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November 14, 2014

VIA HAND DELIVERY

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street, 2nd Floor North
P.O. Box 3265
Harrisburg, PA 17105-3265

Re: Final Annual Report for Program Year 5 of PPL Electric Utilities Corporation's Act 129 Plan - Docket No. M-2012-2334388

Dear Secretary Chiavetta:

Enclosed for filing on behalf of PPL Electric Utilities Corporation ("PPL Electric") is the Final Annual Report for Program Year 5 of PPL Electric's Act 129 Plan. A copy of the Final Annual Report will also be provided to the Act 129 Statewide Evaluator. In addition, PPL Electric will post its Final Annual Report on its ePower website.

If you have any questions concerning this matter, please do not hesitate to contact me.

Respectfully submitted,

Devin Ryan

DTR/jl
Enclosure

cc: Richard F. Spellman (*GDS Associates, Inc., Act 129 Statewide Evaluator*)

Final Annual Report
to the
Pennsylvania Public Utility Commission

For the Period
June 2013 through May 2014
Program Year 5

For Pennsylvania Act 129 of 2008
Energy Efficiency and Conservation Plan

Prepared by The Cadmus Group, Inc.

For

PPL Electric Utilities

November 15, 2014

Table of Contents

Acronyms

ARP	Appliance Recycling Program
C&I	Commercial and Industrial
CFL	Compact fluorescent lamp
Phase II Verified	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
CF	Coincidence factor
CSP	Conservation Service Provider or Curtailment Service Provider
DR	Demand response
EDC	Electric Distribution Company
EE&C	Energy Efficiency and Conservation
EISA	Energy Independence and Security Act of 2007
EF	Energy factor
EM&V	Evaluation, measurement, and verification
EEMIS	Energy Efficiency Management Information System
GNI	Government, Non-Profit, and Institutional
HEW	Home Energy Worksheet
HOU	Hours of use
HPWH	Heat pump water heater
HVAC	Heating, ventilating, and air conditioning
ISR	In-service rate
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
MMMF	Master Metered Low-Income Multifamily Housing
MW	Megawatt
MWh	Megawatt-hour
NEF	National Energy Foundation
NTG	*Net-to-gross*
PTO	Parent Teacher Organization
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
QA/QC	Quality assurance/quality control
SEER	Seasonal Energy Efficiency Rating
SWE	Statewide Evaluator
TRC	Total Resource Cost
TRM	Technical Reference Manual
WRAP	Winter Relief Assistance Program

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 evaluation, measurement, and verification (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).

TOTAL RESOURCE COST COMPONENTS[1]

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 PPL Electric Utilities in Program Year 5 (PY5), defined as June 1, 2013 through May 31, 2014, 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.

The Cadmus Group, Inc. has evaluated the programs, which included measurement and verification of the savings. The final verified savings for PY5 are included in this final annual report.

This report is organized into two major sections. The first section provides an overview of activities for the entire portfolio. This includes summary information and portfolio-level details regarding the progress toward compliance goals, energy and demand impacts, net-to-gross (NTG) ratios, finances, and cost-effectiveness. The following sections include program-specific details, including program updates, impact evaluation findings, and process evaluation findings.

In PY5, PPL Electric's portfolio included ten active programs:

1. The Appliance Recycling Program (ARP) offers customers incentives to have their outdated refrigerators, freezers, and air conditioners recycled.
2. The Custom Incentive Program offers incentives for custom measures to nonresidential customers.
3. The E-Power Wise Program provides low-income customers with information about energy use, along with home energy kits.
4. The Act 129 Winter Relief Assistance Program (WRAP) provides weatherization to low-income customers using Act 129 funding to expand the existing Low-Income Usage Reduction Program.
5. The Prescriptive Equipment Program offers nonresidential customers rebates and incentives from a list of specific energy-efficiency measures and services. The program also offers a Direct Discount component for lighting.
6. The Master Metered Low-Income Multifamily Housing Program targets energy-efficiency improvements in master metered multifamily low-income housing buildings.
7. The Residential Home Comfort Program offers energy-saving measures and rebates for new construction and retrofitted existing homes.
8. The Residential Retail Program offers upstream incentives for energy-efficient lighting and rebates for other energy-efficient products found in retail stores.

9. The School Benchmarking Program works with school administrators to evaluate total building energy use using the Environmental Protection Agency's Portfolio Manager Tool.
10. The Student and Parent Energy-Efficiency Education Program provides school-based energy-efficiency education through in-classroom workshops for students in various grade levels, training for teachers, and community workshops for parents in low-income neighborhoods.

An executive summary of program metrics can be found in **Table 1-1** and **Table 1-1b.**

Table 1-1: PY5 Portfolio Executive Summary - Programs

Program	Phase II *Reported* Energy Savings (MWh/yr)	Phase II *Adjusted Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	*PYTD* Net-to-Gross Ratio	*PYTD* TRC Ratio	*Phase II EDC* Expenditures ($1,000)	Program *Acquisition* Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Appliance Recycling	9,776	9,714	9,255	0.74	3.16	$1,676	$0.18	$0.030	11,510
Continuous Energy Improvement	0	0	0	N/A	N/A	$219	N/A	N/A	0
Custom Incentive	4,909	4,909	5,394	0.55	1.74	$971	$0.18	$0.043	56
E-Power Wise	1,863	1,863	1,525	1.0	2.99	$259	$0.17	$0.033	2,715
Low-Income Energy-Efficiency Behavior and Ed	*0*	*0*	0	*N/A*	N/A	*$268*	N/A	N/A	0
Low-Income WRAP	3,065	3,065	2,810	1.0	0.83	$3,390	$1.21	$0.122	2,791
Master Metered Multi-Family	1,792	1,776	2,039	0.77	1.45	$746	$0.37	$0.059	37
Prescriptive Equipment	86,548	86,549	81,170	0.74	2.31	$10,415	$0.13	$0.040	2,348
Prescriptive Equipment Non-lighting	*2,297*	*2,298*	*2,267*	*N/A*[3]	*2.31*	*$10,415*	*$0.13*	*$0.040*	*24*
Prescriptive Equipment Lighting	*84,251*	*84,251*	*78,903*	*0.74*					*2,324*
Residential Energy-Efficiency Behavior and Ed	0	0	0	N/A	N/A	$708	N/A	N/A	0
Residential Home Comfort	2,367	2,372	2,410	0.57	0.64	$1,188	$0.49	$0.178	2,554
Residential Retail	92,804	90,333	90,314	0.83	7.48	$5,227	$0.06	$0.015	227,378
Residential Retail Equipment	*2,756*	*2,894*	*2,875*	*0.83*	*7.48*	*$5,227*	*$0.06*	*$0.015*	*8,204*
Residential Retail Upstream Lighting	*90,048*	*87,439*	*87,439*						*219,174*[6]
School Benchmarking	0	0	0	N/A	N/A	$152	N/A	N/A	22
Student & Parent Education	*6,910*	*7,643*	5,147	*1.0*	*3.01*	*$1,162*	*$0.23*	*$0.033*	714
Total	**210,033**	**208,223**	**200,065**	**0.79**[4]	**2.20**	**$37,838**[5]	**$0.19**	**$0.044**	**250,125**

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.
[3] The EM&V CSP was unable to complete surveys with any of the nine unique participants who received rebates for installing prescriptive equipment measures.
[4] Weighted by program savings for programs reporting NTG Ratio.
[5] Includes portfolio common costs ($11,457) not assigned to a specific program.
[6] The PY5 participant count for the lighting component uses the bulbs-per-participant estimates derived from the PY5 residential and small commercial customer survey data (a weighted average for CFLs and LEDs of 8.05 bulbs for residential customers and 20.10 bulbs for small commercial customers). Therefore, rounded totals for strata may not equal program total.

Table 1-1b: PY5 Executive Summary - Savings Compliance [1]

PORTFOLIO	
Phase II Verified Gross Energy Savings (MWh/yr)	200,065
Phase I Carryover Savings (MWh/yr)	495,636
Total Verified Savings for Phase II thru PY5 (MWh/yr)	695,701
Phase II Gross Savings Compliance Target for May 2016 (MWh/yr)	821,072
Percent compliance achieved thru PY5	84.7%
SECTORS	
GNI	
Phase II Verified Gross Energy Savings for GNI (MWh/yr)	20,857
Phase I Carryover Savings for GNI (MWh/yr)	92,143
Total Verified Savings for Phase II GNI thru PY5 (MWh/yr)	113,000
Phase II Gross Savings Compliance Target for GNI for May 2016 (MWh/yr)	82,107
Percent GNI compliance achieved thru PY5	137.6%
LOW-INCOME	
Phase II Verified Gross Energy Savings for Low-Income (MWh/yr).	4,335
Phase II Verified Gross Energy Savings for Low-Income Participation in General Residential (MWh/yr)	9,053
Phase I Carryover Savings for Low-Income (MWh/yr)	N/A
Total Verified Savings for Phase II Low-Income thru PY5 (MWh/yr)	13,388
Phase II Gross Savings Compliance Target for Low-Income for May 2016 (MWh/yr)	36,948
Percent Low-Income compliance achieved thru PY5	36.2%
NOTES: *[1] Only the GNI sector and the total portfolio had specific compliance targets in Phase I. All carryover savings* besides GNI do not have a sector designation.	

An executive summary of sector metrics can be found in **Table 1-2.**

Table 1-2: PY5 Portfolio Executive Summary - Sectors

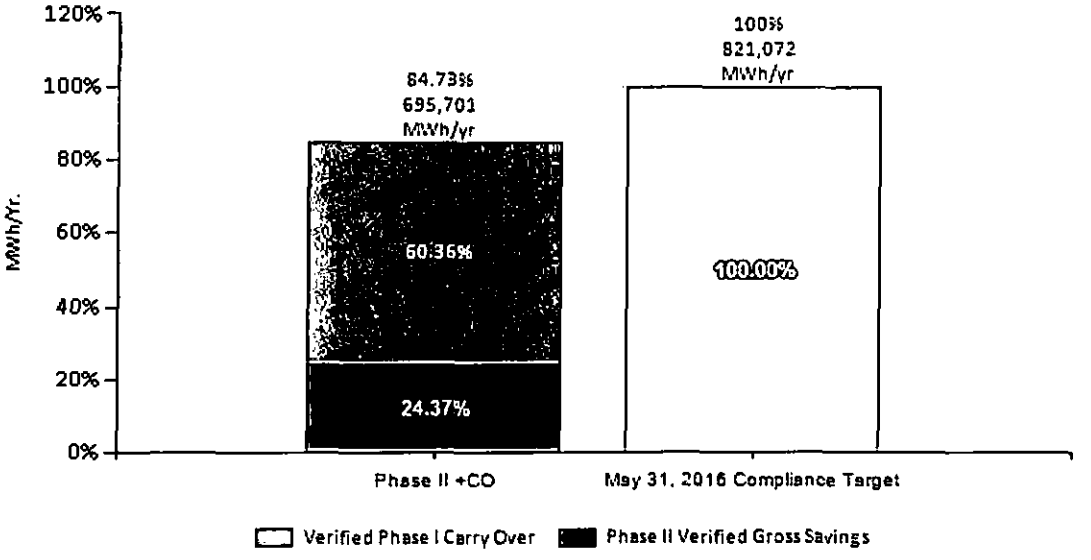
Sector	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Low Income	4,928	4,928	4,335[3]	0.92	$3,918	$0.90	$0.110	5,506
Residential	86,231	87,505	84,597	4.09	$9,624	$0.11	$0.027	231,072
Small C&I	81,383	78,314	75,156	3.23	$7,578	$0.10	$0.030	12,594[5]
Large C&I	15,645	15,645	15,119	1.85	$1,925	$0.13	$0.036	122
Gov't/Non-Profit	21,846	21,830	20,857	1.28	$3,339	$0.16	$0.065	830
Total	**210,033**	**208,223**	**200,065**	**2.20**	**$37,838[4]**	**$0.19**	**$0.044**	**250,125**

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.
[3] Excludes 9,053 MWh/yr LI savings in general residential programs that counts toward the Low-Income compliance target.
[4] Includes portfolio common costs ($11,457) that will not be assigned to a specific sector until the end of Phase II.
[5] Includes 10,582 small C&I participants in the upstream lighting program determined through the PY5 general population survey (see also Table 2-2).

1.1 Summary of Progress Toward Compliance Targets

PPL Electric Utilities has achieved 84.73% 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, PPL Electric Utilities 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 1-3** shows how many MWh/yr of savings from Phase I PPL Electric Utilities is carrying over into Phase II.

Table 1-3: Savings from PY4 Carried Into Phase II

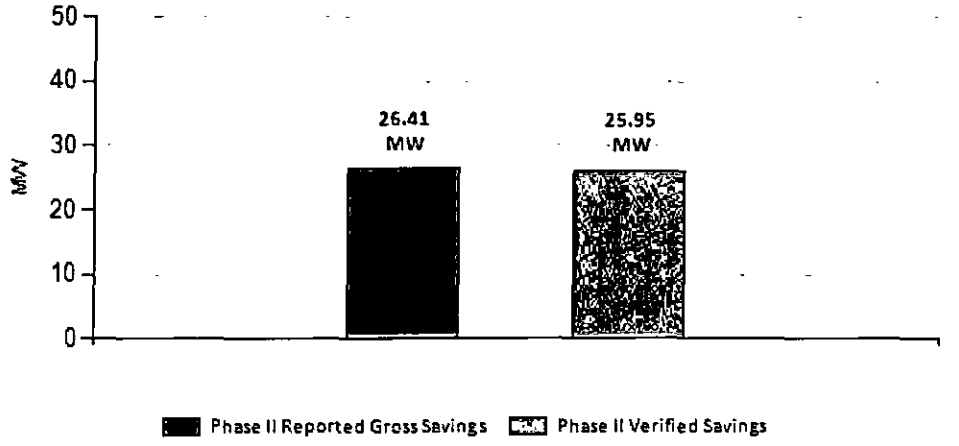
Sector	Phase II Verified Savings (MWh/Yr)	Verified Savings Carried Over from Phase I (MWh/Yr)	Phase II+CO Verified Savings (MWh/Yr)
Residential	84,597	N/A	N/A
Low-Income	4,335	N/A	N/A
Commercial and Industrial	90,275	N/A	N/A
Gov't/Non-Profit	20,857	92,143	113,000
Total	**200,065**	**495,636[1]**	**695,701[1]**

NOTES:
[1] Only the GNI sector and the total portfolio had specific compliance targets in Phase I. All carryover savings besides GNI do not have a sector designation.

As shown in **Figure 1-2**, PPL Electric Utilities has achieved 25.95 MW of gross verified demand reduction during PY5.[2]

[2] Unlike Phase I, there is no compliance target for demand reduction in Phase II.

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



There are 22 measures available at no cost to low-income customers. These measures offered to the low-income sector comprise 52% 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 PPL Electric Utilities territory by (8.64%).[3] These values are shown in **Table 1-4** and **Table 1-5**.

Table 1-4: Low-Income Sector Compliance (Number of Measures)

	Low-Income Sector	All Sectors	Percentage Low-Income	Goal
Number of Measures Offered	22	42	52%	8.64%

Table 1-5: Low-Income Sector Compliance (Percentage of Savings)

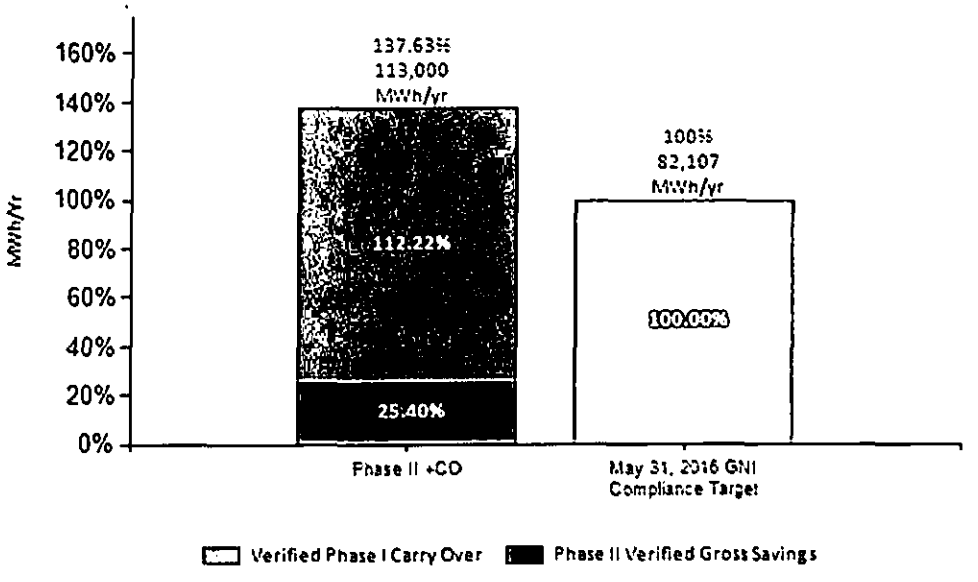
	Low Income *Verified Savings* from Low Income Programs *(MWh/Yr)*	Low Income *Verified Savings* from Other Residential Programs *(MWh/Yr)*	*All Low Income* Verified Savings [Sum of First Two Columns]	Progress Toward Low Income Goal [Previous Column divided by Phase II MWh Target]	Goal
Phase II Verified Gross Energy Savings	4,335	9,053	13,388	36%	4.5%

[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).

The Phase II verified gross energy savings for low-income are 13,388 MWh/yr. This includes 4,335 MWh/yr through programs specifically designed for income-eligible customers and 9,053 MWh/yr through other programs. This (13,388 MWh/yr) is 36% of the 4.5% Phase II total portfolio verified gross energy savings target for the low-income sector (36,948 MWh/yr).

PPL Electric Utilities achieved 25.4% of the May 31, 2016, energy reduction compliance target for the government, non-profit, and institutional sector based on cumulative program/portfolio savings from Phase II verified gross energy savings and 137.6% based on Phase II+CO verified gross energy savings *achieved from the inception of Phase II through PY5 and including carry-over savings from Phase I as* shown in **Figure 1-3**.

Figure 1-3: Government, Non-Profit, and Institutional Sector Phase II Verified Energy Impacts



A summary of 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 1-6**.

Table 1-6: Summary of Phase II Performance by Sector

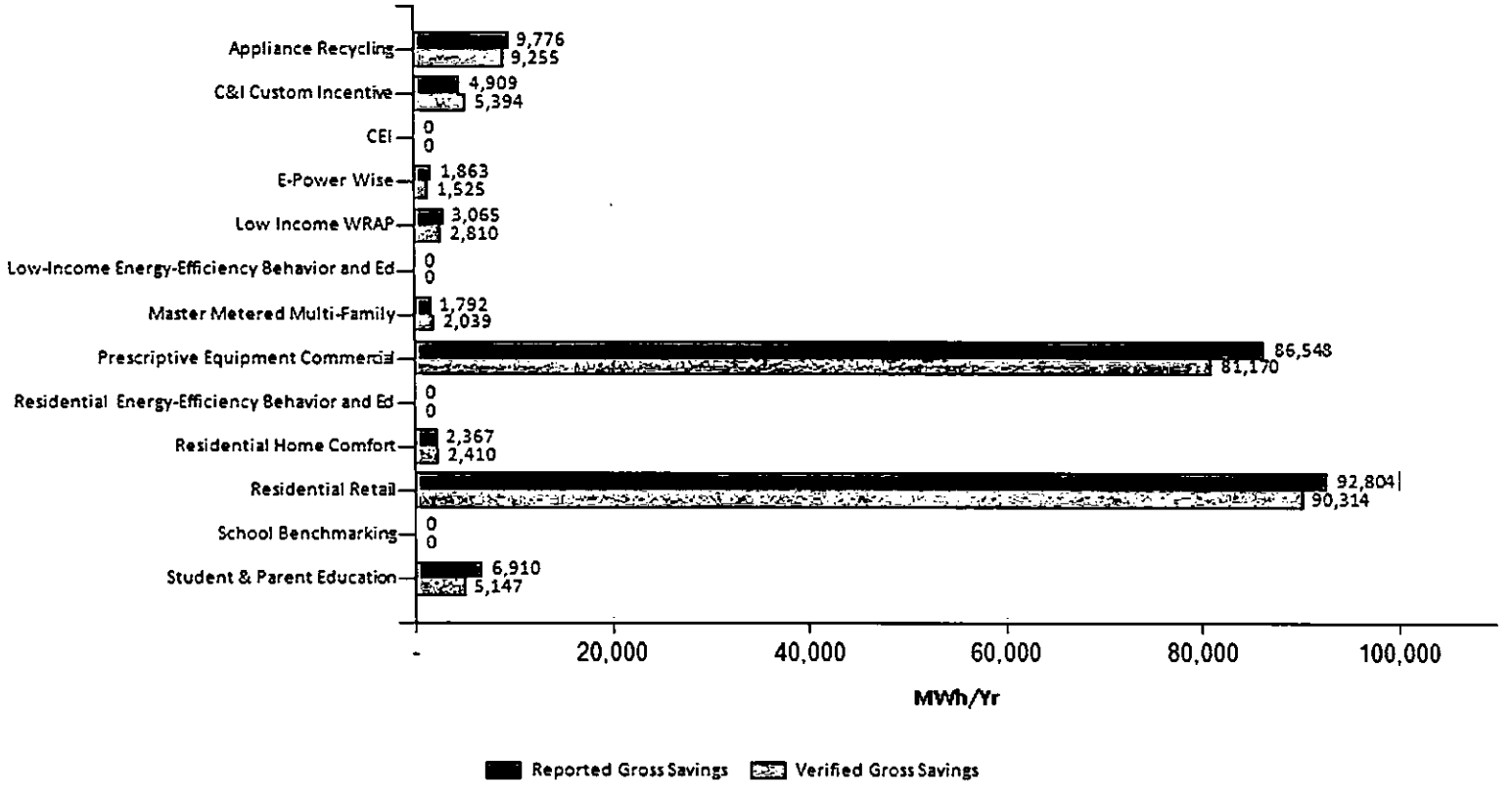
Sector	Participants	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Verified Gross Demand Reduction[1] (MW)	Incentives ($1,000)
Low Income	5,506	4,335[2]	0.59	$0
Residential	231,072	84,597	6.91	$3,245
Small C&I	12,594 [3]	75,156	14.07	$5,133
Large C&I	122	15,119	1.53	$971
Gov't/Non-Profit	830	20,857	2.84	$1,462
PY5 Total	**250,125**	**200,065**	**25.95**	**$10,811**
Phase II Total	***250,125***	***200,065***	***25.95***	***$10,811***

NOTES:
[1] Verified gross demand reductions include T&D losses.
[2] Excludes low-income participation in non-low-income programs savings of 9,053 MWh/yr.
[3] Includes 10,582 small C&I participants in the upstream lighting program determined through the PY5 small C&I general population survey (see also Table 2-2).

1.2 Summary of Energy Impacts

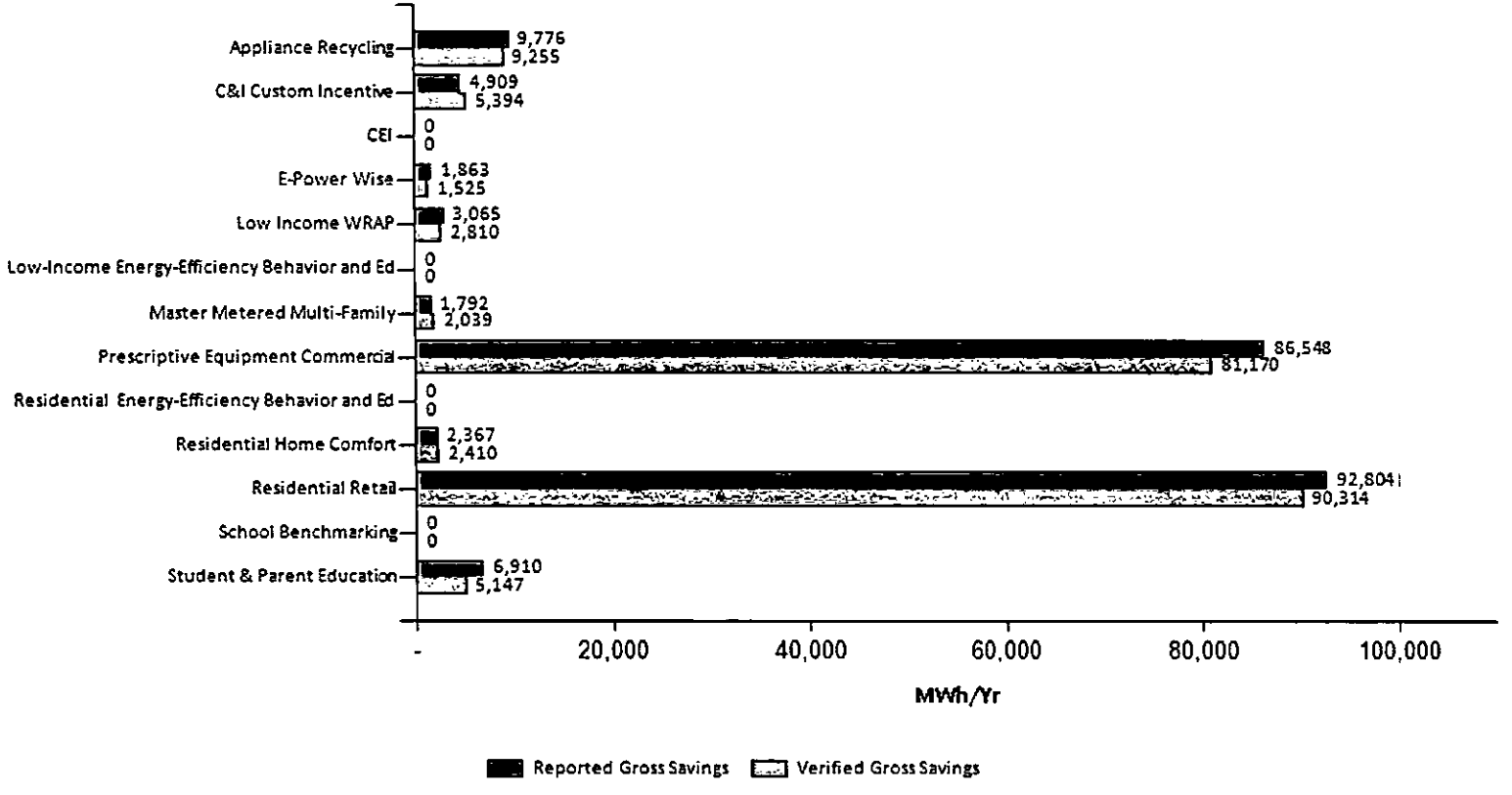
A summary of the reported and verified energy savings by program for PY5 is presented in **Figure 1-4**.

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 PY5 are presented in **Table 1-7** and **Table 1-8** .

Table 1-7: Reported Participation and Gross Energy Savings by Program

Program	Participants		Reported Gross Impact (MWh/Yr)	
	PYTD	Phase II	PYTD	Phase II
Appliance Recycling	11,510	11,510	9,776	9,776
Continuous Energy Improvement	-	-	-	-
Custom Incentive[1]	56	56	4,909	4,909
E-Power Wise	2,715	2,715	1,863	1,863
Low-Income Energy-Efficiency Behavior and Education	-	-	-	-
Low-Income WRAP	2,791	2,791	3,065	3,065
Master Metered Multi-Family	36	36	1,792	1,792
Prescriptive Equipment	2,348	2,348	86,548	86,548
Prescriptive Equipment Non-Lighting	*24*	*24*	*2,297*	*2,297*
Prescriptive Equipment Lighting	*2,324*	*2,324*	*84,251*	*84,251*
Residential Energy-Efficiency Behavior and Education	-	-	-	-
Residential Home Comfort	2,554	2,554	2,367	2,367
Residential Retail[2]	227,378	227,378	92,804	92,804
Residential Retail Equipment	*8,204*	*8,204*	*90,048*	*90,048*
Residential Retail Upstream Lighting	*219,174*	*219,174*	*2,756*	*2,756*
School Benchmarking[3]	22	22	-	-
Student and Parent Energy Education	714	714	6,910	6,910
Total Portfolio	**250,125**	**250,125**	**210,034**	**210,034**

NOTES:

[1] The participant count is based on the number of jobs that contributed to reported savings in PY5. The total number of projects created in PY5 is 107 including those still in progress and those that have since been cancelled.

[2] The Residential Retail program contains an upstream lighting component, in which exact participation is not known. The EM&V CSP estimated the number of participants in this component of the program by dividing the total number of bulbs discounted or given away by a bulb-per-participant value derived from the PY5 residential customer and small commercial telephone survey data (a weighted average for CFLs and LEDs of 8.05 bulbs for residential customers and 20.10 bulbs for small commercial customers).

[3] The School Benchmarking program does not claim energy or demand savings.

Table 1-8: Verified Gross Energy Savings by Program

Program	PYTD Reported Gross Energy Savings (MWh/Year)	PYTD Adjusted *Ex Ante* 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[1]
Appliance Recycling	9,776	9,714	95%	9,255	3.0%	9,255	3.0%
Continuous Energy Improvement	-	-	-	-	-	-	-
Custom Incentive	4,909	4,909	110%	5,394	21%	5,394	21%
E-Power Wise	1,863	1,863	82%	1,525	5.9%	1,525	5.9%
Low-Income Energy-Efficiency Behavior and Education	-	-	-	-	-	-	-
Low-Income WRAP	3,065	3,065	92%	2,810	N/A[3]	2,810	N/A[3]
Master Metered Multi-Family	1,792	1,776	115%	2,039	6%	2,039	6%
Prescriptive Equipment	86,548	86,549	94%	81,170	3.5%	81,170	3.5%
Prescriptive Equipment Non-Lighting	*2,297*	*2,298*	*99%*	*2,267*	*N/A[4]*	*2,267*	*N/A[4]*
Prescriptive Equipment Lighting	*84,251*	*84,251*	*94%*	*78,903*	*4.2%*	*78,903*	*4.2%*
Residential Energy-Efficiency Behavior and Education	-	-	-	-	-	-	-
Residential Home Comfort	2,367	2,372	102%	2,410	0.86%	2,410	0.86%
Residential Retail	92,804	90,333	100%	90,314	0.02%	90,314	0.02%
Residential Retail Equipment	*2,756*	*2,894*	*99%*	*2,875*	0.6%	*2,875*	0.6%
Residential Retail Upstream Lighting	*90,048*	*87,439*	*100%*	*87,439*	*N/A[3]*	*87,439*	*N/A[3]*
School Benchmarking	-	-	-	-	-	-	-
Student and Parent Energy Education	6,910	7,643	67%	5,147	1%	5,147	1%
Total Portfolio	**210,034**	**208,223**	**96%**	**200,065**	**3%[2]**	**200,065**	**3%[2]**
Phase I Carryover						**495,636**	
Total Phase II+CO						**695,701**	
Phase II Compliance Target						**821,072**	

NOTES:
[1] At the 85% confidence level.
[2] At the 90% confidence level.
[3] Because this program's evaluation did not include sampling, C_v and precision are not meaningful.
[4] All non-lighting projects were verified; therefore relative precision is not applicable.

1.3 Summary of Fuel Switching Impacts

In PY5 PPL Electric Utilities offered fuel switching measures (electric to non-electric) in its Residential Home Comfort and Residential Retail programs. There were no fuel switching participants in the Residential Home Comfort Program and three fossil fuel water heater fuel switching participants in the Residential Retail Program. PPL Electric Utilities offered $300 per water heater, for a total of $900 in rebates for these participants. The participants made up less than 1% of the 8,031 participants with rebated equipment in the Residential Retail Program.

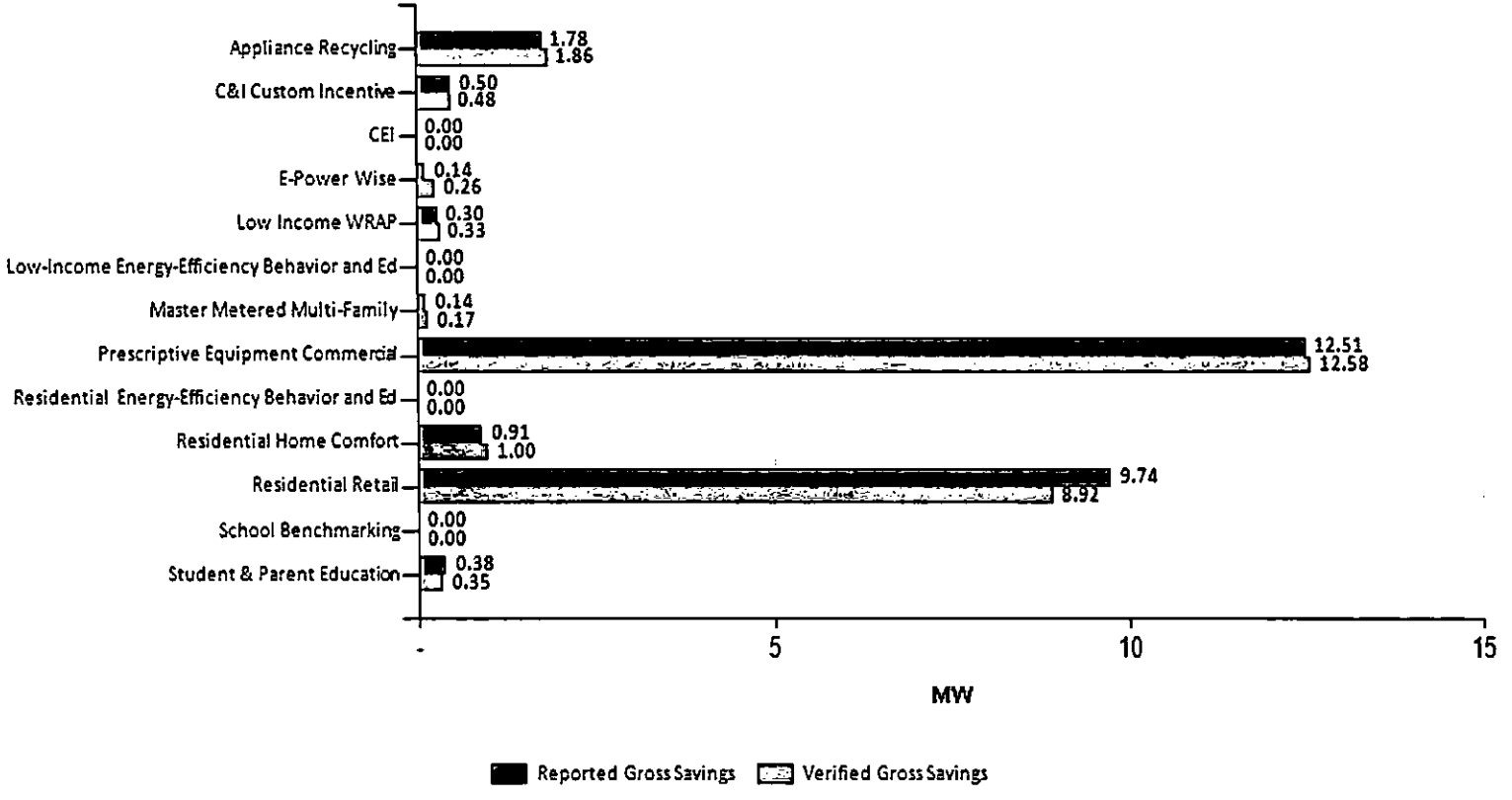
PPL Electric Utilities used the kWh/yr and kW savings algorithms for domestic hot water heater fuel switching measures from Section 3.18 the 2013 TRM to calculate savings. Deemed unit energy savings equaled 3,191 kWh/yr and unit peak demand reduction equaled 0.293 kW.[4] PPL Electric Utilities claimed 10 MWh/yr of gross verified energy savings from the fuel switching measures.

1.4 Summary of Demand Impacts

A summary of the reported and verified demand reduction by program for PY5 is presented in **Figure 1-6**. The impacts below reflect the line loss factors shown in **Table 1-14**.

