sector sales are reflected in the verified impacts, but not in the reported impacts.

Impact Calculations for Upstream Electronics

ADM reviewed upstream electronics manufacturer names and model numbers to verify that the models are in the ENERGY STAR® database and to check the ENERGY STAR tier. In the 2015 TRM, the diagonal screen size is a key parameter in the partially deemed savings algorithm for televisions. ADM verified the diagonal screen size and calculated TRM-specified energy and demand impacts, accordingly.

Gross Impact Evaluation for Appliances

The gross impact evaluation for appliances includes the following components:

Invoice and Application Review

ADM obtained invoices and applications from the Company. For each application, ADM verified that the manufacturer name and model number in the T&R system matches those on the invoice and rebate application. In general, all sampled appliances were matched to the qualifying ENERGY STAR® product lists. ADM independently retrieved the attributes necessary for TRM calculations from the ENERGY STAR®

database. In certain cases, the make or model numbers were entered in with minor typographic errors or with missing or inserted dashes, spaces, or other delimiting characters. Such occurrences do not pose an evaluation difficulty as ADM concentrates the verification effort on a random sample of rebated appliances, rather than the entirety of the database.

Customer Verification Surveys

ADM performed telephone and online surveys on a random sample of customers selected from the T&R data. Nearly all contacted customers verified that they have purchased and installed the stated appliances. The verification rates are used, in part, to inform measure-level realization rates.

Review of Energy Savings and Demand Reduction Calculations

For appliance measures with partially deemed TRM protocols, the T&R system calculated impacts with one savings scenario rather than with specific scenarios that occur in measure implementation. For example, market average values for capacity, efficiency, are used rather than appliance-specific values. For clothes washers, TRM default fractions of electric water heating and clothes drying are used. In general, the per-unit savings reported by the ICSP are rather conservative (the assumed average efficiency levels or capacities are lower than actual average values). For all reviewed records, ADM used site-specific attributes to calculate "On-TRM" impacts.

Gross Impact for Evaluation HVAC Equipment and Tune-Ups

The gross impact evaluation approach for HVAC equipment is similar to that of appliances. The process involves invoice and application reviews, telephone verification surveys, and independent TRM-specific gross impact calculations for sampled items. The three activities are described in more detail below.

Invoice and Application Review

ADM obtained invoices and applications from the Company. For each application, ADM verified that the manufacturer name and model number in the T&R system matches those on the invoice and rebate application. In general, the sampled equipment were verified as more efficient than standard HVAC systems. ADM independently retrieved the attributes necessary for TRM calculations from the AHRI database. In certain cases, the make or model numbers were entered in with minor typographic errors or with missing or inserted dashes, spaces, or other delimiting characters. Such occurrences do not pose an evaluation difficulty as ADM concentrates the verification effort on a random sample of rebated appliances, rather than the entirety of the database. Verified impacts for tune-ups are determined through verification rates from telephone surveys, coupled with average cooling and heating capacities determined from application and invoice reviews.

Customer Verification Surveys

ADM performed telephone and online surveys on a random sample of customers selected from the T&R data. All contacted customers verified that they have purchased and installed the stated HVAC equipment, and all tune-up participants recalled the tune-up event. The telephone surveys are also an opportunity to collect additional data that are exclusive to the T&R system. For example, the installation space and baseline HVAC system types were determined through customer surveys for ductless mini-split heat pumps.

Review of Energy Savings and Demand Reduction Calculations

As with appliances, the ICSP reports energy savings due to market average values for capacity and efficiency, rather than project-specific attributes. The default parameters used in the savings estimations

are conservative in the sense that the ICSP systematically underestimates reported impacts. This is particularly true for ground source heat pumps, air source heat pumps, and tune-ups.

For all reviewed records, ADM used site-specific attributes to calculate “On-TRM” impacts. The process is somewhat more involved in that the make/model lookups involve the Air Conditioning, Heating, and Refrigeration Institute (AHRI) certification directory along with using the TRM’s zip-code to archetypal city map to establish equivalent full load hours. For ductless mini-split heat pumps, customer surveys are required to establish equivalent full load hours of operation and a baseline system type. Although there are at times significant variations between reported and verified savings, the overall variance is insignificant at the program level.

3.2.1 Program Sampling

For the upstream lighting and consumer electronics program components, a census of shipment invoices and the calculations in the T&R system were reviewed to ensure that the energy savings and demand reductions are claimed according to the protocols in the PA TRM.

The sampling approach for the appliance and HVAC program components is stratified random sampling with the stratification defined by measure types. Note that sample sizes may be small for certain small strata, but the overall number of sample points, exclusive of the upstream program components, is sufficient to achieve 90/10 confidence/precision. The impacts of certain measures that have an insignificant number of applications such as solar water heaters and mini-split ACs are not verified through surveys or invoice applications, but are rather passed through to verified impacts provided that the per-unit savings are consistent with values from the PA TRM.

Table 3-1: Phase II Residential Energy Efficient Products Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives Paid (\$1,000)
Residential	694,127	69,725	6.09	3,779
Low-Income				
Small Commercial and Industrial	37,550	8,696	1.85	0
Large Commercial and Industrial				
Gov., Non-Profit, and Institutional				
Phase II Total	731,677	78,421	7.95	3,779
*The incentive amounts associated with cross-sector sales are reported as zero because the Company has already made accounting adjustments for cross-sector sales, as described in Appendix D.				

Table 3-2: Residential Energy Efficient Products Sampling Strategy for PY7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Upstream Lighting	292,099	0%	292,099	292,099	CR,I&A,S*
Upstream Televisions	6,367	0%	6,367	6,367	CR,I&A
Refrigerators / Freezers	3,033	25%	8	9	CR,I&A,S
Upstream Computers/Monitors	1,076	0%	1,076	1,076	CR,I&A
Heat Pump Water Heaters	121	46%	9	10	CR,I&A,S
ASHP	149	51%	2	2	CR,I&A,S
Clothes Washers	1,585	19%	15	21	CR,I&A,S
GSHP	53	55%	6	7	CR,I&A,S
HVAC Tune-Ups	578	36%	4	4	CR,I&A,S
Dehumidifiers	2,724	14%	26	30	CR,I&A,S
CAC	324	51%	2	3	CR,I&A,S
MiniSplit HP	726	12%	35	37	CR,I&A,S
Room AC	305	0%	305	305	CR
Smart Strips	10	0%	10	10	CR,I&A
Whole House Fan	0	n/a	0	0	PT
Electric Resistance Water Heaters	312	51%	2	1	CR,I&A,S
Solar Water Heaters	1	n/a	0	0	PT
ECM Fans	15	n/a	0	0	PT
MiniSplit AC	19	70%	1	1	PT
Pool Pump Motors	4	n/a	0	0	PT
Program Total	309,501	0.31%	299,967	299,982	
CR=Calculation Review, I&A=Invoice and Application Documentation Review, S=Survey, PT = Pass Through					
*Surveys for cross sector sales determination are conducted every other year. PY6 survey results are used for PY7.					

Table 3-3: PY7 Residential Energy Efficient Products Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation in Sample Design	Relative Precision at 85% C.L.
Upstream Lighting	22,320	123.3%	27,530	0.5	0.0%
Upstream Televisions	166	106.0%	176	0.5	0.0%
Refrigerators / Freezers	163	105.4%	172	0.5	24.0%
Upstream Computers/Monitors	50	100.0%	50	0.5	0.0%
Heat Pump Water Heaters	200	115.6%	231	1.0	43.6%
ASHP	40	593.3%	235	0.5	50.6%
Clothes Washers	282	84.4%	238	0.5	15.6%
GSHP	129	79.4%	102	1.0	50.7%
HVAC Tune-Ups	65	127.6%	83	0.5	35.9%
Dehumidifiers	461	77.1%	356	0.5	13.1%
CAC	51	117.0%	60	0.5	41.4%
MiniSplit HP	576	915.0%	5,268	0.5	11.5%
Room AC	2	75.7%	2	0.5	0.0%
Smart Strips	1	106.1%	1	0.5	0.0%
Whole House Fan	0	n/a	0	0.5	n/a
Electric Resistance Water Heaters	40	117.6%	47	0.5	71.9%
Solar Water Heaters	2	n/a	2	0.5	n/a
ECM Fans	7	n/a	7	0.5	n/a
MiniSplit AC	13	n/a	13	0.5	70.1%
Pool Pump Motors	3	n/a	3	0.5	n/a
Program Total	24,568	140.7%	34,573	n/a	1.8%

Table 3-4: PY7 Residential Energy Efficient Products Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation in Sample Design	Relative Precision at 85% C.L.
Upstream Lighting	2.25	103.9%	2.34	0.5	0.0%
Upstream Televisions	0.02	101.1%	0.02	0.5	0.0%
Refrigerators / Freezers	0.02	108.3%	0.02	0.5	24.0%
Upstream Computers/Monitors	0.01	100.0%	0.01	0.5	0.0%
Heat Pump Water Heaters	0.02	127.2%	0.02	1.0	43.6%
ASHP	0.00	1842.9%	0.07	0.5	50.6%
Clothes Washers	0.02	107.2%	0.03	0.5	15.6%
GSHP	0.02	86.4%	0.02	1.0	50.7%
HVAC Tune-Ups	0.07	69.8%	0.05	0.5	35.9%
Dehumidifiers	0.11	81.3%	0.09	0.5	13.1%
CAC	0.04	305.2%	0.12	0.5	41.4%
MiniSplit HP	0.94	31.5%	0.30	0.5	11.5%
Room AC	0.01	44.3%	0.00	0.5	0.0%
Smart Strips	0.00	0.0%	0.00	0.5	0.0%
Whole House Fan	0.00	n/a	0.00	0.5	n/a
Electric Resistance Water Heaters	0.00	122.5%	0.00	0.5	71.9%
Solar Water Heaters	0.00	n/a	0.00	0.5	n/a
ECM Fans	0.00	n/a	0.00	0.5	n/a
MiniSplit AC	0.02	n/a	0.02	0.5	70.1%
Pool Pump Motors	0.00	n/a	0.00	0.5	n/a
Program Total	3.56	87.2%	3.11	n/a	2.4%

3.2.2 On-Site Inspections

The program ICSP, Honeywell, conducts on-site inspections for rebated HVAC units. Honeywell randomly selects approximately 5% of rebated HVAC units for on-site inspections. Inspections are also performed on the first 2 installations by a newly enrolled contractor, units installed by a non-participating contractor, self-installs, and multiple unit installations. There are three possible outcomes of the on-site inspection:

Case 1: The reported HVAC unit is found to be installed as described in rebate application materials

Case 2: A new, efficient HVAC unit is found, but there are discrepancies related to specific model number, capacity, or efficiency of the unit

Case 3: No efficient HVAC unit is installed at the residence

The on-site inspections occur prior to rebate approval. The great majority (95%)¹³ of QA/QC inspections correspond to Case 1 above. Approximately 4% of on-site inspections result in a “Case 2” finding. In such cases, the application materials are updated to reflect the as-found equipment, and the rebate application is processed accordingly. This may involve an adjustment to the rebate amount, if the equipment is found to be in a higher or lower efficiency tier. If there is a failure to verify the equipment, the rebate application is not approved. Based on Honeywell’s historical records, this scenario occurs approximately 1% of the time.

¹³ Percentages here apply to all four FirstEnergy Pennsylvania EDCs.

3.3 IMPACT EVALUATION NET SAVINGS

In PY7, Tetra Tech conducted various market, process, and net impact evaluation activities for the upstream program component. Some of the activities, such as retailer interviews, general population interviews, and shelf stocking studies, helped to develop a market baseline, which may be used for net impact evaluation in Phase III. Retailer interviews and customer surveys also helped to estimate NTG ratios for upstream lighting and upstream electronics.

Tetra Tech conducted interviews with all retail chains that participate in the upstream lighting program. The corporate contacts were asked separately about CFLs and LEDs, and generally indicated higher free ridership for CFLs (30% free ridership) than for LEDs (10% free ridership)¹⁴. This is consistent with results from the shelf stocking study as well – nonparticipating retailers (specifically, retailers that participated in Phase I, but not in Phase II), tended to have comparable shelf space devoted to CFLs as program participants. However, program participants tended to devote 30% of shelf space to LEDs, while non-participants devoted just 5% to LEDs. Tetra Tech also conducted a general population survey, with 500 completed surveys across the four FirstEnergy PA EDCs. Out of 500 completed surveys, only six participants had (1) made a lighting purchase from a participating store in the last year and (2) recalled that the lamp was “bought down” by the utility company. The customers, on average, reported 37% free ridership for LEDs, and 50% free ridership for CFLs. Spillover assessment was not attempted because the retailers cannot speak specifically to how the program influences customers’ actions related to energy efficiency, while the number of completed participant responses was limited. Despite the small sample size, when combined with the retailer interviews, the results indicate that the 50% NTG rate planning assumptions used in FirstEnergy’s Phase III Energy Efficiency and Conservation plans are likely to be conservative.

As a final step in net evaluation activities, ADM performed parametric cost effectiveness tests with variable NTG ratios and confirmed that the program can be cost effective with NTG ratios as low as 30%, and perhaps even lower in Phase III as the incremental cost of LEDs decreases over time.

Tetra Tech conducted interviews with both retail chains that participate in the upstream electronics program. The corporate contacts were asked separately about Televisions and Computers/Monitors, and indicated higher free ridership for computers and monitors (75% free ridership) than for Televisions (50% free ridership). Spillover assessment was not attempted because the retailers cannot speak specifically to how the program influences customers’ actions related to energy efficiency, while the number of completed participant responses was limited. The weighted net to gross ratio for upstream electronics is nearly identical to that of televisions, because the gross impacts are almost entirely attributable to upstream televisions. This NTG ratio is higher than the Company’s planning assumption of 32%, and the measures are cost effective, in part due to the low incremental costs.

The NTG research for the downstream program components was conducted in conjunction with the process evaluation effort for the PY6 sample frame.

The program level free ridership, spillover, and NTG values in Table 3-5 represent populations that span more than one program year. We weighted NTG results by Phase III gross lifetime MWh savings to report

¹⁴ This is consistent with results from the shelf stocking study. Nonparticipating retailers (specifically, retailers that participated in Phase I, but not in Phase II), tended to have comparable shelf space devoted to CFLs as program participants (23% vs. 15%). However, program participants tended to devote 30% of shelf space to LEDs, while non-participants devoted just 5% to LEDs.

program level net-to-gross ratios. Phase III lifetime MWh was selected as the weighting factor because it aligns best with the total resource cost test benefits stream.

Table 3-5: Energy Efficient Products Program Sampling Strategy for Program Year 7 NTG Research

Stratum	Population Size ¹⁵	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ¹⁶ to Achieve Sample
Upstream Lighting	>250,000 customers ¹ 5 retail chains	0.5	85/15	20 participants 5 retail chains	6 participants 5 retail chains	participants: 53% (6,373 of 12,000) retail chains: 100%
Upstream Electronics	>20,000 customers ¹ 2 retail chains	0.5	85/15	2 retail chains	2 retail chains	100%
HVAC & Water Heating ²	673	0.5	85/15	70	65	37%
Appliance ²	5,806	0.5	85/15	70	66	4%
Program Total	counts not additive		85/15	counts not additive	counts not additive	counts not additive

1. Upstream programs do not track individual participants. The initial sample frame was a list with contact information for 12,000 randomly selected participants across the four FirstEnergy PA Companies.

2. These results are from the PY6 NTG effort, and are included here with PY7 results for completeness.

Table 3-6: Phase II Energy Efficient Products Program Summary of Evaluation Results for NTG Research

Target Group or Stratum	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Upstream Lighting	31.9%	n/a	68.1%	0.50 ¹	17.9%
Upstream Electronics	50.4%	n/a	49.6%	0.50 ¹	0.0%
HVAC and Water Heating	58.9%	13.3%	54.4%	0.37	6.6%
Appliances	52.0%	3.7%	51.7%	0.35	6.2%
Program Total¹⁷	37.6%	2.12%	64.5%		14.4%

1. The CV for retailers is not needed since a census was completed. The number of participant completes is too small for a useful CV calculation A CV of 0.5 is applied.

3.4 PROCESS EVALUATION

PY7 process evaluation activities included in-depth interviews with participating retailers in the upstream lighting and electronics programs, along with on-site visits to retailers.

¹⁵ The values in this column represent the population as of the time that the process and NTG samples were drawn, and are generally smaller than the end-of-year values shown in the gross impact evaluation tables above.

¹⁶ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

¹⁷ NTG ratio at program level is developed with Phase II lifetime MWh values for stratum level weights. We selected Phase II MWh, as opposed to MWh values from any one program year, because the weighting factor because the NTG studies spanned different program years. Lifetime MWh is selected because this metric aligns best with the Act 129 TRC benefits stream.

Table 3-7: Energy Efficient Products Program Sampling Strategy for Program Year 6/7

Target Group or Stratum	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities
Upstream Lighting	>250,000 customers ¹ 5 retail chains	0.5	85/15	20 participants 5 retail chains	6 participants 5 retail chains	participants: 53% retail chains: 100%	Process, NTG
Upstream Electronics	>20,000 customers ¹ 2 retail chains	0.5	85/15	2 retail chains	2 retail chains	1	Process, NTG
HVAC and Water Heating	673	0.5	85/15	70	65	37%	Process, NTG
Appliances	5,806	0.5	85/15	70	66	4%)	Process, NTG
Program Total	counts not additive		85/15	counts not additive	counts not additive	counts not additive	Process, NTG

1. Upstream programs do not track individual participants. The initial sample frame was a list with contact information for 12,000 randomly selected participants across the four FirstEnergy PA Companies.

Key Findings

Program Marketing

1. All corporate-level contacts said at least some of their stores have held program-sponsored in-store events. Consistent with the shelf-stocking study findings, most local store managers reported having program signage and/or price stickers displayed in their stores. Local store managers also consistently report speaking with customers about lighting specs, energy efficiency, and non-energy benefits.
2. Feedback indicates that the level of program marketing activity varies by retail chain as well as individual store locations within the same chain.

Program Operations and Interactions with Program Staff

1. Lighting participants specifically commented on the breadth of eligible measures and continuity on the program.
2. *Keeping up with the market:* One interviewee said that he/she would like to see the program be more open to mid-year changes (e.g., equipment eligibility) to respond to the rapidly changing lighting market. Another interviewee thought that they may be opportunities for the program to further leverage the market intelligence of participating retailers and manufacturers to adapt program design (e.g., equipment eligibility) and customer marketing efforts to changing market trends.

Program Satisfaction

1. Participating retail contacts unanimously reported positive interactions with program staff. All corporate-level contacts reported working closely with the program's implementer.
2. Participating retailer contacts were asked to rank their satisfaction with FirstEnergy's program on a 1 to 5 scale, where 1 was very dissatisfied and 5 was extremely satisfied. Overall, participants reported high satisfaction with program. On average, Lighting retailers gave a rating of 4.2 (n=11), while Consumer Electronics retailers gave an average rating of 4.8 (n=2)

Shelf Space and Product Promotion

In participating stores, approximately 55% of lighting shelf space is devoted to incandescent lamps, 15% to CFLs, and 30% to LEDs. In stores that participated in the Phase I upstream CFL program, but did not participate in the Phase II program, 72% of lighting shelf space is devoted to incandescent lamps, 23% to CFLs, and 5% to LEDs. Participating stores are preferentially placing LEDs in more prominent locations such as end caps and in standalone displays.

Process evaluation activities for the EEP downstream measure categories were concluded in PY6. These included participant surveys, and in-depth interviews with FirstEnergy staff, program implementer staff, and HVAC contractor trade allies. The evaluation team conducted the following activities:

FirstEnergy and Program Implementer Staff In-depth Interviews

Tetra Tech and ADM conducted in-depth interviews with program staff at FirstEnergy to discuss Phase II design and implementation updates, program goals, and key researchable issues of interest for the Phase II evaluation. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics.

Participating Customer (Household) Surveys

Tetra Tech conducted a quantitative participant survey effort by phone and by web for this evaluation for the Year 5 (PY5) sample frame. The surveys collected feedback on the following key researchable areas:

- Program infrastructure and participating household satisfaction
- Program communication and processes
- Free-ridership and spillover
- Demographics.

Participating HVAC Contractor Web Surveys and In-depth Interviews

The focus of the contractor web survey was to assess how the program is working for contractors from their perspectives. The following key researchable areas were assessed:

- Program Infrastructure and participating contractor satisfaction
- Program communication and processes
- Program influence
- Firmographics.

Contractors were selected at random from the list of participating contractors provided by the ICSP and 51 contractors completed the web survey. We also completed four in-depth interviews with participating contractors.

Key Findings from the PY6 process evaluation effort are listed below.

Participating Households

1. Participants are highly satisfied with the program overall with a mean score greater than 4 on a 1-point to 5-point scale. Most HVAC and Appliance subprogram components also had a mean score of 4 or higher on this scale.
2. Almost half of participants in the Appliance subprogram are hearing about program rebates from the retailer and about half the HVAC subprogram participants are hearing about program rebates from the contractor. When asked to identify several preferred methods to hear about programs in the future, customers identified utility mail and web contact as the most preferred approaches, with 76 percent and 34 percent support respectively.

3. Participants largely understand program eligibility requirements, but about 7 percent of HVAC participants do not understand the HVAC tune-up or heat pump requirements.

Participating program contractors (HVAC subprogram only)

1. Contractors have a slightly lower mean score for overall program satisfaction (3.7) than program participants. Contractors scored their mean satisfaction the lowest on Technical Support (3.1) and Program Training (3.1). In-depth interviews with contractors suggested they prefer to receive program information through more personalized means, such as one-on-one meetings or direct calls with their ICSP representative. Contractors value these one-on-one program interactions with their ICSP representative.
2. Twenty percent (11) of surveyed contractors rate the paperwork requirements as “difficult” and eight percent (4) voiced concern about the time between their submission of rebate paperwork and the notification when the ICSP determined that paperwork submitted was incomplete and required contractor follow-up.
3. Only about half of the contractors responding to the survey report receiving the contractor newsletter and only three were aware of the ICSP contractor portal.

Contractors are the primary vehicle for communicating the HVAC subprogram to customers. Nearly half of the HVAC participants report hearing about the program from their contractor; contractors estimate less than 25 percent of their customers know about the program before he or she introduces the customer to program options.

3.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort.

Table 3-8: Energy Efficient Products Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Review rebate paperwork processes to identify opportunities to streamline documentation requirements and notify contractors and/or customers more quickly if project documentation is incomplete.	Implemented for Phase III
Increase one-on-one communication and improve response time between participating program contractors and their ICSP representative.	Implemented for Phase III
Use one-on-one communication to increase contractor awareness of program communication tools – such as the newsletter and/or portal – that already exist.	Implemented for Phase III
Consider annual or bi-annual calls or meetings with participating contractors – in lieu of or in addition to webinars – to provide specific information on program offerings and/or changes that are relevant to them, and provide the opportunity for contractor feedback.	Implemented for Phase III
Continue to use individual Appliance and HVAC subprogram NTG ratios during planning, rather than the overall program NTG ratio.	Implemented
For upstream lighting, report lamp source type, lamp type, wattage, lumens in the T&R system.	Implemented for Phase III
Remove the EDC name from equipment descriptions	Implemented for Phase III
Continue to engage participating retailers in program design, implementation, and marketing efforts.	Implemented
Continue direct marketing and outreach efforts to customers, as well as cross-marketing such as retailer displays and signage, to further increase awareness of FE programs	Implemented
Consider additional outreach efforts to inform customers of the energy and non-energy related benefits of program-qualifying LED bulbs.	Implemented for Phase III
Review rebate paperwork processes to identify opportunities to streamline documentation requirements and notify contractors and/or customers more quickly if project documentation is incomplete.	Implemented for Phase III
Increase one-on-one communication and improve response time between participating program contractors and their ICSP representative.	Implemented for Phase III

3.6 FINANCIAL REPORTING

A breakdown of the program finances by program is presented in Table 2-9.

Table 3-9: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 through 4)	\$4,141	\$11,150
2	EDC Incentives to Participants	\$1,404	\$3,779
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$2,737	\$7,371
5	Program Overhead Costs (Sum of rows 6 through 10)	\$1,116	\$3,651
6	Design & Development	\$12	\$30
7	Administration, Management, and Technical Assistance ^[1]	\$861	\$2,923
8	Marketing ^[2]	\$82	\$323
9	EDC Evaluation Costs	\$154	\$276
10	SWE Audit Costs	\$6	\$98
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$5,257	\$14,801
13	Total NPV Lifetime Energy Benefits	\$15,539	\$37,164
14	Total NPV Lifetime Capacity Benefits	\$1,211	\$3,218
15	Total NPV TRC Benefits ^[4]	\$16,750	\$40,383
16	TRC Benefit-Cost Ratio ^[5]	3.19	2.73
NOTES			
Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.			
[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.			
[2] Includes the marketing CSP and marketing costs by program CSPs.			
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.			
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.			
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.			

4 RESIDENTIAL HOME PERFORMANCE PROGRAM

Through the Residential Home Performance Program, customers were incentivized to improve the energy efficiency performance of their homes. The Home Performance Program includes a whole house direct install subprogram, direct delivery of energy conservation kits (including a new school education component), efficient residential new home construction, and home energy reports. Through the whole house direct install subprogram, customers receive diagnostic assessments, followed by the direct installation of low-cost measures or incentivized installation of building shell measures. Customers that received energy efficiency kits either completed an online audit, phone audit, or submitted an online or telephonic request. The New Homes subprogram provides incentives to builders that choose to build new homes to higher efficiencies through the installation of efficient building shell measures, HVAC systems, appliances, lighting, or other features. Home energy reports provide customers with comparative electric energy usage data and offer tips and advice on behavioral and energy saving measures.

4.1 PROGRAM UPDATES

There were no significant changes to this program during PY7. The schools education and conservation kit sub-program was not operated in PY7.

4.1.1 Definition of Participant

The participant counts for this program are determined based on the unique customer receiving a kit or the unique rebate number in the T&R database for the other program components.

4.2 IMPACT EVALUATION GROSS SAVINGS

The gross evaluation methodology for each program component is discussed below.