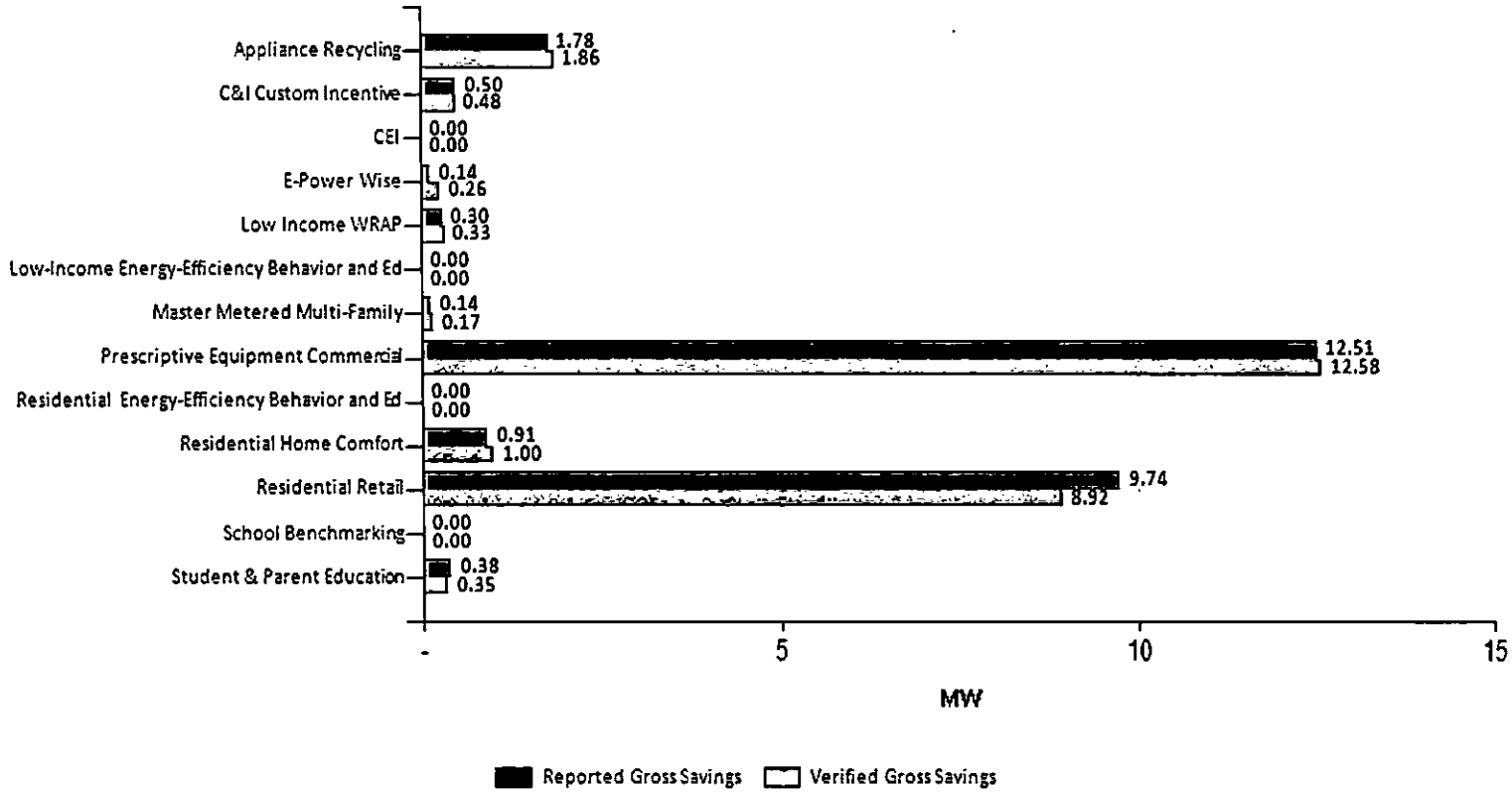
[4] Pennsylvania Public Utility Commission. *Technical Reference Manual.* June 2013. Available online: http://www.puc.pa.gov/pcdocs/1208574.docx.

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



A summary of demand reduction impacts by program through PY5 is presented in **Table 1-9** and **Table 1-10**.

Table 1-9: Reported Participation and Gross Demand Reduction by Program

Program	Participants		Reported Gross Impact (MW)	
	PYTD	Phase II	PYTD	Phase II
Appliance Recycling	11,510	11,510	1.78	1.78
Continuous Energy Improvement	-	-	-	-
Custom Incentive[1]	56	56	0.50	0.50
E-Power Wise	2,715	2,715	0.14	0.14
Low-Income Energy-Efficiency Behavior and Education	-	-	-	-
Low-Income WRAP	2,791	2,791	0.30	0.30
Master Metered Multi-Family	36	36	0.14	0.14
Prescriptive Equipment	2,348	2,348	12.51	12.51
Prescriptive Equipment Non-Lighting	*24*	*24*	*0.27*	*0.27*
Prescriptive Equipment Lighting	*2,324*	*2,324*	*12.25*	*12.25*
Residential Energy-Efficiency Behavior and Education	-	-	-	-
Residential Home Comfort	2,554	2,554	0.91	0.91
Residential Retail[2]	227,378	227,378	9.74	9.74
Residential Retail Equipment	*8,204*	*8,204*	*0.29*	*0.29*
Residential Retail Upstream Lighting	*219,174*	*219,174*	*9.45*	*9.45*
School Benchmarking[3]	22	22	-	-
Student and Parent Energy Education	714	714	0.38	0.38
Total Portfolio	**250,125**	**250,125**	**26.41**	**26.41**

NOTES:

[1] The participant count is based on the number of jobs that contributed to reported savings in PY5. The total number of projects created in PY5 is 107 including those still in progress and those that have since been cancelled.

[2] The Residential Retail program contains an upstream lighting component, in which exact participation is not known. The EM&V CSP estimated the number of participants in this component of the program by dividing the total number of bulbs discounted or given away by a bulb-per-participant value derived from the PY5 residential and small commercial customer telephone survey data (a weighted average for CFLs and LEDs of 8.05 bulbs for residential customers and 20.10 bulbs for small commercial customers).

[3] The School Benchmarking program does not claim energy or demand savings.

Table 1-10: Verified Gross Demand Reduction by Program

Program	PYTD Reported Gross Demand Savings (MW)	PYTD Adjusted *Ex Ante* 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[1]
Appliance Recycling	1.78	1.93	97%	1.86	3.0%	1.86	3.0%
Continuous Energy Improvement	-	-	-	-	-	-	-
Custom Incentive	0.50	0.53	91%	0.48	18%	0.48	18%
E-Power Wise	0.14	0.16	169%	0.26	7.8%	0.26	7.8%
Low-Income Energy-Efficiency Behavior and Education	-	-	-	-	-	-	-
Low-Income WRAP	0.30	0.32	101%	0.33	N/A[3]	0.33	N/A[3]
Master Metered Multi-Family	0.14	0.15	110%	0.17	16%	0.17	16%
Prescriptive Equipment	12.51	13.45	94%	12.58	3.5%	12.64	3.5%
Prescriptive Equipment Non-Lighting	*0.27*	*0.29*	*99%*	*0.28*	*N/A[4]*	*0.28*	*N/A[4]*
Prescriptive Equipment Lighting	*12.25*	*13.16*	*94%*	*12.30*	*3.6%*	*12.35*	*3.6%*
Residential Energy-Efficiency Behavior and Education	-	-	-	-	-	-	-
Residential Home Comfort	0.91	1.00	100%	1.00	0.18%	1.00	0.18%
Residential Retail	9.74	8.92	100%	8.92	0.000001%	8.92	0.000001%
Residential Retail Equipment	*0.29*	*0.32*	*99%*	*0.32*	0.4%	*0.32*	0.4%
Residential Retail Upstream Lighting	*9.45*	*8.6*	*100%*	*8.6*	*N/A[3]*	*8.6*	*N/A[3]*
School Benchmarking	-	-	-	-	-	-	-
Student and Parent Energy Education	0.39	0.52	67%	0.35	1.7%	0.35	1.7%
Total Portfolio	**26.41**	**26.97**	**96%**	**25.95**	**0.05%[2]**	**25.95**	**0.05%[2]**

NOTES:
[1] At the 85% confidence level
[2] At the 90% confidence level
[3] Because this program's evaluation did not include sampling, C_v and precision are not meaningful.
[4] All non-lighting projects were verified; therefore relative precision is not applicable.

1.5 Summary of PY5 Site Visits

The implementation conservation service providers (CSPs) conducted site visits for various reasons, including for example, to determine the *ex ante* savings, to complete Appendix C lighting forms, and quality control site visits for participating projects. The Implementation CSPs site visits provided site specific data to determine the *ex ante* savings.

The evaluation, measurement, and verification (EM&V) CSP conducted verification site visits to verify that program-rebated or funded measures were installed and operating as reported and that correct data were used to calculate *ex ante* savings. No sites or projects were classified as "failed."[5] Discrepancies were documented, and the site-specific data collected during site visits were used to calculate the verified *ex post gross savings.*

Reasons for adjustments to reported *ex ante* savings include corrections to various inputs determined using site-specific data. These could include, for example:

- Baseline equipment adjustments
- Annual operating hours of use or full load hours
- Building type and associated stipulated lighting hours of use and/or coincidence factor
- Space cooling type
- Fixture type
- Measure quantities

For the Custom Incentive Program, a variety of discrepancies were discovered in the on-site inspections. For small strata projects, the EM&V CSP found that operating parameters were typically somewhat different than were assumed by the Implementation CSP. For large strata projects, the EM&V CSP typically conducted the inspection with the Implementation CSP and calculated verified savings based on the inspection results. The inspections found nothing unexpected for the custom projects in this program.

Table 1-11 summarizes programs receiving verification site visits by the EM&V CSP, the number of *inspections, and resolution of discrepancies.*

[5] The SWE defines "failed" as "an installation should be reported as having failed the inspection process if a measure was reported as installed and operating by the CSP and subsequently the onsite inspection finds either that the equipment is not operating according to specifications or the equipment was not installed at the time of the inspection."

Table 1-11. Summary of PY5 Site Visits

Program	Measure	Inspection Firm	Number of Inspections Planned	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
Prescriptive Equipment	Non-lighting	EM&V CSP	16	16	2	Updated baseline equipment
Prescriptive Equipment	Lighting	EM&V CSP	28	34	26	Updated savings based on HOU, fixture type and counts, space cooling and building type
Prescriptive Equipment	Lighting	Implementation CSP	N/A	2,378	N/A	N/A
Custom	All custom projects	EM&V CSP	N/A	19	--	*Savings calculated using* site specific data
Custom	All custom projects	Implementation CSP	N/A	28	--	--
Master Metered Multifamily	Prescriptive and free direct install measures for multifamily buildings	EM&V CSP	17	17	17	Savings adjusted based on site specific data
TOTAL				**2,492**	**45**	

1.6 Summary of PY5 Net-to-Gross Ratios

Per the 2013 TRC Order, EDCs are required to conduct NTG research. NTG ratios are not applied to gross savings and are not used for compliance purposes, but are used for cost-effectiveness reporting and future program planning purposes. **Table 1-12** presents a summary of NTG ratios by program.

Table 1-12: PY5 NTG Ratios by Program

Program	Freeridership	Spillover	PY5 NTG Ratio	NTG Categories Included	Possible Market Effects Affecting Freeridership
Appliance Recycling	0.34	0.08	0.74	Self-report participant freeridership, secondary market impact, induced replacement, participant spillover.	Secondary market impacts assessed in model. No clear means to assess market transformation.
Continuous Energy Improvement	No savings claimed in PY5				
Custom Incentive	0.45	0	0.55	Self-report participant freeridership, spillover.	Installation contractors, and increased awareness and knowledge of energy efficiency may influence decision making.
E-Power Wise	0	0	1.0	Low-income program offers energy conservation kit at no cost to customers. No freeridership.	--
Low-Income Energy-Efficiency Behavior and Ed	Program will launch in PY6				
Low-Income WRAP	0	0	1.0	Low-income program offers measures at no cost to customers. No freeridership.	--
Master Metered Multifamily	0.23	0	0.77	Self-report participant freeridership for rebated measures, spillover.	Installation contractors, efficiency of available equipment.
Prescriptive Equipment	0.26	.01	0.75	Self-report participant freeridership, spillover.	Installation contractors, and increased awareness and knowledge of energy efficiency may influence decision making. Prevalence of efficient equipment in the marketplace will affect purchase decisions.
Residential Energy-Efficiency Behavior and Ed	Program will launch in PY6				
Residential Home Comfort	0.48	0.06	0.58	Self-report participant freeridership, spillover.	RHC is a mature program which has had a SEER13 baseline for 8 years. Low incentive for expensive HVAC equipment could affect freeridership.
Residential Retail - Equipment	0.47	0.04	0.57	Self-report participant freeridership, spillover.	Energy efficient refrigerators are common; small incentive for expensive equipment.
Residential Retail – Upstream Lighting	0.16	0	0.84		Increased awareness of energy efficient lighting options.
School Benchmarking	No savings will be claimed				
Student & Parent Education	0	0	1.0	Classroom education and energy conservation kits offered in school curricula at no cost to the student participants. No freeridership.	--
Weighted by Program Savings for Programs Reporting NTG Ratios	**0.22**	**0.01**	**0.79**		

1.7 Summary of Portfolio Finances and Cost-Effectiveness

A breakdown of the portfolio finances is presented in **Table 1-13**.

Table 1-13: Summary of Portfolio Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$10,811	$10,811
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	**$10,811**	**$10,811**
Design & Development	$1,368	$1,368
Administration, Management, and Technical Assistance[1]	$18,972	$18,972
Marketing[2]	$4,200	$4,200
Subtotal EDC Implementation Costs	**$24,540**	**$24,540**
EDC Evaluation Costs	$1,737	$1,737
SWE Audit Costs	$750	$750
Total EDC Costs[3],[4]	**$37,838**	**$37,838**
Participant Costs[5]	$25,943	$25,943
Total NPV TRC Costs[6]	**$63,781**	**$63,781**
Total NPV Lifetime Energy Benefits	**$122,176**	**$122,176**
Total NPV Lifetime Capacity Benefits	**$7,751**	**$7,751**
Total NPV TRC Benefits[7]	**$140,338**	**$140,338**
TRC Benefit-Cost Ratio[8],[9]	**2.20**	**2.20**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.

[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.

[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.

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

[7] 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.

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

[9] Total NPV TRC Benefits includes $10,410,735 of O&M replacement cost savings for CFL and LED bulbs.

1.8 Summary of Cost-Effectiveness by Program

The total resource cost (TRC) benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. **Table 1-14** shows the TRC ratios by program and other key factors used in the TRC ratio calculation for Phase II programs.

Table 1-14: PYTD 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 Recycling	$5,298	$1,676	3.16	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
Continuous Energy Improvement	-	$219	-	8.14%	-	-
Custom Incentive	$3,874	$2,229	1.74	8.14%	Multiple[2],[3],[4]	Multiple[2],[3],[4]
E-Power Wise	$776	$259	2.99	8.14%	8.33%	8.33%
Low-Income Energy-Efficiency Behavior and Ed	-	$268	-	8.14%	-	-
Low-Income WRAP	$2,827	$3,390	0.83	8.14%	8.33%	8.33%
Master Metered Multi-Family	$1,300	$925	1.41	8.14%	6.23%	6.23%
Prescriptive Equipment	*$69,000*	*$30,767*	2.41	8.14%	Multiple[2],[3],[4]	Multiple[2],[3],[4]
Residential Energy-Efficiency Behavior and Ed	-	$708	-	8.14%	-	-
Residential Home Comfort	$2,370	$3,702	0.64	8.14%	Multiple[1],[2]	Multiple[1],[2]
Residential Retail	$51,399	$6,869	7.47	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
School Benchmarking	-	$152	-	8.14%	6.23%	6.23%
Student & Parent Education	$3,494	$1,162	3.01	8.14%	8.33%	8.33%

NOTES:

[1] Residential line loss factor of 8.33%

[2] Small C&I line loss factor of 8.33%

[3] Large C&I line loss factor of 4.12%

[4] GNI line loss factor of 6.23%. The GNI line loss factor is the average of Small/Large C&I and is consistent with the line loss used in PPL Electric's EE&C plan. Going forward, the actual participant rate class will be used to determine the blended GNI line loss factor.

1.9 Comparison of PY5 Performance to Approved EE&C Plan

Table 1-15 below shows PY5 expenditures compared to the budget estimates set forth in the EE&C plan.

Table 1-15: Comparison of Program Expenditures to EE&C Plan[1]

Program	Budget from EE&C Plan ($1,000)	Actual Expenditures ($1,000)	Percentage Difference from EE&C Plan [(Actual – Planned)/Planned][2]
Appliance Recycling	$1,734	$1,676	-3%
Continuous Energy Improvement	$251	$219	-13%
Custom Incentive	$3,646	$971	-73%
E-Power Wise	$260	$259	0%
Low-Income Energy-Efficiency Behavior and Ed	$0	$268	N/A
Low-Income WRAP	$5,337	$3,390	-36%
Master Metered Multi-Family	$647	$746	15%
Prescriptive Equipment	$20,235	$10,415	-49%
Residential Energy-Efficiency Behavior and Ed	$0	$708	N/A
Residential Home Comfort	$2,434	$1,188	-51%
Residential Retail	$7,983	$5,227	-35%
School Benchmarking	$100	$152	52%
Student & Parent Education	$1,325	$1,162	-12%
Common Costs	$11,754	$11,457	-3%
Portfolio	**$55,706**	**$37,838**	**-32%**

NOTES:

[1] Approximately $7 million of actual program expenditures were incurred for PY5 transactions (savings claimed in PY5) but were paid in PY6 and, therefore, will be accounted for in PY6. This "payment lag" across program years is normal, except for the final year of a phase.

[2] The Final Annual Report template used the equation [(Planned-Actual)/Planned].

Table 1-16 show PY5 program savings compared to the energy and demand savings estimates filed in the EE&C plan.

Table 1-16: PY5 Comparison of Actual Program Savings to EE&C Plan

Program	MWh/yr Savings Projected in EE&C Plan	Verified MWh/yr Savings[1]	Percent Difference [(Actual – Planned)/Planned][2]	MW Savings Projected in EE&C Plan	Verified MW Savings[1]	Percent Difference [(Actual – Planned)/Planned][2]
Appliance Recycling	9,121	9,255	1%	1.30	1.86	43%
Continuous Energy Improvement	Program did not claim savings in PY5					
Custom Incentive	24,951	5,394	-78%	3.52	0.48	-86%
E-Power Wise	1,756	1,525	-13%	0.22	0.26	20%
Low-Income Energy-Efficiency Behavior and Ed	Program will launch in PY6					
Low-Income WRAP	3,655	2,810	-23%	0.45	0.33	-28%
Master Metered Multi-Family	1,757	2,039	16%	0.25	0.17	-32%
Prescriptive Equipment	84,798	81,170	-4%	14.90	12.64	-15%
Residential Energy-Efficiency Behavior and Ed	Program will launch in PY6					
Residential Home Comfort	3,541	2,410	-32%	0.50	1.00	99%
Residential Retail	90,054	90,314	0%	16.00	8.92	-44%
School Benchmarking	Program did not claim savings in PY5					
Student & Parent Education	4,900	5,147	5%	0.60	0.35	-42%
Portfolio	**224,533**	**200,065**	**-11%**	**37.7**	**26.01**	**-31%**

NOTES:
[1] The Final Annual Report template used "Reported" savings
[2] The Final Annual Report template used the equation [(Planned-Actual)/Planned].

The process evaluations provide information about PY5 achievements against planned savings. The *process evaluations also discuss planned changes to the program. PPL Electric Utilities is planning* program changes for PY6/PY7 to manage participation and planned savings. Achievements against planned savings are summarized below.

Most programs achieved savings very close to plans. Appliance Recycling, Residential Retail, Prescriptive Equipment, and the Student and Parent Energy-Efficiency Education program all achieved savings within 5% of the planned savings. E-Power Wise and Master Metered Multi-Family were within 16% of the planned savings. The Custom Program, Low-Income WRAP, and Residential Home Comfort had actual savings that were more than 23% less than the planned savings.

The Custom Incentive Program is designed primarily for larger commercial and industrial customers. Typical projects involve complex decision making and have a long lead time from conception to implementation. This program had few large projects completed in PY5 and achieved fewer savings than planned. However, there are many projects in progress which are expected to complete implementation in PY6, bringing the achievement closer to planned values.

Home Comfort added two components late in PY5—a new construction rebate and manufactured home rebate. While savings for these components were included in the EE&C Plan, there were no participants. Therefore, achieved savings were lower than anticipated. Projects in these components are expected in PY6.

Two low income programs, WRAP and E-Power Wise achieved less than planned. WRAP added full cost jobs late in the year and did not complete full cost jobs. In addition, it was difficult to identify candidates for low cost projects. Changes were made to the program to include full cost jobs in PY6 which will increase savings. E-Power Wise installation rates were lower than anticipated. PPL Electric Utilities is exploring changes to the measures included in the energy-efficiency kits to improve installation rates and increase savings.

TRC ratios in the EE&C Plan assume that in any program year, all costs associated with savings are reported and included in the TRC. In actuality, there is often a time lag reporting costs. Cost reported in one year may actually be associated with energy savings reported in a prior year. Therefore, the TRC estimated in the EE&C Plan is not directly comparable to the TRC reported in a program year.

1.10 Portfolio Level/Cross-cutting Process Evaluation Summary for Program Year 5

The process evaluation of PPL Electric's PY5 portfolio identifies opportunities and offers recommendations to improve the effectiveness of these components—design and implementation, enrollment processes, marketing and outreach, quality assurance, and other elements—for all of PPL Electric's energy-efficiency programs. The process evaluation is a separate document titled *PPL Electric Utilities PY5 Annual Process Evaluation.* Overarching conclusions and recommendations that affect multiple programs within the portfolio are discussed in the *Annual Process Evaluation.* A summary table of recommendations is located in **Appendix A Table A-1** of this impact evaluation report (*PY5 Annual Report*).

Process evaluation activities varied by program in PY5. The main activities conducted were:

- Participant and nonparticipant telephone surveys
- Program literature review and benchmarking
- Database and records review for quality assurance and quality control (QA/QC)
- Shelf-stocking study for residential lighting
- Stakeholder interviews
- Trade ally surveys and interviews
- Process map review

2 Residential Retail Program

The Residential Retail Program offers upstream incentives for energy-efficient lighting, midstream incentives for ENERGY STAR® televisions sold through retailers, and rebates for energy-efficient refrigerators and heat pump water heaters (HPWHs) sold through retailers. The Residential Retail Program also includes efficient fossil-fuel water heaters eligible for rebates under the fuel-switching pilot (see **Appendix H: Fuel Switching**).

An executive summary of program metrics can be found in **Table 2-1**.

Table 2-1: Residential Retail Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross *Energy* Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved *Energy*[2] (TRC $/kWh)	Phase II *Participants*
Equipment	2,756	2,894	2,875	0.57	7.48	$5,227	$0.06	$0.015	8,204
Upstream Lighting	90,048	87,439	87,439	0.84					219,174[3]
Total	**92,804**	**90,333**	**90,314**	**0.83**	**7.48**	**$5,227**	**$0.06**	**$0.015**	**227,378**

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.
[3] The PY5 participant count for the lighting component uses the bulbs-per-participant estimates derived from the PY5 residential and small commercial customer survey data.

2.1 Program Updates

The Residential Retail Program launched in PY5 Q1. Midstream incentives for televisions were eliminated in January 2014 and direct install smart strips were phased out by the end of PY5. Beginning in PY6, the program's upstream lighting component will offer incentives only for LEDs.

2.1.1 Definition of Participant

Residential Retail Program participants are defined for the rebated equipment and midstream components by a unique job or rebate application. For the upstream lighting component jobs are reported as weekly bulb sales by bulb type. The EM&V CSP calculates the number of participants by dividing the total number of bulbs sold or distributed by a bulbs-per-participant estimate derived from general residential population survey respondents who reported having purchased bulbs. In PY5, the EM&V CSP estimated that each participant purchased an average of 8.2 CFLs and 6.4 LEDs.

2.2 Impact Evaluation Gross Savings

The Residential Retail Program included 7,781 equipment-rebate participants, 423 midstream equipment-incentive participants, and an estimated 219,174 upstream lighting participants[6] who purchased 1,891,862 discounted bulbs.

2.2.1 Reported Gross Savings

In PY5, the Residential Retail Program reported energy savings of 92,804 MWh/yr and demand reduction of 9.74 MW, as shown in **Table 2-2**. The savings for the Small Commercial and Industrial (Small C&I) sector include adjustments to account for cross-sector sales in the upstream lighting portion of the program as described in Appendix D in the Phase I Final Annual Report, dated January 15, 2014.[7] The percentage adjustment (12% of bulbs) and savings gross-up factor determined in PY4 was applied to bulbs sold through retailers (giveaway bulbs were excluded) in PY5. This resulted in 25,151 MWh/yr in reported gross savings, or approximately 28% of the upstream lighting savings, being attributed to the Small Commercial sector. (Additional discussion can be found below in **Section 2.2.3 Upstream Lighting**.)

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6 This final estimated participant count has been updated from the value presented in the PY5 Q4 report (250,750 participants). The PY5 participant count of 219,174 uses the bulbs-per-participant estimates derived from the PY5 residential customer survey.

7 PPL Electric Utilities. *Final Annual Report to the Pennsylvania Public Utility Commission for the Period June 2012 through May 2013 Program Year 4*. November 15, 2013. Prepared by Cadmus. Available online: https://www.pplelectric.com/~/media/pplelectric/save%20energy%20and%20money/docs/act129_phase2/py4annualreportrevised11514redline.pdf, Appendix D.

Table 2-2: Phase II Residential Retail Program Reported Results by Customer Sector

Stratum	Participants[1]	Reported Gross Impact (MWh/Year)	Reported Gross Demand Reduction (MW)	Incentives ($1000)
Residential- Upstream Lighting	208,591	64,897	3.17	$2,419
Residential- Equipment	8,092	2,737	0.28	
Small Commercial and Industrial- Upstream Lighting	10,582	25,151	6.28	$185
Small Commercial and Industrial- Equipment	44	11	-	
Large Commercial and Industrial- Equipment	1	-	-	$0
Government, Non-Profit, and Institutional- Equipment	67	7	-	$3
Program Total	**227,378**	**92,804**	**9.74**	**$2,606**

NOTES:
[1] The PY5 participant count for the lighting component uses the bulbs-per-participant estimates derived from the PY5 residential and small commercial customer survey data (a weighted average for CFLs and LEDs of 8.05 bulbs for residential customers and 20.10 bulbs for small commercial customers). Therefore, rounded totals for strata may not equal program total.

2.2.2 EM&V Sampling Approach

The EM&V CSP used methods specific to each program component (upstream and midstream) to review and adjust savings estimates. For the upstream lighting and midstream television components, the EM&V CSP conducted a review of all records. The rebated equipment measures were verified via desk reviews of a simple random sample of rebate forms, and installation was verified via participant phone surveys. The EM&V CSP verified installation of smart strips via the participant phone survey.

The EM&V CSP reviewed a total of 82 rebate applications for PY5 prorated between refrigerators and HPWHs based on reported energy savings. These rebate applications also included the three fuel-switching pilot measures rebated in PY5. A summary of the Residential Retail Program sampling strategy can be found in **Table 2-3** and **Table 2-4**.

Table 2-3: Residential Retail Program Upstream Lighting Sampling Strategy for PY5

Stratum	Population Size[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Upstream Lighting	68,840	N/A[2]	All Records	All Records	Database Review
Program Total	***68,840***	***N/A***			

NOTES:
[1] The population size for Upstream Lighting is the number of distinct data records (CSP job numbers) verified via a database review, not the total number of upstream lighting participants (estimated at 219,174) and not the number of bulbs
[2] Since this program's evaluation is based on the census and did not include sampling, confidence and precision are not meaningful.

Table 2-4: Residential Retail Program Equipment Sampling Strategy for PY5

Stratum	Population Size[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Equipment	8,031	90/10	70	82	Records Review
Equipment	8,031	90/10	150	150	Survey
Fuel Switching	3	N/A[2]	All Records	All Records	Survey and Records Review
Midstream TVs	791	N/A[2]	All Records	All Records	Model Number Lookups
Program Total	**8,825**	**90/10 for equipment**			

NOTES:
[1] Equipment and midstream TVs populations are defined by the number of database records (typically one per rebate).
[2] Since this program's evaluation is based on the census and did not include sampling, confidence and precision are not meaningful.

2.2.3 *Ex Ante* Adjustment Methodology and Findings

The EM&V CSP adjusted the reported savings from EEMIS, the PPL Electric Utilities program tracking database, to align with assumptions specified in the TRM, resulting in adjusted *ex ante* savings.

The TRM *ex ante* adjustments modify the savings reported in EEMIS (when reported *ex ante* savings are placeholders) to reflect the specifications of measures. These adjustments are made to the population, and account for differences among planning assumptions, the TRM assumptions, and specifications of the equipment rebated to participants. The results of these adjustments to the population are the adjusted *ex ante* savings used in the equation to determine the program's realization rate.

Upstream Lighting

The EM&V CSP reviewed all upstream lighting records stored in EEMIS. The EEMIS records contain input parameters supplied by the Implementation CSP that are used to compute energy and demand savings. The Implementation CSP also provides data to fulfill the statewide evaluator's (SWE's) quarterly data request requirements. The EM&V CSP uses these data to cross-check the bulb quantities and bulb types reported in EEMIS extracts, to ensure data used in the impact evaluation are complete and accurate, and as a source for additional data used in the econometric model (see Section 2.3). The EM&V CSP also checks the wattage assumptions provided by the Implementation CSP against the reported lumens, by bulb, to ensure consistency with the TRM.

The EM&V CSP calculated *ex ante* adjusted savings for all PY5 Q4 Residential Lighting Program EEMIS records based on delta watts (baseline minus CFL/LED watts), the in-service rate (ISR), hours of use (HOU), and coincidence factor (CF) assumptions specified in the 2013 TRM. The EM&V CSP then applied an adjustment to reflect cross-sector sales, as described below.

The EM&V CSP used the reported lumens to assign baseline wattages to all bulbs except reflector bulbs and 3-way bulbs, in accordance with the 2013 TRM.[8] For 100W and 75W equivalent general service bulbs, the EM&V CSP used the post-EISA baseline. For lower-wattage bulbs not yet subject to EISA baselines in the 2013 TRM (including candelabra bulbs, which are exempt), the pre-EISA baseline was used. For both CFL and LED reflector lamps, the EM&V CSP used the Reflector Lamps table from the 2013 LED protocol.[9] After applying baseline wattages, the EM&V CSP computed an evaluated wattage delta for each record. This wattage delta is then entered in the TRM savings algorithms for energy and demand savings. In almost all cases, the baseline wattage determined by the EM&V CSP matched that reported by the Implementation CSP, thus the reported savings, prior to any cross-sector sales adjustment, matched those calculated in EEMIS. There were a few instances, however, where the EM&V CSP determined that the reported baseline wattage was not in accordance with the 2013 TRM, thus requiring an *ex ante* adjustment.

Prior to PY5 Q4, adjustments to reflect bulbs purchased by commercial customers through the residential upstream lighting component, also known as cross-sector sales,[10] were aggregated into one adjustment record for each sector and included in the Q3 EEMIS extract. In quarters 1-3, the EM&V CSP adjusted calculated savings, at the bulb-record level, to reflect the increase in savings attributable to cross-sector sales. The EM&V CSP used the percentage adjustment determined in PY4, but updated the commercial ISR, HOU and CF assumptions in accordance with the 2013 TRM, based on mapping small commercial customer building types to those provided in the TRM protocol. In PY5 Q4, PPL Electric Utilities began splitting bulb-specific data into separate residential and commercial records in EEMIS to reflect cross-sector sales quantities and savings. Therefore, in Q4 the EM&V CSP applied 2013 TRM commercial ISR, HOU, and CF assumptions to these commercial records. Savings were then calculated in the same way as described above for residential records.

Rebated Equipment

The EM&V CSP looked up specific model numbers for rebated measures based largely on ENERGY STAR-qualified product lists, to assign the appropriate TRM deemed savings. Refrigerator savings in the TRM are based upon the configuration of the refrigerator. Because EEMIS uses a conservative savings value of 108 kWh/yr as a placeholder for all refrigerators, the TRM *ex ante* adjusted savings are often higher than the reported savings. Deemed savings for HPWHs are based on the energy factor (EF) of the model.

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8 *Pennsylvania Technical Reference Manual*. Table 2-69, "Baseline Wattage by Lumen Output." 2013.

9 *Pennsylvania Technical Reference Manual*. Table 2-81, "Reflector Lamps." 2013

10 PPL Electric Utilities. *Final Annual Report to the Pennsylvania Public Utility Commission for the Period June 2012 through May 2013 Program Year 4*. November 15, 2013. Prepared by Cadmus. *Available online:* https://www.pplelectric.com/~/media/pplelectric/save%20energy%20and%20money/docs/act129_phase2/py4annualreportrevised11514redline.pdf, Appendix D.

Midstream TVs

TRM deemed savings for televisions are based on ENERGY STAR tier and screen size. Savings in EEMIS are based on the assumption that incented models qualify for the ENERGY STAR "Most Efficient" tier. The EM&V CSP adjusted *ex ante* savings for television models not listed on the ENERGY STAR Most Efficient qualified product list.

2.2.4 Ex Post Adjustment Methodology and Findings

Upstream Lighting

The EM&V CSP calculated savings for all records based on the TRM algorithm[11] and the reported bulb quantities match those in the Implementation CSP's data. Because the *ex post* verified energy and demand savings are equal to the *ex ante* energy and demand savings the PY5 realization rate is 100%. If in the future the EM&V CSP finds discrepancies with the number of bulbs recorded in EEMIS when compared with the Implementation CSP's data, any adjustment would affect the realization rate.

Rebated Equipment

The EM&V CSP verified rebated equipment by randomly sampling records and reviewing the associated rebate forms and documentation (invoices, AHRI certificates) obtained from the Implementation CSP. In addition, a phone survey of program participants verified equipment installation and confirmed total quantities reported in the Implementation CSP's extracts matched EEMIS' records. The EM&V CSP did not find any errors in the sample of rebate forms or any incorrect quantities in EEMIS and, therefore, did not make any *ex post* adjustments to rebated equipment measures in PY5.

The EM&V CSP did, however, make *ex post* adjustments to smart strips based on a verified installation rate of 91%.

2.2.5 Summary of Evaluation Results

In PY5, the Residential Retail Program realized 99.98% of the *ex ante* adjusted energy savings, as shown in **Table 2-5.**

[11] *Pennsylvania Technical Reference Manual,* Section 2.30.1, "Algorithms." 2013

Table 2-5: PY5 Residential Retail Program Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Impact (MWh/Year)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)[2]	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Energy Star Refrigerators	694	858	100%	858	N/A[4]	N/A[4]
Fuel Switching	8	10	100%	10	N/A[3]	N/A[3]
HPWHs	1,540	1,540	100%	1,540	N/A[3]	N/A[3]
Midstream TVs	304	276	100%	276	N/A[3]	N/A[3]
Smart Strips	211	211	91%	192	0.23	8%
Upstream Lighting	90,048	87,439	100%	87,439	N/A[3]	N/A[3]
Program Total	**92,804**	**90,333**	**100%**	**90,314**	**0.03**	**0.02%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[3] Since this program's evaluation did not include sampling, confidence and precision are not meaningful.
[4] Even though the evaluation included sampling, no variation was observed between Adjusted *Ex Ante* Energy Savings and Verified Energy savings in the sample, so precision could not be calculated.

In PY5, the Residential Retail Program realized 99.98% of the *ex ante* adjusted demand savings, as shown in **Table 2-6**.

Table 2-6: PY5 Residential Retail Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings[1]	Adjusted *Ex Ante* Demand Savings[2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings[2], [3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Energy Star Refrigerators	0.079	0.11	100%	0.11	N/A[5]	N/A[5]
Fuel Switching	0.001	0.001	100%	0.001	N/A[4]	N/A[4]
HPWHs	0.14	0.15	100%	0.15	N/A[4]	N/A[4]
Midstream TVs	0.047	0.046	100%	0.046	N/A[4]	N/A[4]
Smart Strips	0.015	0.016	91%	0.015	0.23	8%
Upstream Lighting	9.45	8.6	100%	8.6	N/A[4]	N/A[4]
Program Total	**9.74**	**8.92**	**100%**	**8.92**	**0.000002**	**0.00001%**

NOTES:
[1]Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.
[4] Since this program's evaluation did not include sampling, confidence and precision are not meaningful.
[5] Even though the evaluation included sampling, no variation was observed between Adjusted *Ex Ante* Energy Savings and Verified Energy savings in the sample, so precision could not be calculated.

2.3 Impact Evaluation Net Savings

The EM&V CSP conducted an analysis to determine net savings for the Residential Retail Program. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

2.3.1 Net-to-Gross Ratio Methodology

The overriding methods used to determine net savings were defined by the Statewide Evaluator, including instructions provided in the Evaluation Framework and Guidance Memos. The EM&V CSP typically determines net savings by assessing freeridership and spillover.

For the Residential Retail Equipment stratum of the program, the EM&V CSP included freeridership and spillover ratio estimates that were estimated in accordance to the SWE NTG guidelines, which utilizes self-report survey information from participating customers.

To provide estimates of freeridership for the Residential Retail Upstream Lighting, the EM&V CSP conducted demand modeling using bulb sales information from the Implementation CSP. Lighting products that incur price changes and promotion over the program period provide valuable information regarding the correlation between sales and prices. Using the price elasticity to estimate freeridership is the same principle in willingness-to-pay analyses using self-report survey responses as in Phase I.

However, rather than relying on self-report data, elasticities are based on actual observed changes in purchasing behavior in response to program activity.

2.3.2 Net-to-Gross Ratio Sampling

Table 2-7 shows the PY5 Residential Retail NTG sampling strategy.

Table 2-7: Residential Retail Program Sampling Strategy for PY5 NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed C_V or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[2]
Equipment	Participants	5,489[1]	0.5	90/10	150	150	94%
Upstream Lighting	General Population	1,215,560	0.5	90/10	300	301	92%
Program Total	**N/A**	**1,215,560[3]**	**0.5**	**90/10**	**450**	**451**	**N/A**

NOTES:
[1] This number represents unique participants.
[2] Percent contacted means of the entire sample frame list (those drawn specifically for the survey) how many were called to get the completed surveys, often 100% will be the answer.
[3] The rebated measure population is a subset of the total population. Program participants are a subset of all PPL Electric Utilities customers.