4.2.1 Evaluation Methodology

Gross Impact Evaluation for Home Energy Audit Conservation Kits

Two separate types of energy conservation kits were sent to customers depending on their hot water fuel source. The kit provided to customers with electric water heating consists of CFLs, LED night lights, aerators and aerator adapters, a furnace whistle, and an energy saving showerhead. The kit provided to customers with non-electric water heating consists of CFLs, LED night lights, a furnace whistle.

In evaluating the gross impact analysis for the energy conservation kits in PY7, four items must be determined:

1. The average energy savings and demand reduction for the kit elements that are installed;
2. The number and type of kits mailed to customers during PY7;
3. The installation rate for the various kit elements;
4. The delivery rate, or percentage of reported kits sent to customers that were not received by customers, either because of shipping problems, customer moving, or other such scenarios.

The first item has been determined through application of the partially deemed savings protocols in the 2015 TRM. The second item, the total number and type of kits mailed to customers in PY7, is determined by reviewing the program T&R system.

The third item, installation rates, are determined through online customer, except for CFLs which are given “deemed” installation rates of 0.97 (later multiplied by the kit receipt rate as determined through surveys), consistent with the TRM.

For a particular site in a sample, the installation rate for each kit element takes on a binary value of 1, if the element is installed in accordance to the principles that define that element as an energy efficiency

measure, and 0 otherwise¹⁸. In particular, faucet aerators and energy saving showerheads are only counted as “installed” if they are installed in a home that has electric water heating.

The final item, the delivery rate is determined through the online and phone survey instrument. Online and phone survey respondents are asked to indicate whether they received the conservation kit that was mailed to them. The reported in-service rates reflect the kit non-receipt rate as they are calculated as the ratio of the number of items installed to the number of items claimed to be delivered.

The survey instrument that was used to verify that the shipped energy conservation kits were installed asks a series of questions that determine how many of each item was installed and where each item was installed. The accuracy of the survey instrument was verified in prior program years through supplementary on-site data collection activities of a nested sample of the survey respondents. The results of this analysis indicate that the variance in savings attributable to this program is primarily a result of installation rates. This variance is best captured in the survey instrument, as it allows for a large sample size not easily obtained through on-site data collection. As with the Low-Income kits and the Schools kits, the average kit receipt rates and measure-level in service rates are closely correlated across all four FirstEnergy PA EDCs. EDC-specific variations are explicable primarily due to statistical variation in survey responses, which may account for a $\pm 10\%$ uncertainty in final verified impacts at the EDC-level. Due to this, average statewide in service rates are used for all four FirstEnergy EDCs. This reduces the likelihood that one particular EDC will receive an unusually high or low realization rate due solely to statistical fluctuations, and is generally consistent with the PA TRM’s treatment of in-service rates, which are uniform across the state. The statistical precision for this program component is based on the EDC-specific number of customers that completed survey responses.

Gross Impact Evaluation for New Homes

This program contributes a relatively small portion of the program level savings for PY7. For the PY7 evaluation, ADM focused on conducting engineering reviews of a sample of projects. The engineering review involved inspection of the REM/Rate models associated with the rebated buildings. For each sampled home, ADM analysts ran the REM/Rate input files and made the following considerations:

1. Are the baseline specifications in accordance to those in the 2015 PA TRM?
2. Are the claimed impacts attributable to improved construction practices and premium efficiency HVAC systems and appliances, or do they result from modifications that are not supportable by the PA TRM¹⁹
3. Is the REM/Rate modeling performed correctly and does it provide accurate results²⁰?
4. Are the participating HERS raters accurately describing the homes in the REM/Rate models and HERS ratings?

The first three topics can be resolved through a REM/Rate model review. To determine the correspondence of the model inputs to actual building characteristics, ADM reviews detailed notes,

¹⁸ LED night lights are the only exception to this rule. If a nightlight is reported to be installed, the night light ISR may take on a value of 1 if the night light replaces a preexisting incandescent model, a 0 if the night light is a new installation, and a 0.5 if the customer reports to have installed the nightlight, but does not specify whether it supplanted an incandescent night light.

¹⁹ For example, it would not be appropriate to claim energy savings based on differences in the ‘reference’ and ‘as built’ models’ thermostat settings, or by virtue of using different heating or cooling degree days in the two models.

²⁰ There can be relatively minor variations in savings because the HERS raters may have different versions of REM/Rate. ADM used versions 14.6.3 and 15.1 to conduct the simulations for model reviews.

photographs, and measurements from the ICSP's on-site Quality Assurance/ Quality Control (QA/QC) inspections, and also from ADM's own data collection during coordinated QA/QC visits.

For each sampled project, ADM recalculates energy and demand impacts if the above steps result in adjustments to model parameters.

During the course of the PY7 evaluation, there were two versions of the REM/Rate software that were recommended for use by the software manufacturer: 14.6.3 and 15.1. Most of the models were created in a 14.6 version of REM/Rate. We found moderate (approximately 20%) differences in the energy savings outputs developed under the two alternate versions. One software version attempted to simulate baseline duct leakage directly, whereas the other version estimated duct efficiencies through application of a scalar system delivery efficiency adjustment. To reduce the chance of modeling bias, we simulated each sampled home in both versions of the software, and took the average of the two energy savings outputs as the verified impacts.

Gross Impact Evaluation for Whole House Direct Install Measures

This program component is divided into three sub-components for evaluation purposes. Most participants in the direct install component receive an initial home audit which includes installation of low-cost measures by the auditor. The auditor may also recommend capital cost energy savings improvements, and a relatively small number of customers follow through with comprehensive measures that include attic insulation, air sealing, and replacement of HVAC and water heating equipment. Most of the impacts associated with whole house component are attributable to measures such as CFLs, low-flow showerheads and faucet aerators, and hot water pipe insulation. For these "light measures", ADM reviewed a sample of applications and invoices were reviewed for accuracy and also reviewed the T&R system to verify that the proper TRM algorithms are applied. Customers that received comprehensive measures were placed into two savings strata: Those with reported savings above 2.0 MWh and those with reported savings below 2 MWh. ADM performed an exploratory billing analysis for the former set. The main intention of the billing analysis is to provide a feasibility check against a small number of customers that are reported to save well over 5 MWh. Although the small sample size results in significant uncertainties in the billing analysis results, the main conclusion for the high-savings homes is that the apparent bill reductions are large and significant, but are also somewhat lower than reported savings amount. The second stratum of comprehensive measure customers - those with savings below 2 MWh, account for about one *per mil* of reported program savings. The reported impacts for these customers are passed through to verified impacts.

Gross Impact Evaluation for Home Energy Reports

The gross impact evaluation for the Home Energy Reports subprogram has four components, each described below.

Data Preparation and Validation

The majority of FirstEnergy's service territories rely on traditional meter reads, which require a technician to record a customer's metered usage. Due to environmental and resource restrictions, it is not feasible for actual meter data to be obtained on a monthly basis. In order to accommodate these restriction, FirstEnergy generates an estimated metered read based on load shapes and customer's historical usage. The customer's subsequent metered bill then features an adjustment factor to accommodate for any differences between the estimated read and the actual read.

As part of the data preparation process, ADM has corrected for estimated reads and adjusted actual reads by using the "true-up" process. For each metered read and all estimated reads immediately preceding it,

ADM totals the billed usage and number of days in the billing period. The total billed usage for that cumulative period is then divided by the total number of days to generate an average usage per day value. This average usage per day value is then multiplied by the number of days in each individual bill's billing period in order to generate a corrected usage value. Because the number of estimated reads per actual read is not consistent, the number of estimated reads prior to the first actual read in the provided dataset cannot be assumed. Therefore, the first metered read and all estimated reads preceding it in the dataset are filtered from the dataset. Similarly, estimated reads that do not have a corresponding actual read (generally towards the tail end of provided billing data) shall also be excluded from analysis.

As a second step in the preparation and validation process is calendarization. Billing periods for customers do not fall on consistent dates between participants. Calendarization is required to synchronize the time series variables for all customers. In the calendarization process, each day of the month is assigned the average daily usage from the billing period that the day resides in. The daily energy usages are then summed up for each month to result in synchronized monthly time series data.

As a last step in this process, outliers are filtered from the data set—with outliers being defined as months where average daily usage exceeds 300 kWh or is less than -300 kW.

Equivalence Testing

The program is implemented as a randomized control trial. Each 'wave' of participants is assigned its own control group. We test that the household energy usage patterns for treatment and control groups are similar during the pre-treatment period. ADM conducted equivalence testing of pre-treatment data for each cohort and verified that the control and treatment groups are not statistically different at the $p < 0.10$ level (90% confidence level).

Regression Analysis

We use a lagged seasonal (LS) model specified in the equation below:

$$kWh_{i_{my}} = \beta_0 + \sum_{m=1}^{12} \sum_{y=2011}^{2021} I_{my} * \beta_{mys} * (AvgPre_i + AvePreSummer_i + AvePreWinter_i) + \sum_{m=1}^{12} \sum_{y=2011}^{2021} I_{my} * \tau_{my} * treatment_{i_{my}} + \varepsilon_{i_{my}}$$

Equation 4-1. Formula specifying the lagged seasonal regression model.

The terms in Equation 4-1 are described in Table 4-1 below.

Table 4-1. Definition of variables in the lagged seasonal regression model.

Variable	Definition
kWh_{imy}	Customer i 's average daily energy usage in bill month m in year y .
β_0	Intercept of the regression equation.
I_{my}	An indicator variable equal to one for each monthly bill month m , year y , and zero otherwise.
β_{mys}	The coefficient on the bill month m , year y indicator variable interacted with season s .
$AvgPre_i$	Average daily usage for customer i in the pre-treatment period.
$AvePreSummer_i$	Average daily usage for customer i in the pre-treatment period during June through September.
$AvePreWinter_i$	Average daily usage for customer i in the pre-treatment period during December through March.
$treatment_{imy}$	The treatment indicator variable. Equal to one when the treatment is in effect for the treatment group. Zero otherwise. Always zero for the control group.
τ_{my}	The estimated treatment effect in kWh per day per customer; the main parameter of interest.
ϵ_{imy}	The error term.

The regression coefficient of the treatment multiplied by the number of days in its corresponding month and the number of customers in the treatment group in that month generates the monthly kWh savings. The savings is summed across the different participant waves and months in PY7 to generate a total savings value for the subprogram.

Adjustments for Dual Participation

Participants in both the treatment and control groups may participate in other subprograms. The "Home Energy Report" measure received by participants in the treatment group may cause these participants to seek out other programs and measures offered in the FirstEnergy efficiency portfolio to a greater extent than the control group. To the extent that the treatment group participates in other FirstEnergy programs at a rate above and beyond that of the control group, that savings will be reflected in the gross energy savings calculated using the method above. However, savings for these items will also have been attributed to their respective programs and subprograms.

For downstream measures, we conduct a review of the tracking and reporting system for each participant wave to identify instances of control and treatment group accounts that have received other measures in the residential portfolio from the treatment start date to the end of the program year being evaluated (e.g. for the first wave of Phase II participants, we include data from PY4 of Act 129 onward). We calculate the average verified Act 129 energy savings per day in the post treatment period for the control and treatment groups, and make a corrective subtraction in cases where the savings are greater for the treatment group than the control group. Although participation rates for upstream lighting are not known for the two groups, ADM made corrections for potential dual participation in upstream programs according to the guidance provided in the Phase II evaluation framework

Determination of Peak Demand Savings

We used load shape disaggregation to determine peak demand savings. We modeled the monthly energy savings profile as a linear combination of two basic load shapes: interior lighting and heat²¹. Once the weights of the two shapes are determined, then the peak demand reduction is estimated by taking the average of the weighted load shape elements over all Act 129 peak hours.

4.2.2 Program Sampling

The four program components are treated as separate sub-programs, each with distinct populations, samples, and realization rates.

Home Energy Audit Conservation Kits

The sampling approach for the Home Energy Audits energy conservation kits program component is random sampling. Randomly selected customers are invited to complete online surveys, with gift cards offered to the first 50 to complete surveys.

Stratification by kit type was done to ensure that appropriate realization rates are determined for the two individual kit types. The sample size for verification surveys was sufficiently large to determine gross impact with $\pm 10\%$ relative precision at the 90% confidence level. This large sample size is motivated by the fact that installation rates for some items in the kit are relatively low that only a large sample can accurately capture a true estimate of the installation rate. This is the main advantage of a survey instrument as compared to on-site data collection for this program.

New Homes

The sampling approach for this program is simple random sampling. The sample size is sufficient to determine this program's gross impact with $\pm 35\%$ relative precision at the 85% confidence level. ADM sampled homes that have been selected for quality control inspections by the program implementer. It is important to note that the implementer does not overwrite the energy savings for homes that undergo the QC process. This facilitates ADM's evaluation effort because the both the ex-ante savings estimates before and after the QA/QC process are both available. The program's realization rates generally use the ex-ante values that were available prior to QA/QC in the denominator.

Whole House Direct Install

There were very few whole house projects completed in PY6. As described in the methodology section, the projects under this program component are placed into three categories. Projects that solely involve low-cost measures are tracked by measure in the T&R system, and ADM performs calculation review on the census of projects. Comprehensive upgrade projects are placed into two strata, with the high-savings stratum evaluated by billing analysis, and the low-savings stratum evaluated through a T&R system review²².

Home Energy Reports

Sampling is not required for this program's evaluation. Essentially all participant and control group households are considered by the billing analysis

²¹ Initially, we included additional load shapes but observed significant collinearity between some load shapes, and therefore reduced the overall number of load shapes to two.

²² This evaluation stratum accounts for less than 0.02% of program impacts.

Table 4-2: Phase II Residential Home Performance Program Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives Paid (\$1,000)
Residential	408,491	97,658	10.11	7,382
Low-Income	0	0.0	0.00	0
Small Commercial and Industrial	0	0.0	0.00	0
Large Commercial and Industrial	0	0.0	0.00	0
Gov., Non-Profit, and Institutional	0	0.0	0.00	0
Phase II Total	408,491	97,658	10.11	7,382

Table 4-3: Residential Home Performance Program Sampling Strategy for PY7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
HEA Kits	44,322	5.1%	200	160	CR,S
School Kits	n/a	n/a	n/a	n/a	n/a
New Homes	41	40.0%	3.00	3	CR,DR,SV
Direct Install, Prescriptive Measures	67	31.0%	5	3	CR
Weatherization, > 2MWh	5	0.0%	5	1	BA
Weatherization, < 2MWh	2	0.0%	2	1	PT
Home Energy Reports	251,444	15.0%	251,444	251,444	BA, DR
Program Total	295,881	10.2%	251,659	251,612	

CR=TRM Calculation Review, S=Survey, DR/OS=Desk Review of REM/Rate Models, On-Site QA/QC findings, PT=Pass Through to Verified, BA=Billing Analysis.

Table 4-4: PY7 Residential Home Performance Program Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
HEA Kits	17,204	101.2%	17,405	0.5	5.7%
School Kits	n/a	n/a	n/a	n/a	n/a
New Homes	142	87.6%	125	0.5	40.0%
Direct Install, Prescriptive Measures	53	115%	60	0.5	40.6%
Weatherization, > 2MWh	77	10%	8	0.5	64.4%
Weatherization, < 2MWh	2	100%	2	0.5	50.9%
Home Energy Reports	35,443	93.3%	33,060	n/a	4.9%
Program Total	52,921	95.7%	50,660		3.8%

Table 4-5: PY7 Residential Home Performance Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
HEA Kits	1.56	105.3%	1.64	0.5	5.7%
School Kits	n/a	n/a	n/a	n/a	n/a
New Homes	0.02	170.2%	0.04	0.5	40.0%
Direct Install, Prescriptive Measures	0.01	110%	0.01	0.5	40.6%
Weatherization, > 2MWh	0.13	10%	0.01	n/a	100.0%
Weatherization, < 2MWh	0.00	100%	0.00	0.5	50.9%
Home Energy Reports	5.40	67.5%	3.64	n/a	4.9%
Program Total	7.11	75.1%	5.34		3.8%

4.2.3 On-Site Inspections

The ICSP for the Residential Energy Audits and New Homes program components, Performance Systems Development (PSD) conducts on-site QA/QC inspections for both program components. The QA/QC processes for each component is described below.

Whole House Comprehensive Audits

The intent of QA/QC inspections is to ensure work performed under FirstEnergy's Residential Energy Audit Program conforms to program requirements and BPI technical standards related to health and safety requirements, improvement installation, and energy efficiency analysis. PSD reviews all electronic files submitted to the program by participating contractors. PSD also conducts a variety of onsite assessments for each contractor throughout the program year:

- SA = Shadow Audit with contractor during audit for 1 of first 5 audits for program
- QC = Quality Control inspection performed post-audit prior to installation for 5% of audits
- QA = Quality Assurance inspection performed post-installation of major measure improvements for 10% of jobs

Substantial issues found during an electronic file review or an onsite assessment will lead to increased inspection levels for the associated contractor. PSD assigns a QA score that ranges from 0 to 4, with "0" requiring immediate corrective action and "4" given to jobs that meet or exceed all required standards.

PSD's QA/QC site visit reports contain Pass or Fail scores in the following broad categories:

- Verification of Direct-Install Measures
- Review of auditor recommendations
- Building model accuracy
- Health and safety

ADM reviewed 29 QA/QC visit inspection forms from PSD, distributed among the four FirstEnergy PA Companies and found that 27 of them resulted in general verification of measure installation²³. The average AQ/QC score for these 29 sites was 3.6 on a scale of 0 to 4.

ADM determines in-service rates for measures from these QA inspections, and also attempts billing analyses for all projects with gross reported annual energy savings above 2.0 MWh.

Residential New Homes

The intent of QA/QC inspections is to ensure work performed under FirstEnergy's Energy Efficient New Homes Program conforms to program requirements and RESNET standards for energy efficiency analysis. PSD reviews all electronic rating files (including REM-Rate simulation models) submitted by participating raters and conducts on-site QA inspections of at least 10 percent of each rater's submissions. PSD conduct two types of onsite inspections.

- Visual Inspections – Inspection focuses on RESNET minimum rated features including, but not limited to, building dimensions; insulation type and thickness (where accessible); fixture lighting types; appliance efficiencies; and mechanical equipment efficiencies for 8% of all annual submissions. The high frequency of inspections leads to program visibility and opportunities for program participant interaction with PSD technical staff.
- Diagnostic Inspections—Inspections are comprehensive and include visual inspection components as well as building performance measurements using a blower door, duct pressurization, and ventilation airflow devices for 2% of all annual submissions. The lower frequency of inspections allows for a deeper evaluation of performance testing criteria.

Substantial issues found during electronic file review or on-site inspection will lead to increased levels of QA for the associated contractor. PSD assigns a QA score that ranges from 0 to 4, with "0" requiring immediate corrective action and "4" being given to jobs that meet or exceed all required standards.

PSD's QA/QC site visit reports contain Pass or Fail scores in the following broad categories:

- Non-compliance with program standards
- Building model accuracy

ADM reviewed a total of 73 QA/QC site inspection reports from PSD, distributed among the four FirstEnergy PA Companies. The average AQ/QC score for these 73 sites was 3.0 on a scale of 0 to 4. Importantly, PSD retains both initial and post-QC reported impacts for each home. This enables ADM to include the results of PSD's on-site QA/QC findings in the gross impact evaluation effort.

4.3 IMPACT EVALUATION NET SAVINGS

Net impact evaluation activities were completed in PY6 for all program components except for residential New Homes. A formal net impact evaluation is not conducted for New Homes because, on one hand, the subprogram represents a small fraction of overall savings and budget²⁴, yet on the other hand, the subprogram is known to have a total resource cost test below 1.0, even if the NTG is 100%. The focus turned to process evaluation, and the possibility of increasing cost effectiveness through growing the

²³ It is important to note that a "Pass" score is awarded only if the entirety of the project is verified. ADM found examples of inspections where measures such as insulation and duct sealing were verified, but CFLs were not found to be installed. ADM would categorize this job as "mostly installed" while PSD gave the contractor a failing score. The QA/QC process for the Residential Energy Audits does not affect or inform the gross realization rate for the program, as ADM's verified impacts are based on calculation reviews and billing analyses.

²⁴ We used a 50% NTG value for this program component and take a 100% relative precision. Any value between 0% and 200% would not affect the overall program NTG ratio in a significant manner.

program. The program is redesigned for Phase III, and will endeavor to include more housing types including manufactured housing, multi-family housing. The net impact sampling scheme from PY6 is shown below.

Table 4-6: Residential Home Performance Sampling Strategy for PY6 NTG Research

Stratum	Population Size ²⁵	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ²⁶ to Achieve Sample
Residential In-Home Audit	40	0.5	85/15	12	22	100%
Online Audit	2053	0.5	85/15	35	41	6%
Opt-In Kit	30,730	0.5	85/15	35	33	<1%
School Kit	940	0.5	85/15	35	31	12%
New Construction	2	0.5	85/100	0	0	n/a
Home Energy Reports	251,444	0.5	census	census	census	100%
Program Total	285,209		85/15	117	127	0.0%

The program level free ridership, spillover, and NTG values in Table 4-7 are weighted by Phase III gross lifetime MWh savings to report program level net-to-gross ratios. Phase III lifetime MWh was selected as the weighting factor because it aligns best with the total resource cost test benefits stream.

Table 4-7: Phase II Residential Home Performance Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation	Relative Precision
HEA Kits	39.9%	4.9%	65.0%	0.50	8.4%
School Kits	37.0%	3.0%	66.0%	0.35	9.1%
New Construction	50.0%	0.0%	50.0%	n/a	100.0%
In-Home Audits	40.0%	60.0%	120.0%	0.27	8.3%
Home Energy Reports	0.0%	0.0%	100.0%	n/a	0.0%
Program Total²⁷	33.9%	4.2%	70.3%		6.4%

4.4 PROCESS EVALUATION

Most process evaluation activities occurred during PY6, with the exception of participant surveys in PY5 for the first wave of the Home Energy Report program component, and homebuilder and rater interviews for the New Construction program in PY7. The quantities in Table 4-8 represent activities conducted throughout Phase II.

²⁵ The values in this column represent the population as of the time that the process and NTG samples were drawn, and are generally smaller than the end-of-year values shown in the gross impact evaluation tables above.

²⁶ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

²⁷ NTG ratio at program level should be developed using stratum weight and stratum NTG ratios.

Table 4-8: Residential Home Performance Sampling Strategy for Phase II

Target Group or Stratum (if appropriate)	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
Residential In-Home Audit	40	0.5	85/15	12	22	55%	Process, NTG
Online Audit	2,053	0.5	85/15	35	41	2%	Process, NTG
Opt-In Kit	30,730	0.5	85/15	35	33	<1%	Process, NTG
School Kit	940	0.5	85/15	35	31	3%	Process, NTG
New Construction	103	0.5	85/15	14	14	14%	Process
Home Energy Reports	251,444	0.5	85/100	300	309	<1%	Process
Program Total	not additive		85/15	not additive	not additive	not additive	Process, NTG

Process evaluation findings and results for most program components are discussed in previous reports. Results from the PY7 Residential New Construction process evaluation follow.

Key Findings

Builders Perspective

1. Builders project the New Homes market will remain the same or experience modest growth in the next year.
2. All participating builders interviewed are building homes they believe qualify for the program; however, they are time-challenged to complete the rebate paperwork
3. Non-participating builders that are still in the residential market site reasons such as high incremental costs or excessive documentation associated with qualification for program incentives
4. Non-participants or past participants still hold interested in possible program participation
5. Participating builders rate their overall satisfaction of three on a one-to-five scale. They view the relationship & one-on-one support from PSD favorably. Sources of dissatisfaction include the paperwork and logistical burdens associated with the application process – particularly coordination with HERS raters, and the time lag between application submittal and rebate arrival.
6. All six participating builders reported they observe that the value of the ENERGY STAR New Home Certification is declining; many report creating their own Energy Efficiency packages

HERS Raters Perspective

1. Raters are satisfied with the program; the mean score of 4 raters on a 1 to 5 scale is 4.
2. Raters' satisfaction with PSD, in particular, is very high.
3. Raters uniformly indicate their biggest program challenge is appealing to builders about their service value

All interviewees predicted that their rating business would stay the same or grow within the upcoming months. One rater in particular offered a caveat stating that he thought the single-family market would

decline, but that there would be market growth opportunities in the multifamily market. He attributed this market opportunity to the increased focus and funding offered by the Pennsylvania Housing Finance Authority funding towards multifamily energy efficiency projects.

The PY6 process evaluation activities are described below.

FirstEnergy and Program Implementer Staff In-depth Interviews

Tetra Tech and ADM conducted in-depth interviews with program staff at FirstEnergy to discuss Phase II design and implementation updates, program goals, and key researchable issues of interest for the Phase II evaluation. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics.

Participating Customer (Household) Surveys

Tetra Tech conducted a quantitative participant survey effort by web for this evaluation for the Year 6 (PY6) sample frame. The surveys collected feedback on the following key researchable areas:

- Program infrastructure and participating household satisfaction
- Program communication and processes
- Free-ridership and spillover
- Familiarity with LED bulbs
- Demographics.

Participating Home Energy Auditor In-depth Interviews

Tetra tech completed 9 in-depth interviews with participating energy auditors. The focus of the Auditor interviews was to assess how the program is working for auditors from their perspectives. The following key researchable areas were assessed:

- Program infrastructure
- Participating auditor experiences
- Program measures and goals.

Program Material Review

Program documentation reviews included program plans, the program website, and enrollment e-mail communications.

Key Findings

Program participants

- Program participants are highly satisfied with the program overall.
- Participants indicate they want to be notified about future program options via e-mail.
- Most participants are familiar with LEDs and are currently using them in their homes.

Participating program auditors (Residential In-Home Audit subprogram only)

- Auditors welcome the opportunity for business through the program and are enthusiastic program promoters.
- Auditors report receiving inquiries about the program because of marketing efforts by FirstEnergy. Auditors mention noticing customer interest in the audit program that they attribute to FirstEnergy marketing efforts; specifically, bill inserts and Home Energy Reports generated by the Behavior subprogram. Two auditors mentioned the Behavior subprogram as

being effective, and one reported that 60 percent of their referrals are attributed to this program. Auditors shared that “solving a problem” for the customer is more effective than focusing on deficiencies of the house itself or pointing out how much money they will save.