2.3.3 *Net-to-Gross Ratio Findings*

The freeridership and spillover ratio estimates for the Residential Retail Program, estimated in accordance with the SWE NTG guidelines, are shown in

Table 2-8.

The NTG ratio for the Upstream Lighting is based on the estimated freeridership using the econometric model (see **Appendix D: Econometric Study** for more information). The results were NTG ratio of 88% for CFL products and 40% for LEDs. The Lighting portion of program overall had a NTG ratio of 84%.

The NTG ratio estimated for PY5 for the equipment component of the program is lower than that estimated in PY4 for the residential component of the Efficient Equipment program (72%). Notably, in PY5, the freeridership of the respondents asked about refrigerators was 67%; this is nearly twice that for respondents asked about HPWHs (36%). As a result of the relatively high freeridership in PY5, in PY6 PPL Electric Utilities increased the refrigerator rebate from $25 to $100, and also increased the required level of efficiency for rebate eligibility. Refrigerators must now qualify for the ENERGY STAR "most efficient" category.

The EM&V CSP will continue to monitor freeridership and program influence as part of its longer-term efforts to assess the market effects of PPL Electric's programs.

Table 2-8: PY5 Residential Retail Program Summary of Evaluation Results for NTG Research

Stratum	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed C_V or Proportion in Sample Design	Relative Precision
Equipment	0.47[1]	0.04	0.57	0.045	7%
Upstream Lighting	0.16	0	0.84	0.013	2%
Program Total[1]	**0.17**	**0**	**0.83**	**N/A**	**N/A**

NOTES:
[1] Survey sample sizes were determined for the program but not designed to assess individual measures offered in the program. Therefore, measure level assessments of freeridership are for information purposes and are not designed to determine statistical significance. Freeridership was estimated for the heat pump water heater and refrigerator equipment measures, 36% and 67%, respectively. These estimates were weighted by the survey sample-verified program kWh savings. This method ensures that respondents who achieved higher energy savings through the program measures are given a greater influence on the measure level freeridership estimate than those respondents who achieved lower energy savings. The measure level freeridership estimates were then weighted by the measure's *ex post* kWh program population savings to arrive at the final equipment stratum freeridership estimate of 47%.

2.4 Process Evaluation

A process evaluation was conducted In PY5 for the Residential Retail Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

For the Residential Retail Program, the PY5 process evaluation activities were these:

- Participant surveys (n=150)
- General residential surveys (n=300)
- Program staff and implementer interviews (n=2)
- Program literature review and benchmarking
- Database and quality assurance/quality control (QA/QC) review of records
- Process map review

Two surveys were administered as part of the PY5 process evaluation. One was with 150 participants in the Residential Retail Program to ask questions about the program. The second was a general population survey of 301 residential customers in PPL Electric Utilities territory. The general population survey was conducted because the Residential Retail Program offers an upstream incentive for energy-efficient light bulbs, and purchasers (program participants) are unknown. The survey asked questions about energy-efficient bulb awareness and CFL and LED purchase patterns.

Table 2-9 summarizes the sampling plan for the surveys administered by the EM&V CSP.

Table 2-9: Residential Retail Program Process Evaluation Sampling Strategy for PY5

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or C_V in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample[2]	Evaluation Activity
Equipment	Participants	5,489[1]	0.5	90/10	150	150	94%	Survey
Upstream Lighting	General Population	1,215,560	0.5	90/10	300	301	92%	Survey
Program Total	***N/A***	***1,215,560[3]***	***0.5***	***90/10***	***450***	***451***	***N/A***	***N/A***

NOTES:
[1] This number represents unique participants.
[2] Percent contacted means of the entire sample frame list (those drawn specifically for the survey) how many were called to get the completes, often 100% will be the answer.
[3] The rebated measure population is a subset of the total population because program participants are a subset of all PPL Electric Utilities customers included in the Upstream Lighting survey.

2.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-2.**

2.6 Financial Reporting

A breakdown of the Residential Retail Program finances is presented in **Table 2-10**.

Table 2-10: Summary of Residential Retail Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$2,606	$2,606
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	***$2,606***	***$2,606***
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$2,621	$2,621
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	***$2,621***	***$2,621***
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	**$5,227**	**$5,227**
Participant Costs[5]	$1,642	$1,642
Total NPV TRC Costs[6]	**$6,869**	**$6,869**
Total NPV Lifetime Energy Benefits	**$40,077**	**$40,077**
Total NPV Lifetime Capacity Benefits	**$1,340**	**$1,340**
Total NPV TRC Benefits[7]	***$51,399***	***$51,399***
TRC Benefit-Cost Ratio[8], [9]	**7.48**	**7.48**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] *Total TRC Costs includes Total EDC Costs and Participant Costs.*
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[9] Total NPV TRC Benefits includes $9,982,285 to account for fuel switching measures and O&M lighting replacement costs.

3 Prescriptive Equipment Program

The Prescriptive Equipment Program promotes the purchase and installation of high-efficiency equipment by providing customers financial incentives to offset the higher purchase costs of energy efficient equipment. The program offers information on the features and benefits of energy efficient equipment. This program targets small C&I, large C&I, GNI, and agricultural customers. The Prescriptive Equipment Program is divided into lighting, non-lighting, and agriculture components.

The program also offers a direct discount delivery channel that is designed to make it easier and more economical for small businesses and institutions to install energy-efficient lighting and commercial refrigeration upgrades. A contractor evaluates energy-efficient lighting and refrigeration and recommends upgrades to the customer. The customer chooses which projects to install, and then the contractor completes and submits required paperwork on behalf of the customer. The contractor receives the incentive from PPL Electric Utilities and passes those savings onto the customer so that the customer pays the discounted amount upfront, thereby lowering their cost burden. Customers participating in the direct discount delivery channel are required to obtain preapproval from PPL Electric Utilities before ordering energy-efficiency equipment.

The objectives of the Prescriptive Equipment Program are to:

- Provide energy-saving opportunities to qualified customers.
- Increase the market penetration of high-efficiency technologies and building systems for customers by offering incentives for high-efficiency and ENERGY STAR-rated appliances, lighting equipment, and HVAC systems.
- Approve and train contractors to conduct on-site facility assessments and to pass along PPL Electric Utilities' financial incentives for energy-efficient refrigeration measures, lighting upgrades, and lighting control upgrades to the customer through a direct discount delivery channel.
- Engage trade allies to provide high-efficiency technology options to customers.
- Promote other PPL Electric Utilities energy-efficiency programs.

An executive summary of program metrics can be found in **Table 3-1**.

Table 3-1: Prescriptive Equipment Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh	Phase II Participants
Non-Lighting	2,297	2,298	2,267	N/A[3]	2.31	$10,415	$0.13	$0.040	2,348
Lighting	84,251	84,251	78,903	0.74					
Total	**86,548**	**86,549**	**81,170**	**0.74**	**2.31**	**$10,415**	**$0.13**	**$0.040**	**2,348**

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.
[3] The EM&V CSP was unable to complete surveys with any of the nine unique participants who received rebates for installing prescriptive equipment measures.

3.1 Program Updates

There were a number of changes to the Prescriptive Equipment Program from Phase I to Phase II.

- Creating separate Prescriptive Equipment programs for residential and nonresidential customers. (In Phase I, the Efficient Equipment Program offered rebates for Prescriptive Equipment Program measures to both residential and nonresidential customers.)
- Conducting very limited marketing of program rebates in order to avoid oversubscription.
- Streamlining rebate offerings and eliminating rebates for equipment that had shown low participation rates in Phase I.
- Adding energy audits and incentives for agricultural customers. (There was no customer uptake of these measures during PY5, but PPL Electric Utilities expects to receive applications for rebate of agricultural measures in PY6 and PY7.)
- Adding a program requirement that applications must be submitted within 180 days of project completion to minimize freeridership and better track program participation.
- Expanding direct discount to include all nonresidential customers. (For example, PPL Electric Utilities targeted schools during PY5.)
- PPL Electric Utilities added questions to post inspections for direct discount participants to identify and address any concerns customers might have about their projects.
- Starting in PY6, for all projects, customers will be required to obtain preapproval from PPL Electric Utilities before ordering energy-efficiency equipment.

One of PPL Electric's main goals for Phase II was to improve tracking of participation, spending, and savings. With improved tracking, PPL Electric Utilities can manage program participation rates and avoid program oversubscription. PPL Electric's actual level of marketing was fairly limited but that level was appropriate to maintain the planned pace of the program.

3.1.1 Definition of Participant

Participants are PPL Electric Utilities customers in the small C&I, large C&I, and GNI sectors. They are required to sign a participation agreement or rebate application and may submit one or more. Participants are identified in EEMIS, the PPL Electric Utilities program tracking database, by a CSP Job ID that is unique to each project.

3.2 Impact Evaluation Gross Savings

3.2.1 Reported Gross Savings

Table 3-2 shows the cumulative reported results for PY5 by sector for all measures. Results for lighting and non-lighting components are not listed separately.

Table 3-2: Phase II Prescriptive Equipment Program Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Small Commercial and Industrial	1,642	54,039	8.61	$4,822
Large Commercial and Industrial	97	12,810	1.25	$829
Government, Non-Profit, and Institutional	609	19,699	2.65	$1,210
Phase II Total	**2,348**	**86,548**	**12.51**	**$6,861**

3.2.2 EM&V Sampling Approach

For verification activity sampling, measures were stratified by lighting and non-lighting projects. Non-lighting projects did not have any substrata since only two types of measures were rebated in PY5. Lighting measures were assigned to one of four substrata—large, medium-small, small-medium, and small (**Table 3-3**) based on *ex ante* reported savings. Lighting and non-lighting strata are discussed separately below.

Table 3-3: Prescriptive Equipment Program Strata Definitions

Strata	Substrata	Measure Groups Included
Non-Lighting	Non-agriculture	Refrigeration, HVAC, Appliances, Office Equipment
	Agriculture	All measures designed for and offered to the agricultural sector
Lighting	Small	Lighting, See **Table 3-5** for kWh thresholds
	Small - Medium	Lighting, See **Table 3-5** for kWh thresholds
	Medium - Small	Lighting, See **Table 3-5** for kWh thresholds
	Large	Lighting, See **Table 3-5** for kWh thresholds

EM&V Sampling Approach: Non-Lighting Measures

PPL Electric Utilities did not rebate any non-lighting measures until PY5 Q4, and only two measure types received rebates during PY5 (although many other measure types were eligible). The EM&V CSP revised the sample plan proposed in the evaluation plan after establishing the final number of measures rebated in PY5. The EM&V sample plan was designed to meet levels of 90% confidence and 10% precision for the non-lighting stratum.

The EM&V CSP reviewed a census of records and conducted site visits for a sample of 16 PY5 projects. Telephone surveys were attempted for nine projects; however, due to the small sample frame, the same customers contacted for the site visits were also contacted for surveys and none responded to the survey.

Table 3-4: Prescriptive Equipment Non-Lighting Program Sampling Strategy for PY5

Stratum	Population Size[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Non-Lighting	21 unique account numbers	0.5	21	21	Records review
			16	16	Site visits
			9	0	Surveys
Program Total	**21**	**0.5**	**21**	**21**	**21 projects; more than one activity can be conducted per project.**

NOTES:
[1] Defined by unique billing account numbers (unique customers).

EM&V Sampling Approach: Lighting Measures

The EM&V CSP drew samples, conducted site visits and reviewed records in Q2, Q3, and Q4; no lighting projects were reported in PY5 Q1. Quarterly sample sizes were 25% of the annual target, except that in Q2 when the Q1 and Q2 samples were batched. The PY5 sample plan was based on the number and characteristics of nonresidential lighting projects anticipated in PY5.

The EM&V CSP calculated the PY5 sample size by using the PY4 MWh error ratio of 0.17 then increasing it to 0.30 to improve the probability of achieving the goal of reporting with a 90% confidence with a 10% precision (90/10). The EM&V CSP used a stratified ratio estimation approach to further divide the lighting stratum into these four substrata:

- Small
- Small-Medium
- Medium-Small
- Large

Substrata boundaries are established by the substratum's contribution to total gross reported kWh savings, following the methods in *Chapter 13: Sampling in The California Evaluation Framework*.[12] The EM&V CSP determined the number of sample points for each stratum using a Neyman allocation routine that accounts for the variance in each stratum.

Substrata lighting boundaries by quarter are shown in **Table 3-5**.

Table 3-5: PY5 Quarterly Prescriptive Equipment Lighting Program Substrata

Strata	Q2		Q3		Q4	
	kWh High	kWh Low	kWh High	kWh Low	kWh High	kWh Low
Small	20,432	209	24,933	(6,212)	26,499	(4,014)
Small-Medium	45,916	20,710	62,442	24,964	69,546	26,548
Medium-Small	98,894	45,981	156,278	62,506	234,434	70,289
Large	657,202	102,135	1,021,621	160,644	1,360,868	239,526

A breakdown of reported savings by stratum is shown in **Table 3-6**.

Table 3-6: PY5 Prescriptive Equipment Lighting Program Site Visit Sampling Achieved

Stratum	Reported Project Count[1]	Reported Savings (MWh/yr)	Percent Reported Savings
Small	1,528	14,217	17%
Small-Medium	479	18,196	22%
Medium-Small	237	21,805	26%
Large	80	30,033	36%
Total	**2,324**	**84,251**	**100%**
NOTES: [1] Defined by CSP job ID.			

Stratified sampling results in smaller sample sizes and promotes evaluation efficiency better than simple random sampling. **Table 3-7** shows the PY5 sampling plan by quarter.

Table 3-7: PY5 Quarterly Prescriptive Equipment Lighting Program Site Visit Sampling Plan

Sample Count Allocation Plan	Q1	Q2	Q3	Q4	Total
Total, Planned	7	7	7	7	28
Total, Adjusted (no projects in Q1)	0	14	7	7	28

[12] TecMarket Works. *The California Evaluation Framework*. 2004. Pages 368-371.

Due to rounding, the actual sample sizes were larger than planned. **Table 3-8** shows the counts of completed site visits and the EM&V reviews for the PY5 nonresidential lighting sample.

Table 3-8: Prescriptive Equipment Program Lighting Sampling Strategy for PY5

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Small	1,528	N/A[1]	N/A[1]	8	File Review and Site Visit
Small-Medium	479	N/A[1]	N/A[1]	4	File Review and Site Visit
Medium-Small	237	N/A[1]	N/A[1]	6	File Review and Site Visit
Large	80	N/A[1]	N/A[1]	16	File Review and Site Visit
Program Total	**2,324**	**90/10**	**28**	**34**	**File Review and Site Visit**

NOTES:
[1] Sample size was set at the program level then allocated to strata according to Neyman routine. Each stratum does not have a target sample size.

3.2.3 *Ex Ante* Adjustment Methodology and Findings

The EM&V CSP adjusted the reported savings from EEMIS to align with assumptions specified in the TRM resulting in adjusted *ex ante* savings. This adjustment only occurred for two non-lighting measures: high efficiency evaporator fans and Energy Star ice makers.

TRM *ex ante* adjustments modify savings reported in EEMIS (when reported *ex ante* savings are placeholders) to reflect the specifications of measures. Adjustments are made to the population, and accounts for differences among planning assumptions, the TRM assumptions, and specifications of the equipment rebated to participants. The results of these adjustments to the population are the adjusted *ex ante* savings used to determine the program's realization rate.

Ex Ante Adjustment Methodology and Findings: Non-Lighting Measures

Table 3-9 lists the factors using EEMIS reported information in calculating PY5 TRM-adjusted *ex ante* savings for non-lighting measures. All records were assigned an *ex ante* adjusted savings.

Table 3-9: Summary of PY5 TRM *Ex Ante* Adjustments to Prescriptive Equipment Non-Lighting Program Reported Savings

Measure[1]	Factors
High-Efficiency Evaporator Fan Motors	Baseline motor type, new motor type, cooler or freezer, motor wattage, operating hours
ENERGY STAR Ice Makers	Ice machine type, ice harvest rate, and compressor type

NOTES:
[1] Many other non-lighting measure types were eligible for this program, but only two measure types were rebated in PY5.

Ex Ante Adjustment Methodology and Findings: Lighting Measures

No *ex ante* adjustments were made to the PY5 reported *ex ante* savings for lighting measures.

3.2.4 *Ex Post* Adjustment Methodology and Findings

The *ex post* savings adjustments incorporate installation rates, adjustments for non-qualifying equipment, and adjustments for equipment details determined through the sample of projects selected for records review and site visits. The EM&V CSP verified installation and qualification rates for all sampled records.

Ex Post Adjustment Methodology and Findings: Non-Lighting Measures

Records Review

The records review involved verifying information from EEMIS using rebate application forms, customer-submitted supporting documentation, information recorded by the Implementation CSP, and ENERGY STAR databases.[13] The EM&V CSP reviewed the quantities of each measure and verified if the rebated measure qualified for the program. **Table 3-10** shows the elements verified through records review for each measure rebated in PY5

Table 3-10: Prescriptive Equipment Non-Lighting Program Record Verified Elements by Measure

Measure	Record Verified Elements
High-Efficiency Evaporator Fan Motors	*Baseline motor type, new motor type, cooler or freezer, motor wattage*
ENERGY STAR Ice Makers	Ice machine type, ice harvest rate, and compressor type

During the records review, the EM&V CSP found that one project with five ice makers listed the wrong harvest rates for all five machines. The harvest rate was verified by looking up the manufacturer and model numbers in the ENERGY STAR database. The EM&V CSP calculated the verified savings using the correct harvest rates.

Surveys

No surveys were completed by customers who received rebates for non-lighting measures.

Site Visits

At the end of PY5, the EM&V CSP conducted verification site visits to confirm, along with the records review, the data inputs necessary for calculating savings. **Table 3-11** shows the elements verified during the site visits for each measure rebated in PY5. Some variables are not possible to verify during the site visit, as the information is not readily available by inspecting the equipment.

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[13] ENERGY STAR Qualified Products can be found online at: http://www.energystar.gov/index.cfm?fuseaction=find_a_product

Table 3-11: Site Visit Verified Elements for Prescriptive Equipment Non-Lighting Program Measures

Measure	Site Visit Verified Elements
High-Efficiency Evaporator Fan Motors	Baseline motor type, new motor type, cooler or freezer
ENERGY STAR Ice Makers	Ice machine type, compressor type

During site visits, the EM&V CSP found that two high-efficiency evaporator fan motor projects had the wrong baseline motor type (**Table 3-12**). Shaded pole motors were reported as the baseline, but the site contact confirmed that permanent split capacitor motors should have been used for the baseline. The reduction in savings for this project had minimal impact on the overall realization rate for non-lighting measures.

Table 3-12: PY5 Prescriptive Equipment Program Site Inspection Summary of Non-Lighting Projects

Program	Measure	Inspection Firm	Inspections Planned	Inspections Conducted	Sites with Discrepancies from Reports	Resolution of Discrepancies
Prescriptive Equipment	Non-lighting, 21 participants	EM&V CSP	16	16	2	Updated baseline equipment

Ex Post Adjustment Methodology and Findings: Lighting Measures

Lighting samples were drawn on a rolling basis as records became available at the close of each quarter. The EM&V CSP requested all application, review, and payment records for each sampled project. The EM&V CSP then conducted the following verification and M&V activities:

1. Reviewed application files for data accuracy and compliance with Pennsylvania TRM requirements.[14]
2. Conducted on-site reviews at customer facilities for the sample of projects to determine each project's as-built conditions.
3. Conducted metering studies or interval data analysis at selected facilities to determine actual lighting operating hours.
4. Conducted interviews with customers to determine baseline and retrofit fixtures and estimate operating hours.
5. Revised the 2013 TRM's Appendix C inventory based on the findings from the previous steps.[15]
6. Recalculated the project savings to determine the *ex post* savings for the sampled projects.
7. After completing the Q4 review, calculated the sample realization rate, the ratio of evaluated to reported savings.

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[14] Pennsylvania Public Utility Commission. *Technical Reference Manual.* June 2013. Available online: http://www.puc.pa.gov/pcdocs/1208574.docx.

[15] Ibid.

Table 3-13: PY5 Prescriptive Equipment Program Site Inspection Summary for Lighting Projects

Program	Measure	Inspection Firm	Number of Inspections Planned	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
Prescriptive Equipment	Lighting	EM&V CSP	28	34[1]	26	*Updated savings based on HOU, fixture type and counts, space cooling and building type*
		Implementation CSP	--	2,378[2]	--	---

NOTES:
[1] One site metered to determine HOU.
[2] Nine sites metered to determine HOU.

The Implementation CSP conducted site visits and inspections to develop the Appendix C lighting form *for commercial lighting projects.*

The EM&V CSP conducted inspections to verify that rebated measures are installed and operating as reported, and that correct values were used to calculate *ex ante* savings. Discrepancies are adjusted based on site-specific data. *Ex post* savings were calculated based on site specific data. Reasons for adjustments include corrections to:

- Fixture type, fixture count
- Annual lighting hours of use
- Building type and associated stipulated lighting hours of use and/or coincidence factor
- Space cooling type

3.2.5 Summary of Evaluation Results

Table 3-14: PY5 Prescriptive Equipment Program Summary of Evaluation Results for Energy[1]

Stratum	Reported *Gross* Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	*Energy* Realization Rate (%)	Verified *Gross* Energy Savings (MWh/yr)[2]	Observed *Coefficient of* Variation (C_v) or Error Ratio in Sample	*Relative* Precision at 90% C.L.
Non-Lighting	2,297	2,298	99%	2,267	N/A[3]	N/A[3]
Lighting	84,251	84,251	94%	78,903	0.17	4.2%
Program Total	**86,548**	**86,549**	**94%**	**81,170**	**0.16**	**3.5%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[3] All non-lighting projects were verified; therefore the Cv and relative precision are not applicable.

Table 3-15: PY5 Prescriptive Equipment Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings[1]	Adjusted *Ex Ante* Demand Savings[2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings[2], [3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 90% C.L.
Non-Lighting	0.27	0.29	99%	0.28	N/A[4]	N/A[4]
Lighting	12.25	13.16	94%	12.30	0.18	3.6%
Program Total	**12.51**	**13.45**	**94%**	**12.58**	**0.16**	**3.5%**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.
[4] All non-lighting projects were verified; therefore the Cv and relative precision are not applicable.

Table 3-16: PY5 Prescriptive Equipment Program Summary of Evaluation Results for Energy (Lighting Stratum)[1]

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate[3] (%)	Verified Gross Energy Savings (MWh/yr)[2], [3]	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 90% C.L.
Small	14,217	14,217	N/A	N/A	N/A	N/A
Small-Medium	18,196	18,196	N/A	N/A	N/A	N/A
Medium-Small	21,805	21,805	N/A	N/A	N/A	N/A
Large	30,033	30,033	N/A	N/A	N/A	N/A
Lighting Strata Total	**84,251**	**84,251**	**94%**	**78,903**	**0.17**	**4.2%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding
[3] As described in the *California Evaluation Framework* (p. 358), the stratified ratio estimator provides a single realization rate—and a single error ratio and a single precision value—which apply to savings from all strata. The single value incorporates the realization rates, standard errors, and weights from each stratum in the sample.

Table 3-17: PY5 Prescriptive Equipment Program Summary of Evaluation Results for Demand (Lighting Stratum)

Stratum	Reported Gross Demand Savings[1]	Adjusted *Ex Ante* Demand Savings[2] (MW)	*Demand* Realization Rate[3] (%)	Verified Gross Demand Savings[2],[3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 90% C.L.
Small	2.41	2.60	N/A	N/A	N/A	N/A
Small-Medium	3.19	3.43	N/A	N/A	N/A	N/A
Medium-Small	3.37	3.62	N/A	N/A	N/A	N/A
Large	3.28	3.51	N/A	N/A	N/A	N/A
Lighting Strata Total	**12.25**	**13.16**	**94%**	**12.30**	**0.18**	**3.6%**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] As described in the *California Evaluation Framework* (p. 358), the stratified ratio estimator provides a single realization rate—and a single error ratio and a single precision value—which apply to savings from all strata. The single value incorporates the realization rates, standard errors, and weights from each stratum in the sample.

The GNI sector reported gross savings were 23% of the total lighting savings. The PY5 Evaluation Framework[16] requires that these savings be reported as though they were from an independent program as stated in the following quote:

> *"The government, non-profit and institutional populations, and the low-income population should be evaluated as independent programs if their contribution to their respective sectors [the residential sector for the low-income population, and nonresidential sector for the government, non-profit, and institutional (GNI) population] is greater than 20%."*

[16] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase II Energy Efficiency and Conservation Programs.* Prepared by GDS Associates, Inc., and Nexant. June 30, 2013. Available online: http://www.puc.state.pa.us/Electric/pdf/Act129/SWE_PhaseII-Evaluation_Framework063013.pdf

In accordance with the Framework, GNI sector lighting savings are reported below.

Table 3-18: PY5 Prescriptive Equipment Program Summary of Evaluation Results For Energy (GNI Lighting Sector)[1]

Sector	Reported Gross Energy Savings (MWh/yr)	GNI MWh/Total Lighting (%)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)[2]	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 90% C.L.
Government, Non-Profit, and Institutional	19,617	23%	93%	18,227	0.15	7.2%

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding

Table 3-19: PY5 Prescriptive Equipment Program Summary of Evaluation Results For Demand (GNI Lighting Sector)

Sector	Reported Gross Demand *Savings*[1] (MW)	GNI MW/Total Lighting (%)	Demand Realization Rate[1] (%)	Verified Gross Demand *Savings*[2] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 90% C.L.
Government, Non-Profit, *and Institutional*	2.6	22%	90%	2.37	0.14	6.4%

NOTES:
[1] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.
[2] Verified Gross Demand savings for the GNI Lighting Sector do not include T&D losses.

3.3 *Impact Evaluation Net Savings*

The EM&V CSP conducted an analysis to determine net savings for the Prescriptive Equipment Program, lighting measures. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

3.3.1 Net-to-Gross Ratio Methodology

Freeridership is a measure of the savings that participants would have achieved on their own without *the program's treatment. It subtracts from gross savings. Participant spillover on the other hand credits* additional savings that participants achieved on their own because of their experience with the program. Participant spillover adds to gross savings. Participant spillover for the program is 0.01 and is only a minor contributor to the NTG ratio.

The methods used to determine net savings were defined by the Statewide Evaluator, including instructions provided in the Evaluation Framework and Guidance Memos. For this program, the EM&V CSP included freeridership and spillover ratio estimates that were estimated in accordance to the SWE

NTG guidelines, which utilizes self-report survey information from participating customers. Participant telephone surveys collected data to assess these metrics for customers receiving lighting rebates. Surveys were attempted with all non-lighting participants, but none were completed.

3.3.2 Net-to-Gross Ratio Sampling

In PY5, the EM&V CSP completed surveys with 150 lighting participants in the Prescriptive Equipment Program. The surveys included 75 participants from the standard program delivery channel (prescriptive rebates) and 75 participants from the direct discount delivery channel (contractor incentives). In PY5, no measures were rebated through the Agriculture Standard Path program delivery channel and only a handful of non-lighting measures (e.g., motors and VFDs) were rebated. The EM&V CSP was unable to complete surveys with any of the nine unique participants who received rebates for installing prescriptive equipment measures.

Table 3-20: Prescriptive Equipment Program Sampling Strategy for PY5 NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed C_V or Proportion *in Sample* Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
Direct Discount	N/A	1,352	0.5	90/10	75	75	99%
Equipment	N/A	24	0.5	90/10	Census	0	90%
Standard Path Lighting	N/A	972	0.5	90/10	75	75	97%
Program Total	**N/A**	**2,348**	**0.5**	**90/10**	**150**	**150**	**98%**

NOTES:
[1] Percent contacted means, of the entire sample frame list (those drawn specifically for the survey), how many were called to get the completes. Often 100% will be the answer.

1.10.1 Net-to-Gross Ratio Findings

The freeridership and spillover ratio estimates for the Prescriptive Equipment Program, estimated in accordance with the SWE NTG guidelines, are shown in **Table 3-21**.

Table 3-21: Prescriptive Equipment Program Summary of Evaluation Results for NTG Research

Stratum	Estimated Freeridership	Estimated *Participant* Spillover	*NTG Ratio*	Observed C_V or Proportion in Sample Design	Relative Precision
Direct Discount Lighting	0.08[1]	0.00	0.92	0.020	3%
Standard Lighting	0.38[1],[2]	0.01	0.63	0.204	34%
Program Total[3]	**0.26**	**0.01**	**0.75**	**0.178**	**30%**

NOTES:
[1] Estimate is weighted by the survey sample-verified program kWh savings. This method ensures that respondents who achieved higher energy savings through the program measures are given a greater influence on the final freeridership estimate than those respondents who achieved lower energy savings.
[2] A single respondent who was estimated as a 87.5% free rider represents 24% of the survey sample-verified program kWh savings, which translates into the respondent representing over 21 percentage points of the total 38% freeridership estimate.
[3] Freeridership, spillover, and NTG ratios at program level are weighted by the stratum's *ex post* kWh program population savings.

The NTG ratio of 0.75 for the Prescriptive Equipment Program deviates from 1.0 primarily due to freeridership rates for both Direct Discount and standard path lighting.

Direct Discount freeridership is 0.08. Direct Discount targets small business and GNI sectors. The low freeridership rate is not unexpected for these hard-to-reach customers. Without trade ally outreach, installation, and rebate processing they are less likely to retrofit their lighting equipment than those in the large commercial sector.

The prescriptive lighting (standard path rebates) freeridership is 38% for survey respondents. The rate is heavily influenced by one large project with a freeridership rate of 83%. The customer for the project is a large multinational manufacturing corporation with facilities located around the world. Customers of this type are at the opposite end of the spectrum from the hard-to-reach small commercial and GNI sectors because they tend to have the knowledge and resources to pursue the cost savings benefits associated with energy efficiency. Higher freeridership rates are therefore expected with this customer type, and may be an explanation for the PY5 rate.

There are other factors and potential market effects that will be examined in more detail in future research. For example, the Prescriptive Equipment program, and especially the commercial lighting component, is heavily contractor driven. Therefore it is possible that contractors can have a large influence on participant decision making. Repeat customers may be highly influenced by past participation in the program. Businesses that have internal energy-efficiency policies and energy reduction goals may also be more prone to participation.

3.4 Process Evaluation

A process evaluation was conducted In PY5 for the Prescriptive Equipment Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual

program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

The Prescriptive Equipment Program is delivered through two channels—the standard program and the direct discount channel. In PY5, the EM&V CSP conducted these process evaluation activities:

- Participant surveys (n=150)
  - Lighting participants (n=75)
  - Direct discount participants (n=75)
  - Non-lighting participants (n=0)
- Program staff and implementer interviews (n=2)
- Program literature review and benchmarking
- Database and QA/QC review of records
- Process map review

Table 3-22: Prescriptive Equipment Program Process Evaluation Sampling Strategy for PY5

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or C_V in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample[1]	Evaluation Activity
Direct Discount	N/A	1,352	0.5	90/10	75	75	99%	Telephone survey
Equipment	N/A	24	0.5	90/10	Census	0	100%	Telephone Survey
Standard Path Lighting	N/A	972	0.5	90/10	75	75	97%	Telephone survey
Program Total	**N/A**	**2,348**	**0.5**	**90/10**	**150**	**150**	**98%**	

NOTES:
[1] Percent contacted means, of the entire sample frame list (those drawn specifically for the survey), how many were called to get the completes. Often 100% will be the answer.

3.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-3.**

Market effects research in PY6 will focus on the influence of trade allies on project development and decisions about energy-efficiency improvements. This will be completed through interviews with contractors.

3.6 Financial Reporting

A breakdown of the program finances is presented in **Table 3-23.**

Table 3-23: Summary of Prescriptive Equipment Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$6,861	$6,861
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	**$6,861**	**$6,861**
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$3,554	$3,554
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	**$3,554**	**$3,554**
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	**$10,415**	**$10,415**
Participant Costs[5]	$20,352	$20,352
Total NPV TRC Costs[6]	**$30,767**	**$30,767**
Total NPV Lifetime Energy Benefits	**$63,899**	**$63,899**
Total NPV Lifetime Capacity Benefits	**$5,102**	**$5,102**
Total NPV TRC Benefits[7]	**$69,000**	**$69,000**
TRC Benefit-Cost Ratio[8]	**2.24**	**2.24**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

4 Appliance Recycling Program

PPL Electric's Appliance Recycling Program (ARP) offers free pick-up and recycling of operating-but-inefficient refrigerators, freezers, and room air conditioners. ARP's overarching goal is prevention of the continued operation of older, inefficient appliances through a financial incentive and free pick-up service for customers. The program's primary objectives are:

- Encouraging customers to dispose of their existing, inefficient appliances when they purchase new ones, or eliminating a second unit that may not be needed.
- Reducing the use of secondary, inefficient appliances.
- Ensuring that appliances are disposed of in an environmentally responsible manner.
- On-site decommissioning to ensure that appliances are not resold in a secondary market.
- Promoting other PPL Electric Utilities energy-efficiency programs.
- Collecting and recycling no fewer than 13,486 appliances in PY5, with a total energy reduction of 9,255 MWh/yr and demand reduction of 1.7 MW.

An executive summary of program metrics can be found in **Table 4-1**.

Table 4-1: Appliance Recylcing Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Appliance Recycling	9,776	9,714	9,255	0.74	3.16	$1,676	$0.18	$0.030	11,510

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

4.1 Program Updates

There were no significant permanent design changes in the Appliance Recycling Program in PY5.

In PY5, the program achieved 101% of its MWh/yr gross verified savings goal, 143% of its MW goal, and 102% of its participation target.

4.1.1 Definition of Participant

Participant refers to the number of unique participants defined by unique CSP job number. In the case of the ARP a customer who has an appliance picked up and recycled through the program on multiple dates within the program year will have two distinct job numbers.

4.2 Impact Evaluation Gross Savings

4.2.1 Reported Gross Savings

Table 4-2 shows the cumulative reported results by sector for the ARP through the end of PY5. As expected, the vast majority of participants were in the residential sector. The table shows the smaller number of participants in small commercial and industrial; large commercial and industrial; and government, non-profit, and institutional.

Table 4-2: Phase II Appliance Recycling Program Reported Results by Customer Sector

Sector	Participants[1]	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Residential	11,124	9,325	1.71	$13
Small Commercial and Industrial	293	281	0.05	$409
Large Commercial and Industrial	2	1	-	$8
Government, Non-Profit, and Institutional	91	169	0.02	$0
Phase II Total	**11,510**	**9,776**	**1.78**	**$429**

NOTES:
[1] Participant refers to the number of unique participants defined by unique CSP job number.

4.2.2 EM&V Sampling Approach

The EM&V CSP inspected a census of PY5 ARP participant records to verify that all units reported as recycled were consistently recorded in both the EEMIS and the CSP databases. The EM&V CSP also selected a random sample of 140 participants for telephone survey verification. This sample size exceeded 90% confidence and 10% precision for PY5, as shown in **Table 4-3**. The EM&V CSP verified the records by asking respondents about the quantity and type of units collected and if the units were replaced. The survey also included questions that apply to the NTG calculations.

Table 4-3: Appliance Recycling Program Participant Sampling Strategy for PY5

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Freezers	2,250	90/10	70	71	Database review, surveys
Refrigerators	10,106	90/10	70	69	Database review, surveys
Room Air Conditioners	1,130	N/A	N/A	N/A	Database review
Program Total	**13,486**	**90/10**	**140**	**140**	

4.2.3 *Ex Ante* Adjustment Methodology and Findings

Savings for recycled appliances are deemed on a per-unit basis in accordance with the 2013 Pennsylvania TRM.[17] Deemed savings for refrigerators and freezers in PY5 were in line with the TRM, so the EM&V CSP made no *ex ante* adjustments.

Reported savings values for room air conditioners were based on an assumed average of the locations specified in the 2013 TRM rather than mapping savings to the exact locations. The EM&V CSP made *ex ante* adjustments by applying a weighted average of specific locations mapped by zip codes (or city) corresponding to the participants who recycled room air conditioners in the EEMIS database. The 2013 TRM based savings on the geographic location of each participant's home. The EM&V CSP produced a final weighted savings value of 263 kWh/yr per unit, as shown in **Table 4-4**. The table also lists the TRM savings assumptions for each city represented in the PY5 participant population, the number of room air conditioning units picked up in each city, the percentage of units overall, and the overall weighted average savings value.

Table 4-4. Room Air Conditioner Retirement – Savings Assumptions and Participation by City

City	Original Hours ($EFLH_{ES\text{-}RAC}$)[1]	Corrected Hours ($EFLH_{RAC}$)[1]	Energy Impact (kWh)	Demand Impact (kW)	City Counts	City Proportions
Allentown	784	243	268	0.6395	301	27%
Erie	482	149	164		0	0%
Harrisburg	929	288	318		277	25%
Philadelphia	1032	320	353		65	6%
Pittsburgh	737	228	251		0	0%
Scranton	621	193	213		333	29%
Williamsport	659	204	225		154	14%
Weighted Average Per-unit Savings			**263**		**1,130**	

NOTES:
[1] TRM-specified columns. See Table 2-21. Page 55 of the 2013 TRM.