- Satisfaction with field-use of the Surveyor tool is mixed. Some auditors reported both confusion as to how the savings values are generated and frustration with the perceived limitations of the reports generated from Surveyor, such as the inability to upload pictures of problem areas in the house, needing to select inputs from dropdowns instead of entering more specific values, and the need to be connected to the internet while in the field. Auditors indicate they often augment its reports and/or calculate energy savings on their own.
- Auditors feel that the follow-through with audit recommendations can be low because of the rebate structure for recommended upgrades. Auditors reported that although much of the cost of the audit is rebated for the customer, the incentives for implementing recommended upgrades are often not sufficient to prompt implementation of recommended improvements. Additionally, auditors explained that it is especially difficult to identify the requisite 350 kWh in savings if a home has non-electric heating and/or water heating.

Auditors are pleased with the support provided by the ICSP. Auditors expressed satisfaction with their interaction with ICSP staff, commenting that they are “doing a great job” and that they are responsive to their needs and inquiries.

4.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort. Recommendations generated from the PY7 evaluation effort focus mainly on the New Homes program component. It may be possible to simplify the program application process by reducing the documentation requirements (e.g. requiring fewer HERS ratings), but this may require a possible update to the TRM or close coordination with the SWE.

Table 4-9: Residential Home Performance Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
For the New Homes component, flag homes with greater than 20,000 kWh for a REM/Rate baseline heating loads vs. heating energy usage review.	Implemented for Phase III
For the conservation kits, consider including fewer 9W globes. Customers are slower to install those than any other lamps included in the kits.	Implemented for Phase III
Collect customer e-mail addresses during customer contact opportunities such as program feedback, rebate forms, and calls to the Customer Contact Center (CCC), etc., to use in future marketing campaigns. Be sure the language included permits future solicitation. Provide a “subscribe to EE program updates” on the FirstEnergy and ICSP websites.	Being Considered for Phase III based on capabilities of ICSP
Consider revising the rebate structure for the audit-recommended improvements to adjust the focus of the program more towards encouraging implementation of efficiency upgrades.	Implemented for Phase III
Consider other energy savings modeling tools that may have advantages over Surveyor. Holding an informational seminar on how the savings values are determined may also be beneficial for auditors.	Implemented for Phase III
Continue to market the program through bill inserts and steer customers to the program via the Behavior subprogram Home Energy Reports. Communicating how the program can solve energy-related problems for the customer may drive more participation, according to auditors.	Implemented for Phase III
Discount OPower reported impacts by approximately 10% to account for dual-participation adjustments that occur only in evaluation, at the end of the program year	Being Considered / Partially Implemented
The default interior lighting energy usage in REM/Rate appears to be systematically higher than verified through on-site inspections. Consider asking REM/Rate to reduce lighting power density by 20% or to increase baseline CFL saturation to 60% from 50% to compensate for the difference.	Being Considered. The implementer, PSD, updates REM/Rate specifications annually. The next opportunity is for PY9.
Review and ensure the New Homes rebate submission & payment process is as streamlined as possible to improve participant satisfaction	Implemented
Deliver New Homes program value beyond incentives via Webinar, effective program tools, etc. Two of six builders specifically indicated they would attend future webinars explaining program updates or process changes.	Implemented
Market New Homes program specifically to builders that began with the program, but dropped out along the way – especially as the program becomes more streamlined or incentives change.	Implemented
For the New Homes program, consider requiring HERS ratings and associated REM/Rate models on a sampled basis rather than for the census of homes, from high-volume builders.	The Company prefers to represent the actual savings above code for each rebated new home, rather than to rely on sampling. Sampling would not be beneficial for most builders and raters.

4.6 FINANCIAL REPORTING

A breakdown of the program finances by program is presented in in Table 2-9

Table 4-10: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 through 4)	\$2,193	\$7,268
2	EDC Incentives to Participants	\$2,231	\$7,382
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	-\$38	-\$114
5	Program Overhead Costs (Sum of rows 6 through 10)	\$1,789	\$9,679
6	Design & Development	\$38	\$92
7	Administration, Management, and Technical Assistance ^[1]	\$1,330	\$8,112
8	Marketing ^[2]	\$224	\$902
9	EDC Evaluation Costs	\$177	\$270
10	SWE Audit Costs	\$19	\$304
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$3,982	\$16,947
13	Total NPV Lifetime Energy Benefits	\$8,962	\$28,625
14	Total NPV Lifetime Capacity Benefits	\$842	\$2,643
15	Total NPV TRC Benefits ^[4]	\$9,804	\$31,268
16	TRC Benefit-Cost Ratio ^[5]	2.46	1.85
NOTES			
Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.			
[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.			
[2] Includes the marketing CSP and marketing costs by program CSPs.			
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.			
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.			
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.			

5 RESIDENTIAL LOW INCOME PROGRAM

The Low Income Program provides basic to comprehensive whole building measures at no cost to low-income households. This program also educates customers about their home's energy use and ways to save energy. The program is broadly organized into three different delivery types: direct install, giveaway and direct delivery kit programs.

The Direct Install component is comprised of the WARM Plus, WARM Extra Measures, and WARM Multifamily programs. These programs included an onsite home energy audit for income qualified customers and the direct install of energy efficient measures at no cost to participants by the Company's implementation contractor. The WARM Multifamily program continues to provide energy efficient measures to customers who live in multifamily housing units. Appliance replacements were also expanded in Phase II. Measures installed under these programs include²⁸:

- Energy Efficient Lighting
- Smart Power Strips
- Furnace whistles
- Faucet aerators
- Energy-saving showerheads
- LED nightlights
- Heat pump water heaters
- ENERGY STAR refrigerators
- Energy-efficient freezers
- Energy-efficient resistance water heaters
- Programmable thermostats
- Pipe insulation for hot water pipes

The efficiency of refrigerators and freezers was also tested during the in-home audit process. If these appliances were found to be inefficient, customers had the option to have their old units removed and replaced with energy-saving appliances through the program.

The Giveaway component, which is a subset of the Low Income Low Use Program, was targeted to low income customers at community events. CFLs were either distributed directly by the Company or sent to non-profit organizations contracted by the Company that then distributed the items to Company customers.

In PY5 and PY6, Low Income, Low Use Program (LILU) kits were directly mailed to income-qualified customers. There were two types of kits: the first type was for homes with electric water heaters, the second type for homes with non-electric water heaters. These kits were identical to the ones sent out by the Home Energy Audit (HEA) program. Items in these kits (depending on the recipients' water heater type) may have included:

- CFLs
- LED nightlights
- Faucet aerators

²⁸ Many other energy saving measures are provided to customers through the program; however, the expected savings from these other measures are nominal. No ex-ante savings were claimed for measures outside of this list.

- Energy-saving showerhead
- Adapters for faucet aerators

The LILU program met its goals in PY6 and there were no LILU kits distributed during PY7.

5.1 PROGRAM UPDATES

Contracts were awarded to Pure Energy Coach, ACTION Housing, and Performance Systems Development (PSD) to perform Quality Assurance Inspections effective January 1, 2016. Contracts were also awarded to the WARM Plus and Multi Family and WARM Extra Measures Programs' implementation contractors. Procedures for coordination and referrals with Natural Gas distribution companies' Low-Income Usage Reduction Program, and other programs, were finalized.

APPRISE, Inc. was hired as part of a WARM Program evaluation and provided recommendations for improvement that included the WARM Plus and Extra Measures Programs. FirstEnergy contracted with Garrison Hughes Advertising in December of 2015 for market research to provide a marketing plan to reach more customers. The campaign is expected to begin in the fall of 2016. FirstEnergy also worked with the Dollar Energy Fund to create a process aimed at increasing applications for the WARM Programs. Energy Conservation staff worked with the Housing Alliance of Pennsylvania to add FirstEnergy's WARM Program information and website link to their website.

5.1.1 Definition of Participant

For the WARM Plus, Multifamily, and WARM Extra Measure programs, a participant is defined as a home that received direct install measures. This has essentially a direct correspondence with unique homes that received direct install measures, but there is a small amount of overlap (two separate rebates for some customers) as "WARM Extra Measures" can overlap with WARM Plus. For the Giveaway component the participant is defined as a family unit who received the energy efficiency measures, such as faucet aerator or a CFL. In the LILU kit program, a participant is defined as a home to which a kit was delivered.

5.2 IMPACT EVALUATION GROSS SAVINGS

This section provides details of evaluation findings, including reported savings, sample design, and verified savings for the components of the Residential Low Income Program.

5.2.1 Evaluation Methodology

Gross Impact Evaluation for Direct Install Components

During Phase I, verified savings from the WARM Program were determined using a billing analysis of prior-year participants' billing data. This is not possible for Phase II because the Phase II program has been redesigned, and is not represented by the Phase I program or the general WARM LIURP program.

ADM's verification activities for these direct install programs included a review of tracking data and a review of on-site verification forms completed by third party quality assurance contractors. These verification forms noted any discrepancy between what was listed as installed by the implementation contractor and what was still installed in the home. ADM used these forms to verify installation rates for energy efficiency measures and to calculate verified impacts. The on-site QA/QC inspection process is described in greater detail at the end of this section. In general, the inspectors found high in-service rates for the direct install program. The primary source of discrepancy between reported and verified savings is due to a possible synchronization issue regarding the definition of one unit, or the per-unit energy savings for hot water pipe wrap. The PY6 TRM transitioned from a 10-foot measure unit to a 1-foot measure unit for this measure. As such, participating contractors report the number of units by the foot,

rather than in 10-foot increments. For the first month of PY6 (June 2014), the associated savings in the tracking reporting system corresponded to 10-foot increments. ADM has confirmed that the tracking and reporting system uses the correct value. The realization rate for the direct install component reflects ADM's correction. A small number of homes received envelope improvement measures with impacts that are not readily calculable through TRM algorithms. The Company did not report any impacts for these measures.

Gross Impact Evaluation for Giveaway Events

The Company provided to ADM their list of invoices and measures given out through the Low Income Giveaway program component. ADM checked the invoice list against the quantities of give-away items listed in the Company's official tracking database. ADM did not find any discrepancies between the invoice list and the tracking database. However, the in-service rates for certain measures are not directly knowable, and the historically verified in-service rates for measures such as energy saving showerheads and aerators are below the TRM defaults. ADM applied to night lights, aerators, and showerheads, the in-service rates derived from the LILU direct delivery program. ADM also calculated energy savings values for all distributed CFLs. The Company reported energy savings according to the correct EDC-specific "waste heat factors" from the TRM. The in-service rate used in the calculation of reported savings was 96%, while the 2014 PA TRM uses a 97% in-service rate. This adjustment resulted in an approximate 101% realization rate for the giveaway events.

5.2.2 Program Sampling

The two program components are treated as separate sub-programs, each with distinct populations, samples, and realization rates.

Giveaway Events

Sampling was not conducted for the giveaway event evaluation. ADM reviewed invoices and calculations for all reported measures.

Direct Install Programs

The Company's QA/QC contractor performs random on-site verification inspections. ADM received from the Company a list of on-site inspections, and then requested a set of 50 data collection forms and on-site notes for projects that are in the PY7 program population.

Table 5-1: Phase II Residential Low Income Program Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	0	0	0.00	0
Low-Income	24,405	10,439	0.76	0
Small Commercial and Industrial	0	0.0	0.00	0
Large Commercial and Industrial	0	0.0	0.00	0
Government, Non-Profit, and Institutional	0	0.0	0.00	0
Phase II Total	24,405	10,439	0.76	0

Table 5-2: Residential Low Income Program Sampling Strategy for Program Year 7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Direct Install	2,994	10.0%	50	51	DR, OS
CFL Give-away	1,182	0.0%	1,182	1,182	DR
LILU Standard Kits	0	n/a	n/a	n/a	n/a
LILU All Electric Kits	0	n/a	n/a	n/a	n/a
Program Total	4,176	0.0%	1,232	1,233	

DR=Desk Review, S=Survey, OS=On-Site Verification

Table 5-3: Program Year 7 Residential Low Income Program Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (Cv) in Sample Design	Relative Precision at 85% C.L.
Direct Install	1,689	106.4%	1,797	0.5	10.0%
CFL Give-away	179	103.6%	186	0.5	0.0%
LILU Standard Kits	0	n/a	0	n/a	n/a
LILU All Electric Kits	0	n/a	0	n/a	n/a
Program Total	1,868	106.1%	1,982		9.1%

Table 5-4: Program Year 7 Residential Low Income Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (Cv) in Sample Design	Relative Precision at 85% C.L.
Direct Install	0.16	109.0%	0.17	0.5	10.0%
CFL Give-away	0.02	103.8%	0.02	0.5	0.0%
LILU Standard Kits	0.00	n/a	0.00	0.5	n/a
LILU All Electric Kits	0.00	n/a	0.00	0.5	n/a
Program Total	0.18	108.5%	0.19		9.1%

5.2.3 On-Site Inspections

The Company has contracted with Pure Energy Coach, LLC to conduct quality assurance / quality control (QA/QC) inspections for direct install measures. The QA/QC contractor conducted 585 inspections for the Act 129 Multifamily, WARM Plus, and Warm Extra Measures program components. ADM sampled 51 of these inspections for impact evaluation purposes. The table below summarizes the on-site inspection findings.

Table 5-5: Summary of on-site inspection findings for Low Income Direct Install Programs

Measure	Quantity in Database	Verified Quantity by Inspection	In-Service Rates (ISRs)	Resolution of Discrepancies
Attic Insulation (ft ²)	1,330	1,330	100%	n/a
Faucet Aerators	10	9	90%	n/a
Efficient Lighting	423	423	100%	n/a
LED Night Lights	96	89	93%	n/a
Water Heater Pipe Insulation	371	255	69%	insulation installed, but on cold water line
Refrigerator/Freezer Replacement	29	29	100%	n/a
Showerheads	7	7	100%	n/a
Smarts Strips	50	49	98%	n/a
Other Measures (Water Heaters, Furnace Whistles)	6	6	100%	n/a
Total	2,322	2,197	95%	

5.3 IMPACT EVALUATION NET SAVINGS

The program has three main components: Direct Install, LILU Kits, and Giveaway events which distributed CFLs to low income customers. The NTG research for the Direct Install component used the *Common Framework for Downstream NTG Evaluation* self-report method and assessed free ridership and spillover. We targeted 40 participating households. LILU was not active in PY7, but we estimated the NTG for LILU by using the Home Energy Audit kits from the Home Performance Program as a proxy. The LILU and Home Energy Audit kits are identical and are distributed by the same vendor²⁹. It was also not practicable to conduct a formal NTG for the small Giveaway program component because customer contact information is not retained and entered into the tracking and reporting system. The NTG for the CFL Giveaway component is taken to be the same as for LILU, again because CFLs are the main measure in both subprograms.

²⁹ It is possible that, due to demographic differences, free ridership levels may be lower for LILU than for the HEA kits. Approximately 25% of surveyed HEA Kit recipients were low-income qualified, while all LILU participants reported being low-income qualified. The NTGR for LILU, then, may be understated to a small extent. This is not problematic for the program, since the overall NTGR is high, and LILU is the most cost effective program component, both at the gross and net levels.

Table 5-6: Low Income Program Sampling Strategy for Program Year 7 NTG Research

Stratum	Population Size ³⁰	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ³¹ to Achieve Sample
Direct Install	2965	0.5	85/15	40	44	7%
LILU Kits	0	0.5	85/15	0	0	0%
Give-away	1,182	0.5	85/15	0	0	0%
Program Total	4,147		85/15	40	44	5%

The program level free ridership, spillover, and NTG values in Table 5-7 are weighted by Phase III gross lifetime MWh savings to report program level net-to-gross ratios. Phase III lifetime MWh was selected as the weighting factor because it aligns best with the total resource cost test benefits stream

Table 5-7: Phase II Low Income Program Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Direct Install	14.0%	12.0%	97.0%	0.68	32.0%
LILU Kits*	39.9%	4.9%	65.0%	0.50	8.4%
Give-away*	39.9%	4.9%	65.0%	0.50	8.4%
Program Total	26.1%	8.7%	82.1%		20.4%

*LILU was not active for PY7. We applied NTG results from identical kits sent by the same vendor, but for the Home Performance Program. The NTG, and related precision for LILU is applied to giveaways because participant contact information is not available for giveaways, but the measures are similar to those in LILU kits.

5.4 PROCESS EVALUATION

The following activities were completed in PY6 for the evaluation of the WARM Extra Measures, WARM Plus, and Multifamily low income subprograms:

FirstEnergy Program Staff In-depth Interviews

Tetra Tech and ADM conducted in-depth interviews with program staff at FirstEnergy to discuss Phase II design and implementation updates, program goals, and key researchable issues of interest for the Phase II evaluation. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics.

Customer (Household) Phone Surveys for WARM Extra Measures, WARM Plus, and Multifamily Subprograms

Tetra Tech conducted phone surveys with participating households to assess awareness of program, program components effectiveness in meeting customer needs, and satisfaction. The sample frame included PY5 through PY6 Quarter 1.

³⁰ The values in this column represent the population as of the time that the process and NTG samples were drawn, and are generally smaller than the end-of-year values shown in the gross impact evaluation tables above.

³¹ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

LILU Kits Subprogram Participating Customer (Household) Phone Surveys

For the LILU Kits subprogram, Tetra Tech coordinated with ADM to add a limited set of process-related questions to their web and phone verification survey to assess customer satisfaction, usefulness of the educational material included within the kit, and other items households would like to see in the kit.

In-depth Interviews with Participating Contractors and Auditors

Tetra Tech conducted in-depth interviews with contractors and auditors participated in the WARM Extra Measures, WARM Plus and Multifamily subprograms. The contractors and auditors were selected from the PY6 program participant data files. The focus of the contractor interviews was to assess the operation of the program at the contractor and auditor level.

Secondary Research to Benchmark LILU Kit Subprogram Contents

Tetra Tech conducted a secondary benchmarking review on kit programs to determine how the FirstEnergy's LILU program's measures compare to other similar low income programs administered across the country to inform future program design

The sampling strategy for the PY6 process evaluation effort is provided in Table 5-8 below.

Table 5-8: Residential Low Income Program Sampling Strategy for Program Year 6

Target Group or Stratum (if appropriate)	Population Size ³²	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
WARM Extra Measures	2,273	0.5	85/15	35	26	3%	Process
WARM Plus	913	0.5	85/15	35	36	8%	Process
Multifamily	31	0.5	85/15	12	10	100%	Process
LILU Kit	2,740	0.5	85/15	144	123	43%	Process
Program Total	5,957		85/15	226	195	23%	

Key Findings

- 1) Satisfaction is high with households and contractors participating in the low income programs. LILU kit participants are highly satisfied with kit contents and the instructions for installation.
- 2) The WARM Plus, Multifamily and WARM Extra Measures programs are leading to additional energy saving activities in the household, in order of most mentioned to least: turning off the lights when leaving the room, washing laundry in cold water, turning down the thermostat in the winter, unplugging electronics and appliances when not in use, sealing up leaky windows or doors, installing more CFLs, changing the furnace filter, and lowering the water heater temperature.

More than 40 percent of households report that direct install measures received through the WARM Extra Measures, WARM Plus, and Multifamily subprograms were not installed or only partially installed by the energy specialist, or auditor.

³² The values in this column represent the population as of the time that the process and NTG samples were drawn, and are generally smaller than the end-of-year values shown in the gross impact evaluation tables above.

5.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort.

Table 5-9: Residential Low Income Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Enhance quality assurance reviews and follow-up with those contractors for whom households report measures are more frequently “left behind” for future installation.	Implemented
For the conservation kits, consider including fewer 9W globes. Customers are slower to install those than any other lamps included in the kits.	Implemented for Phase III

5.6 FINANCIAL REPORTING

A breakdown of the program finances by program is presented in Table 5-10. Please note for this program, included in Program Overhead Costs are the installed costs of the measures.

Table 5-10: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 through 4)	\$0	\$0
2	EDC Incentives to Participants	\$0	\$0
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$0	\$0
5	Program Overhead Costs (Sum of rows 6 through 10)	\$2,224	\$6,848
6	Design & Development	\$35	\$82
7	Administration, Management, and Technical Assistance ^[1]	\$2,007	\$6,152
8	Marketing ^[2]	\$1	\$18
9	EDC Evaluation Costs	\$164	\$324
10	SWE Audit Costs	\$18	\$272
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$2,224	\$6,848
13	Total NPV Lifetime Energy Benefits	\$834	\$3,752
14	Total NPV Lifetime Capacity Benefits	\$71	\$269
15	Total NPV TRC Benefits ^[4]	\$905	\$4,021
16	TRC Benefit-Cost Ratio ^[5]	0.41	0.59
NOTES			
Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.			
[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.			
[2] Includes the marketing CSP and marketing costs by program CSPs.			
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.			
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.			
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.			

6 C/I ENERGY EFFICIENT EQUIPMENT PROGRAM - SMALL

This program provides for the implementation of cost effective, high efficiency measures through Lighting, HVAC & Water Heating, Appliances, Food Service, and Custom Equipment subprograms. The program also offers appliance recycling, and the program component is operated in a similar manner to the residential appliance recycling program.

6.1 PROGRAM UPDATES

There were no updates to this program in PY7.

6.1.1 Definition of Participant

Each separate rebated project is counted as a participant.

6.2 IMPACT EVALUATION GROSS SAVINGS

6.2.1 Evaluation Methodology

The program has two categorical components: Equipment incentives and appliance recycling. The majority of the gross reported energy savings for this program were attributable to lighting measures, followed by custom projects and then prescriptive HVAC and appliance projects. The M&V methodology for this program is described below.

Gross Impact Evaluation for Efficient Equipment Incentives

For each sampled project, the gross impact evaluation process starts with a desk review, and often continues to an on-site verification visits, metering or logging, and data analysis. The steps are described below for lighting projects, custom projects, and prescriptive (HVAC and food service) projects.

Lighting Projects

Each sampled lighting project first undergoes a desk review. The desk review includes reconciliation of invoices, fixture specification sheets (cut sheets), and re-calculating reported savings using TRM algorithms and/or ex-ante assumptions, and identifying key parameters to be researched in the M&V plan.

Evaluation of all but the simplest of projects requires an M&V plan. The first step in the M&V planning process is to check that the project is sufficiently documented. For example, contractors working on large projects often have detailed, space-by-space inventories of the baseline and new lighting fixtures. If such detailed information is found to be lacking, ADM analysts will contact the applicant or the contractor directly, or through a request to the ICSP, and ask if such documentation is available. For large lighting projects, the M&V plan may call for sampling within the project. In such cases, the targeted precision level is $\pm 20\%$ at the 90% confidence level (90/20), with the sampling unit as the line item in the lighting calculator.

The desk review and M&V plan inform the data acquisition activities needed to evaluate the project. For most lighting projects, the default activities are on-site verification and logging hours of use. Most lighting

projects are metered unless there is a good reason not to meter^{33,34}. In rare cases, the desk review process may indicate that an on-site visit would not add sufficient value to the evaluation effort. In such cases, a verification interview may suffice to reduce uncertainty regarding the project. Data analysis is finalized upon the retrieval of loggers. Billing analysis is a viable option for certain projects, and in some cases the verified results are determined wholly or partially by billing analysis.

As a final step in lighting project analysis, ADM analysts determine the incremental material and labor costs, and “dual-baseline” energy savings in cases that involve T12 lamps. In estimating the material and labor costs, preference is given first to invoices, then to the SWE incremental cost database, and then to the cost values from the CA DEER database, then to other sources as needed and described in Appendix A.

Custom Commercial and Industrial Projects

As with lighting projects, each sampled custom project undergoes a desk review prior to M&V plan construction. The desk review includes a full documentation review and if needed, additional topical research. Evaluation of most projects requires an M&V plan³⁵. The first step in the M&V planning process is to check that the project is sufficiently documented, and that the evaluation engineer can articulate the mechanism or process that will yield the expected energy savings. ADM engineers are encouraged to contact the applicant early on in the M&V planning process to ask for additional documentation, clarification, or even to seek feedback on the feasibility of the proposed data acquisition and analysis methodology. The desk review and M&V plan will depend on the opportunities and constraints posed by each project. However, some defaults or “modes” are discussed for certain categories of projects below:

Air Compressor Projects: In many cases, vendors perform a baseline metering study prior to air compressor upgrades. The data collected from such studies are very useful, provided that they appear to be consistent with the overall project documentation. In many cases it is possible to use metered flow data or power data along with compressor curves to establish the facility’s compressed air load profile. The energy usage of the proposed air compressor may then be derived from application of compressor curves to the compressed air load profile. Additional activities such as post-installation metering or a billing analysis may be recommended, depending on project specifics. In some cases baseline meter data are not available. In these cases ADM will meter the new air compressor and use compressor curves to establish the underlying compressed air load profile, and then determine the baseline usage through application of the baseline compressor curves and (if needed) compressor staging practices.

Water Pumping Projects: Pumping projects are typically evaluated through billing analysis, using water throughput as the normalizing variable.

³³ The most frequent reasons are that the affected lights are installed outdoors and controlled by photocells or time clocks. Increasingly, high quality trending data are available from energy management systems, and the data may be used in-lieu of logging. Other rate cases may be customer-driven, such as the requirement for explosion proof loggers in a chemical plant.

³⁴ Primary and secondary schools are the general exception. TRM hours of use are applied to whole-school lighting upgrades, but logging is still recommended for projects that are confined to just one location such as a gym or library.

³⁵ Some projects already have transparent M&V documentation including baseline and post-implementation meter data and production records. In such cases the M&V focus shifts to analysis, rather than new research and data collection.

General Process Improvements: For general process improvements, the evaluation determines the change in the energy usage intensity associated with the creation or maintenance of one production unit³⁶.

General Space and Process Cooling Improvements: Data acquisition for such projects involves the determination of independent variables that predict the cooling load (units produced, degree-days, etc.) along with utility bills, EMS trending data, or sub-metering. The data analysis may involve regressions or energy simulation models.