Database Review

The EM&V CSP inspected a census from four quarters (Q1-Q4) of PY5 participant records from the EEMIS database to verify that all units reported as recycled by the ARP were consistently recorded in both the EEMIS and the Implementation CSP databases.

In each quarter, the EM&V CSP found that a number of units in the Implementation CSP's database were not matched in EEMIS but then verified that these records appeared in the subsequent quarter's EEMIS

[17] *Pennsylvania Public Utility Commission. Technical Reference Manual.* June 2013. Page 31. Available online: http://www.puc.pa.gov/pcdocs/1208574.docx

data extract. The Q1 CSP records listed 847 units that were not matched to the Q1 EEMIS records but which appeared in the Q2 EEMIS. In the Q2 CSP records, a similar lag occurred with 422 records in the CSP Q2 database that did not match to EEMIS Q2 but appeared in the EEMIS Q3 records. Another lag of 177 records occurred between Q3 and Q4.

Because the records in EEMIS are the basis for reported quantities rather than the CSP tracking database, and because there were no unverified records in EEMIS at the end of PY5, the EM&V CSP made no savings adjustments based on the database review.

4.2.4 *Ex Post* Adjustment Methodology and Findings

Ex post verified gross savings for this program reflect discrepancies identified through the records reviews and survey verification activities. The EM&V CSP adjusted the *ex post* savings based on differences identified between the participant survey responses and the EEMIS database regarding the number of refrigerators or freezers reported as being replaced.

The EM&V CSP survey verification revealed no discrepancies for the quantity, type, or operational condition of appliances. However, it did find differences between replacement rates in PY4 that had been used to generate a weighted average per unit reported kWh value in the PY5 EEMIS database and the rates reported by PY5 survey respondents. Survey results showed that 84% of customers reported replacing a refrigerator in PY5, compared to 63% in PY4.

The survey responses also revealed that 61% of freezers were replaced in PY5. In PY4, however, the per-unit savings did not distinguish appliance type and the participant surveys focused solely on refrigerators, so there was no separately calculated replacement rate for freezers.

The survey responses indicate that 94% of the all units reported as being replaced were replaced with ENERGY STAR® appliances. The EM&V CSP adjusted the savings using the appropriate TRM values to reflect this allocation of replaced units.

Table 4-5 presents the survey results and the energy adjustments. Though not included in the table, the *same proportion of replacements were also applied to adjust demand savings.*

Table 4-5: PY5 Appliance Recycling Program Summary of Survey Verification Results

Measure Category	Percentage of Refrigerator Sample in Category	Deemed Annual Savings Per Unit	Percentage of Freezer Sample in Category	Deemed Annual Savings Per Unit
Not Replaced	16%	1,026	39%	1,170
Replaced with ENERGY STAR	78%	622	58%	753
Replaced with Standard Efficiency	6%	506	3%	667
Weighted Average Annual kWh Per Unit	**100%**	**679**	**100%**	**915**

Surveys

Participant Surveys

For the PY5 survey, the EM&V CSP randomly selected 140 participants, prorating the survey sample points by measure (refrigerators and freezers). To verify the measure, the survey asked each respondent how many appliances were recycled. To determine the gross and net savings, the survey asked each participant the likely usage of the appliance if it had not been recycled through the ARP.

Nonparticipant Surveys

The EM&V CSP also attempted to complete 70 nonparticipant surveys during PY5 to learn what happens to older, operable appliances in the program's absence and, in turn, to produce data for the net savings analysis. Utility program participants may exaggerate the extent to which they would have done what they perceive the interviewer considers "the right thing"—in this case, removing an old appliance from the grid independent of the program. Information from nonparticipants helps mitigate the impact of socially desirable response bias.

However, the EM&V CSP completed only 11 nonparticipant surveys and halted the survey when it was apparent that the 8% production rate would require unacceptable cost to complete. The number of completed surveys was not sufficient for a meaningful, statistically relevant comparison between the participant and nonparticipant responses.

The low production rate was not entirely unexpected. Assuming that an equal number of refrigerators stop being used each year (either due to customer decision or failure), an expected useful life (EUL) of 20 years means approximately one in 20 households (5%) discard a refrigerator annually. Identifying nonparticipants is complicated because customers were surveyed only if they had discarded an operable (therefore program-eligible) appliance. This critical detail reduces the likelihood of identifying a customer who did not participate in the program.

The EM&V CSP reviewed PPL Electric's evaluation from Phase I and recent evaluations from other utilities to determine the potential impact of the bias from not having the nonparticipant responses. These evaluations reported a typical bias of ±3%, with no clear direction of the bias. Due to the lack of significant bias, the EM&V CSP recommended against any adjustment to the participant freeridership.

4.2.5 Summary of Evaluation Results

Overall, the ARP exceeded its participation goals by 2%. Additionally the program exceeded the energy savings goal by 1.5%. Demand savings were 43% above goal.

Table 4-6: PY5 Appliance Recycling Program Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings[2] (MWh/yr)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Freezers	1,969	1,969	104%	2,053	0.23	4%
Refrigerators	7,448	7,448	93%	6,905	0.22	4%
Room Air Conditioners	359	297	100%	297	N/A	N/A
Program Total	**9,776**	**9,714**	**95%**	**9,255**	**0.24**	**3%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.

The primary factor for both energy and demand savings is a discrepancy in the replacement rate described in section 4.2.4.

Table 4-7: PY5 Appliance Recycling Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings[1] (MW)	Adjusted *Ex Ante* Demand Savings[2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings[2], [3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Freezers	0.25	0.27	103%	0.28	0.23	4%
Refrigerators	0.81	0.88	92%	0.81	0.26	5%
Room Air Conditioners	0.72	0.78	100%	0.78	N/A	N/A
Program Total	**1.78**	**1.93**	**97%**	**1.86**	**0.27**	**3%**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy demand due to rounding.

4.3 Impact Evaluation Net Savings

The EM&V CSP conducted an analysis to determine net savings for the ARP. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

4.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP used the methodology described in the SWE's "Common Approach for Measuring Net Savings for Appliance Retirement Programs" to determine the net savings for the ARP.[18] The SWE approach lists three major factors in the net savings analysis:

- *Freeridership*
- Secondary market impacts
- Induced replacement
- Spillover

The EM&V CSP conducted an NTG analysis using findings from the PY5 customer telephone surveys. The survey asked participants how their appliance would have continued to operate in the absence of the program—either as a primary or secondary unit, in their home, or transferred to another home.

Based on the responses given, the EM&V CSP classified respondents as either "keepers" or "removers." Participants classified as "removers" were classified again if their appliance would have been permanently removed from the grid—that is, destroyed at a local waste transfer station or recycling center or picked up by a retailer but deemed unviable on the secondary market.[19] Participants whose appliances would have been removed from the grid in the absence of the program were classified as free riders.

The next factor in the net savings in the analysis is the secondary market impact (SMI). SMI, as described in the Uniform Methods Protocol,[20] accounts for the fact that some of the would-be recipients of the units recycled through the program will seek out another unit once the appliance recycled through the program is unavailable.

Secondary market impacts applies only to units that would have been transferred to another user in the absence of the program. According to the participant survey responses, 35% of refrigerators recycled through the program in PY5 and 27% of freezers would have been transferred. Because of budget limitations and difficulties in finding data to support the potential actions of would-be recipient, and identify those who would seek out another unit once the program unit is unavailable, there is no clear mitigation strategy for secondary market impacts. In addition, the secondary market impacts affect the NTGR considerably less than freeridership.

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[18] Research Into Action. Common Approach for Measuring Net Savings for Appliance Retirement Programs. March 2014.

[19] The SWE's NTG assumes that units in operable condition and under 10 years old are likely to be viable for resale.

[20] The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 7: Refrigerator Recycling Evaluation Protocols, National Renewable Energy Laboratory, March 2013 (Download available at: http://www1.eere.energy.gov/wip/pdfs/53827-7.pdf)

Induced replacement, the final approach, accounts for the program's influence on some participants to purchase a replacement appliance that they otherwise would not have purchased absent the program. During the survey, the EM&V CSP asked participants who replaced their appliances if they would have replaced their appliance regardless of the program. Those who answered *no* were asked a follow-up question to confirm that they would not have purchased the replacement unit without the program. Those who confirmed their *no* answer were considered an induced replacement.

4.3.2 Net-to-Gross Ratio Sampling

The EM&V CSP selected a random sample of 140 participants for telephone survey verification. This sample size exceeded 90% confidence and 10% precision for PY5. The EM&V CSP verified the records by asking participants the quantity and type of units collected, the operational condition of each unit, and if appliances were replaced. The survey also included questions that apply to the NTG calculations.

Table 4-8: Appliance Recycling Program Sampling Strategy for PY5 NTG Research

Stratum	*Stratum* Boundaries	*Population* Size	Assumed C_V *or Proportion* in Sample Design	Assumed *Levels of* Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
Freezers	Measure	1,868	0.5	90/10	70	71	75%
Refrigerators	Measure	8,294	0.5	90/10	70	69	75%
Program Total		**10,162**	**0.5**	**90/10**	**140**	**140**	**75%**

NOTES:
[1] Percent contacted means, of the entire sample frame list (those drawn specifically for the survey), how many were called to get the completes; often 100% will be the answer.

4.3.3 Spillover Methodology

Spillover refers to the program's influence on the participants to install additional measures—in addition to those rebated by the program. To examine spillover attributable to the ARP, the EM&V CSP asked survey respondents if they made any energy-efficiency improvements or installed any energy-efficient measures for which they did not receive a program rebate. The survey also asked respondents the degree of likelihood that they would have installed these measures if they had not participated in the program.

The EM&V CSP made no adjustments to the *ex post* savings to incorporate spillover, in accordance with direction from the SWE. PPL Electric Utilities will use spillover estimates in future program planning.

4.3.4 Net-to-Gross Ratio Findings

For the ARP, the EM&V CSP did not estimate a NTG ratio but instead estimated the net per-unit savings and program-level net savings. This is because replacements were accounted for in the gross savings. The replacement status of the appliance determines the appropriate gross savings value to be applied;

therefore, the EM&V CSP calculated the net savings not from the gross savings but rather from the unit energy cost (UEC) multiplied by part use. This avoids double-counting the penalty to the program for replacements. However, it also means there is no direct relationship between gross and net savings.

Spillover increased considerably from PY4, from 0.77% of gross savings in PY4 to 8% of program savings in PY5. The increase is in part due to one solar panel measure that was reported in the spillover responses.

Table 4-9 shows the estimated per-unit impact on savings for each of the factors described above and the resulting per-unit net savings.

Table 4-9: PY5 Appliance Recycling Program Net Savings Factors

Stratum	UEC*Part Use	Freeridership and Secondary Market Impacts	Induced Replacement	Spillover	Net Per-unit kWh/yr
Freezers	1,152	*300*	41	17	*828*
Refrigerators	994	305	57	65[1]	697

NOTES:
[1] One respondent reported installing solar panels as a result of participating in the ARP with an assumed saving of 5,568 kWh. Not including this respondent results in a spillover value of 24 kWh per unit for refrigerators and 7 kWh for freezers.

Although the EM&V ESP could not calculate a true NTG ratio, the ratio of net per-unit savings to the UEC*part use indicates how effectively the program is achieving savings. In PY5, the ratio was 0.70 for refrigerators and 0.72 for freezers. **Table 4-10** shows the total program net by strata.

Table 4-10. PY5 Appliance Recycling Program Summary of Evaluation Results for Net Savings Research

Stratum	*Population Size*	Net Per-Unit kWh/yr	Verified Net Energy Savings (MWh/yr)	Relative Precision at 85% C.L.
Freezers	2,250	846	1,903	9%
Refrigerators	*10,106*	729	*7,368*	*10%*
Room Air Conditioners	1,130	263	297	N/A
Program Total	**13,486**		**9,568**	

Market effects for appliance recycling programs are difficult to assess. There is not a clear mechanism for market transformation. Presumably the program decreases, to some degree, the number of inefficient secondary appliances operating on the grid. But this does not constitute a lasting transformation. It is quite likely that, if the program were to be discontinued, the used or secondary appliance market would have an increase in supply of older, inefficient appliances. Therefore no market effects were quantified for this program.

Table 4-11 shows the historical NTGR through Phase I and PY5. It is important to reiterate the PY5 NTGR is not a true ratio of net-to-gross savings, as were the other years, but rather net savings to part use*UEC multiplied by the population of each appliance type. Because gross and net savings both account for replacement, and do so differently, there is no direct relationship between verified net and gross savings. In fact net savings, after accounting for freeridership, secondary market impacts, and spillover, would be greater than the verified gross savings (9,568 net and 9,255 gross).

Direct comparison between years is limited because of changes in methodology. However, the proxy NTGR for PY5 is within the range of recent evaluation results from other programs using similar methodology.

Table 4-11. Historical Program NTGR

Program Year	NTGR
PY5	74%
PY4	68%
PY3	63%
PY2	61%

Based on the NTG findings the EM&V CSP concludes there are no issues with program design that need to be addressed. The NTGR is within the range of values found in other similar programs and has been increasing over time.

4.4 Process Evaluation

A process evaluation was conducted In PY5 for the Appliance Recycling Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

An executive summary of the process evaluation follows below, along with the sampling strategy.

For the ARP, the EM&V CSP conducted these PY5 process evaluation activities:

- *Participant surveys (n=140)*
- Nonparticipant surveys (n=11)
- Program staff and implementer interviews (n=2)
- Program literature review and benchmarking
- Database and QA/QC review of records
- Process map review

Table 4-12: Appliance Recycling Program Process Evaluation Sampling Strategy for PY5

Stratum	Stratum Boundaries	Population Size	Assumed C_V or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]	Evaluation Activity
Freezers	Measure	1,868	0.5	90/10	70	71	75%	Survey
Refrigerators	Measure	8,294	0.5	90/10	70	69	75%	Survey
Program Total		**10,162**	**0.5**	**90/10**	**140**	**140**	**75%**	**Survey**

NOTES:
[1] Percent contacted means, of the entire sample frame list (those drawn specifically for the survey), how many were called to get the completes; often 100% will be the answer.

4.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-4**.

4.6 Financial Reporting

The TRC ratio for PY5 was 3.16, a decrease from the 8.51 in PY4 and the total of 8.62 for Phase II. This is likely due to the gross savings specified in the TRM decreasing. The baseline savings for a unit without accounting for replacement decreased approximately 36% on average, from 1,659 kWh to 1,026 kWh for refrigerators and to 1,170 kWh for freezers. The savings for replaced units decreased as well. The consumption of the replacement appliances changed very little while the consumption of the replaced unit decreased.

Between Phase I and Phase II, TRC costs per-unit were relatively similar with a slight decrease of 23% primarily due to less aggressive marketing. However, in the same period, the TRC benefits per-unit decreased to a greater degree, by nearly 71%, due to lower avoided cost benefits.

A breakdown of the program finances is presented in **Table 4-13**.

Table 4-13: Summary of Appliance Recycling Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$429	$429
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	***$429***	***$429***
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$1,247	$1,247
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	**$1,247**	**$1,247**
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	**$1,676**	**$1,676**
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	**$1,676**	**$1,676**
Total NPV Lifetime Energy Benefits	**$4,926**	**$4,926**
Total NPV Lifetime Capacity Benefits	**$372**	**$372**
Total NPV TRC Benefits[7]	**$5,298**	**$5,298**
TRC Benefit-Cost Ratio[8]	**3.16**	**3.16**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

5 Student and Parent Energy-Efficiency Education Program

The Student and Parent Energy-Efficiency Education Program is a new program in Act 129 Phase II of the PPL Electric Utilities Corporation Energy Efficiency and Conservation Plan. For several years, PPL Electric Utilities has offered this program to other schools and students outside of Act 129. PPL Electric Utilities provides school-based energy-efficiency education through in-classroom workshops for students in various grade levels, training for teachers, and community workshops for parents in low-income neighborhoods. Participants in all components receive educational materials and a take-home energy-efficiency kit of low-cost items they can install at home. Take-home energy-efficiency kits are tailored to each grade level participating in the program and contain items such as compact fluorescent lamps, low-flow showerheads, faucet aerators, smart power strips, and electroluminescent nightlights.

The program's three school-based classroom workshop curricula are correlated to Pennsylvania academic standards for the appropriate grade levels and endorsed by the Pennsylvania Department of Education. Teacher workshops are conducted in the summer and are designed to address the sustainability standard of Pennsylvania academic standards and supported by the Pennsylvania Department of Education. Teachers participating in the teacher workshops receive approximately seven hours of credit applicable to Act 48 requirements. The workshops provided through the school Parent Teacher Organizations (PTO workshops) target low-income neighborhoods and provide a fundraising opportunity for the school or PTO by earning an incentive for recruiting parents to attend an energy-efficiency workshop held at their school.

PPL Electric Utilities identified a CSP, National Energy Foundation (NEF), through a competitive bid process to manage the program. NEF undertook a broad spectrum of responsibilities, including marketing to and recruiting potential schools, teachers, and Parent Teacher Organizations; creating curriculum correlated to Pennsylvania academic standards; securing support of the program components by the Pennsylvania Department of Education; conducting the various energy-efficiency presentations; and assembling and shipping the take-home energy-efficiency kits. PPL Electric Utilities collaborated with NEF on the program's strategic direction while maintaining overarching Act 129 administrative, program support, and evaluation and data management systems.

The objectives of the Student and Parent Energy-Efficiency Education Program are to:

- Expand and promote energy-efficiency literacy through education outreach programs.
- Provide energy-efficiency education to students offered through school assemblies and classroom curriculum and presentations to parent groups.
- Ensure that energy-efficiency education correlates to Pennsylvania Education Academic Standards.
- Build awareness of energy efficiency in targeted lower-income neighborhoods.
- Provide students, parents, and teachers with a take-home kit of energy-efficiency measures that can be installed at home.

- Provide teachers with energy-efficiency information, lesson plans, activities, training, materials, and support for classroom use.
    - Obtain participation by approximately 65,000 students, parents, and teachers through 2016, with a total energy reduction of approximately 12,200 MWh/year.

Table 5-1 summarizes the items in each of the energy conservation kits delivered to PPL Electric's customers through this program.

Table 5-1. Measures Included in each Cohort Kit

Measures Included	Program Cohorts			
	Bright Kids (Primary)	Take Action (Intermediate)	Innovation (Secondary)	Parent Workshop
13W CFL (3 bulbs)	✓	✓	✓	
13W CFL (2 bulbs)				✓
Nightlight	✓	✓		✓
Showerhead		✓	✓	
Kitchen Aerator		✓		
Bathroom Aerator			✓	
Furnace Whistle		✓		
Smart Strip			✓	

While the energy conservation kits and training included behaviorally based activities that could reduce energy use, PPL Electric Utilities did not report or claim behaviorally based energy savings for this program. Therefore, savings from behaviorally based activities were not evaluated.

An executive summary of program metrics can be found in **Table 5-2**.

Table 5-2: Student and Parent Energy-Efficiency Education Executive Summary

Program	*Phase II* Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	*PYTD* Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Student and Parent Energy-Efficiency Education	6,910	7,643	5,147	1.0	3.01	$1,162	$0.23	$0.033	714

NOTES:
[1] *Total EDC Costs divided by first year kWh savings.*
[2] Total TRC Costs divided by levelized lifetime kWh savings.

5.1 Program Updates

Under Act 129, this was a new program in PY5. PPL Electric Utilities and NEF delivered the program as planned. There were no significant changes in program delivery or administration.

5.1.1 Definition of Participant

For reporting purposes, the Student and Parent Energy-Efficiency Education Program participant is defined by a distinct job entered into EEMIS. Each distinct job represents one participating classroom. Each classroom reports the number of kits distributed to students and the number of returned Home Energy Worksheets (HEWs). The differences between distributed kits and returned worksheets are noted in applicable tables below.

5.2 Impact Evaluation Gross Savings

5.2.1 Reported Gross Savings

Table 5-3 shows the cumulative reported results by sector.

Table 5-3: Phase II Student and Parent Program Reported Results by Customer Sector

Sector	Participants[1]	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Residential	714	6,910	0.38	$0
Phase II Total	**714**	**6,910**	**0.38**	**$0**

NOTES:
[1] Student and Parent Energy-Efficiency Education Program participants correspond to the number of distinct jobs (classrooms) entered into EEMIS. Total kits issued equaled 21,733.

5.2.2 EM&V Sampling Approach

The sampling approach for impact evaluation data collection is summarized below for the five participating cohorts, including the participating classroom teachers and the student cohorts.

Student Cohorts: For the three participating student cohorts, Bright Kids (primary school students), Take Action (intermediate school students), and Innovation (secondary school students), the EM&V CSP conducted three activities. The EM&V CSP:

1. Conducted a database review to ensure accuracy of EEMIS records compared to the Implementation CSP's records.
2. Analyzed all Home Energy Worksheets (HEWs) returned by students in the classroom who received a kit. The HEWs provided inputs, such as in-service rates, used to calculate energy savings. Not all students elected to return the worksheets, however, all returned worksheets

were included in the analysis. The worksheets provided data for both the process and impact evaluations.

3. Conducted phone and on-line surveys with a sample of parents whose children participated in the classroom instructions. Households opted-in to these surveys by indicating willingness to participate through the written HEWs. The phone and on-line surveys collected data for the process evaluation. Since the household opted in via the worksheets, they also completed the HEWs. Therefore, no inputs for the impact evaluation were collected via the phone and on-line surveys.

Parent Workshop: All participants in the parent workshop filled out a HEW during the workshop in order to receive an energy saving kit. This worksheet asked what measures they intended to install. To identify what measures were actually installed, participants were asked to opt-in to a follow up survey. Those who opted in were contacted either by phone or email and asked which kit measures they installed. Data collected from respondents were used in the impact evaluation.

Participating Classroom Teachers: All teachers who hosted a student presentation were invited to complete an on-line survey. Teachers received a smart strip plug outlet for their participation. Participating teacher smart strip savings were added to EEMIS in PY5 Q4. These savings are included in the PY5 totals. Data collected from participating teachers were used in the impact evaluation. A summary of the program impact sampling can be found in **Table 5-4.**

Table 5-4: Student and Parent Program Sampling Strategy for PY5

Stratum	Population Size (Kits)	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size (Surveys)	Evaluation Activity
Bright Kids (Primary)	4,595	N/A[1]	All Available	3,961[2]	HEW Survey
Take Action (Intermediate)	10,552	N/A[1]	All Available	8,809	HEW Survey
Innovation (Secondary)	4,890	N/A[1]	All Available	2,815	HEW Survey
Bright Kids, Take Action, Innovation	20,037[3]	N/A	90	90[3]	Records Review
Parent Workshop	999	90/10	63	44	Phone or On-line Survey
Participating Classroom Teachers	697	N/A[1]	All Participants	312	On-line Survey
Program Total	**21,733**	**N/A[1]**		**15,941**	

NOTES:
[1] Since this program's evaluation did not include sampling, Cv and target precision are not meaningful.
[2] EEMIS reported 3,952 returned surveys which underrepresented the true value. 3,961 surveys were used in the analysis.
[3] Values are not included in the "Program Total" calculation.

Survey Sample Sizes

Student Cohort Participants

The HEWs collected data necessary for the EM&V CSP to complete engineering calculations and compute energy savings. The Implementation CSP included a HEW in each kit distributed to classroom participants for students to take home and complete. After completing the HEWs, the students transferred their responses from the HEWs onto a Scantron form (a form that can be scanned electronically once completed).

- Two student cohorts, Bright Kids (primary school students) and Take Action (intermediate school students), filled out Scantron forms in the classroom.
- The Innovation (secondary school students) cohort filled out the Scantron forms at home and returned it to the classroom teacher.

The Scantron forms were returned by the participating classroom teachers to the Implementation CSP shortly after the classroom presentations in October 2013. All Scantron forms returned to the Implementation CSP were provided to the EM&V CSP.

Parent Workshop Participants

Parent Workshop participants filled out HEWs at the end of the workshop before they had a chance to take the kit home and install the items. The worksheets provided information about the actions participants intended to take, but not what they actually did. The EM&V CSP, therefore, conducted an opt-in follow-up survey with Parent Workshop participants completing 45 follow-up surveys; 44 participants responded to one or more of the questions about usage of kit measures.

Participating Teachers

All participating teachers received an invitation to complete an online survey. In total, 312 completed the survey. Teachers indicated where they used the smart strip they received, whether at home or in the classroom. These results were used by the EM&V CSP in the savings calculations.

Table 5-5 presents the delivery method, sample size, and functions of each of the surveys used in the impact evaluation.

Table 5-5: Student and Parent Program Survey Data Collection to Determine Energy Impacts

Survey	Survey Delivery Method	Frequency	Sample Size	Data Used For	
				Impact Evaluation	Process Evaluation
Bright Kids Participant HEW[1]	Included in Kit	Q3	3,961[3]	Yes	Yes
Take Action Participant HEW[1]	Included in Kit	Q3	8,809	Yes	Yes
Innovation Participant HEW[1]	Included in Kit	Q3	2,815	Yes	Yes
Parent Workshop Participant Survey[2]	E-mail and phone after opt-in during the workshop	Q3	44	Yes	Yes
Participating Teachers Survey[2]	E-mail	Q3	312	Yes	Yes

NOTES:
[1] Completed HEWs used in the analysis.
[2] Completed surveys by the EM&V CSP.
[3] EEMIS reported 3,952 returned surveys which underrepresented the true value. 3,961 surveys were used in the analysis.

5.2.3 *Ex Ante* Adjustment Methodology and Findings

A savings adjustment was necessary to calculate the Student and Parent Energy-efficiency Education Program realization rate. The EM&V CSP adjusted the reported savings (presented in **Table 5-6**) from EEMIS to align with assumptions specified in the TRM and the characteristics of the kit items themselves, results in adjusted *ex ante* savings.

The TRM *ex ante* adjustment modifies the savings reported in EEMIS (reported *ex ante* savings) to reflect the specifications of the measures included in the kit. This adjustment is made to the population, and accounts for differences between planning assumptions, the TRM assumptions, and the equipment that was actually distributed to participants. The results of this adjustment to the population, prior to any calculations of savings, are the adjusted *ex ante* savings. These are the *ex ante* savings used in the equation to determine the program's realization rate.

Table 5-6 shows the results of the TRM-adjusted *ex ante* calculations by cohort for the varying sets of measures included in each kit.

Table 5-6: Reported and Adjusted *Ex Ante* Savings per Technology and per Unit

Kit Item *Cohort*	Reported *Ex Ante* Savings (kWh/yr)	Adjusted *Ex Ante* Savings (kWh/yr)	Factors Included in TRM *Ex Ante* Adjustments
Furnace Whistle *Take Action*	59	Updated savings for zip codes mapping to Allentown (60 kWh) and Scranton (61 kWh) Other cities stipulate 59 kWh (PPL assumed value).	PPL assumed EFLH hours for Harrisburg as a placeholder. 2013 TRM Table 2-6 was used to update EFLH by mapping school zip codes to the nearest city. 2013 TRM Tables 2-7 through 2-13 specify savings by city.
Low Flow Showerhead *Take Action*	129	170	PPL assumes statewide housing type for 1.75 gpm (2013 TRM Table 2.10.4) and 52% fuel saturation per PPL RASS study. Adjusted *ex ante* uses statewide housing type, kit rating of 1.5gpm, and fuel saturation from student worksheets (51%).
Kitchen Faucet Aerator *Take Action*	25	25	PPL assumes 48 kWh (2013 TRM Section 2-9). PPL applies 52% fuel saturation per PPL RASS study. Adjusted *ex ante* uses fuel saturation from student worksheets.
Bathroom Faucet Aerator *Innovation*	25	27	
Low Flow Showerhead *Innovation*	129	187	PPL assumes statewide housing type for 1.75 gpm (2013 TRM Table 2.10.4) and 52% fuel saturation per PPL RASS study. Adjusted *ex ante* uses statewide housing type, kit rating of 1.5gpm, and fuel saturation from student worksheets (57%).
Smart Strip *Innovation*	184	184	2013 TRM Section 2-13 stipulates 184 kWh for residential use
CFLs (3 bulbs) *Bright Kids, Take Action, Innovation*	121	121	2013 TRM specifies 84% ISR (Table 2-68); PPL assumes ISR as follows: Bright Kids and Innovation: 80% (CFL1), 75% (CFL2), 68% (CFL3) Take Action: 73.5% combined for all bulbs.
CFLs (2 bulbs) *Parent Workshop*	81	81	PPL assumes 84% ISR per 2013 TRM (Table 2-68).
Electroluminescent Nightlight *Bright Kids, Take Action, Parent Workshop*	26	26	2013 TRM Section 2.4 stipulates 26 kWh.
Smart Strip *Participating Teachers*	124	124	2013 TRM Section 3-13 stipulates 124 kWh for commercial use.

5.2.4 Ex Post Adjustment Methodology and Findings

Ex post savings adjustments modify the TRM-adjusted *ex ante* savings in four ways.

- First, the results of quantity adjustments resulting from database review activities are incorporated.
- Second, the kit item savings are modified to reflect the installation rates determined through the returned HEWs and the Parent Workshop survey responses.

- Third, survey results identifying the average number of people per home updated the showerhead savings estimates.
- Fourth, survey results adjusted the savings for participating teacher smart strips by identifying the proportion of smart strips used at home (with corresponding different TRM-specified unit savings).

Database Review

Participant records from EEMIS were compared with enrollment data stored in the Implementation CSP's electronic database to ensure that records were traceable between the CSP and EEMIS databases. When compared at the Teacher ID level, the number of teacher IDs for returned HEWs matched exactly between the two datasets for the Innovation, Parent Workshop, and Participating Teacher groups.

The number of Take Action surveys matched exactly between the two sources, but the number of classrooms differed slightly. These differences did not affect savings calculations.

The count of Bright Kids HEWs between both databases also differed. One Teacher ID with 25 associated HEWs was not present in EEMIS and was not included in the analysis because their existence could not be verified. Another teacher ID had five more HEWs while another had four more HEWs, than were counted in EEMIS. These nine additional HEWs were retained in the analysis and represented less than 0.2% of all returned Bright Kids HEWs.

Table 5-7: Database Review Results for PY5 Student and Parent Program

Cohort	HEWS in EEMIS	HEWs in CSP Database	Database Accuracy
Bright Kids	3,952	3,986[1]	99.1%
Take Action	8,809	8,809	100.0%
Innovation	2,815	2,815	100.0%
Parent Workshop	999	999	100.0%
NOTES: [1] 3,961 HEWs used in analysis.			

Record Review

In addition, the EM&V CSP obtained a random sample of 30 scanned HEWs for each participant group from the Implementation CSP. Participant responses to questions from the scanned HEWS were compared to the database extracts. The initial comparison showed that the scanned copies did not include a code that would allow direct matching to the database extract, but the issue was discussed and resolved. Further review identified extract formatting discrepancies and instances of missing or incorrect data which were discussed and resolved by receipt of corrected database extracts. Once resolved, the sample of scanned copies matched the database extract files with no errors.

Surveys

The EM&V CSP used phone and on-line survey results from participants in the Parent Workshop to calculate *ex post* per-unit savings for each of the items contained in the Parent Workshop kit. This kit contained two CFL bulbs and one electroluminescent nightlight. To calculate energy savings, the EM&V CSP determined relative per-unit savings for each of the items included in the kits using respondent-level installation rates. These installation rates were determined through the participant surveys and TRM algorithms. Each kit distributed to the three grade-level cohorts included a Home Energy Worksheet (HEW). These participant worksheets collected the necessary data to calculate installation rates and actions taken as a result of the program and were ultimately used to determine the measure-level, cohort-level, and program-level realization rates.

A summary of PY5 kits and survey responses by cohort can be found in **Table 5-8**.

Table 5-8: PY5 Summary of Kits and Survey Responses by Cohort

Cohort	Kits in EEMIS	Survey Responses in EEMIS	Survey Responses (Analysis)	Classroom (Teachers) in EEMIS	Number of Classrooms with Survey Responses
Bright Kids	4,595	3,952	3,961[1]	204	188
Take Action	10,552	8,809	8,809	386	359
Innovation	4,890	2,815	2,815	103	79
Parent Workshop	999	N/A[2]	44	20	44[3]
Participating Teachers	697	N/A[4]	312	1[5]	312[6]
Program Total	**21,733**	**15,576**	**15,941**	**714**	**982**

NOTES:
[1] EEMIS reported 3,952 returned surveys which underrepresented the true value. 3,961 surveys were used in the analysis.
[2] Install rates and savings for Parent Workshop calculated from EM&V CSP survey.
[3] Phone and on-line surveys were attempted for all Parent Workshop participants who opted-in.
[4] No HEWs for Participating Teachers. Install rates and savings calculated from EM&V CSP survey.
[5] All 697 Participating Teachers who received a Smart Strip are entered into EEMIS as one record.
[6] On-line surveys were sent to all participants for Participating Teachers, not sampled by classroom.

Methodology to Compute Savings Using Survey Data

The EM&V CSP calculated the total TRM adjusted *ex ante* savings for each student, based on savings associated with each kit item and the specific survey questions answered by each student. (Additional detail is provided in **Appendix E: Methodology for Determining Savings from Energy-efficiency Kits**. The methodology applies to both the Student and Parent Energy Education Program and to E-Power Wise Program.

Each student was eligible for the *ex ante* savings associated with measures for which that student answered the installation question. The *ex ante* savings were assigned if the student answered the survey question, regardless of the response (that is, whether the measure was or was not installed).

Survey-verified *ex post* savings for each student were based on the survey responses indicating the measures were installed. The student level *ex ante* and *ex post* savings were summed within each class (corresponding to a unique teacher ID) to estimate a realization rate, total *ex post* savings, and the standard error at the classroom level.

Sampling weights applied to the student level data were used to estimate total classroom savings, assuming the survey responses represented a simple random sample of students within each class. Sampling weights were applied within each class based on the student population size (the total number of kits distributed) and the sample size (the total number of surveys returned) to estimate the total savings and its standard error within each class.

The EM&V CSP combined the class level savings to estimate the population total within each cohort, assuming that classes that returned surveys represented a simple random sample of classes from the cohort. Additional sampling weights were applied based on the class population (total number of classes in the cohort that participated in the program) and the class sample size (the total number of classes that returned surveys) to estimate the cohort population savings and the standard error at the cohort level.

This approach to estimation is consistent with two-stage cluster sampling methods where the sampling weights and standard error calculation at each stage account for sampling uncertainty both at the class level and the cohort level. Finally, the cohort totals were combined to estimate the program total savings, standard error, and precision as shown in **Table 5-10** (after the following page).

Summary of Survey Findings

Program participants returned 15,941 surveys. **Table 5-9** presents the PY5 in-service rates (ISR) for each of the items in the energy conservation kit. ISRs represent the percent of participants who verified that they installed the measure out of the total number of those who answered the measure-specific question, and not a percentage of the total number of people surveyed. **Table 5-9** shows the savings attributable to each of the measures. The installations rates for kit measures are useful for program planning purposes.

Table 5-9: Student and Parent Program Measure Savings per Distributed Unit

Measure Installed	Valid Survey Responses	ISR	Per-unit Savings (kWh/yr)
CFL(3 bulbs) Bright Kids[1]	3,916	73% combined for 3 bulbs	105.5
CFL (3 bulbs) Take Action[2]	8,725	60% combined for 3 bulbs	86.3
CFL (3 bulbs) Innovation[3]	2,792	67% combined for 3 bulbs	96.2
CFL (2 bulbs) Parent Workshop[4]	43	87% combined for 2 bulbs	83.8
Nightlight Bright Kids	3,934	88%	26.8
Nightlight Take Action	8,475	80%	24.3
Nightlight Parent Workshop	41	90%	27.4
Showerhead Take Action	8,582	31%	93.7
Showerhead Innovation	2,733	34%	103.9
Kitchen Aerator Take Action	8,665	35%	8.7
Bathroom Aerator Innovation	2,763	36%	9.7
Furnace Whistle Take Action	8,475	47% (TRM Stipulated)	59 (varies by geographic location)
Smart Strip Innovation	2,800	80%	147.1
Smart Strip Participating Teachers[5]	312	94%	140.0

NOTES:
[1] Individual CFL ISR for Bright Kids- CFL1 82%, CFL2 73%, CFL3- 64%.
[2] Individual CFL ISR for Take Action- CFL1 67%, CFL2 60%, CFL3 53%.
[3] Individual CFL ISR for Innovation- CFL1 74%, CFL2 67%, CFL3 60%.
[4] Individual CFL ISR for Parent Workshop- CFL1 93%, CFL2 81%.
[5] Per unit savings is ISR*average rate of 140.0 based on survey findings showing 54% used at home (residential savings rate of 184 kWh) and 40% used in the classroom (commercial savings rate of 124 kWh).

5.2.5 Summary of Evaluation Results

Estimated savings for measure installations were established using 2013 TRM algorithms for each item in the kit. Data inputs for ISRs (where EDC data gathering was allowed in the TRM) were derived from the Home Energy Worksheets and from the Parent Workshop survey. Manufacturer's data (for example, aerator and showerhead flow rates) were used in the algorithms to calculate verified savings for each measure.

The realization rate was calculated as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

Program saving results are provided in **Table 5-10** and **Table 5-11.**

Table 5-10: PY5 Student and Parent Program Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Energy Savings (MWh/Year)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings[2] (MWh/yr)	Observed Coefficient of Variation (C_v) or Proportion in Sample	Relative Precision at 85% Confidence Limit
Bright Kids	675	675	91%	612	0.25	0.7%
Take Action	3,798	4,237	56%	2,363	0.60	1.1%
Innovation	2,244	2,538	77%	1,957	0.98	3.1%
Parent Workshop	106	106	104%	111	0.25	6.4%
Participating Teachers	86	86	120%	103	0.25	.2%
Program Total	**6,910**	**7,643**	**67%**	**5,147**	**0.14**	**1%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted ex ante multiplied by the realization rate will not equal verified gross energy savings due to rounding.

Table 5-11: PY5 Student and Parent Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings[1] (MW)	Adjusted *Ex Ante* Demand Savings[2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings[2],[3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Demand Relative Precision at 85% Confidence Limit
Bright Kids	0.028	0.03	87%	0.026	0.30	0.8%
Take Action	0.19	0.27	57%	0.16	0.79	1.4%
Innovation	0.15	0.2	74%	0.15	1.09	3.4%
Parent Workshop	0.004	0.004	102%	0.004	0.33	8.3%
Participating Teachers	0.007	0.008	109%	0.008	0.23	2.1%
Program Total	**0.39**	**0.52**	**67%**	**0.35**	**0.18**	**1.7%**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.

5.3 Impact Evaluation Net Savings

No free riders are anticipated among this program's population receiving the kits. The teacher and school volunteer to offer classroom training, and the energy conservation kits are provided at no cost to classroom and workshop participants. The Student and Parent Energy-Efficiency Education Program is assumed to have an NTG ratio of 1.0.

5.4 Process Evaluation

A process evaluation was conducted In PY5 for the Student and Parent Energy-Efficiency Education Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

An executive summary of the process evaluation follows below, along with the sampling strategy.

In Program Year 5 (PY5), the EM&V CSP conducted the following process evaluation activities:

- Program staff and implementer interviews (n=2)
- *EM&V CSP participant surveys*
  - Parent participant survey (n=194)
  - Parent workshop survey (n=45)
  - Teacher workshop survey (n=10)
  - Teacher participant survey (n=312)
- Analysis of NEF-administered student-parent kit returned surveys (n=15,610) 1
- Analysis of NEF-administered parent postcard returned surveys (n=1,346)
- Net-to-gross literature review and benchmarking
- Database and QA/QC review of records
- Process map

5.4.1 Survey Methodology

The teacher workshop and teacher participant surveys were administered over the Internet and the parent participant and parent workshop surveys were administered over the Internet and by phone. Teachers and parents with e-mail addresses received an invitation to the web-based survey, but not all parents had e-mail addresses. To encourage participation, two e-mail reminders were sent to teachers and parents. After two weeks, parents who had not completed the web-based survey received telephone calls.

Survey Sampling

Table 5-12 summarizes the sampling plan for the surveys administered by the EM&V CSP.

Table 5-12: EM&V CSP Student and Parent Program Process Survey Sampling Strategy for PY5

Survey/ Target *Group*	Stratum Boundaries	Population	Participant Opt-ins *Contacted*[1]	Assumed Proportion or C_V in *Sample* Design	Assumed Levels of Confidence & Precision	Target Sample *Size*	Achieved Sample *Size*	Percent of Population Contacted *to Achieve* Sample[4]
Parent Participant	Student Cohorts	17,439[2]	1,826	N/A[3]	N/A[3]	210	194	100%
Parent Workshop	Parent Workshop	999[2]	262	N/A[3]	N/A[3]	All Records	45	100%
Participating Teachers	Classroom Teachers	713[2]	713	N/A[3]	N/A[3]	70	312	100%
Teacher Workshop	Teacher Workshop	47[2]	46	N/A[3]	N/A[3]	All Records	10	100%
Program Total		**19,198**	**2,847**	**N/A[3]**	**N/A[3]**		**561**	

NOTES:
[1] Participant Opt-ins Contacted is based on the adjusted sample frame, which is the total number of participants who gave the EM&V CSP permission to contact them for the survey. For details on the adjusted sample frame, refer to the full Process Evaluation Report.
[2] Count varies from impact evaluation sampling due to *ex post* adjustments.
[3] Since this program's evaluation did not include sampling, C_V and target precision are not meaningful.
[4] Percent contacted means, of the entire sample frame list (those drawn specifically for the survey), how many were called to get the completes; often 100% will be the answer.

Table 5-13 represents the total number of implementer CSP surveys reviewed by the EM&V CSP for the process evaluation.

Table 5-13: Implementer Student and Parent Program *Process Evaluation Survey Sampling Strategy for PY5*

Survey/ Target Group	Stratum Boundaries	Population (Total Number of Kits)	Returned HEWs & Postcards	Percent of Returned HEWs & Postcards Included in Analysis[2]	Evaluation Activity	
					Process	Impact
Parent Kit (HEW)	Student Cohorts	20,037	15,610[1]	100%	Yes	Yes
Parent Postcard	Student Cohorts	20,037	1,346	100%	Yes	No
Program Total		**40,074**	**16,956**			

NOTES:
[1] Count varies due to *ex post* adjustments.
[2] For the process evaluation, only a single topic or question was selected from the Parent Kit Survey and Parent Postcard Survey for analysis. Due to the EM&V CSP's surveys asking similar or identical questions to that of the Implementer's surveys, double-counting responses would have resulted. The Process Evaluation Report documents the source of the survey results.

5.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-5.**

5.6 Financial Reporting

A breakdown of the program finances is presented in **Table 5-14.**

Table 5-14: Summary of Student and Parent Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$ -	$ -
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	$ -	$ -
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$1,162	$1,162
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	**$1,162**	**$1,162**
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	**$1,162**	**$1,162**
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	**$1,162**	**$1,162**
Total NPV Lifetime Energy Benefits	**$3,103**	**$3,103**
Total NPV Lifetime Capacity Benefits	**$93**	**$93**
Total NPV TRC Benefits[7]	**$3,494**	**$3,494**
TRC Benefit-Cost Ratio[8], [9]	**3.01**	**3.01**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.

[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.

[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.

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

[7] 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.

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

[9] Total NPV TRC Benefits includes $297,362 of O&M replacement cost savings for CFL bulbs.

6 Custom Incentive Program

The Commercial and Industrial (C&I) Custom Incentive Program offers financial incentives to customers for installing extensive energy-efficiency projects, retrocommissioning existing equipment, making repairs, optimizing equipment, installing equipment measures or systems not covered by the Prescriptive Equipment Program, and making operational and process improvements that result in cost-effective energy savings.

The program offers performance-based incentives for the avoided or reduced kilowatt hours per year (kWh/yr) resulting from the project. Incentives are subject to an annual cap for each project ($250,000 in PY5, $500,000 in PY6) and for each participating customer (max $500,000 per customer site per year or up to $1,000,000 per parent company per year). Incentives cannot exceed 50% of the project's incremental cost.

To qualify, C&I customers are required to submit documentation that their proposed efficiency upgrades pass the program's cost-effectiveness threshold. Preapproval is required prior to equipment installation. In PY6 the requirement will change to preapproval prior to equipment *purchase*. PPL Electric Utilities reimburses the customer following successful implementation of a cost-effective project, and the reimbursement may vary by the type or size of the measure.

An executive summary of program metrics can be found in **Table 6-1.**

Table 6-1: Custom Incentive Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Custom Incentive	4,909	4,909	5,394	0.55	1.74	$971	$0.18	$0.043	56

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

6.1 Program Updates

There were some changes to the program in PY5. Beginning in PY5, PPL Electric Utilities required customers to receive preapproval prior to installing any measures. The PY5 incentive rates, cost-effectiveness requirements, and incentive limits also changed for combined heat and power (CHP) and non-CHP projects from the those set for Phase I (**Table 6-2**).

Table 6-2: Phase II Custom Incentive Program Incentive Overview

Sector	Phase I	PY5
Incentive Rate (non-CHP)	$0.10/kWh	$0.08/kWh
Incentive Rate (CHP)	$0.10/kWh	$0.05/kWh
Minimum TRC (non-CHP)	1.0	1.1
Minimum TRC (CHP)	1.0	1.25
Maximum Incentive/Site/Year	$500,000	$250,000

6.1.1 Definition of Participant

A PY5 participant is defined as a C&I job that received an incentive payment between June 1, 2013, and May 31, 2014.[21] Customers that submitted an application in this time period but did not receive an incentive are not considered participants. It is possible for an individual customer to have multiple C&I jobs. It is also typical for C&I projects to take more than one quarter to complete.

6.2 Impact Evaluation Gross Savings

6.2.1 Reported Gross Savings

Table 6-3 summarizes the Custom Incentive Program's PY5 participation, savings, and incentives by sector. As the table shows, the large C&I sector had the highest savings. The large C&I and the small C&I sectors together accounted for 96% of program savings in PY5. Of the PY5 goal from the EE&C Plan, reported savings were 4% for GNI, 15% for large C&I, and 102% for small C&I.

Table 6-3: Phase II Custom Incentive Program Reported Results by Customer Sector

Sector	Participants[1]	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Small Commercial and Industrial	30	1,897	0.16	$113
Large Commercial and Industrial	22	2,833	0.32	$142
Government, Non-Profit, and Institutional	4	179	0.02	$13
Phase II Total	**56**	**4,909**	**0.50**	**$268**

NOTES:
[1] The participant count is based on the number of jobs that contributed to reported savings in PY5. The total number of projects created in PY5 is 107 including those still in progress and those that have since been cancelled.

[21] Note that in the PY5 quarterly reports, the count of participants included those who enrolled but did not complete their project.

6.2.2 EM&V Sampling Approach

To evaluate savings for the Custom Incentive Program, the EM&V CSP defined two strata—large stratum projects and small stratum projects. Projects in the large stratum are identified as those with savings greater than 500,000 kWh/year. These are identified in real time as projects are submitted and reviewed in the application process. Projects with expected savings below this threshold of 500,000 kWh/year are assigned to the small stratum. However, there may be cases where they are assigned to the large stratum.

The EM&V CSP verified the entire population of projects in the large stratum. There were two large stratum projects in PY5. Both initially were identified for the large stratum because they had high savings predicted during the application process; however, both projects' verified savings were below 500,000 kWh/year.

The EM&V CSP selected a sample of small strata projects for verification at the close of PY5 Q3 and another sample at the close of PY5 Q4, for a total of 17 small projects. The EM&V CSP verified savings for this sample and determined a realization rate. This stratum-level realization rate was applied to the population in the small project stratum.

PPL Electric Utilities paid incentives for 56 projects in the Custom Incentive Program in PY5, including two projects in the large stratum and 54 in the small stratum. **Table 6-4** shows the sampling parameters for PY5.

Table 6-4: Custom Incentive Program Sampling Strategy for PY5

Stratum	Population Size[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Small	54	85/15	17	17	Site Visits
Large	2	N/A[2]	Census	2	Site Visits
Program Total	**56**	**85/15**		**19**	

NOTES:
[1] The population size is based on the number of jobs that contributed to reported savings in PY5. The total number of projects created in PY5 is 107 including those still in progress and those that have been since cancelled.
[2] This evaluation included the census of program participants in the large stratum. As a result, the savings estimate in this stratum is not subject to sampling error. The Cv and confidence and precision do not apply to the large stratum.

6.2.3 *Ex Ante* Adjustment Methodology and Findings

No *ex ante* adjustments were made to projects in the Custom Incentive Program.

6.2.4 *Ex Post* Adjustment Methodology and Findings

For all verified projects, the EM&V CSP created a final savings calculation in accordance with the site-specific evaluation, measurement, and verification plan (SSMVP). The EM&V CSP documented the findings in a Project Verification Report and included any deviations from the project's SSMVP. Verified

savings for most custom projects were based on metered data collected by the customer, the Implementation CSP, or the EM&V CSP.

For large strata projects, the SSMVP is typically prepared in coordination with the Implementation CSP. The Implementation CSP informs the EM&V CSP when it receives an application for a project likely to fall into the large strata. The EM&V CSP can then evaluate these large projects at a high level of rigor, often collecting pre-installment measurements without requiring any duplication of effort by customers, the Implementation CSP, and trade allies.

The EM&V CSP conducted pre-installation inspections for the two large strata projects. Therefore, the realization rate is 100% for these projects. In PY5, large-strata projects represented only 7% of total program reported savings. Note that large strata projects contributed a far higher percentage of program savings throughout Phase I and are expected to again contribute more than 80% of savings in the remainder of Phase II.

For small strata projects selected into the verification sample, the EM&V CSP prepares the SSMVP. Pre-installation inspections are not possible for small strata projects because they cannot be selected into the sample until after they are installed and an incentive paid. The EM&V CSP conducted post-installation inspections and verified savings for the 17 small strata projects in the sample. The EM&V CSP calculated the realization rate as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

6.2.5 Site Visits

The Implementation CSP conducted quality assurance site visits during project scoping and developed *ex ante* savings. The EM&V CSP conducted site visits and inspections to verify that program-rebated or funded measures were installed and operating as reported and that correct data were used to calculate *ex ante* savings. Discrepancies were documented and site-specific data were used to calculate the *ex post* verified gross savings.

A wide variety of discrepancies were discovered in the on-site inspections. No sites were classified as having "failed." Instead, for small strata projects, the EM&V CSP found that operating parameters were typically somewhat different than were assumed by the Implementation CSP. For large strata projects, the EM&V CSP typically conducted the inspection with the Implementation CSP and calculated verified savings based on the inspection results. The inspections found nothing unexpected for the custom projects in this program.

Table 6-5 summarizes the number of site visits planned, conducted, and the nature of discrepancies.

Table 6-5: PY5 Custom Program Site Inspection Summary

Program	Measure	Inspection Firm	Inspections Planned	Inspections Conducted	Sites with Discrepancies from Reports	Resolution of Discrepancies
Custom	56 participants, all custom projects	EM&V CSP	--	19[1]	--	--
Custom		Implementation CSP	--	28[2]	--	--

NOTES:
[1] Three sites metered to determine HOU.
[2] 19 sites metered to determine HOU.

6.2.6 Summary of Evaluation Results

As can been seen in **Table 6-6**, the realization rate for energy savings was lower for large strata projects (100%) than for small-strata projects (111%). The total program realization rate for energy savings is 110% in PY5.

Table 6-6: PY5 Custom Incentive Program Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings[2] (MWh/yr)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Small	4,544	4,544	111%	5,029	0.64	22%[4]
Large	365	365	100%	365	N/A[3]	N/A[3]
Program Total	**4,909**	**4,909**	**110%**	**5,394**	**0.53**	**21%[4]**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[3] Because this stratum did not include sampling, C_v and precision are not meaningful.
[4] Two projects are driving the large standard error (SE) and precision values. Verified savings and SE for these two projects are substantially different from other projects within the sample, leading to high total SE and precision.

Table 6-7: PY5 Custom Incentive Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings[1] (MW)	Adjusted *Ex Ante* Demand Savings[2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings[2], [3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Small	0.46	0.48	91%	0.44	0.58	20%[5]
Large	*0.046*	*0.05*	*100%*	0.05	N/A[4]	N/A[4]
Program Total	**0.50**	**0.53**	**91%**	**0.48**	**0.53**	**18%[5]**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[4] Because this stratum did not include sampling, C_v and precision are not meaningful.
[5] Two projects are driving the large standard error (SE) and precision values. Verified savings for these two projects are substantially different than their reported savings values, leading to high total SE and precision.

6.3 Impact Evaluation Net Savings

The EM&V CSP conducted an analysis to determine net savings for the Custom Incentive Program. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

6.3.1 Net-to-Gross Ratio Methodology

The overriding methods used to determine net savings were defined by the Statewide Evaluator, including instructions provided in the Evaluation Framework and Guidance Memos.

For the Custom Incentive Program, the EM&V CSP included freeridership and spillover ratio estimates that were estimated in accordance to the SWE NTG guidelines, which utilizes self-report survey information from participating customers.

6.3.2 Net-to-Gross Ratio Sampling

The EM&V CSP conducted a telephone survey of Custom Incentive Program participants in PY5, surveying 11 PY5 participants representing 14 projects.

In many instances, multiple custom projects were initiated or completed by the same customer. This required the EM&V CSP to generate a final sample of unique decision-makers to ensure no customer contact was called more than once. The EM&V CSP generated the final sample following these steps:

- Identify unique decision-maker phone numbers and contact information
- Remove accounts that had been contacted in the past 12 months for a PPL Electric Utilities or EM&V CSP survey effort
- Remove accounts with in-progress, reserved, or cancelled projects

After completing these steps, the final sample contained 20 unique decision-makers.

Table 6-8: Custom Incentive Program Sampling Strategy for PY5 NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed C_V or Proportion in Sample Design	Assumed Levels of Confidence & *Precision*	Target Sample Size	Achieved Sample Size	*Percent of* Sample Frame Contacted *to Achieve* Sample[2]
Participants [1]	N/A	20	0.50	85/15	15	11	100%
Program Total	***N/A***	***20***	***0.50***	***85/15***	***15***	***11***	***100%***

NOTES:
[1]Unique decision makers based on contact information.
[2]Percent contacted means of the entire sample frame list (those drawn specifically for the survey) how many were called to get the completes, often 100%.

6.3.3 Net-to-Gross Ratio Findings

The freeridership and spillover ratio estimates for the Custom Incentive Program, estimated in accordance with the SWE NTG guidelines, are shown in **Table 6-9**.

Table 6-9: PY5 Custom Incentive Program Summary of Evaluation Results for NTG Research

Stratum	Estimated Freeridership[1]	*Estimated* Participant Spillover	NTG Ratio	*Observed* C_V *or* Proportion in Sample Design	Relative Precision
All	0.45	0.00	0.55	0.120	22%
Program Total	**0.45**	**0.00**	**0.55**	**0.120**	**22%**

NOTES:
[1]Estimate is weighted by the survey sample-verified program kWh savings. This method ensures that respondents who achieved higher energy savings through the program measures are given a greater influence on the final freeridership estimate than those respondents who achieved lower energy savings.

In PY5, surveys with 11 respondents indicated 45% freeridership. Survey respondents were heavily weighted toward small projects and had relatively low cumulative total savings compared to Phase I savings or the Phase II planned savings. The surveys conducted in PY4, with 61 PY3 and PY4 participants, indicated 48% freeridership. PPL Electric Utilities made a substantial change to the program rules for Phase II in an attempt to reduce the program freeridership. Specifically, a project preapproval process was implemented for Phase II. Because of the low participation and small survey sample size in PY5, it is premature to assess the impact of preapproval on freeridership.

It is possible that the PY5 freeridership will be higher than 45% for the remainder of Phase II due to startup issues at the beginning of Phase II. Projects could not be carried over from Phase I and PPL Electric Utilities required that all Phase II projects receive preapproval prior to installation. Therefore, projects that were already substantially developed or partially constructed were ineligible. Custom projects often take a long time to develop, so projects at the beginning of the development cycle at the start of Phase II were unlikely to be completed in PY5. In addition, PY5 projects may have been

dominated by projects that were near the end of the development phase at the beginning of Phase II. Such projects were developed without an assurance that there would be a Phase II and without knowledge of its rules and incentive levels. It is more likely customers (potential participants) did not *consider the program in decisions and may have higher than average freeridership.*

Three respondents who represent 63% of the survey sample-verified program kWh savings have a weighted average freeridership estimate of 54%.[22] Therefore, the three respondents represent 34 percentage points of the total 45% freeridership estimate. One of these respondents participated in the program in Phase I and may have been influenced to participate by this previous participation. Another respondent likely upgraded to increase capacity but installed more efficient equipment than was necessary to achieve increased capacity. In this case, the contractor may have influenced how the project was completed. It is possible this contractor was influenced by the program, but the self-report survey did not capture influences of the trade ally.

Another factor influencing freeridership may be the participant's decision-making process. Particularly for larger custom projects, decision-making can be complex, involve several actors, and span a significant period of time. In these cases, decisions may be made at various levels within a company and the program's influence may not be known by the people directly responsible for completing the application. Similarly, the program may have influenced decisions in the early stage, such as inviting a contractor to conduct a study, but then be forgotten or not considered later when final approval is given for the capital project. An energy service company's performance contracts also involve a complex decision-making processes; at least one of the surveyed participants was the owner in a performance contract. The survey did not capture the program's influence on the projects proposed by the energy service company.

6.4 Process Evaluation

A process evaluation was conducted In PY5 for the Custom Incentive Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

For the Custom Incentive Program, the PY5 process evaluation activities were these:

- Participant surveys (n=11)
- Partial participant surveys (n=2)[23]
- Program staff and implementer interviews (n=3)
- *Program literature review and benchmarking*

[22] Estimate is weighted by the verified program kWh savings.

[23] Partial participants as defined here are customers whose projects were cancelled.

- Database and QA/QC review of records
- Process map review

Table 6-10: Custom Incentive Program Process Evaluation Sampling Strategy for PY5

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or C_V in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample [2]	Evaluation Activity
Participants [1]	N/A	20	0.5	85/15	15	11	100%	Telephone survey
Partial participants [3]	N/A	9	N/A	N/A	Up to 5	2	100%	Telephone survey
Program Total		**29**	**0.5**	**85/15**	**up to 20**	**13**	**100%**	

NOTES:
[1]Unique decision makers based on contact information.
[2]Percent contacted means of the entire sample frame list (those drawn specifically for the survey) how many were called to get the completed surveys, often 100% will be the answer.
[3]Surveys completed with customers who did not receive an incentive but started the application process.

6.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-6.**

Market effects research in PY6 will focus on the influence of trade allies on project development and decisions about energy-efficiency improvements. This will be completed through interviews with contractors and project development engineers.

6.6 Financial Reporting

A breakdown of the program finances is presented in **Table 6-11**.

Table 6-11: Summary of Custom Incentive Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$268	$268
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	**$268**	**$268**
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$703	$703
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	**$703**	**$703**
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3],[4]	**$971**	**$971**
Participant Costs[5]	$1,258	$1,258
Total NPV TRC Costs[6]	**$2,229**	**$2,229**
Total NPV Lifetime Energy Benefits	**$3,664**	**$3,664**
Total NPV Lifetime Capacity Benefits	**$210**	**$210**
Total NPV TRC Benefits[7]	**$3,874**	**$3,874**
TRC Benefit-Cost Ratio[8]	**1.74**	**1.74**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

7 Act 129 Low-Income Weather Relief Assistance Program

The Act 129 Low-Income Winter Relief Assistance Program (WRAP) is a PPL Electric Utilities program designed to reduce electric consumption and improve living comfort for low-income customers. Income-eligible customers receive a free energy audit and a home evaluation to identify energy-saving measures. The WRAP auditors use a preapproved list of measures along with other criteria to determine if appliances and other larger equipment can be replaced cost-effectively. All services and measures are provided to income-qualified customers at no cost. The WRAP also offers energy education to encourage customers to conserve energy.

Outside of Act 129 programs, PPL Electric Utilities offers Universal Services Low Income Usage Reduction Program (LIURP) WRAP. The LIURP WRAP is funded through PPL Electric's Universal Services Rider, separately from Act 129 funds – to provide a whole-house energy-efficiency solution. The Act 129 WRAP uses the same delivery infrastructure (agencies, systems, and processes) as PPL Electric's LIURP WRAP. Building upon the LIURP WRAP infrastructure minimizes customer confusion, avoids competition with existing low-income energy-efficiency programs, achieves economies of scale, reaches customers more quickly, and improves program cost-effectiveness.

Implementer agencies either employ in-house contractors or outsource the installation of energy-saving measures and the replacement of outdated and inefficient equipment with energy-efficient equipment. In the unlikely occurrence that a structure requires minor health and safety repairs before services can be provided, contractors make the repairs so that the agencies implementing the program do not have to deny services.

The LIURP WRAP provides low-income customers with three types of service, also known as job types:

- Baseload (customers without electric space heat and without an electric water heater)[24]
- Low-cost (customers with an electric water heater)

Full-cost (customers with an electric water heater and electric space heat)

In Phase I of Act 129, PPL Electric Utilities offered all three types of WRAP jobs. In Phase II of the Act 129 WRAP, PPL Electric Utilities is focusing on baseload jobs, to which it has added heat pump water heater (HPWH) replacements (essentially making it equivalent to a Low-Cost job).

Baseload jobs' measures include:

- Energy education
- Efficient lighting installations
- *Refrigerator replacement*

[24] Baseload services are provided to those without electric space heat OR electric water heat. Only baseload measures can be installed, such as CFLs/LEDs, and appliances such as refrigerators, dehumidifiers and room AC units.

- Air conditioner replacement
- Dehumidifier replacement
- Heating and cooling filter changing or cleaning
- Dryer venting (electric dryer)
- Power strips and smart plugs
    - HPWH replacement (offered in Phase II to qualified low-income customers *with* electric water heating)

An executive summary of program metrics can be found in **Table 7-1**.

Table 7-1: Act 129 WRAP Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified *Gross* Energy Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Act 129 WRAP	3,065	3,065	2,810	1.0	0.83	$3,390	$1.21	$0.122	2,791

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

7.1 Program Updates

The Phase II EE&C Plan included only baseload jobs and HPWHs. The revised EE&C Plan filed in November, 2013, added 200 full-cost jobs for PY5. Where suitable, PPL Electric Utilities will install a HPWH; where not suitable, PPL Electric Utilities will install an efficient electric water heater. Beginning in PY6, PPL Electric Utilities will no longer offer CFLs to WRAP participants but will instead provide LEDs.

7.1.1 Definition of Participant

An Act 129 WRAP participant is an income eligible household. In the EEMIS database, the household is identified with a unique customer job ID. Participants can receive a baseload job, a HPWH, or both within the same job ID. Customers receiving both a baseload job and a HPWH contribute only once to the participant counts.

7.2 Impact Evaluation Gross Savings

Through Act 129 WRAP, PPL Electric Utilities served 2,791 unique participant households, providing 2,773 baseload jobs and installing 167 HPWHs in PY5.[25] PPL Electric Utilities reported no full-cost jobs in PY5 as this measure was approved too late in the program year to identify potential participants, provide full-cost services, and report savings.

7.2.1 Reported Gross Savings

In PY5, Act 129 WRAP reported savings of 3,065 MWh and a demand reduction of 0.3 MW. **Table 7-2** provides the number of participants, reported gross savings, and demand reductions for the WRAP in PY5.

Table 7-2: PY5 Phase II Act 129 WRAP Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Low-Income	2,791	3,065	0.30	$0
Phase II Total	**2,791**	**3,065**	**0.30**	**$0**

According to the 2013 Pennsylvania TRM,[26] HPWHs achieve 1,698 kWh per year *ex ante* reported energy savings and 0.02 kW demand reductions. For Act 129 WRAP, *ex ante* reported energy savings and demand reductions for baseload and full-cost jobs are deemed by job type rather than by the TRM algorithm for each measure installed.

In Phase II, the EM&V CSP and PPL Electric Utilities use energy savings estimates by job type, derived from a customer usage analysis of the previous years' Act 129 WRAP participants, which is according to the PA Mass Market Protocol.[27] However, because the PA Mass Market Protocol was submitted after the beginning of the PY5 program year, PPL Electric's *ex ante* reported value of 1,003 kWh per year per baseload job was based on a customer usage analysis of LIURP WRAP participants.[28] Beginning in PY6, PPL Electric Utilities will use estimates based on customer usage analyses of Act 129 WRAP participants for *ex ante* savings for baseload and full-cost jobs.

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[25] In PY5, 2,773 unique participants received a Baseload job. Of these, 149 also received a HPWH. Another 18 participants received only a HPWH, for a total of 2,791 unique participants.

[26] Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2013. Page 31. Available online: http://www.puc.pa.gov/pcdocs/1208574.docx

[27] Navigant Consulting, Inc., et al. *PA Mass Market Protocol: Savings Verification Methodology for Whole-Building Retrofit Measures in Low-Income Programs*. August 9, 2013.

[28] The billing analysis was based on calendar year 2010 LIURP WRAP participants.

7.2.2 EM&V Sampling Approach

The EM&V CSP reviewed a sample of records to verify that the customer received the baseload service and/or the HPWH. To verify measure installation, it assigned records to one of three strata (baseload, full-cost, and HPWH). The EM&V CSP designed the sample plan to meet levels of 85% confidence and 15% precision by strata and program by drawing 25 sample points each from the baseload stratum and the HPWH stratum. No sample points were drawn from the full-cost stratum, as the addition of full-cost measures was approved too late for PPL Electric Utilities to report any participants in PY5. The strata definitions and sampling strategy for these strata are shown in **Table 7-3**.

Table 7-3: PY5 Act 129 WRAP Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Baseload	2,773	85/15	25	25	Records Review
Full-cost	0	85/15	25	0	Records Review
HPWH	167	85/15	25	25	Records Review
Program Total	***2,940***		***75***	***50***	

7.2.3 *Ex Ante* Adjustment Methodology and Findings

There are no *ex ante* adjustment to the energy savings.

7.2.4 *Ex Post* Adjustment Methodology and Findings

The EM&V CSP evaluated savings for HPWHs. according to the 2013 TRM, which provides deemed estimates of 1,698 kWh per year energy savings and 0.02 kW demand reduction. These are the same values used to report savings, so the *ex post* evaluated savings equal the *ex ante* reported savings and the realization rate equals 100%.

The PA Mass Market Protocol bases the evaluated savings for each job type on a customer usage *analysis of the previous years' Act 129 WRAP participants. To estimate the ex post evaluated savings per* baseload job for the PY5 evaluation, the EM&V CSP conducted a customer usage analysis of Phase I PY2 and PY3 participants, using a monthly fixed-effects model. This analysis resulted in 911 kWh per year in savings per baseload job which is 91% of the reported value of 1,003 kWh per year. As there are no additional adjustments to participant numbers or energy savings, the realization rate for baseload jobs is 91%. The program's aggregate realization rate for energy savings was 92%.

The EM&V CSP calculated the demand reductions of 0.10748 kW per baseload job using this equation:

$$kW = (kWh * CF)/Hours\ Per\ Year$$

Where:

kWh	=	Evaluated kWh per year per job type
CF	=	Coincidence factor,[29] 0.00011797
Hours per year	=	8,760

The *ex ante* reported savings per baseload job were 0.10693 kW, so the realization rate for the demand reduction was 101%. The program's aggregate realization rate for demand reduction was also 101%.

More detailed information about the billing analysis is provided in **Appendix G: Act 129 WRAP Billing Analysis.**

Records Review

The EM&V CSP requested and reviewed all of the supporting documentation for the sample of 25 baseload jobs and 25 HPWHs. The records review involved verifying information reported in the EEMIS database using program intake forms and contractor-submitted supporting documentation. Records matched and the EM&V CSP made no adjustments to the number of jobs or HPWHs installed.

7.2.5 Site Visits

All full-cost jobs and HPWH installations are slated for verification site visits conducted by PPL Electric Utilities and its trade allies. Although PPL Electric's goal is to conduct site visits at all full-cost jobs and HPWH installations, this goal is not reachable because participants may not keep an appointment for a site inspection. The EM&V CSP does not conduct site visits for this program.

The EM&V CSP also reviewed PPL Electric's on-site inspection documents. During its review of Q3 records, the EM&V CSP noted that three of the 10 HPWH installations selected for review were missing documentation for site visits and advised PPL Electric. Upon further review, PPL Electric Utilities determined that these records had not been designated for a site inspection and subsequently scheduled visits to these residences. PPL Electric Utilities also instituted closer oversight of the HPWH installations to ensure that all future installations were scheduled for site inspections.

7.2.6 Summary of Evaluation Results

In PY5, Act 129 WRAP realized 92% of the *ex ante* adjusted energy savings, as shown in **Table 7-4**. This includes savings of 284 MWh/yr associated with the installation of 167 HPWHs through the program.

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[29] The coincidence factor was calculated using the PJM peak demand window definition of 2:00 p.m.-6:00 p.m. on non-holiday weekdays during June, July, and August. For the Phase II plan, the Act 129 WRAP measures were assigned a *Residential Single-Family Miscellaneous* load shape.

Table 7-4: PY5 Act 129 WRAP Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings[2] (MWh/yr)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Baseload	2,781	2,781	91%	2,526	N/A[3]	N/A[3]
HPWH	284	284	100%	284	N/A[3]	N/A[3]
Program Total	**3,065**	**3,065**	**92%**	**2,810**	**N/A[3]**	**N/A[3]**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[3] Because this program's evaluation did not include sampling, C_v and precision are not meaningful.

In PY5, Act 129 WRAP realized 101% of the ex ante adjusted demand reduction, as shown **Table 7-5**. *This* includes a reduction of 0.003 MW/yr associated with the installation of 167 HPWHs through the program.

Table 7-5: PY5 Act 129 WRAP Summary of Evaluation Results for Demand

Stratum	Reported *Gross* Demand Savings[1] (MW)	Adjusted *Ex Ante* Demand Savings[2] (MW)	*Demand* Realization Rate (%)	Verified *Gross* Demand Savings[2], [4] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	*Relative* Precision at 85% C.L.
Baseload	0.3	0.32	101%	0.32	N/A[3]	N/A[3]
HPWH	0.003	0.003	100%	0.003	N/A[3]	N/A[3]
Program Total	**0.3**	**0.32**	**101%**	**0.33**	**N/A[3]**	**N/A[3]**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Because this program's evaluation did not include sampling, C_v and precision are not meaningful.
[4] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.

7.3 Impact Evaluation Net Savings

The EM&V CSP did not assess freeridership in Act 129 WRAP because freeridership or spillover are not assumed for this program. Measures are installed at no cost to income-eligible customers; therefore, a NTG ratio of 1.0 is assumed.

7.4 Process Evaluation

PPL Electric Utilities regularly conducts a process evaluation for the existing LIURP WRAP, in compliance with the Pennsylvania Public Utility Commission. The Act 129 WRAP processes and projects do not significantly diverge from the LIURP WRAP processes and projects. The EM&V CSP limited its process evaluation to documenting any changes to the Act 129 WRAP.

A limited process evaluation was conducted in PY5 for Act 129 WRAP. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the findings from the research tasks.

For Act 129 WRAP, the EM&V CSP conducted these PY5 process evaluation activities:

- Program staff and implementer interviews (n=1)
- Program literature review and benchmarking
- *Database and QA/QC review of records*
- Process map development

7.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-7.**

7.6 Financial Reporting

A breakdown of the program finances is presented in **Table 7-6.** Act 129 WRAP was not cost-effective in PY5, with a TRC benefit-cost ratio of 0.83. This ratio is considerably lower than the PY4 value of 1.27 and the Phase I value of 0.96.

Table 7-6: Summary of Act 129 WRAP Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$ -	$ -
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	$ -	$ -
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance [1]	$3,390	$3,390
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	**$3,390**	**$3,390**
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	***$3,390***	***$3,390***
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	**$3,390**	**$3,390**
Total NPV Lifetime Energy Benefits	**$2,684**	**$2,684**
Total NPV Lifetime Capacity Benefits	**$143**	**$143**
Total NPV TRC Benefits[7]	**$2,827**	**$2,827**
TRC Benefit-Cost Ratio[8]	**0.83**	**0.83**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.

[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.

[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.

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

[7] 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.

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

8 Residential Home Comfort Program

The Residential Home Comfort Program offers a wide range of energy-efficient measures and rebates for new construction and the retrofitting of existing homes. The program also offers education and services so customers can customize solutions to improve their home's energy efficiency. The PY5 program involved four program components:

- **Audit** offers customer rebates for professional comprehensive home energy audits or, for $50, a less comprehensive walk-through assessment.
- **Weatherization** is based on recommendations from the audit and offers rebates for duct sealing and insulation.
- **Energy-efficient equipment** offers rebates for the installation of high-efficiency heat pumps, ductless mini-split heat pumps, and pool pumps.
- **New homes** encourages construction of energy-efficient new homes by offering a rebate to builders for installing a specific package of measures.

The objectives of the Residential Home Comfort Program are to:

- Encourage customers to view energy-efficiency in a holistic manner
- Promote construction of energy-efficient new homes
- Educate construction industry professionals about the benefits of energy-efficient new homes
- Provide customers with home energy audits, surveys, and energy-saving solutions
- Provide immediate energy savings to customers by offering free direct install measures
- Obtain participation by approximately 13,900 customers and trade allies through 2016, with a total reduction of approximately 12,700 MWh/year

The program is limited to customers in the residential sector.

An executive summary of program metrics can be found in **Table 8-1.**

Table 8-1: Residential Home Comfort Executive Summary

Program	Phase II Reported Energy *Savings* (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Residential Home Comfort	2,367	2,372	2,410	0.57	0.64	$1,188	$0.49	$0.178	2,554

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

8.1 Program Updates

The Residential Home Comfort Program is new in Phase II. It is a hybrid program that combines two Phase I programs—the residential Home Energy Assessment and Weatherization Program and the HVAC rebate component of the Efficient Equipment Program—and it also includes a new construction component.

The audit and weatherization component is a continuation of the Phase I program. Customers can choose one of two home energy audit types. The walk-through assessment, called the "Home Energy Survey," costs $50 but includes no diagnostic testing.

Customers who choose the comprehensive home energy audit select an auditor and pay the market price. The cost varies by auditor; PPL Electric Utilities estimates audits cost about $500. Customers are eligible for a $250 rebate if electricity is the primary space heating fuel source *and* central air conditioning, or, $125 if they have either electric space heat *or* central air conditioning. The comprehensive home energy audit includes diagnostic testing such as a blower door test.