Prescriptive Non-Lighting Projects

These projects are evaluated at the basic level or rigor because they tend to represent an insignificant amount of reported impacts in the program-level sampling scheme. The process verification involves a desk review and an on-site verification or verification by interview and review of invoices and other documentation.

As with lighting projects, incremental costs are evaluated as the gross impact evaluation nears completion. In estimating the material and labor costs, preference is given first to invoices, then to the SWE incremental cost database, and then to the cost values from the CA DEER database, then to other sources as needed and described in Appendix A.

Gross Impact Evaluation for Appliance Recycling

Appliance recycling represents an insignificant amount of the program's reported impacts. The default evaluation is a database review to verify that the per-unit impacts are consistent with verified impacts from the Residential Appliance Turn-In program.

6.2.2 Program Sampling

ADM evaluated the commercial and industrial programs using stratified ratio estimation. Lighting projects with expected savings above 800 MWh, and other projects with expected savings above 400 MWh, were automatically selected for evaluation prior to rebate approval, and were thus placed in a 'certainty' or non-sampling stratum.

At the end of the second and fourth quarter, and once again in September, ADM reviewed tracking data to define a discrete list of rebates that became the sample population for that quarter. Once separated into their respective operating companies and programs, this population was then stratified according to qualitative measure categories, and then by quantitative subcategories defined by expected energy savings. ADM used a coefficient of variation (CV) of 0.5 for all projects.

³⁶ The production unit depends on the project and is determined through documentation review and interviews with the applicant. Examples include a ton of steel produced by a mill, a desired level of dissolved oxygen in a wastewater treatment plan, a ton of refrigeration, and a day of snowmaking at a ski park.

Table 6-1: Phase II C/I Energy Efficient Equipment Program - Small Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	0	0	0.00	0
Low-Income	0	0	0.00	0
Small Commercial and Industrial	1,270	46,322	6.66	2,688
Large Commercial and Industrial	0	0	0.00	0
Government, Non-Profit, and Institutional	411	15,596	2.64	905
Phase II Total	1,681	61,918	9.30	3,593

Table 6-2: C/I Energy Efficient Equipment Program - Small Sampling Strategy for Program Year 7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
CFL Kits-1	0	n/a	0	0	n/a
Lighting-Certainty	0	n/a	0	0	DR,OS,L,B
Lighting-2	32	29.6%	5	5	DR,OS,L,B
Lighting-3	86	28.3%	6	6	DR,OS,L,B
Lighting-4	470	22.5%	10	10	DR,OS,L,B
Custom-Certainty	0	n/a	0	0	DR,OS,M,B,ES
Custom-2	7	43.0%	2	2	DR,OS,M,B,ES
Custom-3	60	23.7%	8	8	DR,OS,M,B,ES
HVAC and DHW-1	2	50.9%	1	1	DR,OS,M,B,ES
HVAC and DHW-2	63	71.4%	1	1	DR,OS,S
Appliance Turn-in-1	55	71.3%	1	1	DR
Kitchen/Appliances-1	18	70.0%	1	1	DR
Program Total	793	13.9%	35	35	

DR=Desk Review, S=Survey, OS=On-Site Verification, L=Logging, M=Metering, B=Billing Analysis, ES=Energy Simulation. At least one, but not all activities are performed for each sampled project.

Table 6-3: Program Year 7 C/I Energy Efficient Equipment Program - Small
Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (C_v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0	n/a	0	0.5	100.0%
Lighting-Certainty	0	n/a	0	0.5	0.0%
Lighting-2	8,218	101.4%	8,331	0.5	29.6%
Lighting-3	8,069	81.5%	6,579	0.5	28.3%
Lighting-4	8,487	84.1%	7,136	0.5	22.5%
Custom-Certainty	0	n/a	0	0.5	0.0%
Custom-2	1,426	82.5%	1,177	0.5	43.0%
Custom-3	1,457	86.2%	1,256	0.5	23.7%
HVAC and DHW-1	57	49.2%	28	0.5	50.9%
HVAC and DHW-2	152	146.8%	224	0.5	71.4%
Appliance Turn-in-1	71	103.8%	74	0.5	71.3%
Kitchen/Appliances-1	354	49.2%	174	0.5	70.0%
Program Total	28,292	88.3%	24,980		14.2%

Table 6-4: Program Year 7 C/I Energy Efficient Equipment Program - Small
Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (C_v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0.00	n/a	0.00	0.5	100.0%
Lighting-Certainty	0.00	n/a	0.00	0.5	0.0%
Lighting-2	0.96	148.7%	1.42	0.5	29.6%
Lighting-3	1.27	112.7%	1.43	0.5	28.3%
Lighting-4	1.34	85.1%	1.14	0.5	22.5%
Custom-Certainty	0.00	n/a	0.00	0.5	0.0%
Custom-2	0.16	78.1%	0.12	0.5	43.0%
Custom-3	0.21	60.2%	0.12	0.5	23.7%
HVAC and DHW-1	0.03	37.5%	0.01	0.5	50.9%
HVAC and DHW-2	0.09	62.8%	0.06	0.5	71.4%
Appliance Turn-in-1	0.01	100.8%	0.01	0.5	71.3%
Kitchen/Appliances-1	0.02	57.6%	0.01	0.5	70.0%
Program Total	4.08	106.2%	4.33		14.9%

6.2.3 On-Site Inspections

The Company's ICSP, CLEAResult, conducts QA/QC on-site inspections for 5% of pending rebate applications. The QA/QC visits are conducted prior to rebate approval, and can occur prior to or after measure installation³⁷. Nonresidential energy efficiency projects typically involve complex or numerous energy efficiency measures. It is therefore inadequate to classify inspections in a binary (e.g. Pass/Fail) manner. Site inspections may result in three general outcomes:

Case 1: The reported energy efficiency measures are found to be installed as described in rebate application materials.

Case 2: The energy efficiency project is completed, but there may be minor discrepancies between the installed measures and the associated documentation. These can include:

- A discrepancy in the quantities for some or all of the energy efficiency measures
- A discrepancy in the description of the energy efficiency measure (e.g. fixture wattage, HVAC system capacity or efficiency, motor horsepower or efficiency)
- A discrepancy in the baseline equipment
- A mischaracterization of equipment operation (e.g. lighting hours of use or control type, VFD control feedback mechanism, space heating and cooling set points)

Case 3: The energy efficiency project is not completed, or there are major discrepancies in the attributes discussed above in Case 2.

The on-site inspections occur prior to rebate approval. Approximately (34%)³⁸ of QA/QC inspections correspond to Case 1 above. Approximately 66% of on-site inspections result in a "Case 2" finding. In such cases, the application materials are updated to reflect the as-found equipment, and the rebate application is processed accordingly. Note that most "Case 2" findings do not result in material changes to the ex-ante savings³⁹ – the high proportion of site-visits that fall into this case is mostly a function of minor updates to project descriptions. However, Case 2 findings may involve an adjustment to the rebate amount and to the reported impacts in CLEAResult's tracking and reporting system⁴⁰. In the event of a Case 3 finding, the rebate application is cancelled. Based on CLEAResult's historical records, this scenario occurs approximately 0% of the time.

These QA/QC activities are exclusive of ADM's on-site verification activities. ADM's independent evaluation activities are described in the preceding section, and the program realization rates are informed, in part, by on-site findings. The primary source of variance between reported and verified

³⁷ In cases where baseline conditions are critical to the overall project energy savings calculation CLEAResult staff may conduct baseline on-site inspections. These inspections may also involve metering to help determine baseline lighting hours of use or other attributes that may correlate with the project's energy savings.

³⁸ Percentages here apply to all CLEAResult administered programs for all four FirstEnergy Pennsylvania EDCs.

³⁹ ADM reviewed summary of 110 on-site inspections conducted by CLEAResult in PY6, and developed a 'QC realization rate' to help inform the annual report. The QC realization rate was 98%, with a CV of 0.39. The adjustments made by CLEAResult accounted for variations in hours of use as well as variations in equipment specification.

⁴⁰ Adjustments to the Company's tracking and reporting are not necessary because QA/QC inspections occur prior to rebate approval.

impacts are not due to failures in verification, but rather to differences between planning assumptions and ex-post measurements in key parameters that describe operational characteristics. These include hours of use for lighting, both hours of use and part-load conditions for HVAC, refrigeration, and motors.

6.3 IMPACT EVALUATION NET SAVINGS

In PY6, Tetra Tech conducted the NTG research according to the Common Approach, Statewide Evaluator Guidance Memos GM-024 (Consistent Free ridership methodology) and GM-025 (Consistent Spillover methodology) using the participant self-report method. Participant data for Phase II, PY6 (Q1-Q4) was first aggregated to the level of individual participants based on account number and multiple record accounts were identified and consolidated for sampling purposes. The NTG research was conducted in conjunction with the process evaluation effort.

Table 6-5: C/I Energy Efficient Equipment Program - Small
Sampling Strategy for Program Year 6 NTG Research

Stratum	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ⁴¹ to Achieve Sample
Lighting	314	0.5	85/15	22	33	n/a
Custom	24	0.5	85/15	2	1	n/a
HVAC and DHW	45	0.5	85/15	3	8	n/a
Kitchen/Appliances	114	0.5	85/15	8	12	n/a
Program Total	497		85/15	35	54	24%

Table 6-6: Phase II C/I Energy Efficient Equipment Program - Small
Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Lighting	36.4%	12.2%	75.8%	0.37	8.9%
Custom	50.0%	16.0%	66.0%	0.49	69.2%
HVAC and DHW	59.4%	9.1%	49.8%	0.41	18.9%
Kitchen/Appliances	50.0%	9.2%	59.2%	0.41	16.2%
Program Total⁴²	37.8%	12.5%	74.6%		9.6%

⁴¹ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

⁴² NTG ratio at program level are developed using stratum weight and stratum NTG ratios. The weights are the Phase II lifetime gross verified MWh.

6.4 PROCESS EVALUATION

Tetra Tech conducted the process evaluation in conjunction with the NTG research during PY6. These activities included:

FirstEnergy and Program Implementer Staff In-depth Interviews

Tetra Tech and ADM conducted in-depth interviews with FirstEnergy program staff and the ICSP to discuss Phase II design and implementation updates, program goals, and key researchable issues of interest for the Phase II evaluation. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics. In addition, both FirstEnergy and ICSP staff provided input on the types of information that would be most beneficial to design and implementation efforts.

Participant Surveys

The participant surveys gathered data and information related to assess free-ridership and spillover and process related topics. The topic areas included:

- Program awareness and marketing
- The company's decision-making process in regards to new equipment
- Energy efficiency at the company
- Program satisfaction

Participant data for Phase II, PY6 (Q1-Q4) was first aggregated to the level of individual participants based on account number and multiple record accounts were identified and consolidated for sampling purposes. The process evaluation survey research was conducted in conjunction with the NTG research

Table 6-7 shows the sampling strategy from the process evaluation effort.

Table 6-7: C/I Energy Efficient Equipment Program - Small Sampling Strategy for Program Year 6

Target Group or Stratum (if appropriate)	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
Lighting	314	0.5	85/15	22	33	n/a	Process, NTG
Custom	24	0.5	85/15	2	1	n/a	Process, NTG
HVAC and DHW	45	0.5	85/15	3	8	n/a	Process, NTG
Kitchen/Appliances	114	0.5	85/15	8	12	n/a	Process, NTG
Program Total	497		85/15	35	54	24%	

Key Findings⁴³

- 1) Participants report high levels of satisfaction with all aspects of the program. Program participants are highly satisfied with the overall program and more than 90 percent of customers said they would likely participate in the program again in the future. Each individual aspect of the program received an average rating of “highly satisfied,” with the exception of the incentive amount, which received a mean satisfaction just shy of “highly satisfied”). Most participants said they did not experience any obstacles or barriers while implementing their project (89 percent) – and those that had difficulties, the issues were typically internal to the customer (e.g. convincing management to fund initial costs). Lastly, two-thirds of customers have recommended the program to colleagues in their industry.
- 2) Almost all aspects of program satisfaction rated higher in Phase II than Phase I. When compared with results from the Phase I C&I evaluation, all aspects of program satisfaction increased in average score between Phase I and Phase II, with the exception of the incentive offered, which decreased marginally.
- 3) The participant information files are improved from Phase I. Interview staff reported high levels of survey completion on their first attempt to contact respondents, which is atypical for C&I studies. The high quality sample information resulted in above-average numbers of participants calling the survey lab to complete the survey, a fact that is directly correlated with the advance letter reaching the correct individual within the firm.
- 4) Although customers’ stated preference of receiving information about energy efficiency via email or direct mail, contractors are successfully marketing the programs to customers. Two-thirds (67 percent) of respondents indicated their preferred method of communication is email newsletters, while 30 percent said they preferred direct mail from their EDC. However, more than half (54 percent) of respondents learned about the program through their contractor.
- 5) Budget and financial plans fall into two planning periods. Almost 45 percent of customers indicated their firm creates budgets/financial plans of one year or less, while 35 percent of customers said their business’ budgets/financial plans span five years or longer. Responses differed between strata – large C&I customers are more likely to create plans spanning more than 5 years (47 percent), while small C&I and GNI customers typically plan in one-year increments (50 percent and 53 percent, respectively).

The budget cycle was a primary factor for when projects can be implemented. Of the 45 percent of respondents who indicated that they had business or production cycles that affect planning and implementation of efficiency projects, more than half of respondents (53 percent) have budget and financial planning cycles that affect when projects can be planned and implemented. Customers’ budget and financial planning periods overwhelmingly fall into two categories, under one year or five years and longer. Customers often cited financial plans and budgets as a driving force behind whether energy improvements could be pursued, highlighting the crucial role of working alongside customers during their planning and budgeting periods.

⁴³ Key findings are reported in aggregate for the four FirstEnergy PA EDCs and for small C/I and large C/I customers, except when noted otherwise. Results were very similar for each EDC and for each program.

6.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort.

**Table 6-8: C/I Energy Efficient Equipment Program - Small
Status Report on Process and Impact Recommendations**

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Ensure continued engagement with past participants as they are likely to participate in the future.	Implemented
If participation is lacking in the future, consider a referral/recruitment award program from past participants.	Being Considered as appropriate
Lower ex ante energy savings Threshold to 750 MWh from 800 to trigger up-front evaluation of lighting projects to better align with 2016 TRM. At the same time, increase threshold from 400 MWh to 500 MWh for non-lighting projects to maintain expected 50/50 balance in reported MWh between sampled and "certainty" projects.	Implemented

6.6 FINANCIAL REPORTING

A breakdown of the program finances by program is presented in Table 6-9.

Table 6-9: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	\$12,363	\$21,756
2	EDC Incentives to Participants	\$1,651	\$3,593
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$10,712	\$18,163
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	\$1,238	\$3,267
6	Design & Development	\$16	\$38
7	Administration, Management, and Technical Assistance ^[1]	\$860	\$2,383
8	Marketing ^[2]	\$127	\$338
9	EDC Evaluation Costs	\$226	\$381
10	SWE Audit Costs	\$8	\$127
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$13,601	\$25,023
13	Total NPV Lifetime Energy Benefits	\$14,433	\$29,904
14	Total NPV Lifetime Capacity Benefits	\$2,002	\$4,122
15	Total NPV TRC Benefits ^[4]	\$16,435	\$34,025
16	TRC Benefit-Cost Ratio ^[5]	1.21	1.36

NOTES
Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

7 C/I ENERGY EFFICIENT BUILDINGS PROGRAM - SMALL

This program has two broad components. The first component is energy conservation kits delivered by mail to nonresidential customers. The second component includes custom “whole building” projects such as new construction, retro-commissioning, and building envelope improvements.

7.1 PROGRAM UPDATES

In PY7, the program included several custom projects in addition to conservation kits.

7.1.1 Definition of Participant

Each separate rebated project is counted as a participant.

7.2 IMPACT EVALUATION GROSS SAVINGS

7.2.1 Evaluation Methodology

The projects rebated under this program include energy conservation kits as well as custom projects that involve new construction, retro-commissioning, building envelope improvements. The M&V methodology for this program is described below.

Gross Impact Evaluation for Conservation Kits

The program distributed conservation kits consisting of 13W and 23W CFLs to commercial and industrial customers.

ADM’s evaluation strategy is to first place the CFLs into one of the following categories through participant surveys:

- 1) Whereabouts unknown: The customer did not receive the CFL conservation kit
- 2) The CFL was found to be broken upon arrival
- 3) The CFL has arrived, and is installed in a non-residential setting
- 4) The CFL has been taken to business owner’s residence for residential use, or has been distributed to an employee, parishioner, etc. for residential use.
- 5) The CFL is in storage, and will likely replace other CFLs that arrived in the kit
- 6) The CFL is in storage, and will likely replace other, non-kit lamps as they burn out.

CFLs that are determined to be in categories 1, 2, and 5 above are credited zero kWh and kW impacts. CFLs that are in category 4 are evaluated according to the 2015 TRM protocols for CFLs in the residential sector. CFLs in category 3 are evaluated with nonresidential TRM protocols, and with hours of use and coincidence factors as determined from the 2014 Metering Study conducted by the SWE⁴⁴. CFLs in category 6 are evaluated as CFLs in category 3. The fractions of distributed CFLs in each of the above six categories are determined primarily through surveys. ADM conducted 182 surveys among all four FirstEnergy PA EDCs and used the results to formulate in-service rates by facility type. The stratification followed facility types because the number of eligible sockets for screw-based lamps varies considerably with facility types, and the in-service rates tend to vary according to the number of available sockets.

⁴⁴ Pennsylvania Statewide ACT 129 2014 Commercial & Residential Light Metering Study, Table 4-13 for Interior Screw-Base CFLs and LEDs.

The nonresidential TRM protocols also include HVAC interactive effects. ADM applied the 12% and 34% values for energy and demand respectively, but also included HVAC applicability factors at the sector level to account for CFLs that are not installed in air conditioned space.

As a last step, ADM identified the fraction of CFLs that were originally sent to a business, but were later distributed for residential use by the business owner. This “cross sector” migration percentage accounts for the participants and impacts reported in the residential sector below. For this program component, cross-sector migration tends to reduce energy savings and demand reductions because the residential sector has lower lighting hours of use and coincidence factors. Portfolio level cross-sector sales determination and the associated adjustments to verified impacts and incentives are discussed in detail in Appendix D.

Gross Impact Evaluation for Efficient Equipment Incentives

Sampling and project-level gross impact evaluation methodologies for efficient equipment and building upgrade measures are identical to the methodology described in Section 6 for the C/I Small Efficient Equipment Program. The projects in this program tend to involve new construction, retro-commissioning, and other controls or envelope upgrades that tend to affect the systemic energy usage performance of the involved facilities. Data acquisition for such projects involves the determination of independent variables that predict the heating and cooling loads along with utility bills, EMS trending data, or sub-metering. The data analysis may involve regressions or energy simulation models.

ADM evaluated the commercial and industrial programs using stratified ratio estimation. Lighting projects with expected savings above 800 MWh, and other projects with expected savings above 400 MWh, were automatically selected for evaluation prior to rebate approval, and were thus placed in a ‘certainty’ or non-sampling stratum.

7.2.2 Program Sampling

At the end of the second and fourth quarter, and once again in September, ADM reviewed tracking data to define a discrete list of rebates that became the sample population for that quarter. Once separated into their respective operating companies and programs, this population was then stratified according to qualitative measure categories, and then by quantitative subcategories defined by expected energy savings. ADM used a coefficient of variation (CV) of 0.5 for all projects.

Table 7-1: Phase II C/I Energy Efficient Buildings Program - Small Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	1,449	1,288	0.23	0
Low-Income	0	0	0.00	0
Small Commercial and Industrial	6,733	6,093	1.11	369
Large Commercial and Industrial	0	0	0.00	0
Government, Non-Profit, and Institutional	1,622	1,932	0.24	117
Phase II Total	9,804	9,313	1.57	486
*The incentive amounts associated with cross-sector flow of CFLs to the residential sector are reported as zero because the Company has already made accounting adjustments for cross-sector sales, as described in Appendix D.				

Table 7-2: C/I Energy Efficient Buildings Program - Small Sampling Strategy for Program Year 7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
CFL Kits-1	3,934	11.3%	40	65	S
Lighting-Certainty	0	n/a	0	0	DR,OS,L,B
Lighting-2	0	n/a	0	0	DR,OS,L,B
Lighting-3	0	n/a	0	0	DR,OS,L,B
Lighting-4	0	n/a	0	0	DR,OS,L,B
Custom-Certainty	0	n/a	0	0	DR,OS,M,B,ES
Custom-2	1	0.0%	1	1	DR,OS,M,B,ES
Custom-3	13	36.5%	3	3	DR,OS,M,B,ES
HVAC and DHW-1	0	n/a	0	0	DR,OS,M,B,ES
HVAC and DHW-2	0	n/a	0	0	DR,OS,S
Appliance Turn-in-1	0	n/a	0	0	DR
Kitchen/Appliances-1	0	n/a	0	0	DR
Program Total	3,948	10.4%	44	69	

DR=Desk Review, S=Survey, OS=On-Site Verification, L=Logging, M=Metering, B=Billing Analysis, ES=Energy Simulation. At least one, but not all activities are performed for each sampled project.

Table 7-3: Program Year 7 C/I Energy Efficient Buildings Program - Small Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	2,560	97.1%	2,487	0.5	8.9%
Lighting-Certainty	0	n/a	0	0.5	0.0%
Lighting-2	0	n/a	0	0.5	0.0%
Lighting-3	0	n/a	0	0.5	0.0%
Lighting-4	0	n/a	0	0.5	0.0%
Custom-Certainty	0	n/a	0	0.5	0.0%
Custom-2	336	119.8%	403	0.5	0.0%
Custom-3	612	99.6%	610	0.5	36.5%
HVAC and DHW-1	0	n/a	0	0.5	0.0%
HVAC and DHW-2	0	n/a	0	0.5	0.0%
Appliance Turn-in-1	0	n/a	0	0.5	0.0%
Kitchen/Appliances-1	0	n/a	0	0.5	0.0%
Program Total	3,509	99.7%	3,499		8.9%

Table 7-4: Program Year 7 C/I Energy Efficient Buildings Program - Small
Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0.49	97.1%	0.48	0.5	8.9%
Lighting-Certainty	0.00	n/a	0.00	0.5	0.0%
Lighting-2	0.00	n/a	0.00	0.5	0.0%
Lighting-3	0.00	n/a	0.00	0.5	0.0%
Lighting-4	0.00	n/a	0.00	0.5	0.0%
Custom-Certainty	0.00	n/a	0.00	0.5	0.0%
Custom-2	0.04	32.3%	0.01	0.5	0.0%
Custom-3	0.06	80.6%	0.05	0.5	36.5%
HVAC and DHW-1	0.00	n/a	0.00	0.5	0.0%
HVAC and DHW-2	0.00	n/a	0.00	0.5	0.0%
Appliance Turn-in-1	0.00	n/a	0.00	0.5	0.0%
Kitchen/Appliances-1	0.00	n/a	0.00	0.5	0.0%
Program Total	0.59	91.3%	0.54		8.5%

7.2.3 On-Site Inspections

This program has two components: Conservation Kits and downstream rebates for commercial and industrial energy efficiency projects. There are no on-site visits conducted for the conservation kits. All other projects are eligible for on-site QA/QC inspections. These QA/QC inspections are identical in process as the effort described for the C/I Energy Efficient Equipment Program - Small.

As with other nonresidential programs, CLEAResult's QA/QC activities are exclusive of ADM's on-site verification activities. ADM's independent evaluation activities are described in the preceding section. The program realization rates are informed, in part, by on-site findings. The primary source of variance between reported and verified impacts are not due to failures in verification, but rather to differences between planning assumptions and ex-post measurements in key parameters that describe operational characteristics. This program may involve projects that involve relatively complex calculations, including building energy simulations and engineering calculations. In many cases, discrepancies between reported and verified impacts result from differences in calculation methodologies and data sources. The impact evaluation effort has the benefit of having access to post-installation utility meter data, trending data, or logger data, and often the newly available information helps to improve project savings estimates.

7.3 IMPACT EVALUATION NET SAVINGS

Tetra Tech conducted the NTG research according to the Common Approach, Statewide Evaluator Guidance Memos GM-024 (Consistent Free ridership methodology) and GM-025 (Consistent Spillover methodology) using the participant self-report method. However, a formal spillover analysis was not attempted for the conservation kit recipients, in part because spillover effects for kits in other programs have resulted in negligible quantifiable spillover, and in part because the program promotes participation in other FirstEnergy programs rather than independent actions.

For the downstream custom program component, participant data for nearly all of Phase II was first aggregated to the level of individual participants based on account number and multiple record accounts (i.e., customers participating in programs more than one time) were identified. The evaluation of the conservation kits focused on PY7 participants only, as the process and NTG survey efforts were combined gross impact verification surveys. The NTG research was conducted in conjunction with the process evaluation effort.

Table 7-5: C/I Energy Efficient Buildings Program - Small
Sampling Strategy for Program Year 7 NTG Research

Stratum	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ⁴⁵ to Achieve Sample
Kits	3,926	0.5	85/15	40	65	8%
Custom	19	0.5	85/15	19	8	100%
Program Total	3,945		85/15	59	73	2%

Table 7-6: Phase II C/I Energy Efficient Buildings Program - Small
Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Kits	26.0%	0.0%	74.0%	1.36	24.1%
Custom	47.0%	0.0%	53.0%	0.13	4.9%
Program Total⁴⁶	35.7%	0.0%	64.3%		15.1%

7.4 PROCESS EVALUATION

Tetra Tech conducted the process evaluation in conjunction with the NTG research. These activities included:

Participating Contractor In-depth Interviews

Tetra Tech conducted in-depth interviews with a dozen contractors that participate in the program. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics. In addition, contractors provided input on the types of information that would be most beneficial to design and implementation efforts.