The efficient equipment component offers rebates for installing the following equipment:

- $100 for a seasonal energy-efficiency rating (SEER) 15 air source heat pump (ASHP)
- $200 for a SEER 16 ASHP
- $100 to $200 per ton for a ductless mini-split heat pumps (DHP) with a minimum SEER of 15
- $150 for installation multi-speed pool pumps

The new construction rebate of $2,000 is available to builders who install the following suite of efficient measures:

- SEER 16 ASHP
- Heat pump water heater (HPWH) with an energy factor greater than or equal to 2.3
- ENERGY STAR® refrigerator and dishwasher
- Ceiling insulation with an R-value greater than or equal to R-49

- *Wall insulation with an R-value greater than or equal to R-20+5*[30]

In April 2014, PPL Electric Utilities filed a revised EE&C plan with the PUC,[31] in which it added new rebates to customers and training and equipment for contractors. These are:

- A bonus rebate of $500 is available to audit participants who follow through and install recommended insulation and duct sealing measures within 180 days of the comprehensive audit.
- A $200 rebate for customers who are on PPL Electric Utilities' Residential Thermal Storage (RTS) rate and who upgrade their heating system to an ASHP or DHP of SEER 15 or greater.
- Two new rebates are offered in the new construction component—a manufactured homes rebate and a performance-based "HERS Option" new construction rebate.[32] These rebates will launch in PY6.
  - The manufactured homes rebate offers $1,200 to encourage customers to purchase a new high-efficiency ENERGY STAR manufactured home. Customers who also install energy-efficient heating are eligible to receive an additional $200 for a SEER 15 ASHP or $300 for a SEER 16 ASHP.
  - The HERS Option offers rebates of up to $2,000, based on the projected kWh savings modeled by energy rating software such as REM/Rate.
- The revised plan offers thermal imaging guns and training on how to use them to contractors certified by the Building Performance Institute (BPI).

8.1.1 Definition of Participant

In the Residential Home Comfort Program, a participant is defined as a record (participant) with a unique CSP Job ID. There may be (and often are) multiple measures installed by a single participant, for example, the low-cost efficiency measures installed at the time of the audit. All measures with the same CSP Job ID are defined and counted as one participant.

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30 "R-20+5" refers to R-20 cavity insulation plus R-5 insulated sheathing. See IECC 2009 Section 402.1.1 Insulation and Fenestration Criteria. Available online at: http://publicecodes.cyberregs.com/icod/iecc/2009/icod_iecc_2009_4_sec002.htm

31 PPL Electric. *PPL Electric Utilities Corporation Energy Efficiency and Conservation Plan Act 129 Phase II*. Pennsylvania Public Utilities Commission. Docket Number M-2012-2334388. April 7, 2014.

32 Home Energy Rating System. More information available online at: http://www.resnet.us/hers-index

8.2 Impact Evaluation Gross Savings

8.2.1 Reported Gross Savings

Table 8-2 shows the reported gross energy savings and incentives paid. Participant numbers include counts for all program components: audit, weatherization, efficient equipment, and new construction. PPL Electric Utilities paid no new construction rebates in PY5.

Table 8-2: Phase II Residential Home Comfort Program Reported Results by Customer Sector

Sector	*Participants*	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Residential	2,551	2,362	0.91	$417
Small Commercial and Industrial	3	4	0.00	$0
Phase II Total	**2,554**	**2,367**	**0.91**	**$417**

8.2.2 EM&V Sampling Approach

The evaluation, measurement, and verification (EM&V) methodology includes telephone survey verification and records verification (desk audit). The EM&V CSP designed the sampling to meet or exceed the confidence and precision targets for all programs in the residential sector of the Act 129 portfolio, that is, 90% confidence and 10% precision (90/10) for the residential sector as a whole. The EM&V requirements target 85% confidence and 15% precision (85/15) at the program level. **Table 8-3** shows the population, targets, achieved, confidence and precision, and activities of the strata.

The EM&V CSP used the telephone surveys to assess participant satisfaction with the program and to verify the measures and measure quantities recorded in EEMIS, PPL Electric's program tracking database. The EM&V CSP designed the survey instruments to capture information unique to the measures installed by participants through the audit, weatherization, and efficient equipment components.

Table 8-3: Residential Home Comfort Program Sampling Strategy for PY5[1]

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Audit Measures	555	85/15	30	33	Records Review
Audit Measures	555	90/10	72	72	Telephone Survey
Efficient Equipment – HVAC	1,836	85/15	30	30	Records Review
Efficient Equipment – Pool Pump	70	85/15	30	69	Records Review
Efficient Equipment	1,806	90/10	75	75	Telephone Survey
Weatherization	88	85/15	30	40	Records Review
Weatherization	88	90/10	75	17	Telephone Survey
Program Total[2]	**2,549**		**342**	**336**	**Multiple Activities**

NOTES:
[1] For Telephone Surveys, population size is the number of unique customers; customers can receive multiple rebates.
[2] This table provides data for multiple evaluation activities conducted for the same population so the program total for the Population Size will not equal the sum of the individual strata population sizes.

The achieved sample size for telephone surveys of the weatherization stratum is considerably lower than the target sample size because the population size was small. The EM&V CSP obtained responses from 19% of the population of 88. For the records review, the EM&V CSP achieved higher sample sizes than the targets set for all strata. For the audit measures and the weatherization strata, the EM&V CSP sampled by CSP Job ID, but it requested and reviewed all audit intake/rebate records associated with an individual home.

Because weatherization rebates are contingent upon participation in the home energy audit component of the program, there is considerable cross-participation and hence the achieved sample sizes are higher than the target. For the efficient equipment – pool pump stratum, the EM&V CSP sampled by CSP Job ID, but all of the parameters needed to calculate savings using the algorithms in the 2013 Pennsylvania TRM were not uploaded in EEMIS.[33] However, this information was available on the rebate applications and there were only 70 participant records, so the EM&V CSP requested all of the participant records and received and reviewed 69.

8.2.3 *Ex Ante* Adjustment Methodology and Findings

All measure savings were calculated using algorithms provided in the 2013 TRM and input parameters provided in EEMIS or in supporting documentation received from the Implementation CSP. For all measures other than pool pumps, there was no *ex ante* adjustment.

Both two-speed and variable-speed pool pumps were eligible for the PPL Electric Utilities rebate in PY5. The 2013 TRM provided different savings algorithms for these two measures, but the savings reported in

[33] Pennsylvania Public Utilities Commission. *Technical Reference Manual*. June 2013.

EEMIS for all pool pumps used a deemed value corresponding to a two-speed pool pump. In PY5, all but one pool pump rebated under the program were variable-speed pumps. The EM&V CSP calculated savings for the variable-speed pumps using default values and the 2013 TRM algorithm, resulting in reported values that were, in aggregate, 13% higher than the reported estimates. Realization rates for all measures are the *ex post* evaluated savings as a percentage of the *ex ante* adjusted savings.

8.2.4 *Ex Post* Adjustment Methodology and Findings

The EM&V CSP calculated *ex post* evaluated savings using information collected as part of the records reviews and participant telephone surveys. Both of these evaluation activities employed a stratified random sample for the four measure groups in the records review—audit measures, weatherization, efficient equipment (HVAC), and efficient equipment (pool pumps). For the telephone surveys, the EM&V CSP organized the population into three strata—audit participants, weatherization participants, and efficient equipment rebate recipients. Evaluation activities and the findings are discussed by stratum in the following sections.

8.2.5 Records Review

The objectives of the records review were to verify the measure quantities reported in EEMIS and to collect and verify the input parameters necessary to calculate savings using the 2013 TRM algorithms. For all sampled records, the EM&V CSP compared the measure quantities in the EEMIS extract to the values recorded on the original audit intake or rebate forms.

Audit Measures

The EM&V CSP selected a simple random sample of 33 audit participants and compared the low-cost measure quantities reported in EEMIS to those provided on the rebate forms. The Residential Home Comfort Program installed a variety of bulb types ranging from 9W to 23W CFLs and participants could receive up to eight bulbs as part of the audit. The majority of measure quantity discrepancies were found in the lighting measures. Of the 33 records reviewed, PPL Electric Utilities reported installation of 259 measures, and the EM&V CSP verified 253 measures.

Weatherization

The EM&V CSP selected a simple random sample of 40 weatherization participants and compared the measure quantities reported in EEMIS to those provided on the rebate form. Measure quantities are calculated by the square footage of the weatherized area. The EM&V CSP noted no differences in the measure quantities but found one record with an incorrect measure code. This reported measure code did not account for heating savings provided by the insulation, which were considerable. The EM&V recalculated savings using the correct measure code, which increased the savings for this installation.

Additionally, the EM&V CSP found several records where the weatherized area prior to program participation was uninsulated. The 2013 TRM provides minimum R values of R-3 for wall insulation and

R-5 for ceiling/attic insulation; however, these records reported energy savings using only the R-3 value. The EM&V CSP adjusted the minimum R-value for the ceiling insulation records to R-5.

The EM&V CSP also noted that several algorithm input values had been entered incorrectly into EEMIS and consequently resulted in inaccurate savings calculation. An example was an existing R value of 19 that was entered as 9.

Efficient Equipment – HVAC

The EM&V CSP selected a stratified random sample of 30 program participants who received a rebate for either an ASHP or a DHP. The sample contained nine records from participants who received a rebate for installing a SEER 15 ASHP, nine records from participants who received a rebate for installing an ASHP SEER 16 or greater, and 12 records from participants who had installed a DHP. The EM&V CSP noted no differences in the installed measure quantities or the savings algorithm input parameters.

Efficient Equipment – Pool Pumps

All parameters necessary to calculate pool pump savings using the 2013 TRM were not reported in EEMIS, so the EM&V CSP requested supporting documentation for all 70 records in the participant population and received documentation for 69 records. It found no difference in the installed measure quantities but found that 69 of the 70 pumps were variable-speed pumps rather than two-speed pumps.

The EM&V CSP used the variable-speed pump algorithm and data gathered from the rebate application forms regarding hours of operation per day for both a single-speed pump and a variable-speed pump and calculated an average *ex post* evaluated savings per pool pump of 1,699 kWh versus the average *ex ante* adjusted savings per pool pump of 602 kWh. The primary contributor to the increased savings was the higher number of hours; pool pump owners indicated they operated their existing single-speed pump an average of 13 hours per day, rather than the 5.18 hours per day used in the TRM. Although an additional parameter—the number of days of pump operation per year—has a fixed value of 100 days in the TRM, the EM&V CSP notes that program participants reported an average of 148 days of operation per year.

8.2.6 Surveys

The EM&V CSP conducted a telephone survey of 72 home energy audit program participants to obtain verification of measure quantities and the information necessary to calculate the evaluated in-service rate (ISR) of measures where the source of the ISR is denoted as "EDC Data Gathering." For the Residential Home Comfort Program these measures are CFLs and faucet aerators. The ISR is reflected in the realization rate calculation.

The EM&V CSP calculated an evaluated ISR of 96% for CFLs[34] and 97% for faucet aerators.[35] Adjusting the ISR for CFLs raises savings (over the deemed value of 84%) for this measure by approximately 14% for kWh and 13% for kW.

The evaluated ISR of 97% for faucet aerators is lower than the default value of 100% provided in the 2013 TRM. Using the 2013 TRM algorithm and the evaluated ISR of 97% reduces the *ex ante* adjusted energy savings from faucet aerators of 48 kWh by 1 kWh, and the evaluated energy savings from faucet aerators is 47 kWh. The demand reduction is 0.0042 kW.

For participants responding to the telephone survey, the EM&V CSP compared measure quantities recorded in EEMIS to those provided by the survey respondents and made adjustments for any differences.

8.2.7 Site Visits

The EM&V CSP conducts no on-site verification for the Residential Home Comfort Program. The Implementation CSP conducted 15 site visits for the program during PY4, but none in PY5. The Implementation CSP will conduct site visits in PY6.

The purpose of the Implementation CSP's site visits will be to verify measure installation and the quality of the installation. QC reviewers will inspect a random sample of homes, checking for health and safety concerns, and items such as the inches of insulation installed or the SEER and HSPF of the heat pump installed. If problems are identified, the installation contractor will be flagged for additional site reviews and instructed to address the issues identified by the QC reviewer. Any contractor consistently demonstrating work quality problems or reporting accuracy issues will be removed from the program.

8.2.8 Summary of Evaluation Results

The EM&V CSP calculated energy savings per measure using the algorithms in the 2013 TRM and EDC data gathering. The EM&V CSP calculated the realization rate using findings from the projects chosen for telephone verification and from the results of the records reviews. The realization rate was then applied to the population and calculated as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

The EM&V CSP's final estimate of program-wide savings for each component of the program employed a single realization rate, which was calculated by first aggregating savings by customer (for TRM-adjusted *ex ante* and for *ex post*) and then calculating a single realization rate that applies to the program-wide TRM-adjusted *ex ante* total. As this approach employs a single realization rate, rather than a collection of interdependent realization rates, standard variance calculations yield valid program-wide precision estimates. The program-wide realization rate for the Residential Home Comfort Program is 102% with precision of 0.86% at the 85% confidence level.

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[34] Ibid., p. 130-135.

[35] Ibid., p. 41-44.

Audit Measures

The overall realization rate for the audit measure stratum is 107%. Evaluated savings for the direct install measures provided with the audit will differ from the *ex ante* adjusted savings for two primary reasons: differences in the verified measure quantities; and differences in any of the savings algorithm input parameters. These differences are discussed by measure below. Realization rates for the individual measures are unweighted.

- **Showerheads and Water Heater Pipe Wrap** – the EM&V CSP found no changes to the measure quantities or savings algorithm inputs for showerheads and water heater pipe wrap, so the realization rate for these two measures is 100%.
- **Smart Power Strips** – although there were no changes to the algorithm inputs for smart power strips, its verified measure quantity was greater than the reported quantity, resulting in higher savings and a realization rate of 107%.
- **Lighting Measures** – the realization rate for lighting measures in aggregate is 114%, due to the increase in the ISR from 84% to 96%. The realization rate for LED nightlights is 118%, due to the increase in the nightlight ISR from 84% to 97%.
- **Faucet Aerators** – The faucet aerator realization rate is 97%, due to the decrease in the ISR from 100% to 97%.

Weatherization

For the weatherization measures, corrections to the measure code of one record, adjustments to the minimum R-values of uninsulated areas, and adjustments for data entry errors resulted in evaluated savings that were 79% of the *ex ante* adjusted savings.

Efficient Equipment - HVAC

For the HVAC measures, the savings calculated using algorithm input parameters gathered from the records review produced savings identical to those reported in the database. As there was no *ex ante* adjustment for these measures, the realization rate is 100%.

Efficient Equipment - Pool Pumps

For pool pumps, the savings calculated using algorithm input parameters gathered from the records review produced savings that are 180% greater than the *ex ante* adjusted savings.

The Residential Home Comfort Program evaluation results for energy are shown in **Table 8-4** and for demand in **Table 8-5**.

Table 8-4: PY5 Residential Home Comfort Program Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings[2] (MWh/yr)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Audit Measures	283	283	107%	302	0.16	2.51%
Efficient Equipment - HVAC	1,779	1,779	100%	1,779	0.001	0.02%
Efficient Equipment - Pool Pump	37	42	280%	118	0.04	0.7%
Weatherization	267	267	79%	211	0.40	9.28%
Program Total	**2,367**	**2,372**	**102%**	**2,410**	**0.09**	**0.86%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.

Table 8-5: PY5 Residential Home Comfort Program Summary of Evaluation Results for Demand

Stratum	Reported *Gross* Demand Savings[1] (MW)	Adjusted *Ex Ante* Demand Savings[2] (MW)	*Demand* Realization Rate (%)	Verified *Gross* Demand Savings[2], [3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Audit Measures	0.018	0.02	105%	0.021	0.16	2.40%
Efficient Equipment - HVAC	0.86	0.93	100%	0.93	0.001	0.02%
Efficient Equipment - Pool Pump	0.02	0.027	100%	0.027	0.00001	0.0001%
Weatherization	0.018	0.019	100%	0.019	0.38	8.94%
Program Total	**0.91**	**1.0**	**100%**	**1.0**	**0.002**	**0.18%**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.

8.3 Impact Evaluation Net Savings

The EM&V CSP conducted an analysis to determine net savings for the Residential Home Comfort Program. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

8.3.1 Net-to-Gross Ratio Methodology

The methods used to determine net savings were defined by the Statewide Evaluator, including instructions provided in the Evaluation Framework and Guidance Memos. The EM&V CSP typically determines net savings by assessing freeridership and spillover.

For the Residential Home Comfort Program, the EM&V CSP included freeridership and spillover ratio estimates that were estimated in accordance to the SWE NTG guidelines, which utilizes self-report survey information from participating customers.

8.3.2 Net-to-Gross Ratio Sampling

The EM&V CSP collected data for the NTG analysis in the telephone survey of program participants and employed a stratified random sample. Survey instruments tailored to the measure(s) installed in each stratum were employed. To ensure representation in the response data, the EM&V CSP sub-stratified the Audit population by audit type and attempted to achieve 50% of the responses from each audit type. Likewise, the EM&V CSP sub-stratified the Efficient Equipment population by equipment type, and set the target sample by the percentage of kWh contributed by each equipment type. A summary of the population, target and achieved sample sizes with related statistics by primary strata are provided in **Table 8-6**.

Table 8-6: Residential Home Comfort Program Sampling Strategy for PY5 NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed C_V or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
Audit	Walk-through Audit, Comprehensive Audit	555	0.5	90/10	72	72	100%
Efficient Equipment	ASHP, DHP, Pool Pump	1,806	0.5	90/10	75	75	81%
Weatherization		88	0.5	90/10	75	17	100%
Program Total		**2,449**	**0.5**	**90/10**	**222**	**164**	**91%**

NOTES:
[1] Percent contacted means of the entire sample frame list (those drawn specifically for the survey) how many were called to get the completes, often 100% will be the answer.

8.3.3 Net-to-Gross Ratio Findings

The freeridership and spillover ratio estimates for the Residential Home Comfort Program, estimated in accordance with the SWE NTG guidelines, are shown in **Table 8-7**.

Table 8-7: PY5 Residential Home Comfort Program Summary of Evaluation Results for NTG Research [1]

Stratum	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed C_V or Proportion in Sample Design	Relative Precision
Audit	0.18	0.10	0.92	0.050	8%
Efficient Equipment	0.54	0.05	0.51	0.084	18%
Weatherization	0.35	0.08	0.73	0.107	19%
Program Total	**0.48**	**0.06**	**0.58**	**0.193**	**32%**

NOTES:
[1] Freeridership, spillover, and NTG ratios at the program level are weighted by the stratum's *ex post* kWh program population savings.

For the audit stratum, the estimated freeridership of 18% reflects participants' intent to *have an energy audit* without the rebate provided by PPL Electric, not to independently purchase and install the low-cost measures installed by the auditor. The freeridership value for the audit is higher than anticipated. The primary drivers of this value are:

- The freeridership section of the survey did not preface the questions by providing information about the market cost of an audit. Sixty percent of respondents had a $50 home energy survey and may not have been aware that the market price of a home energy audit is approximately $400 to $500. These individuals may have assumed they could get an audit for $50 without PPL Electric's program.
- The audit is a prerequisite to eligibility for rebates for attic and wall insulation and for duct sealing. Respondents may have had this requirement in mind when stating they would have had the audit anyway even if the PPL Electric Utilities audit rebate were not available because they knew they needed an audit to take advantage of the weatherization rebate.

Estimated freeridership for the efficient equipment measures, i.e., ASHP, DHP, and pool pumps, is 54%. Only 11 of the 70 pool pump rebate participants completed the telephone survey, so the majority (64) of the 75 respondents to the efficient equipment survey were ASHP and DHP rebate recipients. There are several factors driving the freeridership estimate of 54%.

- The federally mandated minimum of SEER 13 for cooling equipment has been in effect for eight and a half years. (It will increase to SEER 14 on January 1, 2015.)
- The HVAC rebate program is a mature program. PPL Electric Utilities has provided rebates for efficient SEER 15 and higher ASHP since 2009. Over the past five years, the rebates have decreased from $325 for a SEER 15 ASHP and $400 for a SEER 16 and higher ASHP to the current rebates of $100 and $200, respectively. Lower rebates are less likely to provide sufficient motivation for customers to purchase higher efficiency equipment.

- Additionally, federal tax credits were available for purchase of high-efficiency heating and cooling equipment up through December 2013, providing additional incentives for installation of higher-efficiency HVAC units.[36]

Recent interviews with HVAC contractors conducted by the EM&V CSP indicated that customer awareness of energy efficiency has increased over the last five years, and customers are already interested in heat pumps before they hear of PPL Electric's rebate. Contractors attributed the increased customer awareness of energy efficiency to the PPL Electric Utilities rebate program. Additionally, PPL Electric's rebate program influences what contractors sell. Over half of the 15 contractors interviewed reported that the PPL Electric Utilities energy-efficiency program is *very important* (n=2) or *somewhat important* (n=6) in their firm's decision to sell or install heat pumps. Since PPL Electric Utilities rebates became available, the percentage of contractors *always* promoting heat pumps increased from 47% to 60%.

With increased customer awareness of energy efficiency and the PPL Electric Utilities rebate program influencing contractor promotion of heat pumps, the market has changed. The combination of a mature market and mature programs is leading to a market transformation.

Estimated freeridership for the weatherization rebates (i.e., attic and wall insulation and duct sealing) was 35%, which is higher than the 25% reported in the PY4 evaluation of the Home Assessment and Weatherization Program. Primary drivers of the difference in freeridership are:

- The PY4 participant population of weatherization rebate recipients was substantially larger than the PY5 participant population (1,994 and 88, respectively). Consequently, the number of completed surveys from which the EM&V CSP estimated freeridership and NTG ratio was also greater in PY4 than in PY5 (70 and 17).
- Additionally, because all PY4 weatherization rebates were reported in PY4, regardless of the measure installation date, the PY4 installation dates ranged from 2009 through 2013. All PY5 participant installation dates were limited to PY5 (June 1, 2013, through May 31, 2014). Therefore, the PY5 respondents had more time to internalize the energy-efficiency message provided by the program.

Finally, the difference in the algorithm used in PY5 to estimate freeridership in accordance with the SWE NTG guidelines produced higher freeridership values for all strata of the Residential Home Comfort Program.

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[36] The Residential Energy Efficiency Tax Credit applies to energy efficiency improvements in the building envelope of existing homes and for the purchase of high-efficiency heating, cooling and water-heating equipment. Efficiency improvements or equipment must serve a dwelling in the United States that is owned and used by the taxpayer as a primary residence. The credit is equal to the full cost of the equipment up to a cap of $300 for an electric heat pump, which achieves the highest efficiency tier established by the Consortium for Energy Efficiency: SEER 14.5 for split system ASHP, and SEER 14 for packaged system ASHP. The maximum tax credit for all improvements made in 2011, 2012, and 2013 is $500. The cap includes tax credits for any improvements made in any previous year. This tax credit expired on December 31, 2013.

8.4 Process Evaluation

A process evaluation was conducted In PY5 for Residential Home Comfort Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

An executive summary of the process evaluation follows below, along with the sampling strategy. For the Residential Home Comfort program, the PY5 process evaluation activities were these:

- Participant surveys (n=164)
- Equipment (n=75)
- Audit (n=72)
- Weatherization (n=17)
- Program staff and implementer interviews (n=2)
- Program literature review and benchmarking
- Database and QA/QC review of records
- Process map review

Table 8-8: Residential Home Comfort Program Process Evaluation Sampling Strategy for PY5[1]

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or C_V in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted to Achieve Sample	Evaluation Activity
Audit Measures	Walk-through Audit, Comprehensive Audit	555	0.5	90/10	72	72	100%	Telephone Survey
Efficient Equipment	ASHP, DHP, Pool Pump	1,806	0.5	90/10	75	75	81%	Telephone Survey
Weatherization		88	0.5	90/10	75	17	100%	Telephone Survey
Program Total		**2,449**	**0.5**	**90/10**	**222**	**164**	**91%**	

NOTES:
[1] Freeridership, spillover, and NTG ratios at the program level are weighted by the stratum's *ex post* kWh program population savings.

8.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-8.**

8.6 Financial Reporting

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

Table 8-9: Summary of Residential Home Comfort Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$417	$417
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	**$417**	**$417**
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$771	$771
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	**$771**	**$771**
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	**$1,188**	**$1,188**
Participant Costs[5]	$2,514	$2,514
Total NPV TRC Costs[6]	**$3,702**	**$3,702**
Total NPV Lifetime Energy Benefits	**$1,959**	**$1,959**
Total NPV Lifetime Capacity Benefits	**$394**	**$394**
Total NPV TRC Benefits[7]	**$2,370**	**$2,370**
TRC Benefit-Cost Ratio[8], [9]	**0.64**	**0.64**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.

[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.

[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.

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

[7] *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.

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

[9] Total NPV TRC Benefits includes $16,524 to account for O&M lighting replacement costs.

9 E-Power Wise Program

The E-Power Wise Program provides low-income customers with energy-efficiency education to enable them to make informed choices about energy use. The program targets PPL Electric Utilities customers with incomes at or below 150% of the federal poverty level. The program is available to customers in single-family housing and in multifamily housing where each unit is metered (not master metered).

The program uses a train-the-trainer model, in which the program Implementation CSP (Resource Action Program Inc., or RAP) trains Community Based Organization (CBO) staff and/or others it identifies to provide energy workshops at locations convenient to the targeted customer segment. Workshops have been held during days, in evenings, and on weekends, making the sessions accessible to as many low-income customers as possible. CBOs also conduct one-on-one energy education sessions with customers. Program outreach focuses on (but is not limited to) attracting low-income seniors to participate. Customers attending each session were asked to complete a survey, and these survey results were used to evaluate various program metrics. The program also offers a direct mail delivery channel to customers. This alternative delivery method enables eligible customers to receive an energy-savings kit directly from the Implementation CSP.

The objectives of the E-Power Wise Program are:

- Provide quality energy conservation and efficiency education to low-income customers.
- Provide information about low-cost/no-cost energy-efficiency strategies that low-income customers can use in their homes.
- Provide low-income customers with energy-efficiency measures in free take-home and direct mail energy-efficiency kits.
- Obtain participation by 7,900 customers and achieve energy savings of 3,379 MWh/yr.

An executive summary of program metrics can be found in **Table 9-1**.

Table 9-1: E-Power Wise Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II *Adjusted Ex Ante* Energy Savings (MWh/yr)	Phase II *Verified* Gross Energy Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
E-Power Wise	1,863	1,863	1,525	1.0	2.99	$259	$0.17	$0.033	2,715

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

Table 9-2 summarizes the items in the energy savings kit delivery to PPL Electric's customers through the E-Power Wise Program.

Table 9-2. Measures Included in E-Power Wise Program Energy Savings Kit

Measures Included	Agency Delivery Channel	Direct Mail Delivery Channel
13W CFL (2 bulbs)	✓	✓
LED Nightlight	✓	✓
Low-Flow Showerhead	✓	✓
Kitchen Aerator	✓	✓
Bathroom Aerator	✓	✓
Furnace Whistle	✓	✓
Smart Strip	✓	✓

The energy savings kits and training also included behaviorally based activities that could reduce energy use. PPL Electric Utilities claims behaviorally based energy savings for this program.

9.1 Program Updates

PPL Electric Utilities did not make any changes to the program in PY5.

9.1.1 Definition of Participant

Participants in PY5 are defined as any low-income customer who received an energy-efficiency kit either through the CBO or direct mail delivery channel of PPL Electric's E-Power Wise Program between June 1, 2013 and May 31, 2014.

9.2 Impact Evaluation Gross Savings

9.2.1 Reported Gross Savings

Table 9-3 shows the cumulative reported results by sector.

Table 9-3: Phase II E-Power Wise Program Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)[1]
Low-Income	2,715	1,863	0.14	$0
Phase II Total	**2,715**	**1,863**	**0.14**	**$0**

NOTES:
[1] Beginning in PY3 Q3, the value of the free home energy kits and education are not classified as an incentive, consistent with the Pennsylvania PUC's August 2011 TRC Order. These costs are treated as direct program costs in the "Management" financial category.

9.2.2 EM&V Sampling Approach

The EM&V CSP conducted a database review of the census of EEMIS records each quarter. The CSP included all written surveys returned by participants in the energy savings analysis. Record reviews and phone surveys were not conducted in PY5.

Database Review Sample Sizes

The E-Power Wise Program conducted a database review of the census of EEMIS records, as presented in **Table 9-4**. The database review checked the Implementation CSP's records against the EEMIS records for accuracy and consistency.

Table 9-4: E-Power Wise Program Sampling Strategy for PY5

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
All	2,715	N/A[1]	All Records	2,711[2]	Database Review
Phase II Total	**2,715**	**N/A[1]**	**All Records**	**2,711[2]**	

NOTES:
[1] Since this program's evaluation did not include sampling, confidence and precision are not meaningful.
[2] During verification activities, the EM&V CSP identified and removed four accounts that received multiple kits or could not be traced between databases.

Kit Survey Sample Sizes

The Implementation CSP included a paper survey in each kit distributed. The surveys were returned by participants to the Implementation CSP throughout the year. All surveys returned to the Implementation CSP were provided to the EM&V CSP. This survey gathered the data necessary for the EM&V CSP to complete engineering calculations to compute energy savings in PY5.

Of the 1,599 participants who entered the program through the agency-based delivery channel, 199 returned kit surveys. Of 1,112 participants who entered through the direct mail delivery channel, 188 returned kit surveys. All kit surveys returned by PY5 participants were included in the program evaluation. **Table 9-5** presents the delivery method, sample size, and functions of each of the surveys used in this evaluation.

Table 9-5: Kit Survey Data Collection for E-Power Wise Program

Survey	Survey Delivery Method	Frequency	Sample Size	*Impact Evaluation*	
				Measure Installation Energy Savings	Behavior Change Energy Savings
Agency-Based Participant Kit	Included in kit	All quarters	199 (All)	Yes	Yes
Direct Mail Participant Kit	Included in kit	All quarters	188 (All)	Yes	Yes

9.2.3 *Ex Ante* Adjustment Methodology and Findings

A savings adjustment was necessary to calculate the E-Power Wise Program realization rate. The EM&V CSP adjusted the reported savings (presented in **Table 9-6**) from EEMIS to align with assumptions specified in the TRM and the characteristics of the kit items themselves, results in adjusted *ex ante* savings.

The TRM *ex ante* adjustment modifies the savings reported in EEMIS (reported *ex ante* savings) to reflect the specifications of the measures included in the kit. This adjustment is made to the population, and accounts for differences among planning assumptions, the TRM assumptions, and the equipment that was actually distributed to participants. The results of this adjustment to the population, prior to any calculations of savings, are the adjusted *ex ante* savings. These are the *ex ante* savings used in the equation to determine the program's realization rate.

Table 9-6 shows the results of the TRM-adjusted *ex ante* calculations for the seven measures included in each kit.

Table 9-6: Reported and Adjusted *Ex Ante* Savings per Technology and per Unit

Measure[1]	Reported *Ex Ante* Savings (kWh/yr)	TRM Adjusted *Ex Ante* Savings (kWh/yr)	Factors
Furnace Whistle	59	Updated savings by zip code mapping; Scranton (61 kWh), Philadelphia/Williamsport/ Harrisburg/Allentown (59 kWh)	PPL Electric Utilities assumed EFLH hours for Harrisburg as a placeholder. 2013 TRM Table 2-6 used to update EFLH by mapping participant zip codes to the nearest city.
Smart Strip	184	184	2013 TRM Section 2-13 stipulates 184 kWh.
CFL	40	40	PPL Electric Utilities assumes 84% ISR per 2013 TRM.
CFL 20W[2]	42	40	PPL Electric Utilities assumes 84% ISR per 2013 TRM. TRM adjusted value (13W CFL).
CFL3[2]	40	40	PPL Electric Utilities assumes 84% ISR per 2013 TRM. EEMIS database update with correct kit CFL wattage and kWh savings.
Faucet Aerator - Bath	25	25	PPL Electric Utilities uses 52% fuel saturation per PPL RASS study.
Faucet Aerator - Kitchen	25	25	PPL Electric Utilities uses 52% fuel saturation per PPL RASS study.
Low-Flow Showerhead	129	Direct mail participants (129 kWh), Agency multifamily (114 kWh), Agency single-family (131 kWh)	PPL Electric Utilities uses 52% fuel saturation per PPL Electric Utilities RASS study. 2013 TRM stipulates different fixed values based on housing type.[3]
Energy Education (Initial)	160	160	Behavior-based Custom Measure Protocol (CMP) approved by the SWE in Phase I.[4]
LED Nightlight	22	24	TRM adjusted value (0.5W).[5]

NOTES:

[1] All measures are part of the low-income sector.

[2] During PY5 Q1-Q3, EEMIS contained two placeholder values for kit CFL bulbs, noted above as CFL and CFL20W. The 13W CFL was incorrectly noted as a 20W CFL bulb. For Q1-Q3, a TRM *ex ante* adjustment applied to the 20W CFL wattage brought it in line with the appropriate kit bulb wattage. PPL Electric Utilities adjusted this assumption by updating EEMIS in PY5 Q4 with an additional placeholder value, noted above as CFL3, with the correct kit CFL saving information.

[3] E-Power Wise Program kit showerhead is rated at 1.75 gpm, which match PPL planning assumptions. The 2013 TRM provides fixed variables for single-family and multifamily home types based on the number of persons and showers in the house. Enrollment data regarding home type was available for agency participants but not direct mail participants. A weighted average of single-family and multifamily home type saturation determined the number of people and showers per day for direct mail participants. For agency participants, actual home types are used from enrollment information.

[4] Savings from energy education and related behavioral activities were derived from survey data using the PY3 *Custom Measure Protocol Measuring Impacts of Behaviorally Based Activities in Low-Income Energy Education/Energy Kit Programs.* The EM&V CSP updated the CMP in PY5 to conform with updates to the 2013 TRM water heaters, clothes washers, and programmable thermostats algorithms (see Appendix F: E-Power Wise Behavior Savings Calculations for more information). This update affects the survey-verified savings for survey respondents.

[5] Uses the 2013 TRM calculation for the LED nightlight. The nightlight included in the E-Power Wise kits is a 0.5W lamp.

9.2.4 Ex Post Adjustment Methodology and Findings

Ex post savings adjustments modify the TRM-adjusted *ex ante* savings in two ways:

- First, the results of quantity adjustments resulting from database review activities are incorporated.
- Second, the kit item and energy education savings are modified to reflect the installation rates determined through the participants' returned surveys.

Results of these adjustments are reflected in the *ex post* savings. The *ex post* savings are used in the calculations to determine the savings realization rate.

Database Review

The EM&V CSP conducted a database review of all PY5 participant records in EEMIS. Participants' PPL Electric Utilities account numbers, E-Power Wise Program kit numbers, and other data stored in EEMIS were reviewed across all previous program years and quarters to ensure that the program counted only one kit per household. Additionally, participant records from EEMIS were compared with enrollment data stored in the Implementation CSP's electronic database to ensure that records were traceable between the CSP and EEMIS databases.

EEMIS listed a total of 2,715 participants prior to the database review. Through the database review, the EM&V CSP identified and removed accounts that received multiple kits or could not be traced between databases. As a result, the total number of program kits was reduced to 2,711, representing 99.9% accuracy.

Table 9-7 summarizes the database review and the number of kits verified in the PY5 analysis. The EM&V CSP accounted for the four duplicate accounts and total savings estimate by assigning them zero verified savings.

Table 9-7: Database Review Results for PY5 E-Power Wise Program

Sector	Measure	Kits in EEMIS	Database Accuracy	PY5 Eligible Kits
Low-Income	Kit (including all measures)	2,715	99.9%	2,711

Participant Kit Surveys

Each kit distributed through the program included a PPL Electric-approved participant survey. These surveys collected the necessary data to calculate installation rates and to determine participant actions taken as a result of the program. In total, the analysis included 199 mail-in surveys returned by the participants who received the kit from the CBO agency and 188 surveys returned by direct mail participants. A total of 387 mail-in surveys were included in the program evaluation.

Participant Kit Surveys Methodology

The EM&V CSP used participant returned paper kit surveys to calculate *ex post* per-unit savings for each item contained in the E-Power Wise Program kit as well as for behavior change savings. In PY5 the EM&V CSP updated the survey verification methodology to calculate energy savings. The methodology relied on individual survey respondent-level information available from returned surveys and the program enrollment cards. The EM&V CSP assigned specific survey *ex ante* and survey-verified *ex post* savings values to each respondent for each measure based on the following variables:

- Whether the respondent answered the measure-specific question
- Home characteristics recorded on the respondent's enrollment card (i.e., gas or electric space and water heat)
- How the respondent answered the questions asking if measures were installed
- How the respondent answered questions about actions taken that could result in behaviorally-based energy savings

TRM adjusted *ex ante* savings were assigned as measure-level survey *ex ante* savings for all measure-specific questions. *Ex ante* savings calculations for energy education (behaviorally based savings) is described in detail in section 0. Refer **Appendix F: E-Power Wise Behavior Savings Calculations** to for more information on updates to the energy education savings calculations.

No *ex ante* savings were assigned to measures corresponding to questions that respondents did *not* answer. These measures were not included in the calculation of the *ex post* savings and realization rate. For example, one survey respondent answered some but not all of the survey questions.