Participant Surveys

The participant surveys gathered data and information related to assess free-ridership and spillover and process related topics. The topic areas included:

- Program awareness and marketing
- The company's decision-making process in regards to new equipment
- Energy efficiency at the company
- Program satisfaction

⁴⁵ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

⁴⁶ NTG ratio at program level is developed using stratum weight and stratum NTG ratios. We use the Phase II lifetime verified MWh as the weights.

Participant data for Phase II, PY5-PY7Q3 was first aggregated to the level of individual participants based on account number and multiple record accounts were identified and consolidated for sampling purposes. The process evaluation survey research was conducted in conjunction with the NTG research.

Table 7-7: C/I Energy Efficient Buildings Program - Small Sampling Strategy for Program Year 7

Target Group or Stratum (if appropriate)	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
Kits	3,926	0.5	85/15	40	65	8%	Process, NTG
Custom	19	0.5	85/15	19	8	100%	Process, NTG
Program Total	3,945		85/15	59	73	2%	

Key Findings⁴⁷

- 1) Overall, average participant satisfaction ratings were high in the custom program component. Satisfaction was highest with equipment installed (9.0/10.0) and satisfaction with the amount of incentive available and the application process were lowest (8.0/10.0). The average likelihood of participating again is 9.4 (where 10 is "very likely") and 69% of participants have recommended the program to others.
- 2) Participants in the conservation kit program component were also happy with their experience, rating the overall program a 4.8 on a 1 to 5 scale.
- 3) Participants in the conservation kit program expressed interest in program continuation, and in upgrading lamps to LEDs.
- 4) Small businesses struggle the most with understanding requirements and the application process.
- 5) Of the 12 contractors interviewed, 9 reported customer barriers including education, financing, ROI, trust, and equipment failure
- 6) Approximately 90% of customers heard about savings potential from contractors, 86% discussed payback and ROI with contractors, and 51% thought contractors discussed other equipment benefits.
- 7) Two thirds of contractors reported discussing savings potential and ROI with their customers. Other benefits discussed included brighter facilities, reduction of operating and maintenance expenses, longer product life, low energy footprint, code compliance, and comfort. A few felt that customer mistrust is the primary barrier they have to overcome.
- 8) Participant contact information was highly accurate, but the accuracy of contractor contact information can be improved.
- 9) Most contractors that participated in the custom program expressed difficulties with documentation and paperwork requirements, pre-approval wait times, eligibility requirements, and frequent quality assurance inspections by the ICSP.
- 10) In general, contractors also stated that the ICSP was accessible, and was able to answer questions related to the program.

⁴⁷ Key findings are reported in aggregate for the four FirstEnergy PA EDCs and for small C/I and large C/I customers, except when noted otherwise. Results were very similar for each EDC and for each program.

7.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

Table 7-8: Program Year 7 C/I Energy Efficient Buildings Program – Small
Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
In Phase III, consider subsuming this program into the C/I Energy Efficient Equipment Program - Small to reduce administrative costs and to ensure adequate budget is available in case participation levels increase significantly.	Implemented
Review and improve contractor tracking procedures.	Implemented for Phase III
Review the application process for possible efficiencies.	Implemented for Phase III
Continue support to contractors, including consistent ICSP contact and marketing materials.	Implemented for Phase III
Continue to market to past participants as well as nonparticipants if additional participation is needed.	Implemented for Phase III

7.6 FINANCIAL REPORTING

A breakdown of the program finances (by program) is presented in Table 7-9. This program's TRC benefit-cost ratio is relatively low primarily because the program has not yet achieved the scale necessary to dilute fixed costs associated with implementation.

Table 7-9: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	\$1,669	\$2,188
2	EDC Incentives to Participants	\$147	\$486
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$1,522	\$1,701
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	\$493	\$1,415
6	Design & Development	\$7	\$16
7	Administration, Management, and Technical Assistance ^[1]	\$358	\$1,049
8	Marketing ^[2]	\$90	\$238
9	EDC Evaluation Costs	\$35	\$57
10	SWE Audit Costs	\$3	\$54
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$2,162	\$3,602
13	Total NPV Lifetime Energy Benefits	\$965	\$2,737
14	Total NPV Lifetime Capacity Benefits	\$119	\$294
15	Total NPV TRC Benefits ^[4]	\$1,084	\$3,031
16	TRC Benefit-Cost Ratio ^[5]	0.50	0.84

NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.

[2] Includes the marketing CSP and marketing costs by program CSPs.

[3] Total TRC Costs includes Total EDC Costs and Participant Costs.

[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.

[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

8 C/I ENERGY EFFICIENT EQUIPMENT PROGRAM - LARGE

This program provides for the implementation of cost effective, high efficiency measures through Lighting, HVAC, and Custom Equipment incentive subprograms. The program also offers appliance recycling, and the program component is operated in a similar manner to the residential appliance recycling program.

8.1 PROGRAM UPDATES

There were no updates to this program in PY7.

8.1.1 Definition of Participant

Each separate rebated project is counted as a participant.

8.2 IMPACT EVALUATION GROSS SAVINGS

8.2.1 Evaluation Methodology

The projects rebated under this program include equipment upgrades and custom projects that often involve hardware and process improvements at industrial facilities. The M&V methodology for this program is described below.

Gross Impact Evaluation for Efficient Equipment Incentives

For each sampled project, the gross impact evaluation process starts with a desk review, and often continues to an on-site verification visits, metering or logging, and data analysis. The steps are described below for lighting projects, custom projects, and prescriptive (HVAC and food service) projects.

Lighting Projects

Each sampled lighting project first undergoes a desk review. The desk review includes reconciliation of invoices, fixture specification sheets (cut sheets), and re-calculating reported savings using TRM algorithms and/or ex-ante assumptions, and identifying key parameters to be researched in the M&V plan.

Evaluation of all but the simplest of projects requires an M&V plan. The first step in the M&V planning process is to check that the project is sufficiently documented. For example, contractors working on large projects often have detailed, space-by-space inventories of the baseline and new lighting fixtures. If such detailed information is found to be lacking, ADM analysts will contact the applicant or the contractor directly, or through a request to the ICSP, and ask if such documentation is available. For large lighting projects, the M&V plan may call for sampling within the project. In such cases, the targeted precision level is $\pm 20\%$ at the 90% confidence level (90/20), with the sampling unit as the line item in the lighting calculator.

The desk review and M&V plan inform the data acquisition activities needed to evaluate the project. For most lighting projects, the default activities are on-site verification and logging hours of use. Most lighting projects are metered unless there is a good reason to *not* to meter^{48,49}. In rare cases, the desk review

⁴⁸ The most frequent reasons are that the affected lights are installed outdoors and controlled by photocells or time clocks. Increasingly, high quality trending data are available from energy management systems, and the data may be used in-lieu of logging. Other rate cases may be customer-driven, such as the requirement for explosion proof loggers in a chemical plant.

⁴⁹ Primary and secondary schools are the general exception. TRM hours of use are applied to whole-school lighting upgrades, but logging is still recommended for projects that are confined to just one location such as a gym or library.

process may indicate that an on-site visit would not add sufficient value to the evaluation effort. In such cases, a verification interview may suffice to reduce uncertainty regarding the project. Data analysis is finalized upon the retrieval of loggers. Billing analysis is a viable option for certain projects, and in some cases the verified results are determined wholly or partially by billing analysis.

As a final step in lighting project analysis, ADM analysts determine the incremental material and labor costs, and “dual-baseline” energy savings in cases that involve T12 lamps. In estimating the material and labor costs, preference is given first to invoices, then to the SWE incremental cost database, and then to the cost values from the CA DEER database, then to other sources as needed and described in Appendix A.

Custom Commercial and Industrial Projects

As with lighting projects, each sampled custom project undergoes a desk review prior to M&V plan construction. The desk review includes a full documentation review and if needed, additional topical research. Evaluation of most projects requires an M&V plan⁵⁰. The first step in the M&V planning process is to check that the project is sufficiently documented, and that the evaluation engineer can articulate the mechanism or process that will yield the expected energy savings. ADM engineers are encouraged to contact the applicant early on in the M&V planning process to ask for additional documentation, clarification, or even to seek feedback on the feasibility of the proposed data acquisition and analysis methodology. The desk review and M&V plan will depend on the opportunities and constraints posed by each project. However, some defaults or “modes” are discussed for certain categories of projects below:

Air Compressor Projects: In many cases, vendors perform a baseline metering study prior to air compressor upgrades. The data collected from such studies are very useful, provided that they appear to be consistent with the overall project documentation. In many cases it is possible to use metered flow data or power data along with compressor curves to establish the facility’s compressed air load profile. The energy usage of the proposed air compressor may then be derived from application of compressor curves to the compressed air load profile. Additional activities such as post-installation metering or a billing analysis may be recommended, depending on project specifics. In some cases baseline meter data are not available. In these cases ADM will meter the new air compressor and use compressor curves to establish the underlying compressed air load profile, and then determine the baseline usage through application of the baseline compressor curves and (if needed) compressor staging practices.

Water Pumping Projects: Pumping projects are typically evaluated through billing analysis, using water throughput as the normalizing variable.

General Process Improvements: For general process improvements, the evaluation determines the change in the energy usage intensity associated with the creation or maintenance of one production unit⁵¹.

General Space and Process Cooling Improvements: Data acquisition for such projects involves the determination of independent variables that predict the cooling load (units produced, degree-days, etc.)

⁵⁰ Some projects already have transparent M&V documentation including baseline and post-implementation meter data and production records. In such cases the M&V focus shifts to analysis, rather than new research and data collection.

⁵¹ The production unit depends on the project and is determined through documentation review and interviews with the applicant. Examples include a ton of steel produced by a mill, a desired level of dissolved oxygen in a wastewater treatment plan, a ton of refrigeration, and a day of snowmaking at a ski park.

along with utility bills, EMS trending data, or sub-metering. The data analysis may involve regressions or energy simulation models.

Prescriptive Non-Lighting Projects

These projects are evaluated at the basic level or rigor because they tend to represent an insignificant amount of reported impacts in the program-level sampling scheme. The process verification involves a desk review and an on-site verification or verification by interview and review of invoices and other documentation. As with lighting projects, incremental costs are evaluated as the gross impact evaluation nears completion. In estimating the material and labor costs, preference is given first to invoices, then to the SWE incremental cost database, and then to the cost values from the CA DEER database, then to other sources as needed and described in Appendix A.

8.2.2 Program Sampling

ADM evaluated the commercial and industrial programs using stratified ratio estimation. Lighting projects with expected savings above 800 MWh, and other projects with expected savings above 400 MWh, were automatically selected for evaluation prior to rebate approval, and were thus placed in a 'certainty' or non-sampling stratum.

At the end of the second and fourth quarter ADM reviewed tracking data to define a discrete list of rebates that became the sample population for that quarter. Once separated into their respective operating companies and programs, this population was then stratified according to qualitative measure categories, and then by quantitative subcategories defined by expected energy savings. ADM used a coefficient of variation (CV) of 0.5 for all projects

Table 8-1: Phase II C/I Efficient Equipment Program – Large Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	0	0	0.00	0
Low-Income	0	0	0.00	0
Small Commercial and Industrial	0	0	0.00	0
Large Commercial and Industrial	308	74,598	9.79	3,668
Government, Non-Profit, and Institutional	93	9,323	1.65	458
Phase II Total	401	83,921	11.43	4,127

Table 8-2: C/I Efficient Equipment Program – Large Sampling Strategy for Program Year 7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
CFL Kits-1	0	n/a	0	0	n/a
Lighting-Certainty	4	0.0%	4	4	DR,OS,L,B
Lighting-2	5	64.4%	1	1	DR,OS,L,B
Lighting-3	17	47.8%	2	2	DR,OS,L,B
Lighting-4	92	35.2%	4	4	DR,OS,L,B
Custom-Certainty	7	0.0%	7	5	DR,OS,M,B,ES
Custom-2	11	68.6%	1	1	DR,OS,M,B,ES
Custom-3	23	38.8%	3	3	DR,OS,M,B,ES
HVAC and DHW-1	3	58.8%	1	1	DR,OS,M,B,ES
HVAC and DHW-2	0	n/a	0	0	DR,OS,S
Appliance Turn-in-1	0	n/a	0	0	DR
Kitchen/Appliances-1	0	n/a	0	0	DR
Program Total	162	11.4%	23	21	

Table 8-3: Program Year 7 C/I Efficient Equipment Program – Large Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0	n/a	0	0.5	100.0%
Lighting-Certainty	4,250	100.0%	4,250	0.5	0.0%
Lighting-2	2,583	101.3%	2,616	0.5	64.4%
Lighting-3	4,691	69.4%	3,254	0.5	47.8%
Lighting-4	4,418	176.6%	7,802	0.5	35.2%
Custom-Certainty	18,309	100.0%	18,309	0.5	17.2%
Custom-2	4,862	68.2%	3,317	0.5	68.6%
Custom-3	2,255	83.8%	1,889	0.5	38.8%
HVAC and DHW-1	36	39.8%	14	0.5	58.8%
HVAC and DHW-2	0	n/a	0	0.5	0.0%
Appliance Turn-in-1	0	n/a	0	0.5	0.0%
Kitchen/Appliances-1	0	n/a	0	0.5	0.0%
Program Total	41,406	100.1%	41,451		12.9%

Table 8-4: Program Year 7 C/I Efficient Equipment Program – Large Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0.00	n/a	0.00	0.5	100.0%
Lighting-Certainty	0.78	100.0%	0.78	0.5	0.0%
Lighting-2	0.29	142.6%	0.41	0.5	64.4%
Lighting-3	0.59	110.0%	0.65	0.5	47.8%
Lighting-4	0.47	244.6%	1.14	0.5	35.2%
Custom-Certainty	2.25	100.6%	2.26	0.5	17.2%
Custom-2	0.72	78.7%	0.57	0.5	68.6%
Custom-3	1.03	58.3%	0.60	0.5	38.8%
HVAC and DHW-1	0.03	14.1%	0.00	0.5	58.8%
HVAC and DHW-2	0.00	n/a	0.00	0.5	0.0%
Appliance Turn-in-1	0.00	n/a	0.00	0.5	0.0%
Kitchen/Appliances-1	0.00	n/a	0.00	0.5	0.0%
Program Total	6.15	104.2%	6.41		12.9%

8.2.3 On-Site Inspections

The Company's ICSP, CLEAResult, conducts QA/QC on-site inspections for 5% of pending rebate applications. The QA/QC visits are conducted prior to rebate approval, and can occur prior to or after measure installation⁵². Nonresidential energy efficiency projects typically involve complex or numerous energy efficiency measures. It is therefore inadequate to classify inspections in a binary (e.g. Pass/Fail) manner. Site inspections may result in three general outcomes:

Case 1: The reported energy efficiency measures are found to be installed as described in rebate application materials.

Case 2: The energy efficiency project is completed, but there may be minor discrepancies between the installed measures and the associated documentation. These can include:

- A discrepancy in the quantities for some or all of the energy efficiency measures
- A discrepancy in the description of the energy efficiency measure (e.g. fixture wattage, HVAC system capacity or efficiency, motor horsepower or efficiency)
- A discrepancy in the baseline equipment
- A mischaracterization of equipment operation (e.g. lighting hours of use or control type, VFD control feedback mechanism, space heating and cooling set points)

⁵² In cases where baseline conditions are critical to the overall project energy savings calculation CLEAResult staff may conduct baseline on-site inspections. These inspections may also involve metering to help determine baseline lighting hours of use or other attributes that may correlate with the project's energy savings.

Case 3: The energy efficiency project is not completed, or there are major discrepancies in the attributes discussed above in Case 2.

The on-site inspections occur prior to rebate approval. Approximately (34%)⁵³ of QA/QC inspections correspond to Case 1 above. Approximately 66% of on-site inspections result in a “Case 2” finding. In such cases, the application materials are updated to reflect the as-found equipment, and the rebate application is processed accordingly. Note that most “Case 2” findings do not result in material changes to the ex-ante savings⁵⁴ – the high proportion of site-visits that fall into this case is mostly a function of minor updates to project descriptions.

This may involve an adjustment to the rebate amount and to the reported impacts in CLEAResult’s tracking and reporting system⁵⁵. In the event of a Case 3 finding, the rebate application is cancelled. Based on CLEAResult’s historical records, this scenario occurs approximately 0% of the time.

These QA/QC activities are exclusive of ADM’s on-site verification activities. ADM’s independent evaluation activities are described in the preceding section, and the program realization rates are informed, in part, by on-site findings. The primary source of variance between reported and verified impacts are not due to failures in verification, but rather to differences between planning assumptions and ex-post measurements in key parameters that describe operational characteristics. These include hours of use for lighting, both hours of use and part-load conditions for HVAC, refrigeration, and motors.

8.3 IMPACT EVALUATION NET SAVINGS

In PY6, Tetra Tech conducted the NTG research according to the Common Approach, Statewide Evaluator Guidance Memos GM-024 (Consistent Free ridership methodology) and GM-025 (Consistent Spillover methodology) using the participant self-report method. The complete participant dataset for Phase II, PY6 (Q1-Q4) was used for this evaluation effort. The tables below summarize last year’s evaluation results and include updated net impact values, weighted by stratum with Phase II lifetime MWh.

Table 8-5: C/I Energy Efficient Equipment Program - Large Sampling Strategy for Program Year 6 NTG Research

Stratum	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ⁵⁶ to Achieve Sample
Lighting	109	0.5	85/15	21	37	n/a
Custom	17	0.5	85/15	3	9	n/a
HVAC and DHW	12	0.5	85/15	2	5	n/a
Kitchen/Appliances	0	0.5	85/15	0	0	n/a
Program Total	138		85/15	26	51	59%

⁵³ Percentages here apply to all CLEAResult administered programs for all four FirstEnergy Pennsylvania EDCs.

⁵⁴ ADM reviewed summary of 110 on-site inspections conducted by CLEAResult in PY6, and developed a ‘QC realization rate’ to help inform the annual report. The QC realization rate was 98%, with a CV of 0.39. The adjustments made by CLEAResult accounted for variations in hours of use as well as variations in equipment specification.

⁵⁵ Adjustments to the Company’s tracking and reporting are not necessary because QA/QC inspections occur prior to rebate approval.

⁵⁶ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

Table 8-6: Phase II C/I Energy Efficient Equipment Program - Large
Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Lighting	27.4%	7.7%	80.3%	0.37	7.2%
Custom	23.6%	6.7%	83.1%	0.49	16.2%
HVAC and DHW	70.0%	5.0%	35.0%	0.41	20.1%
Kitchen/Appliances	0.0%	0.0%	100.0%	0.41	100.0%
Program Total⁵⁷	26.1%	7.3%	81.2%		7.8%

8.4 PROCESS EVALUATION

Tetra Tech conducted the process evaluation in conjunction with the NTG research during PY6. The evaluation activities included:

FirstEnergy and Program Implementer Staff In-depth Interviews

Tetra Tech and ADM conducted in-depth interviews with FirstEnergy program staff and the ICSP to discuss Phase II design and implementation updates, program goals, and key researchable issues of interest for the Phase II evaluation. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics. In addition, both FirstEnergy and ICSP staff provided input on the types of information that would be most beneficial to design and implementation efforts.

Participant Surveys

The participant surveys gathered data and information related to assess free-ridership and spillover and process related topics. The topic areas included:

- Program awareness and marketing
- The company's decision-making process in regards to new equipment
- Energy efficiency at the company
- Program satisfaction

The complete participant dataset for Phase II, PY6 (Q1-Q4) was used for this evaluation effort

⁵⁷ NTG ratio at program level should be developed using stratum weight and stratum NTG ratios.

Table 8-7 shows the sampling strategy from the process evaluation effort.

Table 8-7: C/I Energy Efficient Equipment Program - Large Sampling Strategy for Program Year 6

Target Group or Stratum (if appropriate)	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
Lighting	109	0.5	85/15	21	37	n/a	Process, NTG
Custom	17	0.5	85/15	3	9	n/a	Process, NTG
HVAC and DHW	12	0.5	85/15	2	5	n/a	Process, NTG
Kitchen/Appliances	0	0.5	85/15	0	0	n/a	Process, NTG
Program Total	138		85/15	26	51	59%	

Key Findings⁵⁸

- 1) Participants report high levels of satisfaction with all aspects of the program. Program participants are highly satisfied with the overall program and more than 90 percent of customers said they would likely participate in the program again in the future. Each individual aspect of the program received an average rating of “highly satisfied,” with the exception of the incentive amount, which received a mean satisfaction just shy of “highly satisfied”. Most participants said they did not experience any obstacles or barriers while implementing their project (89 percent) – and those that had difficulties, the issues were typically internal to the customer (e.g. convincing management to fund initial costs). Lastly, two-thirds of customers have recommended the program to colleagues in their industry.
- 2) Almost all aspects of program satisfaction rated higher in Phase II than Phase I. When compared with results from the Phase I C&I evaluation, all aspects of program satisfaction increased in average score between Phase I and Phase II, with the exception of the incentive offered, which decreased marginally.
- 3) The participant information files are improved from Phase I. Interview staff reported high levels of survey completion on their first attempt to contact respondents, which is atypical for C&I studies. The high quality sample information resulted in above-average numbers of participants calling the survey lab to complete the survey, a fact that is directly correlated with the advance letter reaching the correct individual within the firm.
- 4) Although customers’ stated preference of receiving information about energy efficiency via email or direct mail, contractors are successfully marketing the programs to customers. Two-thirds (67 percent) of respondents indicated their preferred method of communication is email newsletters, while 30 percent said they preferred direct mail from their EDC. However, more than half (54 percent) of respondents learned about the program through their contractor.
- 5) Budget and financial plans fall into two planning periods. Almost 45 percent of customers indicated their firm creates budgets/financial plans of one year or less, while 35 percent of customers said their business’ budgets/financial plans span five years or longer. Responses differed between strata – large C&I customers are more likely to create plans spanning more than 5 years (47 percent), while small C&I and GNI customers typically plan in one-year increments (50 percent and 53 percent, respectively).

⁵⁸ Key findings are reported in aggregate for the four FirstEnergy PA EDCs and for small C/I and large C/I customers, except when noted otherwise. Results were very similar for each EDC and for each program.

The budget cycle was a primary factor for when projects can be implemented. Of the 45 percent of respondents who indicated that they had business or production cycles that affect planning and implementation of efficiency projects, more than half of respondents (53 percent) have budget and financial planning cycles that affect when projects can be planned and implemented. Customers' budget and financial planning periods overwhelmingly fall into two categories, under one year or five years and longer. Customers often cited financial plans and budgets as a driving force behind whether energy improvements could be pursued, highlighting the crucial role of working alongside customers during their planning and budgeting periods.

8.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort.

Table 8-8: C/I Energy Efficient Equipment Program - Large Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Continue conducting outreach with trade allies and contractors to promote the program when working with commercial customers, and continue incorporating case studies and testimonials into marketing materials provided to customers and trade allies.	Implemented
Seek opportunities to provide contractors and targeted customers with additional literature and marketing materials they can use to convey benefits of the program to management staff.	Being Considered for Phase III with ICSP
Continue working closely with contractors and business owners to establish time periods during which project installations occur.	Implemented
Lower ex ante energy savings Threshold to 750 MWh from 800 to trigger up-front evaluation of lighting projects to better align with 2016 TRM. At the same time, increase threshold from 400 MWh to 500 MWh for non-lighting projects to maintain expected 50/50 balance in reported MWh between sampled and "certainty" projects.	Implemented

8.6 FINANCIAL REPORTING

A breakdown of the program finances by program is presented in Table 8-9.

Table 8-9: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	\$8,268	\$18,829
2	EDC Incentives to Participants	\$1,929	\$4,127
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$6,339	\$14,702
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	\$823	\$1,807
6	Design & Development	\$5	\$12
7	Administration, Management, and Technical Assistance ^[1]	\$395	\$1,010
8	Marketing ^[2]	\$41	\$109
9	EDC Evaluation Costs	\$379	\$635
10	SWE Audit Costs	\$3	\$41
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$11,439	\$11,439
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$20,529	\$32,074
13	Total NPV Lifetime Energy Benefits	\$25,845	\$48,078
14	Total NPV Lifetime Capacity Benefits	\$3,239	\$6,301
15	Total NPV TRC Benefits ^[4]	\$29,084	\$54,379
16	TRC Benefit-Cost Ratio ^[5]	1.42	1.70
NOTES			
Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.			
[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.			
[2] Includes the marketing CSP and marketing costs by program CSPs.			
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.			
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.			
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.			

9 C/I ENERGY EFFICIENT BUILDINGS PROGRAM - LARGE

This program includes energy conservation kits consisting of CFLs, and custom “whole building” projects such as new construction, retro-commissioning, and building envelope improvements.

9.1 PROGRAM UPDATES

In PY7, the program included several custom projects.

9.1.1 Definition of Participant

Each separate rebated project is counted as a participant.

9.2 IMPACT EVALUATION GROSS SAVINGS

9.2.1 Evaluation Methodology

The projects rebated under this program include energy conservation kits as well as custom projects that involve new construction, retro-commissioning, building envelope improvements. The M&V methodology for this program is described below.

Gross Impact Evaluation for Conservation Kits

The program distributed conservation kits consisting of 13W and 23W CFLs to commercial and industrial customers. No conservation kits were distributed in PY7.

Gross Impact Evaluation for Efficient Equipment Incentives

Sampling and project-level gross impact evaluation methodologies for efficient equipment and building upgrade measures are identical to the methodology described in Section 6 for the C/I Small Efficient Equipment Program. The projects in this program tend to involve new construction, retro-commissioning, and other controls or envelope upgrades that tend to affect the systemic energy usage performance of the involved facilities. Data acquisition for such projects involves the determination of independent variables that predict the heating and cooling loads along with utility bills, EMS trending data, or sub-metering. The data analysis may involve regressions or energy simulation models.

Table 9-1: Phase II C/I Energy Efficient Buildings Program – Large Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	6	862	0.09	0
Low-Income	0	0	0.00	0
Small Commercial and Industrial	0	0	0.00	0
Large Commercial and Industrial	102	7,485	0.80	522
Government, Non-Profit, and Institutional	104	4,199	0.39	293
Phase II Total	212	12,546	1.28	815
*The incentive amounts associated with cross-sector flow of CFLs to the residential sector are reported as zero because the Company has already made accounting adjustments for cross-sector sales, as described in Appendix D.				