An example of a kit survey question is:

> *Did you install the new High-Efficiency Showerhead from your Kit?*

Possible responses included in the survey:

> *(1) Yes, I installed it, (2) Yes, I plan to install it, (3) No.*

The revised PY5 methodology calculates the variation among program participants by applying specific values to each survey respondent's answers to measure-specific questions and about home characteristics. The resulting realization rate reflects this variation and the precision captures any uncertainty associated with the participant level variation and sampling. Refer to **Appendix E: Methodology for Determining Savings from Energy-efficiency Kits** for more information on the respondent-level methodology.

Behaviorally Based Savings

E-Power Wise Program behaviorally based savings obtained through energy education are calculated using a Custom Measure Protocol (CMP). The behavior savings CMP includes algorithms include some fixed variables. In PY5, the EM&V CSP adjusted the CMP in two ways:

- Reviewed and updated the CMP savings assumptions to ensure that the fixed variables reflected the 2013 Pennsylvania TRM engineering calculations
- Defined the criteria for applying survey-verified savings to respondents based on individual actions of behavior change

Three household actions affecting behaviorally based energy savings include:

- Lowering the temperature of the water heater
- Changing the frequency that laundry is washed in cold water
- Adjusting the home thermostat according to the heating/cooling season

Additional details on the updated CMP can be found in **Appendix F: E-Power Wise Behavior Savings Calculations.**

The EM&V CSP updated the method for applying behavior savings. Savings are assigned depending on how respondents answered each question asking if measures were installed. It is possible for a respondent to conduct one behavior change activity and not another. Therefore, each respondent receives behavioral savings according to individual actions. For example, a respondent may lower the temperature on the home's water heater but not raise the home temperature/thermostat setting in the summer. In this case, the savings would be lower than a respondent who took both actions.

Summary of Survey Findings

Program participants returned a total of 387 surveys that were included in the energy-efficiency kits. **Table 9-8** presents the PY5 installation rates (ISR) for each of the energy saving kit items. ISRs are presented as a percentage of participants who answered the question, and not a percentage of the total number of people surveyed. The installations rates for kit measures are useful for program planning purposes.

Table 9-8: Installation Rates for Kit Measures Distributed Through E-Power Wise Program

Measure Installed	Kit Delivery Method			
	PY5 CBO/Agency		PY5 Direct Mail	
	Sample Count (n)	ISR	Sample Count (n)	ISR
Bathroom Aerator	115	71%	113	66%
Kitchen Aerator	115	72%	113	74%
Low-Flow Showerhead	119	65%	117	72%
13W CFL	191	96%	187	100%
13W CFL	174	88%	171	91%
LED Nightlight	194	88%	183	94%
Furnace Whistle	82	43%	65	58%
Smart Strip[1]	198	61%	180	58%

NOTES:
[1]The TRM does not allow EDC data gathering for the ISR for smart strips but the information collected via participant surveys is useful for program planning.

The EM&V CSP determined relative per-unit savings for each of the items included in the kits using respondent-level installation rates determined through the participant surveys and TRM algorithms. **Table 9-9** shows the survey verified savings attributable to each of the measures included in the kit.

Table 9-9: E-Power Wise Program Survey Verified Measure Savings per Distributed Unit

Measure Installed	PY5 Agency-Based Per-Unit Savings (kWh/yr)	PY5 Direct Mail Per-Unit Savings (kWh/yr)
Bathroom Aerator	25	25
Kitchen Aerator	25	25
Low-Flow Showerhead[1]	131	129
13W CFL	48.03	48.03
13W CFL[2]	48.03	48.03
LED Nightlight	24	24
Furnace Whistle	Allentown (60 kWh), Scranton (61 kWh), Erie (62 kWh), Pittsburgh (58 kWh), Other cities (59 kWh)	Allentown (60 kWh), Scranton (61 kWh), Erie (62 kWh), Pittsburgh (58 kWh), Other cities (59 kWh)
Smart Strip	184	184

NOTES:
[1] The difference in savings is due to actual household enrollment data available for agency delivered kits.
[2] EEMIS contains separate placeholder values for each kit 13W CFL bulb.

9.2.5 Summary of Evaluation Results

Program energy savings results are provided in **Table 9-10** and **Table 9-11**.

Table 9-10: PY 5 E-Power Wise Program Summary of Evaluation Results for Energy[1]

Stratum	*Reported* Gross Energy Savings (MWh/yr)	*Adjusted Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	*Verified* Gross Energy Savings (MWh/yr)[2]	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Agency	1,097	1,096	80%	879	0.84	8.6%
Direct Mail	765	767	84%	646	0.73	7.6%
Program Total	**1,863**	**1,863**	**82%**	**1,525**	**0.81**	**5.9%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of *consumption.) Due to line losses, savings at the point of generation are systematically larger.*
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.

Table 9-11: PY5 E-Power Wise Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings[1]	Adjusted *Ex Ante* Demand Savings (MW)[2]	Demand Realization Rate (%)	Verified Gross Demand Savings (MW)[2], [3]	Observed Coefficient of Variation (C_v) or Error Ratio in Sample	Relative Precision at 85% C.L.
Agency	0.083	0.092	136%	0.125	1.27	13.0%
Direct Mail	0.058	0.065	216%	0.139	0.88	9.2%
Program Total	**0.140**	**0.157**	**169%**	**0.264**	**1.07**	**7.8%**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.

9.3 *Impact Evaluation Net Savings*

This program targets the low-income community, and no free riders are anticipated among the population receiving the kits. The E-Power Wise Program is assumed to have an NTG ratio of 1.0.

9.4 Process Evaluation

A process evaluation was conducted In PY5 for the E-Power Wise Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

An executive summary of the process evaluation follows below. For the E-Power Wise Program, the PY5 process evaluation activities were these:

- Program staff and implementer interviews (n=2)
- Interviews with community based organizations (n=5)
- Paper surveys for energy-efficiency kit participants (n=387)
- Program literature review and benchmarking
- Database and QA/QC review of records
- Process map development

9.4.1 Survey Sampling

Table 9-12 summarizes the sampling plan for the surveys administered by the EM&V CSP.

Table 9-12 : EM&V CSP E-Power Wise Program Process Survey Sampling Strategy for PY5

Survey/ Target Group	Stratum Boundaries	Population	Assumed Proportion or C_v in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population Contacted to Achieve Sample[2]
Community Based Organizations	Participating Agencies	18	N/A[1]	N/A[1]	4	5	28%
Program Total		**18**	**N/A[1]**	**N/A[1]**	**4**	**5**	**28%**

NOTES:
[1] Since this program's evaluation did not include sampling, C_v and target precision are not meaningful.
[2] Percent contacted means, of the entire sample frame list (those drawn specifically for the survey), how many were called to get the completes.

Table 9-13 represents the total number of implementer CSP surveys reviewed by the EM&V CSP for the process evaluation.

Table 9-13: Implementer E-Power Wise Program Process Evaluation Survey Sampling Strategy for PY5

Survey/ Target Group	Stratum Boundaries	Population (Total Number of Kits)	Returned Kit Surveys	Percent of Returned Kit Surveys Included in Analysis[2]	Evaluation Activity	
					Process	Impact
Participant Kit Survey	Agency	1,600	199[1]	100%	Yes	Yes
Participant Kit Survey	Direct Mail	1,115	188[1]	100%	Yes	Yes
Program Total		**2,715**	**387**			

NOTES:
[1] Count varies due to *ex post* adjustments.
[2] For the process evaluation, only a few topics or questions concerned with program satisfaction were selected from the E-Power Wise Participant Kit Survey for analysis.

9.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-9**.

9.6 Financial Reporting

A breakdown of the program finances is presented in **Table 9-14.**

Table 9-14: Summary of E-Power Wise Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$ -	$ -
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	$ -	$ -
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$259	$259
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	**$259**	**$259**
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3],[4]	**$259**	**$259**
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	**$259**	**$259**
Total NPV Lifetime Energy Benefits	**$705**	**$705**
Total NPV Lifetime Capacity Benefits	**$42**	**$42**
Total NPV TRC Benefits[7]	**$776**	**$776**
TRC Benefit-Cost Ratio[8],[9]	**2.99**	**2.99**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories

[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.

[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.

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

[7] 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.

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

[9] Total NPV TRC Benefits includes $26,686 of O&M replacement cost savings for CFL bulbs.

10 Master Metered Low-Income Multifamily Housing Program

The Master Metered Low-Income Multifamily Housing (MMMF) Program targets energy-efficiency improvements in master metered multifamily low-income housing buildings. For this new program in the Phase II portfolio, eligible multifamily buildings must have five or more residential units and be PPL Electric Utilities customers. Tenants must also be income-eligible (meeting the low-income definition of 150% of the federal poverty level). The program targets decision-makers, that is, property owners and managers of multifamily buildings. MMMF Program savings are reported in the GNI sector.

The program provides a free walk-through audit of master metered multifamily buildings followed with analysis and a report that shows the potential energy savings for installing recommended measures.

Energy-efficiency improvements recommended in the audit report may include direct installation and prescriptive efficiency measures. Customers may also qualify for custom measure rebates offered by other PPL Electric Utilities programs to help offset the incremental costs between high-efficiency and baseline measures.

A turnkey implementation conservation services provider (CSP), SmartWatt Energy, manages the program and handles initiation, planning, and completion of customers' energy projects.

An executive summary of program metrics can be found in ***Table 10-1***.

Table 10-1: MMMF Executive Summary

Program	*Phase II* Reported Energy Savings (MWh/yr)	*Phase II* Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	PYTD Net-to-Gross Ratio	PYTD TRC Ratio	Phase II EDC Expenditures ($1,000)	*Program* Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
MMMF	1,792	1,776	2,039	0.77	1.45	$746	$0.37	$0.059	37

NOTES:
[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

10.1 Program Updates

The MMMF Program was established in PPL Electric's Phase II EE&C plan and began offering incentives in late 2013.[37] In PY5, the MMMF Program successfully completed 36 projects in multifamily buildings across PPL Electric Utilities' service territory.

Program implementation has remained unchanged since inception. A significant program change in terms of measures installed was the transition from direct install medium screw base CFLs to LEDs. PPL Electric Utilities implemented this approach across all of its residential programs starting in PY6.

10.1.1 Definition of Participant

Participants are master metered multifamily buildings located in PPL Electric Utilities' service territory and identified by unique service account numbers. The program requires multifamily property owners and/or managers to sign a participation agreement and, working with Implementation CSP, complete at least one project at the property. Each individual project is assigned a unique CSP job number.

10.2 Impact Evaluation Gross Savings

10.2.1 Reported Gross Savings

Table 10-2 shows the MMMF Program reported results for PY5 by sector.

Table 10-2: PY5 MMMF Program Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Government, Non-Profit, and Institutional	36	1,792	0.14	$229
Phase II Total	**36**	**1,792**	**0.14**	**$229**

10.2.2 EM&V Sampling Approach

PPL Electric Utilities projected a total of 29 projects completed per year.[38] The evaluation, measurement, and verification (EM&V) CSP reviewed a census of EEMIS records and conducted project documentation reviews and site visits for a sample of 17 projects completed in PY5.

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[37] PPL Electric. *PPL Electric Utilities Corporation Energy Efficiency and Conservation Plan Act 129 Phase II*. Pennsylvania Public Utilities Commission. Docket Number M-2012-2334388. April 7, 2014.

[38] Based on PPL Electric. *PPL Electric Utilities Corporation Energy Efficiency and Conservation Plan Act 129 Phase II*. Pennsylvania Public Utilities Commission. Docket Number M-2012-2334388. April 7, 2014.

The EM&V CSP completed site visits in two rounds, one after the end of Q2 and the other after the end of Q4. Because the MMMF Program was new in Phase II, the EM&V CSP believed it necessary to collect data and provide early feedback.

In the first round of site visits, the EM&V CSP conducted site visits to all nine completed projects. In the second round of site visits, the EM&V CSP revised the sampling approach to reflect the total number of projects completed in PY5 and the distribution of reported kWh savings across these projects. It selected four of the six largest projects completed in Q3 or Q4 and selected at random four additional completed projects from the remaining population. The EM&V CSP visited all eight projects.

In total, the EM&V CSP conducted site visits at 17 of the 36 projects completed in PY5. These projects represented 63% (1,127,703 kWh/yr) of the 1,791,567 kWh/yr savings reported for PY5. This approach helped ensure the EM&V CSP achieved results with the 85% confidence at 15% precision at the program level, as stipulated in the EM&V plan.[39]

During site visits, the EM&V CSP verified the information reported in project documentation and EEMIS for these measures:

- A census of lighting and direct install measures installed in building common areas (e.g., hallways, stairwells, and laundry rooms) and on the exterior of building and in adjacent areas such as parking lots
- *All direct install measures installed in a sample of tenant units*

At each building in which direct install measures were installed in tenant units, the EM&V CSP randomly selected a sample of units to visit sufficient to achieve results with 90% confidence at 20% precision as stipulated in the EM&V plan.[40]

[39] Based on Cadmus. *PPL Electric Utilities EM&V Plans Act 129 Phase II*. January 1, 2014. P. 259.

[40] Ibid.

Table 10-3: MMMF Program Sampling Strategy for PY5

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
EEMIS Database	36	All Available	36	All Available	Database Review
Projects[1]	36	85/15	17	17	Site Visits and Records Review
Tenant Units within Sampled Projects[2]	*1,378*	*90/20*	*180*	*143*[3]	*Site Visits*
Program Total	**36 Projects, 1,378 Tenant Units**		**As Above, per Sampling Unit**	**As Above, per Sampling Unit**	

NOTES:
[1] Identified by unique CSP job number.
[2] Identified by unique unit number within each CSP job number selected for site visits.
[3] Three projects with LEDs installed in tenant units were not verified due to scheduling constraints and the amount of time property managers needed in advance of site visits to notify tenants.

10.2.3 *Ex Ante* Adjustment Methodology and Findings

The EM&V CSP adjusted the reported savings from EEMIS to align with assumptions specified in the 2013 Pennsylvania TRM, resulting in adjusted *ex ante* savings.

The 2013 Pennsylvania TRM *ex ante* adjustments modify the savings reported in EEMIS (when reported *ex ante* savings are placeholders) to reflect each measure's specifications. These adjustments are made to the population and account for differences among planning assumptions, the 2013 Pennsylvania TRM assumptions, and specifications of the equipment. The result of these adjustments to the population are the adjusted *ex ante* savings used in the equation to determine the program's realization rate.

The most significant *ex ante* adjustments corrected EEMIS kW estimates for direct install lighting measures (medium screw base CFLs, LEDs, and T8 linear fluorescent fixtures). Reported savings for these measures had been rounded to two decimal places. EEMIS-reported savings estimates for common area lighting measures are derived from project-specific calculations listed in a completed 2013 Pennsylvania TRM Appendix C file for each project. Therefore, the EM&V CSP did not adjust the 2013 Pennsylvania TRM savings for these measures.

Database Review

The EM&V CSP conducted a review of the records for a census of PY5 MMMF Program participants to verify EEMIS accurately captured all required project data and that the reported quantity and savings values were reasonable. The EM&V CSP found no discrepancies outside of minor rounding issues to the savings values (discussed in the previous section above).

10.2.4 Ex Post Adjustment Methodology and Findings

The records review and site visits to verify measures installed in PY5 revealed differences between the 2013 Pennsylvania TRM *ex ante* adjusted savings and the *ex post* verified gross savings for several projects. The most significant discrepancy for direct install measures was fewer installed measures verified than reported (or factored into savings calculations via deemed in-service rate [ISR] estimates). **Table 10-4** provides the deemed 2013 Pennsylvania TRM ISR estimates, by measure, used in the reported energy savings calculation and the ISR verified while on the site.

Table 10-4: Verified Direct Install Measure In-Service Rates[1]

Building Area	Direct Install Measure	2013 Pennsylvania TRM ISR	Verified ISR
Tenant Units	Medium Screw Base CFLs (13W)	84%	79%
	Medium Screw Base CFLs (20W)	84%	83%
	Bath Aerators	100%[2]	96%
	Kitchen Aerators	100%[2]	96%
	Showerheads	100%[2]	100%
	T8 Linear Fluorescent Fixtures	95%[3]	100%
Common Areas	Beverage Vending Machine Controls	100%[2]	89%
	Smart Strips	100%[2]	89%

NOTES:
[1] 2013 Pennsylvania TRM ISR values are to be used absent EDC data gathering. If no ISR provided, 100% used in calculations. Values specified on the following pages: Medium screw base CFL (13 and 20W): p.132, bath and kitchen aerator: p.43, T8 linear fluorescent: p. 132.
[2] No deemed ISR estimate specified in 2013 Pennsylvania TRM for this measure.
[3] The 2013 Pennsylvania TRM in-service rate for residential CFLs (84%) was incorrectly used in reported savings calculations for one project.

The differences between the EEMIS-reported savings and the *ex post* verified gross savings for common area lighting measures resulted from two types of adjustments:

- Retrofit-specific adjustments made to reflect difference in measure quantities, specifications, replaced equipment, controls, or other factors observed by the EM&V CSP staff during site visits; and
- Differences in the EM&V CSP's interpretation of the 2013 Pennsylvania TRM assumptions used in energy savings calculations compared to the Implementation CSP.

Differences in the EM&V CSP' interpretation of the 2013 Pennsylvania TRM assumptions are:

- When whole-building hours-of-use (HOU) and coincidence factor estimates should be used in common area lighting savings calculations rather than using area-specific estimates calculated for each retrofit from information provided by the customer, posted schedules, and other sources; and

- When common areas should be considered cooled spaces and therefore the 2013 Pennsylvania TRM interactive factor for cooled spaces should be applied in savings calculations.[41]

During the site visits, the EM&V CSP confirmed that the vast majority of the key project information (listed below) was correct as reported. However, in a few isolated cases, the EM&V CSP found slightly different quantities and types of installed measures.

Making area-specific HOU and coincidence factor adjustments had a significant impact on project-level energy savings and demand reduction estimates, especially for projects that focused on lighting retrofits in specific, low-use areas such as refuse rooms or maintenance closets. Another *ex post* adjustment made was a correction to the specification of heated and cooled spaces and the associated interactive effects. Making interactive factor adjustments also had a significant impact on project-level energy savings and demand reduction estimates.

Records Review

The EM&V CSP compared project documentation for the 17 projects selected for site visits to the data reported in EEMIS. The EM&V CSP found no discrepancies outside of minor rounding issues to the savings values reported in EEMIS (discussed above).

Site Visits

The EM&V CSP completed site visits in two rounds, one after the end of Q2 and a second after the end of Q4, verifying a total of 17 completed projects. **Table 10-5** and the section immediately following describe the key calculation inputs the EM&V CSP verified while on site and subsequently used to determine *ex post* verified gross savings. While on site, the EM&V CSP also collected measure model numbers, types of equipment plugged into smart strips, and other information. These data informed but were not directly included in *ex post* verified gross savings calculations.

[41] See page 188 of the 2013 Pennsylvania TRM: Table 3-5: Interactive Factors and Other Lighting Variables.

Table 10-5. Key information Verified On-Site for Direct Install Measures

Measure	*Location*	*Qty*	*GPM*	Machine Capacity	Lamps/ Fixture	Lamp Type	Lamp Length	Watts/ *Lamp* (Bulb)	Ballast Type
Medium Screw Base CFLs (13W and 20W)	✓	✓						✓	
Medium Screw Base LEDs (10W)	✓	✓						✓	
Bath Aerators	✓	✓	✓						
Kitchen Aerators	✓	✓	✓						
Shower Heads	✓	✓	✓						
T8 Linear Fluorescent Fixtures[1]	✓	✓			✓	✓	✓	✓	✓
Beverage Vending Machine Controls	✓	✓		✓					
Smart Strips	✓	✓							

NOTES:
[1] Key inputs also collected for replaced fixtures, to the extent possible.

Key information verified on site for common area lighting measures include:

- Building type
- Measure location inside or outside building (e.g., second floor storage room, parking lot, etc.)
- Measure HOU and coincidence factor
- Space cooling where measures installed
- Pre- and post-installation fixture quantity
- Pre- and post-installation fixture lamps/fixture
- Pre- and post-installation fixture lamp type
- Pre- and post-installation fixture lamp length
- Pre- and post-installation fixture watts/lamp
- Pre- and post-installation fixture ballast type
- *Pre- and post-installation fixture controls.*

The EM&V CSP conducted verification site visits to verify that program-rebated or funded measures were installed and operating as reported and that correct data were used to calculate *ex ante* savings. Discrepancies were documented, and the site-specific data collected during site visits were used to calculate the verified gross savings. Reasons for adjustments to reported *ex ante* savings include corrections to the variables listed above.

The Implementation CSP conducted quality control site visits for each participating project. **Table 10-6** lists the number of site visits planned, conducted, and the type of discrepancies identified by the EM&V CSP.

Table 10-6: MMMF Site Visit Summary

Measure	Inspection Firm	Number of Inspections Planned	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
MMMF	EM&V CSP	17	17	17	Savings adjusted based on site specific data

10.2.5 Summary of Evaluation Results

Adjustments to the key calculation inputs identified above resulted in the evaluation results summarized in **Table 10-7** and **Table 10-8**.

Table 10-7: PY5 MMMF Program Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	*Energy* Realization Rate (%)	Verified *Gross* Energy Savings[2] (MWh/yr)	Observed *Coefficient of* Variation (C_v) or Error Ratio in Sample	Relative *Precision* at 85% Confidence Limit
Common Area Direct Install	50	48	83%	40	0.022	10%
Common Area Lighting	1,050	1,050	127%	1,337	0.18	7%
Tenant Unit Direct Install	691	677	98%	662	0.031[3]	18%[3],[4]
Program Total	**1,792**	**1,776**	**115%**	**2,039**	**0.27**	**6%**

NOTES:
[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[3] Relative precision for Tenant Unit Direct Install measures calculated at the 90% confidence limit.
[4] Three projects are driving the large standard error (SE) and precision values. Verified savings for these projects in the sample are substantially different than savings for other projects in the sample, leading to high total SE and precision.

Table 10-8: PY5 MMMF Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings	Adjusted *Ex Ante* Demand Savings[1] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings[2],[3] (MW)	Observed Coefficient of Variation (C_v) or Error Ratio in Sample Design	Relative Precision at 85% Confidence Limits
Common Area Direct Install	0.00047	0.0004	89%	0.00035	0.12	5%
Common Area Lighting	0.1	0.11	114%	0.13	0.59	22%[6]
Tenant Unit Direct Install	*0.034*	*0.04*	*98%*	*0.038*	*0.28*	*16%*[4],[5]
Program Total	**0.14**	**0.15**	**110%**	**0.17**	**0.69**	**16%**

NOTES:
[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.
[4] Relative precision for Tenant Unit Direct Install measures calculated at the 90% confidence limit.
[5] Three projects are driving the large standard error (SE) and precision values. Verified savings for these projects in the sample are substantially different than savings for other projects in the sample, leading to high total SE and precision.
[6] One project is driving the large standard error (SE) and precision values. Verified savings for this project in the sample are substantially different than savings for other projects in the sample, leading to high total SE and precision.

10.3 Impact Evaluation Net Savings

The EM&V CSP conducted an analysis to determine net savings for the MMMF Program. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

10.3.1 Net-to-Gross Ratio Methodology

The methods used to determine net savings were defined by the SWE, including instructions provided in the Evaluation Framework and Guidance Memos.

For the MMMF Program, the EM&V CSP included freeridership and spillover ratio estimates that were estimated in accordance to the SWE NTG guidelines, which utilizes self-report survey information from project decision-maker interviews.

10.3.2 Net-to-Gross Ratio Sampling

The EM&V CSP attempted to complete interviews with the decision-makers for all 17 projects selected for site visits and one additional decision-maker who represented a large project completed in Q4 (a total of 11 unique decision-makers).

Table 10-9: MMMF Program Sampling Strategy for PY5 NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed C_V or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[2]
Landlord Participants (Decision-Makers)	Projects Included in Site Visits	11[1]	0.5	85/15	11	8	100%
Program Total	**Projects Included in Site Visits**	**11**	**0.5**	**85/15**	**11**	**8**	**100%**

NOTES:
[1] *Identified by unique decision-maker contact information.*
[2] Percent contacted means of the entire sample frame list (those drawn specifically for the survey) how many were called to get the completes, often 100% will be the answer.

10.3.3 Net-to-Gross Ratio Findings

The freeridership and spillover ratio estimates for the MMMF Program, estimated in accordance with the SWE NTG guidelines, are shown in **Table 10-10**.

Table 10-10: PY5 MMMF Program Summary of Evaluation Results for NTG Research

Stratum	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Common Area Lighting (Rebated)	0.28[1]	0.00	0.72	0.159	32%
Tenant and Common Area Direct Install Measures [2]	0.00	0.00	1.00	N/A	N/A
Program Total[3]	**0.23**	**0.00**	**0.77**	**N/A**	**N/A**

NOTES:
[1] Estimate is weighted by the survey sample-verified program kWh savings. This method ensures that respondents who achieved higher energy savings through the program measures are given a greater influence on the final freeridership estimate than those respondents who achieved lower energy savings. A single respondent who was estimated as a 62.5% free rider represents 38% of the survey sample-verified program kWh savings. This translates into the respondent representing 24 *percentage points of the total 28% freeridership estimate.*
[2] NTG ratio was assumed to be 1.00 because the direct install measures are free upgrades, offered at no cost to the participating customer.
[3] Freeridership, spillover, and NTG ratios at the program level are weighted by the stratum's *ex post* kWh program population savings.

The MMMF program offers multifamily property decision-makers both rebated measures and direct install measures at no cost to the customer. Rebated measures are improvements property decision-makers might make on their own. For example, replacing older inefficient lighting in building common areas may be included in planned maintenance work. In PY5 all rebated measures were common area lighting retrofits.

The likelihood that a property decision-maker would install the free direct install measures is low. The free measures are typically installed in tenant units. In the absence of the program, tenants are generally responsible for maintaining their own unit, and energy costs are included in tenant rent. Therefore, when calculating program freeridership, the EM&V CSP assumed no freeridership for measures offered at no cost to property decision-makers (direct install measures).

The EM&V CSP determined freeridership for rebated measures using self-report data from interviews with participating property decision-makers. The EM&V CSP attempted to complete interviews with the decision-makers for all 17 projects selected for site visits and one additional decision-maker who represented a large project completed in Q4 (a total of 11 unique decision-makers). However, only six respondents completed the freeridership and spillover questions. Therefore, results are heavily influenced by responses from individual respondents. For instance, a single respondent represents 24 percentage points of the total 28% freeridership estimate. In future research, the EM&V CSP will attempt to collect data on program freeridership from a greater proportion of program participants.

Table 10-11 provide a summary of MMMF freeridership scores by respondents who were able to complete the survey.

Table 10-11: PY5 MMMF Freeridership Respondent Detail

Respondent	*Freeridership* Score	*Ex Post* kWh Savings	Customer *Contribution To* Program Freeridership	Common Area Lighting Rebate Amount
Respondent 1	0.00	27,044	.00	$2,164
Respondent 2	0.00	6,026	.00	$1,528
Respondent 3	0.25	38,669	.02	$5,845
Respondent 4	0.00	123,058	.00	$10,241
Respondent 5	0.63	181,534	.24	$17,351
Respondent 6	0.13	99,281	.03	$9,437
Program Total	**0.28[1]**	**475,612**	**N/A**	**$46,566**

NOTES:
[1] Program-level freeridership weighted by the stratum's *ex post* kWh program population savings.

10.4 Process Evaluation

A process evaluation was conducted in PY5 for the MMMF Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology, sampling approach, and the findings from the research tasks.

For the MMMF Program, the PY5 process evaluation activities were these:

- Participant property owners and operator decision-makers (*n*=8)

- Participant tenant leave-behind surveys (n=42)
- Program staff and implementer interviews (n=1)
- Program literature review and benchmarking
- *Database and QA/QC review of records*
- Process map development

Table 10-12: MMMF Process Evaluation Sampling Strategy for PY5

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or C_V in Sample Design	Assumed Levels of Confidence & *Precision*	Target Sample Size	Achieved Sample Size	Percent of Population Frame Contacted *to Achieve* Sample	Evaluation Activity
Landlord Participants (Decision-Makers)[1]	N/A	11	0.5	85/15	8	8	100%[2]	Telephone Survey
Participating Tenants	N/A	143	N/A	N/A	143	42	29%	Leave Behind Postcard Survey[3]
Program Total	**N/A**	**154**	**0.5**	**85/15**	**151**	**50**	**33%**	

NOTES:
[1] Identified by unique decision-maker contact information.
[2] Percent contacted means of the entire sample frame list (those drawn specifically for the survey) how many were called to get the completes, often 100% will be the answer.
[3] While conducting site visits to tenant units, the EM&V CSP provided the tenant with a postage-paid leave-behind survey.

10.5 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-10**.

10.6 Financial Reporting

A breakdown of the program finances is presented in **Table 10-13**.

Table 10-13: Summary of MMMF Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$229	$229
EDC Incentives to Trade Allies	$-	$-
Subtotal EDC Incentive Costs	**$229**	**$229**
Design & Development	$-	$-
Administration, Management, and Technical Assistance[1]	$517	$517
Marketing[2]	$-	$-
Subtotal EDC Implementation Costs	**$517**	**$517**
EDC Evaluation Costs	**$-**	**$-**
SWE Audit Costs	**$-**	**$-**
Total EDC Costs[3],[4]	**$746**	**$746**
Participant Costs[5]	$178	$178
Total NPV TRC Costs[6]	**$925**	**$925**
Total NPV Lifetime Energy Benefits	**$1,160**	**$1,160**
Total NPV Lifetime Capacity Benefits	**$55**	**$55**
Total NPV TRC Benefits[7]	**$1,300**	**$1,300**
TRC Benefit-Cost Ratio[8]	**1.41**	**1.41**

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[9] Total NPV TRC Benefits includes $84,880 to account for O&M lighting replacement costs.

11 Residential Energy-Efficiency Behavior and Education Program

PPL Electric's Residential Energy-Efficiency Behavior & Education Program informs customers about their home energy consumption and encourages them to initiate no- to low-cost energy-saving behaviors. Customers will be mailed bi-monthly home energy reports. Each report will contain the customer's household energy consumption data, comparisons to neighbor consumption data, and three energy-saving tips. The program does not provide any financial incentives for participating. Instead, the program's objective is for customers to gain the awareness, knowledge, and motivation to save energy and achieve cost savings on their monthly utility bills.

The program uses an experimental design called a randomized control trial, wherein customers are randomly assigned to either a treatment group (recipients of home energy reports) or a control group (non-recipients). Customers in the treatment group will be automatically enrolled into the program. These customers can voluntarily opt out by contacting the program's Customer Service Representatives (CSR) call center whose phone number will be provided in every home energy report. Customers in the control group will not be made aware of the home energy reports.

For PY6 through PY7, the Residential Energy-Efficiency Behavior & Education Program will operate with 128,000 customers in the treatment group and 12,600 customers in the control group. A total of 32,205 MWh savings is planned for PY6 through PY7. PPL Electric Utilities has contracted with Opower—the implementation conservation services provider (CSP)—to select the eligible customers for the program, and produce and distribute the home energy reports. The EM&V CSP provided the random assignment of the eligible customers to the treatment or control group.

11.1 Program Updates

The Residential Energy-Efficiency Behavior & Education Program did not operate in PY5; therefore, no savings were claimed. The program launched in October 2014 (PY6 Q2). In addition to the bi-monthly mailed home energy reports, the program will begin delivering monthly e-mailed home energy reports in November 2014 (PY6 Q2) to customers.

11.2 Process Evaluation

A process evaluation was conducted In PY5 for the Residential Behavior and Education Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology and the findings from the research tasks.

The PY5 process evaluation activities for the Residential Behavior and Education Program were:

- Program staff and implementer interviews (n=4)
- Process map development

- Benchmarking research

11.3 *Recommendations for Program*

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A**, **Table A-11**.

11.4 Financial Reporting

A breakdown of the program finances is presented in **Table 11-1**.

Table 11-1: Summary Residential Energy-Efficiency Behavior and Education Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$ -	$ -
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	$ -	$ -
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$708	$708
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	$708	$708
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	$708	$708
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	$708	$708
Total NPV Lifetime Energy Benefits	$ -	$ -
Total NPV Lifetime Capacity Benefits	$ -	$ -
Total NPV TRC Benefits[7]	$ -	$ -
TRC Benefit-Cost Ratio[8]	N/A	N/A

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

12 Low-Income Energy-Efficiency Behavior and Education Program

Like its residential counterpart, PPL Electric's Low-Income Energy-Efficiency Behavior & Education Program will inform customers about their home energy consumption and encourage them to initiate energy-saving behaviors. The main difference, however, is that the program is specifically for low-income households who are at or below 150% of the Federal Poverty Income Guideline.

A home energy report will be mailed to customers bi-monthly. The mailed report will contain the customer's household energy consumption data, comparisons to neighbor consumption data, and three energy-saving tips. Customers will not receive any financial incentives for participating in the program. Instead, the program's objective is for customers to gain the awareness, knowledge, and motivation to save energy and achieve cost savings on their monthly utility bills.

The program uses an experimental design called a randomized control trial in which customers are randomly assigned to either a treatment group (recipients of home energy reports) or a control group (non-recipients). Customers in the treatment group will be automatically enrolled into the program. These customers can voluntarily opt out by contacting the program's Customer Service Representatives (CSR) call center whose phone number will be provided in every home energy report. Customers in the control group will not be made aware of the home energy reports.

For PY6 through PY7, the Low-Income Energy-Efficiency Behavior & Education Program will operate with 70,000 customers in the treatment group and 12,600 customers in the control group. A total of 8,325 MWh savings is planned for PY6 through PY7. PPL Electric Utilities has contracted with Opower—the implementation conservation services provider (CSP)—to select eligible customers for the program, and produce and distribute the home energy reports. The EM&V CSP provided the random assignment of the eligible customers to the treatment or control group.

12.1 Program Updates

The Low-Income Energy-Efficiency Behavior & Education Program did not claim any savings in PY5 as it is a new program to Phase II. The program is scheduled to launch in November 2014 (PY6 Q2).

In addition to the bi-monthly mailed home energy reports, the program will begin delivering monthly e-mailed home energy reports in December 2014 (PY6 Q3) to customers who have provided e-mail addresses.

PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) filed with the Pennsylvania Public Utility Commission on April 7, 2014 (Table L5, pp. 95) projected the program's participation count at 50,000 customers. However, PPL Electric Utilities and the Implementation CSP have decided to increase the participation count to 70,000 customers in order to meet its planned savings goal. PPL Electric Utilities will make revisions to the EE&C Plan at the end of the year to reflect the change in the participation count.

12.2 Process Evaluation

A process evaluation was conducted In PY5 for the Low-Income Behavior and Education Program. The full evaluation is included in a separate report, *PPL Electric Utilities PY5 Annual Process Evaluation.* The separate document provides results for the portfolio as a whole and includes a chapter for each individual program implemented or planned in PY5. The full process evaluation includes a discussion of the methodology and the findings from the research tasks.

The PY5 process evaluation activities for the Low-Income Behavior and Education Program, were these:

- Program staff and implementer interviews (n=4)
- Process map development
- *Benchmarking research*

12.3 Recommendations for Program

Conclusions, recommendations, and PPL Electric Utilities' plans to address the recommendations can be found in **Appendix A, Table A-12**.

12.4 Financial Reporting

A breakdown of the program finances is presented in **Table 12-1**.

Table 12-1: Summary of Low-Income Energy-Efficiency Behavior and Education Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$ -	$ -
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	$ -	$ -
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$268	$268
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	$268	$268
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	$268	$268
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	$268	$268
Total NPV Lifetime Energy Benefits	$ -	$ -
Total NPV Lifetime Capacity Benefits	$ -	$ -
Total NPV TRC Benefits[7]	$ -	$ -
TRC Benefit-Cost Ratio[8]	N/A	N/A

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

13 School Benchmarking Program

The School Benchmarking Program works with school administrators to evaluate total building energy use using the Environmental Protection Agency's (EPA) Portfolio Manager tool.[42] School administrators are provided with information to evaluate short- and long-term energy-efficiency goals and paybacks for energy-efficiency investment opportunities. A turnkey conservation services provider (CSP) manages the program, which will be offered to up to 25 schools per program year. The CSP also provides school administrators with information about PPL Electric's rebates and incentives. The benchmarking report details specific characteristics and energy indicators for each of the district's participating schools, including total energy use per square foot; electric use per square foot; heating fuel use per square foot and per heating degree day; and energy cost per square foot and per student. Additionally, schools receive assistance in developing action plans to reduce their consumption.

The program's objectives include the following:

- Provide an opportunity for school districts within the PPL Electric's territory to participate in benchmarking.
- Train school staff to use the EPA's Portfolio Manager tool, and encourage and assist schools in achieving the ENERGY STAR® label (awarded if they are in the top 25% compared to peers).
- Educate school staff about their energy usage, and provide recommendations about how to use energy more wisely and about PPL Electric Utilities rebates and incentives.
- Collaborate with the U.S. Department of Energy and the Pennsylvania Department of Environmental Protection regarding their benchmarking initiatives.
- Promote other PPL Electric Utilities Energy Efficiency and Conservation programs.
- Obtain participation of up to 75 schools through 2016.