Table 9-2: C/I Energy Efficient Buildings Program - Large Sampling Strategy for Program Year 7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
CFL Kits-1	0	n/a	0	0	S
Lighting-Certainty	0	n/a	0	0	DR,OS,L,B
Lighting-2	0	n/a	0	0	DR,OS,L,B
Lighting-3	0	n/a	0	0	DR,OS,L,B
Lighting-4	0	n/a	0	0	DR,OS,L,B
Custom-Certainty	1	0.0%	1	1	DR,OS,M,B,ES
Custom-2	2	50.9%	1	1	DR,OS,M,B,ES
Custom-3	5	39.4%	2	2	DR,OS,M,B,ES
HVAC and DHW-1	0	n/a	0	0	DR,OS,M,B,ES
HVAC and DHW-2	0	n/a	0	0	DR,OS,S
Appliance Turn-in-1	0	n/a	0	0	DR
Kitchen/Appliances-1	0	n/a	0	0	DR
Program Total	8	13.4%	4	4	

Table 9-3: Program Year 7 C/I Energy Efficient Buildings Program – Large Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0	0.0%	0	0.5	0.0%
Lighting-Certainty	0	n/a	0	0.5	0.0%
Lighting-2	0	n/a	0	0.5	0.0%
Lighting-3	0	n/a	0	0.5	0.0%
Lighting-4	0	n/a	0	0.5	0.0%
Custom-Certainty	1,989	100.0%	1,989	0.5	0.0%
Custom-2	768	104.0%	798	0.5	50.9%
Custom-3	417	71.3%	297	0.5	39.4%
HVAC and DHW-1	0	n/a	0	0.5	0.0%
HVAC and DHW-2	0	n/a	0	0.5	0.0%
Appliance Turn-in-1	0	n/a	0	0.5	0.0%
Kitchen/Appliances-1	0	n/a	0	0.5	0.0%
Program Total	3,173	97.2%	3,084		13.7%

Table 9-4: Program Year 7 C/I Energy Efficient Buildings Program - Large Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (C _v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0.00	0.0%	0.00	0.5	0.0%
Lighting-Certainty	0.00	n/a	0.00	0.5	0.0%
Lighting-2	0.00	n/a	0.00	0.5	0.0%
Lighting-3	0.00	n/a	0.00	0.5	0.0%
Lighting-4	0.00	n/a	0.00	0.5	0.0%
Custom-Certainty	0.13	100.0%	0.13	0.5	0.0%
Custom-2	0.09	37.7%	0.03	0.5	50.9%
Custom-3	0.06	110.7%	0.06	0.5	39.4%
HVAC and DHW-1	0.00	n/a	0.00	0.5	0.0%
HVAC and DHW-2	0.00	n/a	0.00	0.5	0.0%
Appliance Turn-in-1	0.00	n/a	0.00	0.5	0.0%
Kitchen/Appliances-1	0.00	n/a	0.00	0.5	0.0%
Program Total	0.28	82.4%	0.23		12.9%

9.2.2 On-Site Inspections

This program has two components: Conservation Kits and downstream rebates for commercial and industrial energy efficiency projects. There are no on-site visits conducted for the conservation kits. All other projects are eligible for on-site QA/QC inspections. These QA/QC inspections are identical in process as the effort described for the C/I Energy Efficient Equipment Program - Large.

As with other nonresidential programs, CLEAResult's QA/QC activities are exclusive of ADM's on-site verification activities. ADM's independent evaluation activities are described in the preceding section. The program realization rates are informed, in part, by on-site findings. The primary source of variance between reported and verified impacts are not due to failures in verification, but rather to differences between planning assumptions and ex-post measurements in key parameters that describe operational characteristics. This program may involve projects that involve relatively complex calculations, including building energy simulations and engineering calculations. In many cases, discrepancies between reported and verified impacts result from differences in calculation methodologies and data sources. The impact evaluation effort has the benefit of having access to post-installation utility meter data, trending data, or logger data, and often the newly available information helps to improve project savings estimates.

9.3 IMPACT EVALUATION NET SAVINGS

Tetra Tech conducted the NTG research according to the Common Approach, Statewide Evaluator Guidance Memos GM-024 (Consistent Free ridership methodology) and GM-025 (Consistent Spillover methodology) using the participant self-report method.

For the downstream custom program component, participant data for nearly all of Phase II was first aggregated to the level of individual participants based on account number and multiple record accounts were identified and consolidated for sampling purposes. The evaluation of the conservation kits focused on PY7 participants only, as the process and NTG survey efforts were combined gross impact verification

surveys. Due to the fact that there were no PY7 customers in this stratum, the NTG values from the C/I Energy Efficient Equipment Program - Small is applied to this stratum. The NTG research was conducted in conjunction with the process evaluation effort.

Table 9-5: C/I Energy Efficient Buildings Program - Large
Sampling Strategy for Program Year 7 NTG Research

Stratum	Population Size	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ⁵⁹ to Achieve Sample
Kits	0	0.5	85/15	0	0	n/a
Custom	10	0.5	85/15	10	5	100%
Program Total	10		85/15	10	5	50%

Table 9-6: Phase II C/I Energy Efficient Buildings Program - Large
Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Kits	26.0%	0.0%	74.0%	0.5	24.1%
Custom	50.0%	0.0%	50.0%	0.5	22.8%
Program Total⁶⁰	49.9%	0.0%	50.1%		22.6%

9.4 PROCESS EVALUATION

Tetra Tech conducted the process evaluation in conjunction with the NTG research. These activities included:

Participating Contractor In-depth Interviews

Tetra Tech conducted in-depth interviews with a dozen contractors that participate in the program. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics. In addition, contractors provided input on the types of information that would be most beneficial to design and implementation efforts.

Participant Surveys

The participant surveys gathered data and information related to assess free-ridership and spillover and process related topics. The topic areas included:

- Program awareness and marketing
- The company's decision-making process in regards to new equipment
- Energy efficiency at the company
- Program satisfaction

⁵⁹ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

⁶⁰ NTG ratio at program level is developed using stratum weight and stratum NTG ratios. We use the Phase II lifetime verified MWh as the weights.

Participant data for Phase II, PY5-PY7Q3 was first aggregated to the level of individual participants based on account number and multiple record accounts were identified and consolidated for sampling purposes. The process evaluation survey research was conducted in conjunction with the NTG research.

Table 9-7: C/I Energy Efficient Buildings Program - Large Sampling Strategy for Program Year 7

Target Group or Stratum (if appropriate)	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
Kits	0	0.5	85/15	0	0	0%	Process, NTG
Custom	10	0.5	85/15	10	5	100%	Process, NTG
Program Total	10		85/15	10	5	100%	

Key Findings⁶¹

- 1) Overall, average participant satisfaction ratings were high in the custom program component. Satisfaction was highest with equipment installed (9.0/10.0) and satisfaction with the amount of incentive available and the application process were lowest (8.0/10.0). The average likelihood of participating again is 9.4 (where 10 is "very likely") and 69% of participants have recommended the program to others.
- 2) Of the 12 contractors interviewed, 9 reported customer barriers including education, financing, ROI, trust, and equipment failure
- 3) Approximately 90% of customers heard about savings potential from contractors, 86% discussed payback and ROI with contractors, and 51% thought contractors discussed other equipment benefits.
- 4) Two thirds of contractors reported discussing savings potential and ROI with their customers. Other benefits discussed included brighter facilities, reduction of operating and maintenance expenses, longer product life, low energy footprint, code compliance, and comfort. A few felt that customer mistrust is the primary barrier they have to overcome.
- 5) Participant contact information was highly accurate, but the accuracy of contractor contact information can be improved.
- 6) Most contractors that participated in the custom program expressed difficulties with documentation and paperwork requirements, pre-approval wait times, eligibility requirements, and frequent quality assurance inspections by the ICSP.
- 7) In general, contractors also stated that the ICSP was accessible, and was able to answer questions related to the program.

⁶¹ Key findings are reported in aggregate for the four FirstEnergy PA EDCs and for small C/I and large C/I customers, except when noted otherwise. Results were very similar for each EDC and for each program.

9.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort.

Table 9-8: C/I Energy Efficient Buildings Program - Large
Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
In Phase III, consider subsuming this program into the C/I Energy Efficient Equipment Program - Large to reduce administrative costs and to ensure adequate budget is available in case participation levels increase significantly.	Implemented
Review and improve contractor tracking procedures.	Implemented for Phase III
Review the application process for possible efficiencies.	Implemented for Phase III
Continue support to contractors, including consistent ICSP contact and marketing materials.	Implemented for Phase III
Continue to market to past participants as well as nonparticipants if additional participation is needed.	Implemented for Phase III
Consider engaging new contractors.	Implemented for Phase III

9.6 FINANCIAL REPORTING

A breakdown of the program finances by program is presented in Table 9-9.

Table 9-9: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	\$718	\$1,163
2	EDC Incentives to Participants	\$246	\$815
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$471	\$348
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	\$303	\$802
6	Design & Development	\$4	\$9
7	Administration, Management, and Technical Assistance ^[1]	\$206	\$587
8	Marketing ^[2]	\$31	\$80
9	EDC Evaluation Costs	\$61	\$95
10	SWE Audit Costs	\$2	\$31
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$1,021	\$1,965
13	Total NPV Lifetime Energy Benefits	\$2,006	\$7,906
14	Total NPV Lifetime Capacity Benefits	\$122	\$665
15	Total NPV TRC Benefits ^[4]	\$2,128	\$8,571
16	TRC Benefit-Cost Ratio ^[5]	2.08	4.36

NOTES
Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

10 GOVERNMENTAL AND INSTITUTIONAL PROGRAM

This program provides for the implementation of cost effective, high efficiency measures through Lighting, HVAC & Water Heating, Appliances, Multifamily and Audit subprograms. Participation in most measures are restricted to certain rate classes that are designated for nonprofit organizations. GNI customers in other rate classes participate through other C/I programs.

10.1 PROGRAM UPDATES

There were no updates to this program in PY7.

10.1.1 Definition of Participant

Each separate rebated project is counted as a participant.

10.2 IMPACT EVALUATION GROSS SAVINGS

10.2.1 Evaluation Methodology

This program offers all measures included in the other nonresidential programs, but eligibility is restricted to certain rate classes that are designated for nonprofit organizations. The program has limited participation due to the rate class eligibility restriction. Historically, most of the projects rebated under this program involve lighting upgrades, and a small percentage of impacts are attributable to HVAC replacements or other non-lighting projects. The participants are often volunteer fire departments, municipalities, and religious organizations.

Gross Impact Evaluation for Efficient Equipment Incentives

The sampling and gross impact evaluation process for this program is identical to the process used for the commercial and industrial programs. There are some differences in evaluation results, however. The Government and Institutional Program tends to have volatile realization rates, in part due to low participation rates, and in part due to inaccuracies in the rebate applications related to lighting hours of use and baseline fixture types. The lighting hours of use in this sector, in particular for volunteer fire departments, are quite low – perhaps 1,000 hours per year or less. In PY7, the ICSP lowered hours of use for reported by volunteer fire department applicants prior to processing rebates.

A second issue is that some of the customers tend to self-install, but may not be familiar with “standard” lighting fixture types and codes, and may enter incorrect baseline fixture types. For these customers, ADM tends to supplement on-site data collection activities with a review of utility meter data. In many cases, the facilities’ consumption history helps to provide reasonable upper limits on the project energy savings, and can help to guide baseline fixture specification in cases where physical evidence of baseline fixture types may not exist.

Table 10-1: Phase II Government and Institutional Program Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	0	0	0.00	0
Low-Income	0	0	0.00	0
Small Commercial and Industrial	0	0	0.00	0
Large Commercial and Industrial	0	0	0.00	0
Government, Non-Profit, and Institutional	38	1,771	0.28	73
Phase II Total	38	1,771	0.28	73

Table 10-2: Government and Institutional Program Sampling Strategy for Program Year 7

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
CFL Kits-1	0	n/a	0	0	n/a
Lighting-Certainty	0	n/a	0	0	DR,OS,L,B
Lighting-2	1	0.0%	1	1	DR,OS,L,B
Lighting-3	2	0.0%	2	2	DR,OS,L,B
Lighting-4	11	28.7%	4	4	DR,OS,L,B
Custom-Certainty	0	n/a	0	0	DR,OS,M,B,ES
Custom-2	0	n/a	0	0	DR,OS,M,B,ES
Custom-3	0	n/a	0	0	DR,OS,M,B,ES
HVAC and DHW-1	0	n/a	0	0	DR,OS,M,B,ES
HVAC and DHW-2	0	n/a	0	0	DR,OS,S
Appliance Turn-in-1	0	n/a	0	0	DR
Kitchen/Appliances-1	0	n/a	0	0	DR
Program Total	14	14.1%	7	7	

Table 10-3: Program Year 7 Government and Institutional Program
Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Observed Coefficient of Variation (C_v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0	n/a	0	0.5	0.0%
Lighting-Certainty	0	n/a	0	0.5	0.0%
Lighting-2	81	93.9%	76	0.5	0.0%
Lighting-3	82	75.4%	62	0.5	0.0%
Lighting-4	157	96.0%	150	0.5	28.7%
Custom-Certainty	0	n/a	0	0.5	0.0%
Custom-2	0	n/a	0	0.5	0.0%
Custom-3	0	n/a	0	0.5	0.0%
HVAC and DHW-1	0	n/a	0	0.5	0.0%
HVAC and DHW-2	0	n/a	0	0.5	0.0%
Appliance Turn-in-1	0	n/a	0	0.5	0.0%
Kitchen/Appliances-1	0	n/a	0	0.5	0.0%
Program Total	319	90.2%	288		15.0%

Table 10-4: Program Year 7 Government and Institutional Program
Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)	Observed Coefficient of Variation (C_v) in Sample Design	Relative Precision at 85% C.L.
CFL Kits-1	0.00	n/a	0.00	0.5	0.0%
Lighting-Certainty	0.00	n/a	0.00	0.5	0.0%
Lighting-2	0.01	89.4%	0.01	0.5	0.0%
Lighting-3	0.01	112.3%	0.01	0.5	0.0%
Lighting-4	0.04	98.4%	0.04	0.5	28.7%
Custom-Certainty	0.00	n/a	0.00	0.5	0.0%
Custom-2	0.00	n/a	0.00	0.5	0.0%
Custom-3	0.00	n/a	0.00	0.5	0.0%
HVAC and DHW-1	0.00	n/a	0.00	0.5	0.0%
HVAC and DHW-2	0.00	n/a	0.00	0.5	0.0%
Appliance Turn-in-1	0.00	n/a	0.00	0.5	0.0%
Kitchen/Appliances-1	0.00	n/a	0.00	0.5	0.0%
Program Total	0.06	97.9%	0.06		18.5%

10.2.2 On-Site Inspections

The Company's ICSP, CLEAResult, conducts QA/QC on-site inspections for 5% of pending rebate applications. The QA/QC visits are conducted prior to rebate approval, and can occur prior to or after measure installation⁶². Nonresidential energy efficiency projects typically involve complex or numerous energy efficiency measures. It is therefore inadequate to classify inspections in a binary (e.g. Pass/Fail) manner. Site inspections may result in three general outcomes:

Case 1: The reported energy efficiency measures are found to be installed as described in rebate application materials.

Case 2: The energy efficiency project is completed, but there may be minor discrepancies between the installed measures and the associated documentation. These can include:

- A discrepancy in the quantities for some or all of the energy efficiency measures
- A discrepancy in the description of the energy efficiency measure (e.g. fixture wattage, HVAC system capacity or efficiency, motor horsepower or efficiency)
- A discrepancy in the baseline equipment
- A mischaracterization of equipment operation (e.g. lighting hours of use or control type, VFD control feedback mechanism, space heating and cooling set points)

Case 3: The energy efficiency project is not completed, or there are major discrepancies in the attributes discussed above in Case 2.

The on-site inspections occur prior to rebate approval. Approximately (34%)⁶³ of QA/QC inspections correspond to Case 1 above. Approximately 66% of on-site inspections result in a "Case 2" finding. In such cases, the application materials are updated to reflect the as-found equipment, and the rebate application is processed accordingly. Note that most "Case 2" findings do not result in material changes to the ex-ante savings⁶⁴ – the high proportion of site-visits that fall into this case is mostly a function of minor updates to project descriptions.

Case 2 findings may involve an adjustment to the rebate amount and to the reported impacts in CLEAResult's tracking and reporting system⁶⁵. In the event of a Case 3 finding, the rebate application is cancelled. Based on CLEAResult's historical records, this scenario occurs approximately 0% of the time.

These QA/QC activities are exclusive of ADM's on-site verification activities. ADM's independent evaluation activities are described in the preceding section, and the program realization rates are informed, in part, by on-site findings. The primary source of variance between reported and verified impacts are not due to failures in verification, but rather to differences between planning assumptions and ex-post measurements in key parameters that describe operational characteristics. These include hours of use for lighting, both hours of use and part-load conditions for HVAC, refrigeration, and motors.

⁶² In cases where baseline conditions are critical to the overall project energy savings calculation CLEAResult staff may conduct baseline on-site inspections. These inspections may also involve metering to help determine baseline lighting hours of use or other attributes that may correlate with the project's energy savings.

⁶³ Percentages here apply to all CLEAResult administered programs for all four FirstEnergy Pennsylvania EDCs.

⁶⁴ ADM reviewed summary of 110 on-site inspections conducted by CLEAResult in PY6, and developed a 'QC realization rate' to help inform the annual report. The QC realization rate was 98%, with a CV of 0.39. The adjustments made by CLEAResult accounted for variations in hours of use as well as variations in equipment specification.

⁶⁵ Adjustments to the Company's tracking and reporting are not necessary because QA/QC inspections occur prior to rebate approval.

10.3 IMPACT EVALUATION NET SAVINGS

In PY6, Tetra Tech conducted the NTG research according to the Common Approach, Statewide Evaluator Guidance Memos GM-024 (Consistent Free ridership methodology) and GM-025 (Consistent Spillover methodology) using the participant self-report method. The complete participant dataset for Phase II, PY6 (Q1-Q4) was used for this evaluation effort. Due to the small number of participants in the Government and Institutional Program, the NTG statistics are combined across the four FirstEnergy PA Companies. The tables below summarize last year's evaluation results and include updated net impact values, weighted by stratum with Phase II lifetime MWh.

Table 10-5: Government and Institutional Program Sampling Strategy for Program Year 6 NTG Research

Stratum	Population Size ⁶⁶	Assumed CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted ⁶⁷ to Achieve Sample
Lighting	25	0.5	85/15	6	18	n/a
Custom	0	0.5	85/15	0	0	n/a
HVAC and DHW	2	0.5	85/15	1	0	n/a
Kitchen/Appliances	0	0.5	85/15	0	0	n/a
Program Total	27		85/15	7	18	89%

Table 10-6: Phase II Government and Institutional Program Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Free Ridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Lighting	37.5%	10.7%	73.2%	0.37	6.7%
Custom	37.5%	10.7%	73.2%	0.37	6.7%
HVAC and DHW	59.3%	10.4%	51.1%	0.41	100.0%
Kitchen/Appliances	47.9%	10.6%	62.7%	0.41	100.0%
Program Total⁶⁸	37.9%	10.7%	72.8%		5.7%

⁶⁶ Due to the low number of participants in this program, NTG and process evaluation results are reported by combining statistics across the four FirstEnergy EDCs in PA.

⁶⁷ Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completed surveys.

⁶⁸ NTG ratio at program level should be developed using stratum weight and stratum NTG ratios. Phase II Verified MWh are used as weights

10.4 PROCESS EVALUATION

Tetra Tech conducted the process evaluation in conjunction with the NTG research during PY6. The process evaluation activities included:

FirstEnergy and Program Implementer Staff In-depth Interviews

Tetra Tech and ADM conducted in-depth interviews with FirstEnergy program staff and the ICSP to discuss Phase II design and implementation updates, program goals, and key researchable issues of interest for the Phase II evaluation. The interviews assessed the effectiveness of the program's current operations, detailed program implementation practices, and identified key researchable topics. In addition, both FirstEnergy and ICSP staff provided input on the types of information that would be most beneficial to design and implementation efforts.

Participant Surveys

The participant surveys gathered data and information related to assess free-ridership and spillover and process related topics. The topic areas included:

- Program awareness and marketing
- The company's decision-making process in regards to new equipment
- Energy efficiency at the company
- Program satisfaction

The complete participant dataset for Phase II, PY6 (Q1-Q4) was used for this evaluation effort. Table 10-7 shows the sampling strategy from the process evaluation effort.

Table 10-7: Government and Institutional Program Sampling Strategy for Program Year 6

Target Group or Stratum (if appropriate)	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Used For Evaluation Activities (Impact, Process, NTG)
Lighting	25	0.5	85/15	6	18	n/a	Process, NTG
Custom	0	0.5	85/15	0	0	n/a	Process, NTG
HVAC and DHW	2	0.5	85/15	1	0	n/a	Process, NTG
Kitchen/Appliances	0	0.5	85/15	0	0	n/a	Process, NTG
Program Total	27		85/15	7	18	89%	

Key Findings⁶⁹

- 1) Participants report high levels of satisfaction with all aspects of the program. Program participants are highly satisfied with the overall program and more than 90 percent of customers said they would likely participate in the program again in the future. Each individual aspect of the program received an average rating of "highly satisfied," with the exception of the incentive amount, which received a mean satisfaction just shy of "highly satisfied"). Most participants said they did not

⁶⁹ Key findings are reported in aggregate for the four FirstEnergy PA EDCs. Results were very similar for each EDC.

experience any obstacles or barriers while implementing their project (89 percent) – and those that had difficulties, the issues were typically internal to the customer (e.g. convincing management to fund initial costs). Lastly, two-thirds of customers have recommended the program to colleagues in their industry.

- 2) Almost all aspects of program satisfaction rated higher in Phase II than Phase I. When compared with results from the Phase I C&I evaluation, all aspects of program satisfaction increased in average score between Phase I and Phase II, with the exception of the incentive offered, which decreased marginally.
- 3) The participant information files are improved from Phase I. Interview staff reported high levels of survey completion on their first attempt to contact respondents, which is atypical for C&I studies. The high quality sample information resulted in above-average numbers of participants calling the survey lab to complete the survey, a fact that is directly correlated with the advance letter reaching the correct individual within the firm.
- 4) Although customers' stated preference of receiving information about energy efficiency via email or direct mail, contractors are successfully marketing the programs to customers. Two-thirds (67 percent) of respondents indicated their preferred method of communication is email newsletters, while 30 percent said they preferred direct mail from their EDC. However, more than half (54 percent) of respondents learned about the program through their contractor.
- 5) Budget and financial plans fall into two planning periods. Almost 45 percent of customers indicated their firm creates budgets/financial plans of one year or less, while 35 percent of customers said their business' budgets/financial plans span five years or longer. Responses differed between strata – large C&I customers are more likely to create plans spanning more than 5 years (47 percent), while small C&I and GNI customers typically plan in one-year increments (50 percent and 53 percent, respectively).

The budget cycle was a primary factor for when projects can be implemented. Of the 45 percent of respondents who indicated that they had business or production cycles that affect planning and implementation of efficiency projects, more than half of respondents (53 percent) have budget and financial planning cycles that affect when projects can be planned and implemented. Customers' budget and financial planning periods overwhelmingly fall into two categories, under one year or five years and longer. Customers often cited financial plans and budgets as a driving force behind whether energy improvements could be pursued, highlighting the crucial role of working alongside customers during their planning and budgeting periods.

10.5 STATUS OF RECOMMENDATIONS FOR PROGRAM

The following recommendations resulted from the process and impact evaluation effort.

Table 10-8: Government and Institutional Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Continue conducting outreach with trade allies and contractors to promote the program when working with commercial customers, and continue incorporating case studies and testimonials into marketing materials provided to customers and trade allies.	Implemented
Seek opportunities to provide contractors and targeted customers with additional literature and marketing materials they can use to convey benefits of the program to management staff.	Being Considered
Continue working closely with contractors and business owners to establish time periods during which project installations occur.	Implemented
Consider stipulating an annual indoor lighting hours of use of 1,000 hours for all program participants	Implemented in latter part of PY7. ADM has also provided a memo with this recommendation to the new ICSP in PY8.

10.6 FINANCIAL REPORTING

A breakdown of the program finances (by program) is presented in Table 10-9. This program's TRC benefit-cost ratio is relatively low primarily because the program has not yet achieved the scale necessary to dilute fixed costs associated with implementation. A secondary factor regards a prevalence of volunteer fire departments that tend to undertake relatively costly lighting upgrades, but have very low annual hours of use. Therefore, the annual energy savings are small compared to the project incremental costs. For such projects, the expected useful life of the measures may exceed 15 years.

Table 10-9: Summary of Program Finances

Row #	Cost Category	Actual PYTD Costs (\$1,000)	Actual Phase II Costs (\$1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	\$302	\$799
2	EDC Incentives to Participants	\$19	\$73
3	EDC Incentives to Trade Allies	\$0	\$0
4	Participant Costs (net of incentives/rebates paid by utilities)	\$283	\$726
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	\$191	\$573
6	Design & Development	\$3	\$7
7	Administration, Management, and Technical Assistance ^[1]	\$138	\$448
8	Marketing ^[2]	\$23	\$59
9	EDC Evaluation Costs	\$26	\$35
10	SWE Audit Costs	\$1	\$23
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	\$0	\$0
12	Total TRC Costs ^[3] (Sum of rows 1, 5 and 11)	\$493	\$1,371
13	Total NPV Lifetime Energy Benefits	\$171	\$537
14	Total NPV Lifetime Capacity Benefits	\$29	\$80
15	Total NPV TRC Benefits ^[4]	\$200	\$617
16	TRC Benefit-Cost Ratio ^[5]	0.41	0.45
NOTES			
Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2013 Total Resource Cost Test Order. Please see the "Report Definitions" section of this report for more details.			
[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.			
[2] Includes the marketing CSP and marketing costs by program CSPs.			
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.			
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.			
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.			

APPENDIX A | EM&V INFORMATION

Participant Definitions

Table A-0-1: Program Year 7 Participant Definition by Program⁷⁰

Program	Participant Definition	Can there be more than one measure per participant?	Sample Defined By:
EE Products: Upstream Lighting	One package of lamps	Yes	Achieved Census
EE Products: Upstream Televisions	One Television	Yes	Achieved Census
EE Products: Refrigerators / Freezers	Unique Rebate ID	Yes	Each Appliance
EE Products: Heat Pump Water Heaters	Unique Rebate ID	Yes	Each Appliance
EE Products: ASHP	Unique Rebate ID	Yes	Each Appliance
EE Products: Clothes Washers	Unique Rebate ID	Yes	Each Appliance
EE Products: GSHP	Unique Rebate ID	Yes	Each Appliance
EE Products: HVAC Tune-Ups	Unique Rebate ID	Yes	Each Appliance
EE Products: Dehumidifiers	Unique Rebate ID	Yes	Each Appliance
EE Products: CAC	Unique Rebate ID	Yes	Each Appliance
EE Products: Mini-split HP	Unique Rebate ID	Yes	Each Appliance
EE Products: RAC	Unique Rebate ID	Yes	Each Appliance
EE Products: Smart Strips	Unique Rebate ID	Yes	Each Appliance
EE Products: Upstream Smart Strips	Unique Rebate ID	Yes	Achieved Census
EE Products: Electric Resistance Water Heaters	Unique Rebate ID	Yes	Each Appliance
EE Products: Upstream Computers/Monitors	Unique Rebate ID	Yes	Achieved Census
EE Products: Solar Water Heaters	Unique Rebate ID	Yes	Each Appliance
EE Products: ECM Fans	Unique Rebate ID	Yes	Each Appliance
EE Products: Dishwashers	Unique Rebate ID	Yes	Each Appliance
EE Products: Mini-split AC	Unique Rebate ID	Yes	Each Appliance
EE Products: Tune-Up with ECM	Unique Rebate ID	Yes	Each Appliance
Appliance Turn-In: Refrigerators	Unique Rebate ID	No	Each Appliance
Appliance Turn-In: Freezers	Unique Rebate ID	Yes	Each Appliance
Appliance Turn-In: RACs	Unique Rebate ID	Yes	Each Appliance
HEA: HEA Kits	Unique Rebate ID	No	Each Kit
HEA: School Kits	Unique Rebate ID	No	Each Kit
HEA: New Construction	Unique Rebate ID	No	Each Home
HEA: Direct Install, Prescriptive Measures	Unique Rebate ID	Yes	Each itemized measure
HEA: Weatherization, > 2MWh	Unique Rebate ID	Yes	Each home
HEA: Weatherization, < 2MWh	Unique Rebate ID	Yes	Each home
HEA: Home Energy Reports	Unique Rebate ID	No	Each home
Low-Income - Lighting Giveaway	One lamp	No	Achieved Census
Low-Income - Furnace Whistle Giveaway	One Furnace Whistle	No	Achieved Census
Low-Income - Showerhead Giveaway	One Showerhead	No	Achieved Census

⁷⁰ EDCs can modify table as necessary to provide additional granularity.

Low-Income - LED Night Light Giveaway	One LED Night Light	No	Achieved Census
Low-Income - Aerator Giveaway	One Aerator	No	Achieved Census
Low-Income - Direct Install	One Home	Yes	Each Home
Low-Income - LILU Conservation kits	One Kit	No	Each Kit
Nonresidential Programs – Conservation Kit	One Kit	Yes	Each Kit
Nonresidential Programs – Appliance Recycling	Unique Rebate ID	Yes	Each rebate
Nonresidential Programs – All other projects	Unique Rebate ID	Yes	Each rebate

Program Year 7 Evaluation Activities

Table A-0-2: Program Year 7 Gross Impact Evaluation Activities

Programs (Sub Programs if necessary)	Sectors	Records Review	Participant Surveys ⁷¹	Site Visits	Metering or EMS Data	Billing Analysis or Energy Simulation
Refrigerators	Res Appliance Turn-In	Census	57	0	0	0
Freezers	Res Appliance Turn-In	Census	15	0	0	0
RACs	Res Appliance Turn-In	Census	11	0	0	0
Upstream Lighting	Residential EE Products	Census	1000	0	0	0
Upstream Televisions	Residential EE Products	Census	0	0	0	0
Refrigerators / Freezers	Residential EE Products	4	5	0	0	0
Upstream Computers/Monitors	Residential EE Products	Census	0	0	0	0
Heat Pump Water Heaters	Residential EE Products	4	6	0	0	0
ASHP	Residential EE Products	1	1	0	0	0
Clothes Washers	Residential EE Products	7	15	0	0	0
GSHP	Residential EE Products	4	3	0	0	0
HVAC Tune-Ups	Residential EE Products	2	2	0	0	0
Dehumidifiers	Residential EE Products	14	17	0	0	0
CAC	Residential EE Products	2	1	0	0	0
MiniSplit HP	Residential EE Products	17	21	0	0	0
Room AC	Residential EE Products	0	0	0	0	0
Smart Strips	Residential EE Products	Census	0	0	0	0
Whole House Fan	Residential EE Products	0	0	0	0	0
Electric Resistance Water Heaters	Residential EE Products	1	0	0	0	0
Solar Water Heaters	Residential EE Products	0	0	0	0	0
ECM Fans	Residential EE Products	0	0	0	0	0
MiniSplit AC	Residential EE Products	0	1	0	0	0
Pool Pump Motors	Residential EE Products	0	0	0	0	0
HEA Kits	Res Home Energy Audits	Census	160	0	0	0
School Kits	Res Home Energy Audits	n/a	n/a	n/a	n/a	n/a
New Construction	Res Home Energy Audits	3	0	0	3	0

⁷¹ Nonparticipant surveys were not conducted for impact evaluation.

Programs (Sub Programs if necessary)	Sectors	Records Review	Participant Surveys ⁷¹	Site Visits	Metering or EMS Data	Billing Analysis or Energy Simulation
Direct Install, Prescriptive	Res Home Energy Audits	3	0	0	0	0
Weatherization, > 2MWh	Res Home Energy Audits	0	0	0	0	1
Weatherization, < 2MWh	Res Home Energy Audits	0	0	0	0	1
Home Energy Reports	Res Home Energy Audits	0	0	0	0	Census (billing)
Direct Install	Low-Income Res	51	0	0	51	0
Giveaway Measures	Low-Income Res	1182	0	0	0	0
LILU Kits	Low-Income Res	n/a	0	0	0	0
C/I Lighting	C/I	40	0	40	27	5
C/I Custom	C/I	27	0	22	18	8
C/I HVAC and DHW	C/I	3	0	3	0	0
C/ I Kitchen/Appliances	C/I	1	0	1	0	0
C/I Appliance Recycling	C/I	1	0	0	0	0
C/I CFL Kits	C/I	Census	65	0	0	0

Table A-0-3: Program Year 7 Net Impact and Process Evaluation Activities

Programs (Sub Programs if necessary)	Program Staff Interviews	ICSP Interviews	Participant Surveys	Nonparticipant Surveys	Trade Ally Surveys
Appliance Turn-In	No	No	Yes	No	No
Efficient Products	No	No	Yes	Yes	Yes
Home Performance	No	No	Yes	Yes	Yes
Low Income	No	No	No	No	No
Small C/I Equipment	No	No	No	No	No
Small C/I Buildings	No	No	Yes	No	Yes
Large C/I Equipment	No	No	No	No	No
Large C/I Buildings	No	No	Yes	No	Yes
Gov./Institutional	No	No	No	No	No

APPENDIX B | TRC INCREMENTAL COSTS

Incremental costs for most measures offered in the residential sector are taken from the Incremental Cost Database provided by the SWE (SWE IC DB). To facilitate TRC calculations for certain programs, the verified impacts and incremental costs are calculated individually for all evaluated measures, and then are cast into per-unit average impacts and incremental costs, with the incremental costs weighted by gross verified energy savings. For example, the first line in the table below shows a cost of \$7.70 for the average package of lamps sold through the upstream lighting program. Exact costs are known for certain measures such as energy conservation kits in the residential sector.

For early replacement' measures, exact costs from invoices are preferred to other cost estimates. In the residential sector, exact costs are known for the energy conservation kits distributed by the Home Performance Program and the Low-Income Low-Use program component and are as provided by the Company. Though the costs of the low-income audits are known, they are incorporated into TRC costs as program administration costs rather than participant costs. For appliance recycling, the incentive cost is taken to approximate the incremental cost of participation, as it is assumed that the incentive is equal to the residual value of the appliance.

For nonresidential measures, ADM develops a project-specific incremental cost for each evaluated project. The program-level incremental cost is developed through the application of the same sample weights as those used to determine verified gross impacts. For nonresidential projects, the order of preference for material and labor costs is as follows: Invoices, SWE IC DB, DEER 2008 Incremental Cost Database (escalated 15% to account for inflation) and industry research. The incremental material cost for most projects is derived from invoices. The SWE IC DB provides costs for the most frequently encountered fixture types, but there are many relatively rare fixture types that are not listed. To expand the applicability of the SWE IC DB to all fixture types listed in the TRM Appendix C, ADM modeled the linear fluorescent fixture costs in the SWE IC DB as a function of wattage, the number of lamps, and lamp types, then applied the modeled costs to all linear fluorescents listed in Appendix C. A similar process, starting with the DEER 2008 incremental cost database, yielded costs for all HID lamp types.

Incremental costs for new construction lighting projects were derived in a two-step process. First, the actual cost of installed fixtures was determined (almost exclusively from invoices). The cost of meeting the baseline lighting power density allowance with typical fixtures (T5, T8, HID, as appropriate for the space type) was then calculated from the aforementioned per-fixture cost models. The incremental cost is taken as the actual cost of the installed fixtures minus the cost of the baseline fixtures. Projects that achieved savings through more efficient application of lamps, rather than relying on premium efficiency lamps, have negative incremental costs (e.g. a customer could have installed 100 fixtures, but installed 77 instead). Incremental costs for Non lighting measures were taken from SWE IC DB costs in 'replace on burnout' scenarios, and from invoices for early replacement measures. If labor costs were not available in invoices, ADM used labor to material cost fractions as published in or extrapolated from the DOE Report, *Process Equipment Cost Estimation, and Final Report*⁷².

⁷² *Process Equipment Cost Estimation, Final Report*, H.P. Loh, Jennifer Lyons, and Charles White, III. DOE/NETL-2002.1169, 2002. The labor factors in Table 6 are extrapolated to other equipment such as air compressors.

Table A-0-1: Summary of Incremental Costs

Program	Measure	Incremental Cost	Incremental Cost Source
Residential Appliance Turn-In	Refrigerators	50.00	Assume Incentive ≈ Incremental Cost
Residential Appliance Turn-In	Freezers	50.00	Assume Incentive ≈ Incremental Cost
Residential Appliance Turn-In	RACs	25.00	Assume Incentive ≈ Incremental Cost
Residential EE Products	Upstream Lighting	6.13	SWE DB (Weighted Average per Package)
Residential EE Products	Upstream Televisions	1.00	EE&C Plan
Residential EE Products	Refrigerators / Freezers	27.02	SWE DB (Weighted for Freezer/Frig Mix)
Residential EE Products	Upstream Computers/Monitors	1.00	EE&C Plan
Residential EE Products	Heat Pump Water Heaters	1,082.19	SWE DB (Weighted for tonnage, HSPF)
Residential EE Products	ASHP	1,968.39	SWE DB (Weighted for tonnage, HSPF)
Residential EE Products	Clothes Washers	150.00	SWE DB
Residential EE Products	GSHP	10,897.00	SWE DB
Residential EE Products	HVAC Tune-Ups	88.00	SWE DB
Residential EE Products	Dehumidifiers	20.00	SWE DB
Residential EE Products	CAC	1,598.38	SWE DB (Weighted for tonnage, SEER)
Residential EE Products	MiniSplit HP	447.75	SWE DB
Residential EE Products	Room AC	50.00	SWE DB
Residential EE Products	Smart Strips	21.00	SWE DB
Residential EE Products	Whole House Fan	490.00	SWE DB
Residential EE Products	Electric Resistance Water Heaters	111.49	SWE DB (Weighted for EF)
Residential EE Products	Solar Water Heaters	7,414.00	SWE DB
Residential EE Products	ECM Fans	360.00	SWE DB
Residential EE Products	MiniSplit AC	447.75	SWE DB
Residential EE Products	Pool Pump Motors	750.00	SWE DB
Residential Home Performance	HEA Kits	45.51	Invoices
Residential Home Performance	School Kits	n/a	Invoices

Program	Measure	Incremental Cost	Incremental Cost Source
Residential Home Performance	New Construction	2,561.00	SWE DB
Residential Home Performance	Direct Install, Prescriptive Measures	252.36	SWE DB
Residential Home Performance	Weatherization, > 2MWh - Per kWh saved	4,918.00	invoice review
Residential Home Performance	Weatherization, < 2MWh - Per kWh saved	n/a	invoice review
Residential Home Performance	Home Energy Reports	0.00	Included in Admin Costs
Low-Income Program	All Measures	0.00	All measures paid for by program
Large C/I Equipment	CR_PRJ-254397 Lighting-Certainty	417,612	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-292139 Custom-3	20,392	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-314348 Lighting-4	136	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-317355 Custom-3	3,434	Material: SWE DB, Labor: ADM Analysis for New Construction
Small C/I Equipment	CR_PRJ-349377 Lighting-4	10,556	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-350683 Custom-Certainty	3,499,228	Material: Invoice, Labor: Invoice
Government	CR_PRJ-353948 Lighting-4	5,112	Material: ADM Analysis for New Construction, Labor: ADM Analysis for New Construction
Small C/I Equipment	CR_PRJ-361950 Custom-3	27,151	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-362440 Lighting-3	51,250	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-363230 Lighting-2	204,110	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-364309 Lighting-4	3,682	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-364757 Lighting-4	9,087	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-372195 Lighting-3	9,602	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-375942 Lighting-4	2,612	Material: Invoice, Labor: SWE DB
Small C/I Buildings	CR_PRJ-378132 Custom-3	15,200	Material: Invoice, Labor: SWE DB
Small C/I Buildings	CR_PRJ-378136 Custom-3	14,400	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-379725 Custom-3	2,171	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-383775 Custom-3	18,700	Material: Invoice & SWE DB, Labor: Invoice & SWE DB
Small C/I Equipment	CR_PRJ-385177 Lighting-4	34,589	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-388290 Lighting-3	34,266	Material: Invoice, Labor: Invoice
Small C/I Buildings	CR_PRJ-388502 Custom-3	64,350	Material: Invoice, Labor: Invoice
Government	CR_PRJ-388749 Lighting-3	18,077	Material: Invoice, Labor: SWE DB
Large C/I Buildings	CR_PRJ-393288 Custom-Certainty	621,722	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-402588 HVAC and DHW-1	29,561	Material: SWE DB, Labor: SWE DB
Large C/I Equipment	CR_PRJ-405349 Custom-3	2,381	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-405803 Lighting-3	5,791	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-410722 Lighting-4	16,000	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-414393 Lighting-4	-10,083	Material: ADM Analysis for New Construction, Labor: ADM Analysis for New Construction

Program	Measure	Incremental Cost	Incremental Cost Source
Small C/I Equipment	CR_PRJ-415340 Lighting-4	11,990	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-417688 Lighting-4	14,299	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-424297 Custom-3	10,783	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-424367 Lighting-4	0	Material: ADM Analysis for New Construction, Labor: ADM Analysis for New Construction
Large C/I Equipment	CR_PRJ-424370 Lighting-4	0	Material: ADM Analysis for New Construction, Labor: ADM Analysis for New Construction
Small C/I Equipment	CR_PRJ-428234 Custom-3	19,823	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-441629 Lighting-Certainty	229,385	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-443899 Kitchen/Appliances-1	13,323	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-444039 Lighting-2	31,709	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-446959 Lighting-4	33,788	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-447499 Custom-3	1,629	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-452966 Lighting-3	24,305	Material: Invoice & SWE DB, Labor: SWE DB
Small C/I Equipment	CR_PRJ-464927 Lighting-3	95,822	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-465013 HVAC and DHW-2	30,203	Material: Invoice, Labor: Invoice
Large C/I Buildings	CR_PRJ-471424 Custom-3	12,325	Material: Invoice, Labor: Invoice
Large C/I Buildings	CR_PRJ-471447 Custom-2	12,325	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-471859 Lighting-2	46,548	Material: SWE DB, Labor: SWE DB
Large C/I Equipment	CR_PRJ-473187 Custom-Certainty	85,624	Material: SWE DB, Labor: SWE DB
Government	CR_PRJ-474208 Lighting-2	133,168	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-482516 Custom-3	7,606	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-486513 Custom-3	28,610	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-488021 Lighting-2	254,890	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-491580 Custom-2	58,294	Material: SWE DB, Labor: SWE DB
Government	CR_PRJ-494173 Lighting-4	4,075	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-496583 Custom-Certainty	63,015	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-500425 Custom-2	44,175	Material: Invoice, Labor: SWE DB
Government	CR_PRJ-504755 Lighting-3	11,000	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-508814 Lighting-3	45,088	Material: Invoice, Labor: SWE DB
Government	CR_PRJ-512594 Lighting-4	31,452	Material: SWE DB, Labor: SWE DB
Government	CR_PRJ-517437 Lighting-4	4,672	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-530170 Custom-Certainty	131,229	Material: Invoice, Labor: Invoice
Large C/I Buildings	CR_PRJ-535262 Custom-3	11,000	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-538286 Lighting-4	8,469	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-568338 Custom-Certainty	349,457	Material: Invoice, Labor: Invoice
Small C/I Buildings	CR_PRJ-587185 Custom-2	11,000	Material: Invoice, Labor: Invoice

Program	Measure	Incremental Cost	Incremental Cost Source
Large C/I Equipment	CR_PRJ-594930 Lighting-2	93,984	Material: Invoice, Labor: SWE DB
Large C/I Equipment	CR_PRJ-598946 Lighting-Certainty	246,020	Material: Invoice, Labor: Invoice
Large C/I Equipment	CR_PRJ-602539 Lighting-Certainty	221,563	Material: Invoice, Labor: Invoice
Small C/I Equipment	CR_PRJ-655593 Lighting-3	20,783	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-735948 Lighting-2	32,658	Material: Invoice, Labor: SWE DB
Small C/I Equipment	CR_PRJ-736042 HVAC and DHW-1	54,274	Material: DEER 2008, Labor: DEER 2008
Small C/I Equipment	CR_PRJ-787996 Custom-2	125,000	Material: Invoice, Labor: Invoice
Small C/I Equipment	JACO-4104521 Appliance Turn-in-1	0	Material: SWE DB, Labor: SWE DB
Small C/I Buildings	PD_PN_SB CFL Kits-1	169,074	Material: SWE DB, Labor: SWE DB
Large C/I Buildings	PD_PN_LB CFL Kits-1	0	Material: SWE DB, Labor: SWE DB

APPENDIX C | LOW-INCOME PARTICIPATION IN NON-LOW-INCOME PROGRAMS

For PY6 surveys, the evaluation team added income questions in each residential survey effort to assess low income participation in non-low income specific programs.

Table 1 provides the 2014 income ranges by household sizes, based on 2015 Federal Poverty Level (FPL). The income ranges will be updated annually. The survey will be programmed so that the interviewer reads the annual income ranges associated with their household sizes as listed in Table 1, supporting determination of whether the household is above or below 150% of FPL.⁷³ For example, if the respondent answers that three people lived in the household in 2014/2015, the interviewer will then ask Responses 1 through 5 for Household Size equals 3 as stated in Table 1.

Q1 Including yourself, how many people live in your household? _____ People

Q2 Including all money earned from wages, salaries, tips, commissions, workers' compensation, unemployment insurance, child support, or other sources, about how much was your total annual household income before taxes? Was it less than \$XX [FILL RESPONSES FOR MAX 150% FROM TABLE 1]?

If no, was it over \$YY [FILL RESPONSES FOR MIN 200% FROM TABLE 1]? (PROBE: IF R DOESN'T KNOW ANNUAL RANGE, PROMPT WITH MONTHLY RANGE)

- 1 Less than or equal to 150% poverty
- 2 151%-200% poverty
- 3 Over 200% poverty
- D Don't know
- R Refused

Table 1. Income Range Table (2015)⁷⁴

Household Size	Response 1 (≤50% FPL)	Response 2 (51%-100% FPL)	Response 3 (101%-150 FPL)	Response 4 (151%-200% FPL)	Response 5 (>200% FPL)
1	≤\$5,885	\$5,885 - \$11,770	\$11,770 - \$17,655	\$17,655 - \$23,540	≥\$23,540
2	≤\$7,965	\$7,965 - \$15,930	\$15,930 - \$23,895	\$23,895 - \$31,860	≥\$31,860
3	≤\$10,045	\$10,045 - \$20,090	\$20,090 - \$30,135	\$30,135 - \$40,180	≥\$40,180
4	≤\$12,125	\$12,125 - \$24,250	\$24,250 - \$36,375	\$36,375 - \$48,500	≥\$48,500
5	≤\$14,205	\$14,205 - \$28,410	\$28,410 - \$42,615	\$42,615 - \$56,820	≥\$56,820
6	≤\$16,285	\$16,285 - \$32,570	\$32,570 - \$48,855	\$48,855 - \$65,140	≥\$65,140
7	≤\$18,365	\$18,365 - \$36,730	\$36,730 - \$55,095	\$55,095 - \$73,460	≥\$73,460
8	≤\$20,445	\$20,445 - \$40,890	\$40,890 - \$61,335	\$61,335 - \$81,780	≥\$81,780

The low-income participation in upstream CFLs was determined from a survey in September 2015. The survey included the same questions as above with the annual income ranges rounded to the nearest \$1,000 to facilitate the telephone survey effort. Respondents were categorized as low-income qualified if the stated incomes were below 150% of FPL.

⁷³ Monthly income (annual/12) will be programmed for cases where the respondent answers "Don't know" to the annual value.

⁷⁴ Source: <http://aspe.hhs.gov/poverty/15poverty.cfm>

APPENDIX D | RESIDENTIAL LIGHTING UPSTREAM PROGRAM CROSS-SECTOR SALES

It is well known and reasonable that some lamps in the upstream programs are purchased and installed in nonresidential settings. As a result, these lamps experience higher annual hours of use and higher peak demand impacts. In September 2015, ADM conducted a “random digit dial” (RDD) telephone survey for residential customers to assess the impact of cross sector sales. The surveys focused on customers that have purchased either CFLs and LEDs in the last 12 months, from stores that participate in the upstream lighting programs offered by the four FirstEnergy EDCs in Pennsylvania.

The extrapolation from the residential surveys is straightforward. Out of 980 completed survey responses (11,118 efficient lamps purchased in the last 12 months), 36 reported installing a total of (646) CFLs or LEDs in non-residential settings. The fraction of efficient lamps that are installed in non-residential settings is $646/11118=5.81\%$.

There are incremental demand reductions and incremental energy savings associated with the crossover of CFLs from the residential sector to the nonresidential sector. The hours of use and demand coincidence factors applied to the cross-sector CFLs are taken from the 2014 Metering Study conducted by the SWE⁷⁵.

PY6 Upstream Cross Sector Sales Impact Calculation Parameters

Building Type	Hours	Hours	CF	Space Cooling Likelihood
Auto Related	15%	2,001	31%	50%
Education - Primary School	3%	2,944	36%	50%
Education - Secondary School	1%	2,944	36%	50%
Education - University	0%	2,944	36%	80%
Medical - Clinic	2%	2,476	42%	90%
Lodging - Common Spaces	2%	2,925	37%	90%
Nursing Home	4%	2,476	42%	90%
Police and Fire Station - Unmanned	4%	1,456	22%	80%
Religious Worship	8%	1,456	22%	80%
Restaurant - Sit-Down	9%	3,054	57%	90%
Retail - Large	8%	2,383	50%	90%
Retail - Small	10%	2,383	50%	90%
Storage /Warehouse	4%	2,815	44%	20%

The nonresidential TRM protocols also include HVAC interactive effects. ADM applied the 12% and 34% values for energy and demand respectively, but also included applicability factors to account for our the fact that not all of the CFLs are installed in air conditioned space. The HVAC applicability factors are presented in the last column of the above table, and are estimates based on ADM’s on-site evaluation experience in Pennsylvania.

Cross sector sales imply that a some amount of incentives that were intended for the residential sector also migrated to the nonresidential sector. The table below shows the overall amount of incentives

⁷⁵ Pennsylvania Statewide ACT 129 2014 Commercial & Residential Light Metering Study, Table 4-13 for Interior Screw-Base CFLs and LEDs.

associated with upstream lighting, the amount that remained in the residential sector, and the amount that migrated to the commercial (presumably the small commercial) sector.

Incentive shifts to account for Residential to Small C/I crossover CFLs

EDC	Total Incentives for Upstream Lighting	Total Incentives for Residential Sector (95.07%)	Total Incentives for Small Commercial Sector (4.93%)
Penelec	\$453,104	\$426,777	\$26,327
Penelec	\$452,462	\$426,172	\$26,290
Penn Power	\$114,721	\$108,055	\$6,666
West Penn	\$489,260	\$460,832	\$28,428

Note that the Companies also included CFLs in their nonresidential sector programs. Based on customer surveys, a portion of CFLs distributed to small commercial customers in the C/I Energy Efficient Buildings Program - Small were subsequently redistributed to employees, members, or parishioners for use in their homes. The TRM residential lighting protocols are used to evaluate the energy and demand impacts associated with these “crossover” CFLs. The table below also shows the budget shifts needed to account for the crossover.

Incentive shifts to account for Small C/I to Residential crossover CFLs

EDC	Total Incentives for CFL Kits in the “Small Buildings” Programs	Total Incentives Small Commercial Sector	Total Incentives for Residential Sector
Penelec	\$100,634	\$75,675	\$24,959
Penelec	\$154,754	\$116,764	\$37,990
Penn Power	\$60,452	\$45,643	\$14,809
West Penn	\$151,260	\$107,449	\$43,810

Similarly, some participants of the CFL kits program component in the C/I Energy Efficient Buildings Program – Large also reported CFL migration to the residential sector. The table below shows the necessary budget shifts to account for this migration.

Incentive shifts to account for Large C/I to Residential crossover CFLs

EDC	Total Incentives for CFL Kits in the “Large Buildings” Programs	Total Incentives Large Commercial Sector	Total Incentives for Residential Sector
Penelec	\$14,051	\$10,805	\$3,246
Penelec	\$5,724	\$5,079	\$645
Penn Power	\$1,440	\$1,215	\$225
West Penn	\$6,300	\$5,427	\$873

The net funding shift for each EDC is summarized in the table below. The net flow of funding is in the opposite direction of CFL flow.

Net funding shifts between sectors to account for crossover CFLs

EDC	Monies to be shifted from Small C/I to Residential Energy Efficient Products	Monies to be shifted from Residential EE Products to Small C/I Buildings	Monies to be shifted from Residential to Large C/I Buildings
Penelec	\$1,368	\$0	\$3,246
Penelec	\$0	\$11,700	\$645
Penn Power	\$0	\$8,143	\$225
West Penn	\$0	\$15,382	\$873

APPENDIX E | GLOSSARY OF TERMS

This Glossary of Terms was provided by the SWE.

-A-

Administration Management and Technical Assistance Costs: Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.

Avoided Cost: In the context of energy efficiency, the costs that are avoided by the implementation of an energy efficiency measure, program, or practice. Such costs are used in benefit/cost analyses of energy efficiency measures and programs as defined by the Pennsylvania PUC in the 2013 TRC Test Order.

-B-

Baseline: Conditions that would have occurred without implementation of the subject measure or project. Baseline conditions are sometimes referred to as “business-as-usual” conditions and are used to calculate program-related efficiency or emissions savings. Baselines can be defined as either project-specific baselines or performance-standard baselines (e.g., building codes). For the purposes of Act 129, baselines are defined in the Pennsylvania TRM, in approved custom protocols, and in TRM interim approved protocols.

Baseline Data: The information representing the systems being upgraded before the energy efficiency activity takes place.

Benefit/Cost Ratio: The mathematical relationship between the benefits and costs associated with the implementation of energy efficiency measures, programs, or practices. The benefits and costs are typically expressed in dollars. This is the ratio of the discounted total benefits of the program to the discounted total costs over the expected useful life of the energy efficiency measure. The explicit formula for use in Pennsylvania is set forth in the TRC Order. Also see *Benefit-Cost Test*.

Benefit-Cost Test: Also called *Cost-Effectiveness Test*, defined as the methodology used to compare the benefits of an investment to the costs. For programs evaluated under Act 129, the TRC Test is the required benefit-cost test as established in the TRC Order.

Bias: The extent to which a measurement, sampling, or analytic method systematically underestimates or overestimates a value. Some examples of types of bias include engineering model bias; meter bias; sensor bias; an inadequate or inappropriate estimate of what would have happened absent a program or measure installation; a sample that is unrepresentative of a population; and selection of other variables in an analysis that are too correlated with the savings variable (or each other) in explaining the dependent variable (such as consumption).

-C-

Coefficient of Variation: The mean (average) of a sample divided by its standard error.

Coincident Demand: The demand of a device, circuit, or building that occurs at the same time as the system peak demand. For purposes of Act 129 reporting, the coincident demand is during the peak period as defined in the TRM (June through August, excluding weekends and holidays between 2 and 6 PM).

Coincidence Factor: The ratio, expressed as a numerical value or as a percentage of connected load, of the coincident demand of an electrical appliance or facility type to the system peak.

Completed Project: A project in which the energy conservation measure has been installed and is commercially operable, and for which an incentive has been provided.

Confidence: An indication of the probability that an estimate is within a specified range of the true value of the quantity in question. Confidence is the likelihood that the evaluation has captured the true value of a variable within a certain estimated range. Also see *Precision*.

Correlation: For a set of observations, such as for participants in an energy efficiency program, the extent to which values for one variable are associated with values of another variable for the same participant. For example, facility size and energy consumption usually have a high positive correlation.

Cost-Benefit and Cost-Effectiveness Analysis: See *Benefit-Cost Test*.

Cost-Effectiveness: An indicator of the relative performance or economic attractiveness of an investment or practice. In the energy efficiency field, the present value of the estimated benefits produced by an energy efficiency program is compared to the estimated total costs to determine if the proposed investment or measure is desirable from a variety of perspectives (e.g., whether the estimated benefits exceed the estimated costs consistent with definitions in the TRC Order. See *Benefit-Cost Test*.

Cost-Effectiveness Test: See *Benefit-Cost Test*.

Cumulative Energy Savings: The summation of energy savings associated with multiple projects or programs over a specified period of time.

Custom Program: An energy efficiency program intended to provide efficiency solutions to unique situations not amenable to common or prescriptive solutions addressed by the Pennsylvania TRM. Each custom project is examined for its individual characteristics, savings opportunities, efficiency solutions, and often, customer incentives. Under Act 129, these programs fall outside of the jurisdiction of the Pennsylvania TRM, and thus the M&V protocols for each should be approved by the SWE.

-D-

Deemed Savings: An estimate of energy or demand savings for a single unit of an installed energy efficiency measure that: (1) has been developed from data sources and analytical methods that are widely considered acceptable for the measure and purpose, and (2) is applicable to the situation being evaluated. Individual parameters or calculation methods can also be deemed. Deemed savings for measures implemented under Act 129 are stipulated in the Pennsylvania TRM, which undergoes an annual review and update process, as well as in the Interim TRM Measures, which are subject to interim approval by the SWE.

Defensibility: The ability of evaluation results to stand up to scientific scrutiny. Defensibility is based on assessments by experts of the evaluation's validity, reliability, and accuracy. Under Act 129, it is the role of the SWE to determine the defensibility of the verified savings estimates reported by each of the EDCs.

Delta Watts: The difference in the connected load (wattage) between existing or baseline equipment and the energy-efficient replacement equipment, expressed in Watts or kilowatts.

Demand: The rate of energy flow. Demand usually refers to the amount of electric energy used by a customer or piece of equipment over a defined time interval (e.g., 15 minutes), expressed in kW (equals kWh/h). Demand can also refer to natural gas usage over a defined time interval, usually as Btu/hr, kBtu/hr, therms/day, or ccf/day.

Demand Reduction: See *Demand Savings*.

Demand Response: The reduction of customer energy usage at times of peak usage in order to help system reliability, to reflect market conditions and pricing, or to support infrastructure optimization or deferral of additional infrastructure. Demand response programs may include contractually obligated or voluntary curtailment, direct load control, and pricing strategies.

Demand Savings: The reduction in electric demand from the demand associated with a baseline system to the demand associated with the higher-efficiency equipment or installation. Demand savings associated with energy efficiency measures implemented under Act 129 are calculated according to the approved calculation methods stipulated in the TRM or subsequently approved through alternative methods (e.g., interim measures, custom protocols).

Demand-side Management: Strategies used to manage energy demand including energy efficiency, load management, fuel substitution, and load shedding.

-E-

Energy Efficiency and Conservation (EE&C) Plan: Plan as filed by the EDC and approved by the PUC.

EE&C Plan Estimate for Program Year: An estimate of the energy savings or demand reduction for the current program year as filed in the EDC EE&C plans.

Effective Useful Life: An estimate of the median number of years that efficiency measures installed under a program are still in place and operable. For measures implemented under Act 129, it is required that the effective useful life or 15 years, whichever is less, be used to determine measure assessments.

Electric Distribution Company (EDC): In reference to Act 129, there are seven EDCs with at least 100,000 customers that are required to adopt a plan to reduce energy and demand consumption within their service territory in accordance with 66 Pa. C.S. § 2608. The seven EDCs are: Duquesne Light, Pennsylvania Electric Company, Pennsylvania Electric Company, Pennsylvania Power Company, PECO Energy Company, PPL Electric Utilities and West Penn Power.

End Use: An appliance, activity, system, or equipment that uses energy.

Energy Conservation: Using less of a service in order to save energy. The term often is used unintentionally instead of *energy efficiency*.

Energy Efficiency: The use of less energy to provide the same or an improved level of service to the energy consumer; or the use of less energy to perform the same function.

Energy Efficiency Measure: An installed piece of equipment or a system, modification of equipment systems, or modified operations in customer facilities that reduce the total amount of electrical or gas energy and the capacity that otherwise would have been needed to deliver an equivalent or improved level of comfort or energy service.

Energy Savings: A reduction in electricity use (kWh) or in fossil fuel use in thermal unit(s).

Evaluation: The conduct of any of a wide range of assessment studies and other activities aimed at documenting an enhanced understanding of a program or portfolio, including determining the effects of a program, understanding or documenting program performance, program-related markets and market operations, program-induced changes in energy efficiency markets, levels of potential demand or energy savings, and/or program cost-effectiveness. Market assessments, monitoring and evaluation, and M&V are aspects of evaluation.

Ex Ante Savings Estimate: Forecasted savings used for program and portfolio planning purposes.

Ex Post Savings Estimate: Savings estimate reported by an evaluator after the energy impact evaluation has been completed.

-F-

Free Driver: A program nonparticipant who adopted a particular efficiency measure or practice as a result of the evaluated program. Also see *Spillover*.

Free-Rider: A program participant who would have implemented the program measure or practice in the absence of the program. Free-riders can be: (1) total, in which the participant's activity would have completely replicated the program measure; (2) partial, in which the participant's activity would have partially replicated the program measure; or (3) deferred, in which the participant's activity would have completely replicated the program measure, but after the program's timeframe.

Free-Ridership Rate: The percent of savings attributable to free-riders.

-G-

Gross Impact: See *Gross Savings*.

Gross Savings: The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated.

Gross kW: Expected demand reduction based on a comparison of standard or replaced equipment with equipment installed through an energy efficiency program.

Gross kWh: Expected kWh reduction based on a comparison of standard or replaced equipment with equipment installed through an energy efficiency program.

-H, I-

Impact Evaluation: An evaluation of the program-specific, directly induced quantitative changes (kWh, kW, and therms) attributable to an energy efficiency program.

Incremental Cost: The difference between the cost of an existing or baseline equipment or service and the cost of an alternative energy efficient equipment or service.

Incremental Energy Savings: The difference between the amount of energy savings associated with a project or a program in one period and the amount of energy savings associated with that project or program in a prior period.

-J, K-

Kilowatt (kW): A measure of the rate of power used during a pre-set time period (e.g., minutes, hours, days, months) equal to 1,000 Watts.

Kilowatt-Hour (kWh): A common unit of electric energy; one kilowatt-hour is numerically equal to 1,000 Watts used for one hour.

-L-

Lifetime kW: The expected demand savings over the lifetime of an installed measure, equal to the annual peak kW reduction associated with a measure multiplied by the expected lifetime of that measure. It is expressed in units of kW-years.

Lifetime MWh: The expected electrical energy savings over the lifetime of an installed measure, calculated by multiplying the annual MWh reduction associated with a measure by the expected lifetime of that measure.

Lifetime Supply Costs: The net present value of avoided supply costs associated with savings, net of changes in energy use that would have happened in the absence of the program over the life of the energy efficiency measure, factoring in persistence of savings. See *Avoided Cost*.

Load Factor: A percentage indicating the ratio of electricity or natural gas used during a given timeframe to the amount that would have been used if the usage had stayed at the highest demand the whole time. The term is also used to indicate the percentage of capacity of an energy facility, such as a power plant or gas pipeline, that is utilized for a given period of time.

Load Management: Steps taken to reduce power demand at peak load times or to shift some of it to off-peak times. Load management may coincide with peak hours, peak days, or peak seasons. Load management may be pursued by persuading consumers to modify behavior or by using equipment that regulates some electric consumption. This may lead to complete elimination of electric use during the period of interest (load shedding) and/or to an increase in electric demand in the off-peak hours as a result of shifting electric usage to that period (load shifting).

-M-

Market Assessment: An analysis that provides an assessment of how and how well a specific market or market segment is functioning with respect to the definition of well-functioning markets or with respect to other specific policy objectives. Generally includes a characterization or description of the specific market or market segments, including a description of the types and number of buyers and sellers in the market, the key factors that influence the market, the type and number of transactions that occur on an annual basis, and the extent to which market participants consider energy efficiency as an important part of these transactions. This analysis may also include an assessment of whether a market has been sufficiently transformed to justify a reduction or elimination of specific program interventions. Market assessments can be blended with strategic planning analysis to produce recommended program designs or budgets. One particular kind of market assessment effort is a baseline study, or the characterization of a market before the commencement of a specific intervention in the market, for the purpose of guiding the intervention and/or assessing its effectiveness later.

Measurement and Verification (M&V): A subset of program impact evaluations that are associated with the documentation of energy savings at individual sites or projects using one or more methods that can involve measurements, engineering calculations, statistical analyses, and/or computer simulation modeling.

Measurement Error: In the evaluation context, a reflection of the extent to which the observations conducted in the study deviate from the true value of the variable being observed. The error can be random (equal around the mean) or systematic (indicating bias).

Megawatt (MW): A unit for measuring electricity equal to 1,000 kilowatts or one million Watts.

Megawatt-Hour (MWh): A unit of electric energy numerically equal to 1,000,000 Watts used for one hour.

Metered Data: Data collected over time through a meter for a specific end use, energy-using system (e.g., lighting, HVAC), or location (e.g., floors of a building, a whole premise). Metered data may be collected over a variety of time intervals. Usually refers to electricity or gas data.

Metering: The collection of energy consumption data over time through the use of meters. These meters may collect information about an end use, a circuit, a piece of equipment, or a whole building (or facility). *Short-term metering* generally refers to data collection for no more than a few weeks. *End-use metering* refers specifically to separate data collection for one or more end uses in a facility, such as lighting, air conditioning, or refrigeration. *Spot metering* is an instantaneous measurement (rather than over time) to determine equipment size or power draw.

Monitoring: The collection of relevant measurement data over time at a facility, including but not limited to energy consumption or emissions data (e.g., energy and water consumption, temperature, humidity, volume of emissions, and hours of operation) for the purpose of conducting a savings analysis or to evaluate equipment or system performance.

-N-

Net Impact: See *Net Savings*.

Net Present Value: The discounted value of the net benefits or costs over a specified period of time (e.g., the expected useful life of the energy efficiency measure).

Net Savings: The total change in load that is attributable to an energy efficiency program. This change in load may include, implicitly or explicitly, the effects of spillover, free-riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand. Net savings are calculated by multiplying verified savings by a NTG ratio.

Net-to-Gross (NTG): A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts.

Nonparticipant: Any consumer who was eligible but did not participate in the subject efficiency program in a given program year.

-O-

Off-Peak Energy kWh Savings: The kWh reduction that occurs during a specified period of off-peak hours for energy savings (see the PA TRM Table 1-1).

On-Peak Energy kWh Savings: The kWh reduction that occurs during a specified period of on-peak hours for energy savings (see the PA TRM Table 1-1).

-P-

Participant: A utility customer partaking in an energy efficiency program, defined as one transaction or one rebate payment in a program. For example, a customer receiving one payment for two measures within one program counts as one participant. A customer receiving two payments in two programs counts as two participants. A customer partaking in one program at two different times receiving two separate payments counts as two participants.

Participant Costs: Costs incurred by a customer participating in an energy efficiency program.

Peak Demand: The maximum level of metered demand during a specified period, such as a billing month or a peak demand period.

Peak Load: The highest electrical demand within a particular period of time. Daily electric peaks on weekdays typically occur in the late afternoon and early evening. Annual peaks typically occur on hot summer days.

Percent of Estimate Committed: The program year-to-date total committed savings as a percent of the savings targets established in each EDC EE&C Plan, calculated by dividing the PYTD total committed by the EE&C Plan program year estimate.

Portfolio: Can be defined as: (1) a collection of programs addressing the same market (e.g., a portfolio of residential programs), technology (e.g., motor efficiency programs), or mechanisms (e.g., loan programs); or (2) the set of all programs conducted by one or more organizations, such as a utility or program administrator, and which could include programs that cover multiple markets, technologies, etc.

Precision: An indication of the closeness of agreement among repeated measurements of the same physical quantity. It is also used to represent the degree to which an estimated result in social science (e.g., energy savings) would be replicated with repeated studies.

Preliminary Program Year-to-Date (PYTD) Net Impact: Net impacts reported in quarterly reports. These net impacts are preliminary in that they are based on preliminary realization rates.

Preliminary Program Year-to-Date (PYTD) Verified Impact: Verified impacts reported in quarterly reports. These verified impacts are preliminary in that they are based on preliminary realization rates.

Preliminary Realization Rate: Realization rates reported in quarterly reports based on the results of M&V activities conducted on the sample to date. These results are preliminary because the sample-to-date is likely not to have met the required levels of confidence and precision.

Prescriptive Program: An energy efficiency program focused on measures that are one-for-one replacements of the existing equipment and for which anticipated similar savings results across participants.

Process Evaluation: A systematic assessment of an energy efficiency program for the purposes of documenting program operations at the time of the examination and identifying and recommending improvements to increase the program's efficiency or effectiveness for acquiring energy resources, while maintaining high levels of participant satisfaction.

Program Administrator: Those entities that oversee the implementation of energy efficiency programs. This generally includes regulated utilities, other organizations chosen to implement such programs, and state energy offices.

Program Year Energy Savings Target: Energy target established for the given program year as approved in each EDC EE&C Plan.

Program Year Sample Participant Target: Estimated sample size for evaluation activities in the given program year.

Program Incentive: An incentive, generally monetary, that is offered to a customer through an energy efficiency program to encourage their participation. The incentive is intended to overcome one or more barriers that keep the customer from taking the energy efficiency action on their own.

Program Participant: A consumer that received a service offered through an efficiency program in a given program year. The term "service" can refer to one or more of a wide variety of services, including financial rebates, technical assistance, product installations, training, energy efficiency information, or other services, items, or conditions.

Program Year-to-Date (PYTD): Beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).

Program Year-to-Date (PYTD) Net Impact: The total change in load that is attributable to an energy efficiency program from June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).

Program Year-to-Date (PYTD) Participants: The number of utility customers participating in an energy efficiency program beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).

Program Year-to-Date (PYTD) Reported Gross Impact: The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated, beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30). This value is unverified by an independent third-party evaluator.

Program Year-to-Date (PYTD) Sample Participants: Total participant sample beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).

Program Year-to-Date (PYTD) Total Committed: The estimated gross impacts, including reported impacts and in-progress impacts, beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30), calculated by adding PYTD reported gross impacts for projects in progress.

Project: An activity or course of action involving one or multiple energy efficiency measures at a single facility or site.

Projects in Progress: Energy efficiency and demand response projects currently being processed and tracked by the EDC, but that are not yet complete at the time of the report. See *Completed Project*.

-Q,R-

Realization Rate: The term is used in several contexts in the development of reported program savings. The primary applications include the ratio of project tracking system savings data (e.g., initial estimates of project savings) to savings that: 1) are adjusted for data errors, and 2) incorporate the evaluated or verified results of the tracked savings.

Rebate Program: An energy efficiency program in which the program administrator offers a financial incentive for the installation of energy-efficient equipment.

Rebound Effect: Also called “snap back,” defined as a change in energy-using behavior that yields an increased level of service that is accompanied by an increase in energy use and occurs as a result of taking an energy efficiency action. The result of this effect is that the savings associated with the direct energy efficiency action are reduced by the resulting behavioral change.

Regression Analysis: Analysis of the relationship between a *dependent variable* (response variable) to specified *independent variables* (explanatory variables). The mathematical model of their relationship is the *regression equation*.

Regression Model: A mathematical model based on statistical analysis where the dependent variable is quantified based on its relationship to the independent variables that are believed to determine its value. In so doing, the relationship between the variables is estimated statistically from the data used.

Reliability: The quality of a measurement process that would produce similar results on: (1) repeated observations of the same condition or event, or (2) multiple observations of the same condition or event by different observers.

Renewable Energy: Energy derived from resources that are naturally replenishing. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

Reported Gross Impact: The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated. This value is unverified by an independent third-party evaluator. Also referred to as “ex post” impact.

Reporting Period: The time following implementation of an energy efficiency activity during which results are to be determined.

Representative Sample: A sample that has approximately the same distribution of characteristics as the population from which it was drawn.

Rigor: The level of effort expended to minimize uncertainty due to factors such as sampling error and bias. The higher the level of rigor, the more confidence there is that the results of the evaluation are accurate and precise.

-S-

Sample: In program evaluation, a portion of the population selected to represent the whole. Differing evaluation approaches rely on simple or stratified samples (based on some characteristic of the population).

Sample Design: The approach used to select the sample units.

Sampling Error: The error in estimating a parameter caused by the fact that all of the disturbances in the sample are not zero.

Savings Factor (SVG): The percent of time the lights are off due to lighting controls relative to the baseline controls system (typically a manual switch). Also referred to as the *lighting controls savings factor*.

Simple Random Sample: A method for drawing a sample from a population such that all samples of a given size have an equal probability of being drawn.

Snap Back: See *Rebound Effect*.

Simulation Model: An assembly of algorithms that calculate energy use based on engineering equations and user-defined parameters.

Spillover: Reductions in energy consumption and/or demand caused by the presence of an energy efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program. There can be participant and/or nonparticipant spillover. *Participant spillover* is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy-saving practices after having participated in the efficiency program as a result of the program’s influence. *Nonparticipant spillover* refers to energy savings that occur when a program nonparticipant installs energy efficiency measures or applies energy-saving practices as a result of a program’s influence.

Spillover Rate: An estimate of energy savings attributable to spillover effects expressed as a percent of savings installed by participants through an energy efficiency program.

Standard Error: A measure of the variability in a data sample indicating how far a typical data point is from the mean of a sample. In a large sample, approximately two-thirds of observations lie within one standard error of the mean, and 95% of observations lie within two standard errors.

Statistically Adjusted Engineering Models: A category of statistical analysis models that incorporate the engineering estimate of savings as a dependent variable. The regression coefficient in these models is the percentage of the engineering estimate of savings observed in changes in energy usage. For example, if the coefficient of the statistically adjusted engineering term is 0.8, the customers are, on average, realizing 80% of the savings from their engineering estimates.

Stipulated Values: See *Deemed Savings*.

Stratified Random Sampling: The population is divided into subpopulations, called *strata*, that are non-overlapping and together comprise the entire population. A simple random sample of each stratum is taken to create a sample based on stratified random sampling.

Stratified Ratio Estimation: A sampling method that combines a stratified sample design with a ratio estimator to reduce the coefficient of variation by using the correlation of a known measure for the unit (e.g., expected energy savings) to stratify the population and allocate a sample from the strata for optimal sampling.

-T-

Takeback Effect: See *Rebound Effect*.

Total Resource Cost (TRC) Test: A cost-effectiveness test that measures the net direct economic impact to the utility service territory, state, or region. The TRC Order details the method and assumptions to be used when calculating the TRC Test for EE&C portfolios implemented under Act 129. The results of the TRC Test are to be expressed as both a net present value and a benefit-cost ratio.

Total Resource Cost (TRC) Test Benefits: Benefits calculated in the TRC Test that include the avoided supply costs, such as the reduction in transmission, distribution, generation, and capacity costs, valued at a marginal cost for the periods when there is a consumption reduction. The PA TRC benefits will consider avoided supply costs, such as the reduction in forecasted zonal wholesale electric generation prices, ancillary services, losses, generation capacity, transmission capacity, and distribution capacity. The avoided supply costs will be calculated using net program savings, defined as the savings net of changes in energy use that would have happened in the absence of the program. The persistence of savings over time will also be considered in the net savings.

Total Resource Cost (TRC) Test Costs: The costs calculated in the TRC Test will include the costs of the various programs paid for by an EDC (or by a default service provider) and the participating customers, and costs that reflect any net change in supply costs for the periods in which consumption is increased in the event of load shifting. Note that the TRC Test should use the incremental costs of services and equipment. Thus, for example, this would include costs for equipment, installation, operation and maintenance, removal (less salvage value), and administrative tasks, regardless of who pays for them.

-U-

Uncertainty: The range or interval of doubt surrounding a measured or calculated value within which the true value is expected to fall with some degree of confidence.

Upstream Program: A program that provides information and/or financial assistance to entities in the delivery chain of high-efficiency products at the retail, wholesale, or manufacturing level. Such a program is intended to yield lower retail prices for the products.

-V-

Verification: An independent assessment of the reliability (considering completeness and accuracy) of claimed energy savings or an emissions source inventory.

Verified Gross Impact: Calculated by applying the realization rate to reported gross impacts. Also referred to as “ex ante” impact.

-W-

Watt: A unit of measure of electric power at a point in time as capacity or demand. One Watt of power maintained over time is equal to one Joule per second. The Watt is named after Scottish inventor James Watt, and is shortened to W and used with other abbreviations, as in kWh (kilowatt-hours).

Watt-Hour: One Watt of power expended for one hour, or one-thousandth of a kilowatt-hour.

Whole-Building Calibrated Simulation Approach: A savings measurement approach (defined in the International Performance Measurement and Verification Protocol Option D and in the American Society of Heating, Refrigerating and Air-Conditioning Engineers Guideline 14) that involves the use of an approved computer simulation program to develop a physical model of the building in order to determine energy and demand savings. The simulation program is used to model the energy used by the facility before and after the retrofit. The pre- or post-retrofit models are developed by calibration with measured energy use, demand data, and weather data.

Whole-building Metered Approach: A savings measurement approach (defined in the International Performance Measurement and Verification Protocol Option C and in the American Society of Heating, Refrigerating and Air-Conditioning Engineers Guideline 14) that determines energy and demand savings through the use of whole-facility energy (end-use) data, which may be measured by utility meters or data loggers. This approach may involve the use of monthly utility billing data or data gathered more frequently from a main meter.

References

PAH Associations, prepared by Paul Horowitz. Facilitated by the Northeast Energy Efficiency Partnerships. Glossary of Terms Version 1.0. A project of the Regional Evaluation, Measurement and Verification Forum. March 2009.