13.1 Program Updates

The School Benchmarking program will not claim energy or demand savings in Phase II. The program's Process evaluation will be completed in PY6.

[42] http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

13.2 Financial Reporting

A breakdown of the program finances is presented in **Table 13-1**.

Table 13-1: Summary of School Benchmarking Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$ -	$ -
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	$ -	$ -
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$152	$152
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	$152	$152
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	$152	$152
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	$152	$152
Total NPV Lifetime Energy Benefits	$ -	$ -
Total NPV Lifetime Capacity Benefits	$ -	$ -
Total NPV TRC Benefits[7]	$ -	$ -
TRC Benefit-Cost Ratio[8]	N/A	N/A

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

14 Continuous Energy Improvement Program

PPL Electric Utilities targets its Continuous Energy Improvement (CEI) Program to school districts, where it provides technical support for schools to develop and implement a Strategic Energy Management Plan (SEMP). In mid-year PY5, PPL Electric Utilities identified 10 school districts to participate in the program. A CEI advisor (Implementation CSP) will assist each district in selecting one school or facility to participate and to develop a SEMP to implement during PY6 and PY7. Each district will identify an energy manager, which may be a facility manager, energy expert, teacher, or administrator. The districts will work together during monthly meetings, workshops, and conference calls that are led by the Implementation CSP, where best practices will be shared. By the end of the program, each district will have an energy reduction goal, a methodology for measuring energy savings, and a plan to continually improve its energy performance. During PY7, all buildings within the school district will be able to implement CEI, based on the experience gained at the first pilot building during PY6.

The SEMP will include equipment and operation and maintenance (O&M) improvements and staff faculty and student behavior changes. Most equipment upgrades will be eligible for a rebate through other PPL Electric Utilities programs, such as the Prescriptive Equipment Program and the Custom Program.

The objectives of the CEI Program are to:

- Encourage school districts to identify energy-saving opportunities through cultural change, which drives behavioral and business process changes and fostering sustainability through individual engagement.
- Assist school districts with defining an energy vision, resources, and goals of their own energy-efficiency program.
- Demonstrate how the program fits into the school districts' structure and use a systematic approach to quantify the success of energy management.
- Raise employee and student engagement surrounding activities that directly influence the amount of energy consumed by systems and the schools.
- Promote other PPL Electric Utilities energy-efficiency programs.
- Achieve participation from 10 schools/school districts through 2016, with a total reduction of approximately 3,150 MWh/year.

14.1 Program Updates

The CEI program began recruiting school districts in PY5. The program's process evaluation is scheduled for PY6.

14.2 Financial Reporting

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

Table 14-1: Summary of Continuous Energy Improvement Program Finances

	PYTD ($1,000)	Phase II ($1,000)
EDC Incentives to Participants	$ -	$ -
EDC Incentives to Trade Allies	$ -	$ -
Subtotal EDC Incentive Costs	$ -	$ -
Design & Development	$ -	$ -
Administration, Management, and Technical Assistance[1]	$219	$219
Marketing[2]	$ -	$ -
Subtotal EDC Implementation Costs	$219	$219
EDC Evaluation Costs	$ -	$ -
SWE Audit Costs	$ -	$ -
Total EDC Costs[3], [4]	$219	$219
Participant Costs[5]	$ -	$ -
Total NPV TRC Costs[6]	$219	$219
Total NPV Lifetime Energy Benefits	$ -	$ -
Total NPV Lifetime Capacity Benefits	$ -	$ -
Total NPV TRC Benefits[7]	$ -	$ -
TRC Benefit-Cost Ratio[8]	N/A	N/A

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] Per the 2013 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only. EDC costs include EDC Incentive Costs; Design & Development; Administration, Management, Technical Assistance; Marketing, EDC Evaluation Costs, and SWE Audit Costs categories.
[4] Actual PY5 EDC costs are potentially higher; not all CSP invoices were processed before the PY5 report. These "carryover" costs will be included in PY6 financials.
[5] Per the 2013 Total Resource Cost Test Order, the Participant Costs are the costs for the end-use customer.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Appendix A: EM&V Information and PY5 Conclusions and Recommendations

This appendix contains the conclusions and recommendations for each program. Sections are organized according to impact on the overall portfolio, beginning with portfolio-level conclusions and recommendations and moving to the largest program and ending with the smallest. Each table summarizes the recommendations the EM&V CSP suggests that PPL Electric Utilities consider in Phase II.

Section A-13 summarizes definitions of participants for each program. Section A-14 summarizes actual evaluation activities by program.

A.1 Portfolio

A.1.1 Process Conclusions and Recommendations

Conclusion:
PPL Electric's flexible approach to program marketing is aligned with program plans to intentionally *control the pace of each program. This approach seemed to work well for many programs, but others* that did not meet savings and participation goals may benefit from increased outreach on a case-by-case basis.

Recommendation:
Consider reviewing the current marketing and outreach plans for the programs that are not meeting energy-saving targets. Explore selectively deploying outreach for these underperforming programs or measure groups, being cautious of the program's own word-of-mouth momentum. Recommendations for program-specific marketing and outreach tools as well as other options to drive participation are *located in the individual program chapters of this report.*

Conclusion:
Commercial survey respondents were more likely to learn about the program from an installer or contractor than from PPL Electric, suggesting that PPL Electric's efforts to engage trade allies are effective. However, this seems limited to lighting. Improvements in non-lighting trade ally engagement would likely boost participation for other prescriptive measures.

Recommendation:
For Prescriptive Equipment, consider new ways to more effectively engage non-lighting trade allies. One way to do that would be to host more frequent meetings and training sessions on non-lighting measures. HVAC contractors that the EM&V CSP interviewed specifically said they would like more training; one person expressed frustration about attending PPL Electric Utilities events but rarely obtaining information applicable for the business.

Conclusion:
Participants were highly satisfied with the PY5 programs and over half recommended the program to a friend, relative, or colleague.

Conclusion:
Most program participants were *very satisfied* with PPL Electric Utilities and almost half said their opinion of PPL Electric Utilities improved *significantly* or *somewhat* as a result of their participation.

Conclusion:
Participants in PPL Electric's programs view themselves as more knowledgeable about energy efficiency than the general population.

Conclusion:
A strong majority of customers said they take steps to save energy at home, reporting a wide range of behaviors but using only a few strategies consistently. For example, most people turn off lights. They may need more education about other low- or no-cost energy-savings solutions.

Recommendation:
Building on the existing "Home Energy Tips" on the PPL Electric Utilities website,[43] consider opportunities to inform customers about specific energy-savings behaviors via the Internet, direct mailings, and other outreach. Consider promoting just two to three specific behaviors in education campaigns initially, and use annual surveys to track the campaigns' effectiveness to change customer behavior over time. Focusing on fewer behaviors, rather than comprehensive energy-savings options, could help break through information barriers.

The following behaviors have high energy savings but currently low customer adoption:

- ***Washing clothes in cold water (reported by 5% of respondents).*** The U.S. Environmental Protection Agency estimates that washing clothes in cold water reduces the energy required to do a load of laundry by 90%.[44]
- ***Hanging clothes on clothesline or rack (reported by 2% of respondents).*** According to a recent Opower blog, this action could save customers as much as $100 per year.[45] Opower data confirms PPL Electric's PY5 survey findings that hanging clothes to dry is a woefully underutilized tactic to save energy, yet the potential for savings is tremendous:

  "With approximately 85% of U.S. households owning tumble dryers and the vast majority of them toasting up 2+ loads of sopping wet laundry per week, clothes dryers account for a big chunk of home energy use. Joining water heaters and refrigerators among the top three electricity-hogging appliances in U.S. homes, dryers account for 6%

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[43] PPL Electric Utilities. "Save Energy & Money." Accessed September 2014: https://www.pplelectric.com/save-energy-and-money/energy-savings-101/for-your-home/home-energy-tips.aspx

[44] ENERGY STAR®. "Best Practices: Clothes Washer Tips." Accessed September 2014: http://www.energystar.gov/index.cfm?c=clotheswash.clothes_washers_performance_tips

[45] Fischer, Barry, and Nate Kaufman. "America's most unpopular way of saving energy...is one of Europe's favorites." July 31, 2013. Available online: http://blog.opower.com/2013/07/americas-most-unpopular-way-of-saving-energy-is-one-of-europes-favorites/

of the country's residential electricity consumption and each year add $9 billion to American families' utility bills."[46]

Conclusion:
Residential customers put more emphasis on energy efficiency when making purchasing decisions than business customers do, especially after they participated in a PPL Electric Utilities rebate program.

Recommendation:
Consider more ways to communicate the value proposition of energy-efficient upgrades to small businesses. Because small businesses often lack the resources to hire a dedicated energy manager or advisor, they would likely benefit from more energy education from PPL Electric, particularly on how to overcome financial barriers. Further, survey results found that unlike the residential program participants, nonresidential program participants do not actually act differently than the general population when considering capital upgrades. PPL Electric's direct discount path has been an effective method to reach the small business segment but again, is focused primarily on lighting. More education is necessary for non-lighting measures.

To help small business participants make more energy-efficient purchases in the long-run, especially for non-lighting measures, the EM&V CSP recommends PPL Electric Utilities:

- *Explore how to reaffirm the participant's smart financial decision to make energy-efficient* upgrades, so that their program experience is more likely to impact future decisions. One idea could be to use e-mail addresses captured on the application form to send participants follow-up information about the average cost savings of their particular measure. Alternatively, PPL Electric Utilities could send such information along with the rebate check in the mail.

To reach the small business sector in general, the EM&V CSP recommends that PPL Electric Utilities:

- Improve how the financial benefits of energy efficiency are communicated on the PPL Electric Utilities website. For example, some information is provided on a measure-by-measure basis in the "ENERGYsmart Library,"[47] but some high-level, easily digestible facts on costs savings for common measures could be brought to PPL Electric's main "Energy Savings 101" business landing page.[48]
- Illustrate the cost savings of energy-efficient equipment when compared to "business as usual." For example, the "ENERGYsmart Library" compares the savings for different SEER ratings of a heat pump,[49] but it does not address the cost savings of installing a heat pump over the base

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[46] Ibid.

[47] Aclara Technologies LLC. "ENERGYsmart Library for your business." Accessed September 2014: https://www.energyguide.com/library/energylibraryhome.asp?sid=451&referrerid=223&bid=ppl&prd=20

[48] PPL Electric Utilities. "Save Energy & Money: Energy Savings 101." Accessed September 2014: https://www.pplelectric.com/save-energy-and-money/energy-savings-101.aspx

[49] An example of information from the ENERGYsmart Library: "When buying a new heat pump, make sure it has a SEER rating of 12 or higher. A heat pump with a SEER value of 12 or better will save 15% to 20% in air

case standard efficiency units (to replace central air, an electric furnace, or electric resistance heat). Often this may be the value proposition a small business customer is considering. Distribute such examples of energy-efficiency cost savings in e-newsletters and other program materials sent to trade allies and customers.

Conclusion:
PPL Electric Utilities has an opportunity to influence business customers' corporate policies and energy management through training.

Recommendation:
Explore the creation of an energy management training initiative. PPL Electric Utilities could work with EPower Solutions to gather more information from program participants about specific topics of interest and assess gaps in staff technical expertise that could help focus the training. Energy management training could include training for executives on how program participation can advance company energy goals, developing and integrating an energy management plan as part of company policy, collecting and analyzing energy usage data, or building operator certification training. The EM&V CSP can assist with program planning and developing this training initiative, and other resources are available as well.

PPL Electric Utilities is currently working with Strategic Energy Group as part of the Continuous Energy Improvement Program and this group could be helpful when planning and developing this training. Other resources are classes about building systems and principles of energy management to building operating engineers or Building Operator Certification training courses offered by Pennsylvania College of Technology. This recommendation is also made specifically for the Custom Incentive Program later in this report, but it is mentioned here because it could be applicable for all nonresidential programs.

Conclusion:
Customers in older age groups were more knowledgeable about energy efficiency and more likely to engage in activities to save energy, while other demographic factors had no influence.

Recommendation:
Consider energy-education campaigns aimed at younger people, particularly those aged 34 years and younger. This could include an increased focus on social media platforms and strategic online advertising. Focus on low- and no-cost energy-savings solutions because the resources of this demographic may be limited. For example, this age group is more likely to rent than own a home.

PPL Electric's Student-Parent Energy-Efficiency Education Program is a good strategy to begin educating younger generations in the classroom; as that program continues, knowledge and actions to save energy may increase among younger adults. The EM&V CSP notes that this is consistent with PPL Electric's own

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conditioning costs, compared to a heat pump with a SEER value of 10." Aclara Technologies LLC. "ENERGYsmart Library for your business, Air-Source Heat Pumps." Accessed September 2014: https://www.energyguide.com/library/EnergyLibraryTopic.asp?bid=ppl&prd=20&TID=21960&SubjectID=9542

market segmentation research, for which they classified customers based on attitudes toward the environment, lifestyle characteristics, energy use, and other data.

That research found that younger customers often fell into the "Green Tomorrow" group—a segment described as less immediately concerned about the future of the environment and, though they may want to help, they do not always believe they can make a difference and do not know where to start.

Conclusion:
Residential customers were more willing to purchase LEDs than small business customers at all price points except the cheapest.

Conclusion:
Customers in both segments were more willing to pay for an LED—at all price points—if they had previously purchased one.

Recommendation:
PPL Electric Utilities could consider options to motivate new customers who have no experience with LEDs to use them or to buy them for the first time. More detail about this recommendation on how PPL Electric Utilities would increase first-time LED purchasers is located in the Residential Retail Program chapter. It is worth noting here as well because this strategy should apply to both residential and small business segments.

Table A-1: Portfolio Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Consider reviewing the current marketing and outreach plans for the *programs that are not meeting energy-saving targets and explore* selectively deploying outreach for these underperforming programs or measure groups, being cautious of the program's own word-of-mouth momentum.	Implemented. PPL constantly monitors *the performance of its programs (savings* and costs versus EE&C Plan) and adjusts marketing, outreach, and other implementation as necessary.
Ensure that non-lighting trade allies are knowledgeable and well-informed about all of PPL Electric's offerings.	Being considered. PPL generally agrees with the recommendation.
Building on existing resources, consider opportunities to inform customers about specific energy-savings behaviors that have low customer penetration, such as washing clothes in cold water. Consider promoting just two to three specific behaviors in education campaigns initially.	Being considered. PPL generally agrees with the recommendation.
Consider more ways to communicate the value proposition of lighting and non-lighting energy-efficient upgrades to small businesses, such as reaffirming the participant's smart financial decision to make energy-efficient upgrades and improving how financial benefits are communicated on the PPL Electric Utilities website.	*Being considered.*
Explore the creation of an energy management training initiative; work with EPower Solutions to gather more information from program participants about specific topics of interest and assess gaps in staff technical expertise that could inform the training focus.	*PPL will consider this for Ph 3. PPL* proposed this initiative in a revision to its Ph 2 EE&C Plan but it was rejected by the PaPUC.
Consider energy-education campaigns aimed at younger people, such as increased focus on social media platforms and strategic online advertising that offer low- and no-cost energy-savings solutions.	Being considered
Consider options to motivate new customers who have no experience with LEDs to use them or to buy them for the first time.	Implemented in PY6 as part of the incentives, marketing, and education for the LED-only upstream lighting program. *PPL will consider additional education if* LED sales are lower than expected.

A.2 Residential Retail Program

Overall, the program is being delivered efficiently and is in line to meet its Phase II energy savings goals. Customer satisfaction is high and PPL Electric Utilities and Implementation CSP program staff did not identify any major barriers to effective program delivery.

A.2.1 Equipment Conclusions and Recommendations

Conclusion:

HPWH participation dipped significantly after the federal tax credit expired in December 2013. PPL Electric Utilities is on track to meet its savings and participation goals for PY5 for the Residential Retail Program overall. However, HPWH participation was somewhat shy of the goal for PY5, and new

outreach strategies and higher incentives may be necessary for PY6 and PY7 to achieve projected participation in the absence of federal assistance.

Recommendation:
Participants learn about the program primarily from retailers. Although this is consistent with the program delivery strategy, PPL Electric Utilities should consider educating licensed contractors and plumbers about the rebate. (Currently, only 11% of participants learned about the program through a contractor.) If PPL Electric Utilities intends to increase program participation in PY6, these market actors can help reach a different segment of customers who may not purchase their HPWH from a participating retailer.

Conclusion:
Time lags in processing HPWH rebates led to dissatisfaction among some participants. Thirty percent of participants reported waiting more than six weeks to receive a rebate check; this was the most common reason cited as a cause for dissatisfaction with the program. Only 20% of refrigerator purchasers reported receiving their rebate check after six weeks. However, program-tracking data indicate approximately 10% of refrigerator rebates took longer than 6 weeks to process, and 12% of HPWH rebates took longer than 6 weeks. These slow rebates occurred across the program year, indicating there may be room for improvement in HPWH rebate processing.

Recommendation:
Work with the Implementation CSP to determine if there are ways to reduce the time it takes to process and distribute rebates; implement identified process improvements.

Conclusion:
For refrigerators, the rebate's influence on purchasing decisions was relatively low. In PY5, the rebate amount was $25, and 49% of respondents reported that the rebate was *not too important* or *not important at all* in their decision to purchase the refrigerator. Instead, respondents reported that product features, size or fit, and base price of the equipment was most influential. Also, while the survey sample sizes to compute the PY5 freeridership estimates were not designed to produce statistically valid results at the measure level, the EM&V CSP notes that the freeridership of the respondents asked about refrigerators was 67%; this is nearly twice that for respondents asked about HPWHs (36%). As a result of the relatively high freeridership, in PY6 PPL Electric Utilities increased the refrigerator rebate from $25 to $100, and also increased the required level of efficiency for rebate eligibility. Refrigerators must now qualify for the ENERGY STAR "most efficient" category.

Recommendation:
The EM&V CSP suggests that the impact of this change in eligibility and rebates and their influence on buyers' decision-making be investigated in PY6. This will help determine whether market conditions support dropping the measure from the program.

A.2.2 Lighting Conclusions and Recommendations

Conclusion:
LED purchases are lagging behind CFLs, despite higher satisfaction with LEDs. This finding is likely due to natural market adoption as well as to the longer bulb-life of LEDs. As more people try LEDs and have positive experiences, the gap between CFL and LED purchases will narrow. By marketing to a larger segment of its customer base (in PY5, 30% of survey respondents reported seeing educational materials or advertisements), PPL Electric's LED awareness campaigns can accelerate market adoption by emphasizing the positive traits of LEDs and customer satisfaction to increase LED adoption.

Recommendation:
Continue investing in LED education and awareness and consider expanding the messaging to include *the non-energy benefits of LEDs, such as long bulb life and brighter light, and explore ways to showcase* the high satisfaction of LED purchasers. In addition, the EM&V CSP can assess the importance of LEDs non-energy benefits in its next general residential population survey (PY6).

Conclusion:
Customers who used LEDs in the past are willing to pay more for them and are very likely to replace a burned-out LED with another LED. These data are in line with the satisfaction findings and indicate that encouraging CFL and incandescent bulb users to convert to LEDs may be the most important first step in transforming the market. This conversion could be challenging because people who have not yet tried LEDs (non-purchasers) are less likely to purchase them at various price points than are users. However, these non-purchasers are somewhat more responsive to hypothetical reductions in price.

The EM&V CSP found that the price of LEDs at the end of PY5—an LED discounted through the Residential Retail Program averaged more than $11 (blend of all bulbs (A-line/reflectors[50]) —may still be a market barrier for non-purchasers of LEDs. This price is higher than most non-purchasers reported they would be likely to buy an LED. Nearly half (46%) said they would be willing to buy an LED at $10, 53% said they would be willing to buy one at $7, and 65% said they would be willing to buy one at $5. The EM&V CSP's understanding of the program design for PY6 is that the incentive level will increase because only LED incentives will be offered.

Recommendation:
PPL Electric Utilities could consider options to motivate new customers who have no experience with LEDs to use them or to buy them for the first time.

- Continue the recently-implemented increased LED discount to better align with willingness-to-pay data for this group of customers.
- *Simultaneously or alternatively, explore options for targeting customers who have never used* LEDs. PPL Electric Utilities could gather specific information about customers' prior experiences

[50] In Q4 of PY5, the average promotional price of LED reflector lamps, comprising 23% of bulbs incented in that quarter, was $24.95. The A-line LEDs incented in PY5Q4 (77% of bulbs) had an average promotional price of $6.90.

with LEDs using existing channels, such as adding a question on rebate applications. By analyzing these data, PPL Electric Utilities could then mail a free LED bulb to individuals who have not previously used one. This is an accurate and systematic way to distribute bulbs to new users; however, the administrative costs could be high.

- *Explore options for distributing LEDs at no cost to the low-income community through food* banks, senior-assistance programs, and other local sources.
- Consider including LEDs in the "leave-behind" package provided by the Appliance Recycling Program implementer at the time of appliance pick-up.
- PPL Electric Utilities could take a more broad-brushed approach by honing marketing messages to appeal to customers who have not yet tried LEDs, explore advertisement placements to target specific communities, or target specific demographics (for example, lower income or less educated) that were found less likely to have purchased and/or used an LED.

Conclusion:

Awareness of PPL Electric's subsidization of bulbs is low, but this is typical for upstream lighting programs. Among survey respondents, awareness of CFLs and LEDs is very high—95% and 92%, respectively. However, just 12% of respondents knew that PPL Electric Utilities provides funding to reduce the price of these bulbs, in spite of the fact that 30% of respondents reported seeing promotional materials from PPL Electric Utilities about the energy benefits of CFLs or LEDs. This suggests that marketing materials may not sufficiently highlight PPL Electric's contribution to reducing bulb prices.

Recommendation:

To increase customer awareness of the incentives, the implementer could work with retailers and/or manufacturers to increase the prevalence of signage and labeling (in stores that allow this) that indicate bulbs are subsidized by PPL Electric. PPL Electric Utilities may also want to ensure its advertising and educational materials clearly state it is responsible for buying down the cost of LEDs.

Conclusion:

People still throw CFLs in the trash. Customer behavior has not changed very much over the last four years. More than half of the survey respondents stated they still dispose of CFLs in the trash, and many are still unsure how to properly dispose of them. This rate is very similar to survey findings from PY2 and PY3; however, it should be noted that the number of respondents who reported throwing the CFL away decreased by 10% between PY4 and PY5 but increased by 22% between PY3 and PY4. Very few customers reported seeing CFL recycling bins at retail stores, although they are available at all Lowe's and Home Depot locations and some independent hardware stores.

Recommendation:

PPL Electric Utilities should explore ways to increase awareness of CFL recycling bins. Some options are:

- Distribute information about the CFL recycling bins via a bill insert.
- *Work with the implementer to ensure that representatives conducting in-store demonstrations* point out the CFL recycling bins to customers.

- Make the information regarding recycling bins more visible on the PPL Electric Utilities website.
- Consider working with locations other than participating retailers (e.g., grocery stores or community-based organizations, food pantries, senior-service centers) to increase the number of CFL recycling bins available to customers. Coordinate with these centers to pick up full bins for disposal.

Table A-2: Residential Retail Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Consider options for educating licensed contractors and plumbers about the HPWH rebate.	Being considered
Consider consulting with the Implementation CSP to identify and remedy the cause of rebate-processing delay.	Implemented
Consider investigating the impact of the change in HPWH eligibility and rebates and their influence on buyers' decision-making in PY6.	Being considered. PPL agrees
Consider expanding marketing messaging to include non-energy benefits of LEDs.	Being considered. PPL will consider additional education if LED sales are lower than expected.
Explore options for targeting marketing to customers who have never used LEDs or demographics found to be less likely to have purchased/used LEDs.	Being considered. PPL will consider additional education if LED sales are lower than expected.
Continue to offer increased discounts on LEDs.	Implemented. PPL frequently adjusts LED incentives to control the pace of the program.
Explore options for distributing LEDs at no cost to the low-income community, through food banks, senior-assistance programs, etc.	Being considered. PPL will consider this if it needs to increase Low-Income savings to meet its compliance target.
Consider including LEDs in the "leave-behind" package provided by the Appliance Recycling Program Implementation CSP or at the time of appliance pick-up.	Being considered. PPL will consider this if it needs additional savings.
Encourage retailers (in stores that allow it) and/or manufacturers to increase prevalence of signage and clarify labeling indicating that bulbs are subsidized by PPL Electric.	Being considered. PPL agrees and attempted to do this. However, most retailers, especially the big box stores, have policies that restrict this.
Examine promotional materials to ensure they clearly indicate that PPL Electric Utilities subsidizes bulbs.	Being considered. PPL agrees.
Explore ways to increase customer awareness of CFL recycling bins.	Being considered. PPL agrees.
Consider working with locations other than participating retailers (e.g., grocery stores or community-based organizations, food pantries, senior-service centers) to increase the number of CFL recycling bins available to customers.	Implemented (in progress). PPL implemented recycling bins for several municipalities, including notifications in municipal newsletters. PPL is currently expanding this into other agencies and locations.

A.3 Prescriptive Equipment Program

A.3.1 Impact Conclusions and Recommendations

Conclusion:

Adjustments to gross savings resulted in realization rates of 94/94% for MWh/MW. While the adjustments are small they are consistent with findings in PY4 (98/93%) and PY3 (95/94%).

Recommendation:

Review corrections to applications and project submittals to identify trade allies who may need additional training. Consider conducting targeted re-training of trade allies who have persistent corrections and monitor identified trade allies for improved performance.

A.3.2 Process Conclusions and Recommendations

Conclusion:

Overall, PPL Electric's prescriptive equipment program offerings reflect leadership in guiding market transformation among the EDCs and attention to customer-friendly delivery mechanisms. However, PPL Electric's average lighting incentives are higher than other EDCs, while their non-lighting offerings provide fewer options for end users and are in some cases much lower than other EDC programs.

Conclusion:

PPL Electric's lighting offerings reflect recent federal regulations and are most progressive among the EDCs. PPL Electric's incentive structure emphasizes simplicity and ease of upfront comparison for the customers. However, the incentive structure (in the prescriptive rebate delivery mechanism) does not encourage customers to maximize energy savings since it is tied to the number of lamps and fixtures replaced or removed, rather than the energy savings resulting from the retrofit. The rebate for the Direct Discount delivery mechanism is based on energy savings.

Recommendation:

The EM&V CSP recommends that PPL Electric Utilities keep the current incentive structure, but add a requirement to the incentive program stating that a lighting retrofit must result in a total annual energy consumption reduction to qualify for incentives for the prescriptive rebate delivery mechanism.

Conclusion:

Participation in appliance and equipment incentives was low among PPL Electric's C&I customers. The underlying reasons for low participation could be the amount of the incentive offered (which is low compared to other EDCs) and a lack of awareness about the program among customers. Further, PPL Electric Utilities offers incentives for fewer non-lighting prescriptive measures than other EDCs, with the exception of PECO.

Recommendation:

Review the number of commercial appliance and equipment incentives in PY4 and the program progress compared to the portfolio targets in order to decide if a change in the amount of the incentive or marketing strategy is necessary. If meeting program targets is a concern, consider increasing the rebate

amounts, expanding the non-lighting prescriptive offerings to additional appliances and equipment, or a change in marketing strategy to boost participation.

Conclusion:
A preapproval process should provide PPL Electric Utilities with up-to-date information on the program's progress against goals, but may impact customer satisfaction and could substantially increase PPL Electric's program costs due to increased project reviews.

Recommendation:
The EM&V CSP proposes that program participants are asked about their satisfaction with the program and the preapproval process during the PY6 surveys. PPL Electric's program staff will also be interviewed to determine if the increase in time and program costs balances the risk of an oversubscribed program. Additionally, the program's TRC value for PY6 will be assessed. The results of the participant surveys, staff interviews, and TRC calculations will help determine if changes to the preapproval process are necessary.

Conclusion:
Program satisfaction among standard path (customer prescriptive rebates) is high, however, room for improvement exists among customers completing application materials for rebates through the standard path. In Pennsylvania, large lighting projects are required to include a completed TRM Appendix C lighting calculator, which requires a thorough understanding of the lighting technologies replaced and installed through the program. Thus, customers with larger projects may have more difficulties and challenge with the process.

Recommendation:
Review program information resources such as information posted to the PPL Electric Utilities program website and availability of support staff to ensure customers pursuing rebates through the standard path have the resources necessary to complete their application packages. Providing an example of a completed form may assist customers new to this program requirement.

Conclusion:
Free energy assessments offered through the direct discount delivery channel are effectively encouraging customers to complete energy-efficiency projects. Most direct discount respondents (88%) implemented all the recommendations offered in the assessment, up from 82% in PY4.

Conclusion:
Participation in the standard path improves customer opinions about PPL Electric Utilities as an electricity provider. Approximately half of respondents (55% standard path and 45% direct discount) reported participation improved their opinion of PPL Electric, while only one of 150 survey respondents indicated a decrease in opinion of PPL Electric Utilities as a result of participating in the program.

Table A-3: Prescriptive Equipment Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Review corrections to application and project submittals and consider conducting additional training for trade allies.	Being considered. PPL generally agrees but it is very difficult to improve trade ally performance.
Consider adding a requirement to the incentive program for the standard path *(prescriptive rebate delivery mechanism) stating that a lighting retrofit must* result in a total annual energy consumption reduction in order to qualify for incentives.	Being considered.
Consider reviewing the number of commercial appliance and equipment incentives in PY4 and a review of the program progress compared to the portfolio targets, in order to decide if a change in the amount of the incentive or marketing strategy is necessary.	Implemented as part of an upcoming revision to the Ph 2 EE&C Plan
Review program information resources such as information posted to the PPL Electric Utilities program website and availability of support staff to ensure customers pursuing rebates through the standard path have the resources, such as support from program staff (implementation CSP), to complete their application packages.	Being considered. PPL generally agrees.

A.4 Appliance Recycling Program

A.4.1 Process Conclusions and Recommendations

Conclusion:
The program appears to be well established and ran smoothly in PY5. All parties communicate regularly and effectively. There were no issues with the program tracking data provided by JACO. None of the program staff identified any issues that needed to be addressed. Given the high satisfaction and the program's achievements against goals, this conclusion appears well supported.

Conclusion:
In many aspects (gross savings, the NTG ratio, program design, satisfaction, and restrictions on eligible appliances), PPL Electric's ARP is very similar to other programs operating across North America. This suggests that other utilities have not identified additional opportunities that PPL Electric Utilities has not already implemented or can implement with its current program design.

Conclusion:
Program participants do not think of PPL Electric Utilities as a resource for information regarding energy efficiency. ARP programs reach a large number of PPL Electric Utilities customers and participants report high levels of satisfaction. This suggests there is an opportunity to take advantage of the positive interaction and leave materials with customers to introduce them to all of PPL Electric's program offerings.

Recommendation:
Consider ways of increasing customer awareness regarding energy-efficiency resources, and help customers understand that they can look to PPL Electric Utilities for credible information and rebate opportunities.

Follow up with JACO to confirm they are leaving behind information when they pick up appliances.

Consider leaving behind an energy-savings kit with information and some free, low-cost measures, such as a CFL or an LED. This could add low-cost, incremental savings to the program. In addition, leaving behind something tangible may increase the likelihood that participants will review the other materials left behind.

Conclusion:
ARP participants were very responsive to PPL Electric's marketing and outreach. PPL Electric's various advertising efforts were the primary drivers of program participation and without them participation would likely drop significantly. Adjusting advertising to manage participation was an effective strategy to keep the program on track with savings and participation goals in PY5, with the program achieving 101% of savings goal and 102% of participation goal.

Recommendation:
Continue to control advertising to manage participation goals. Also, continue to utilize a variety of advertising and marketing channels to inform potential participants about the program. Over the last three years, survey respondents consistently mentioned bill inserts, newsletters, and media advertising as ways they have heard about the program; PPL Electric Utilities should continue to emphasize these channels.

Conclusion:
Satisfaction with the program improved in PY5. Both the number of respondents reporting issues that led to dissatisfaction (eight in PY4, down to two in PY5) and the number of issues mentioned decreased. Additionally, the issues respondents raised last year during the participant surveys (the incentive being too low and trouble scheduling pick-ups) were not mentioned this year, suggesting PPL Electric Utilities and JACO have successfully resolved those issues.

Conclusion:
One aspect of PPL Electric's program that stands out is the TRC benefit/cost ratio, which is considerably higher than both of the other Pennsylvania EDCs and programs operating outside of Pennsylvania. The average TRC ratio for programs operating outside of Pennsylvania was around 2.4, while the average TRC ratio for programs within Pennsylvania was approximately 5.5 for Phase I. The relatively high demand savings for room air conditioners may help offset some of the impact of the decrease in both deemed energy and demand savings for refrigerators and freezers on the cost-effectiveness of the program (starting with the 2013 Technical Resource Manual).

Recommendation:
Continue to take advantage of the demand savings for room air conditioners, which appear to contribute to the higher than average TRC results.

Table A-4: Appliance Recycling Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Consider ways to increase the number of customers that look to PPL Electric Utilities as a resource providing information about energy efficiency, such as leaving behind materials during pick-up.	Being considered. PPL will consider this if it needs additional savings from other programs.
Consider leaving an energy-savings kit with information and some free, low-cost measures, such as CFLs or an LED.	Being considered. PPL will consider this if it needs additional savings.
Continue to selectively deploy advertising to manage participation goals. Continue to utilize a variety of advertising and marketing channels to inform potential participants about the program.	Implemented. PPL constantly monitors the performance of its programs (savings and costs versus EE&C Plan) and adjusts marketing, outreach, and other implementation as necessary.
Continue to take advantage of the relatively high demand savings for room air conditioners to maintain cost-effectiveness.	Implemented. PPL will consider modifying its marketing & educational materials to further promote room air conditioners, if that does not negatively program impact savings or costs.

A.5 Student and Parent Energy-Efficiency Education Program

A.5.1 Conclusions and Recommendations

Conclusion:
The Student and Parent Energy-efficiency Education Program achieved its energy savings goal and receive overwhelming positive feedback from its parent and teacher participants. Still, the program did not reach its demand savings goal. Installation rates and participant survey responses suggest that kit measures and how they are present to students and parents are areas for improvement.

Conclusion:
PPL Electric's decision to replace CFLs with LEDs in the kits for the next program year meets participant interests as both teachers and parents frequently requested LEDs. Teachers and parents showed concern about the disposal safety of CFLs and the heat emitted from CFLs.

Recommendation:
In addition to providing LEDs instead of CFLs in the kits, provide safety and energy savings information on LEDs compared to CFLs and incandescent bulbs. Educating teachers and parents about the benefits of using LEDs over CFLs, especially when safety is of concern, should increase the use of LEDs.

Conclusion:
Across all the teacher and parent kits, participants used "plugged-in" measures (CFLs, LED bulbs, smart power strips, and nightlights) more than the "inspection" or "reminder" measures (shower flow test bag, furnace whistle, and light switch stickers). According to survey data, the parent classroom kit showed a usage trend where participants tended to use two or three measures; however, as the

number of measures increased, the overall use of measures appeared to decrease. CFLs (44%), the showerhead (24%), the smart power strip (14%), and the nightlight (7%) generated the most energy savings from the parent classroom kits. The measures generating the least savings were the furnace whistle (6%), the kitchen aerator (3%), and the bathroom aerator (1%).

Recommendation:
Consider adding another "plugged-in" measure to the Bright Kids kit, such as the smart power strip, to increase energy savings for this student group and for the overall program.

Recommendation:
Consider providing information on or removing the furnace whistle from the Take Action kit; besides the low energy savings, parents indicated that they were unfamiliar with the furnace whistle or that they were unfamiliar with the installation procedure. Due to its moderate installation rate and very low energy savings, consider removing the bathroom aerator from the Innovation kit. Alternatively, if these items remain in the kit, consider increasing the classroom instructions and discussion about how to install the items and the benefits of energy savings.

Recommendation:
Currently, NEF's Think!Energy website features installation videos, but these videos are technical and lack a personable presence. Consider working with NEF on developing training and demonstration videos presented by classroom teachers that focus on the education and installation of the kit measures. The videos would be posted on the Think!Energy website for students, parents, and teachers to view. Developing these teacher-presented videos can be a reinforcing way to bring the information taught in school to the home as well as increase installation rates and to promote the program to students, parents, and teachers

Conclusion:
Parent participants typically did not use a particular measure because they already had the measure installed, could not install the measure due to structural mismatch, and/or did not have a need for the measure. In particular, parents frequently reported structural mismatch with the kitchen aerator and furnace whistle measures, the measures with the lowest energy savings. These findings help to explain why installation rates for kitchen aerators were lower than expected (35% vs. 59%).

Recommendation:
Explore the feasibility of offering parents an opportunity to customize their kit as a way to increase installation rates. Customization options include (but are not limited to) allowing parents to choose from a selection of pre-designed kits or allowing parents to build their own kit by checking off preferred items from a list. The benefit of providing a choice is that the installation rates for individual items in the kit may increase. The downside is that offering a choice adds work and coordination with NEF, the teachers, and the student households.

Conclusion:
Secondary school students (58%) generated the lowest return rates for the home energy worksheet compared to primary school (87%) and intermediate school students (83%). Secondary school students

were the only participants who filled out the final computer-readable form (Scantron form) at home instead of in the classroom. The in-class method used to fill out the Scantron forms for primary and intermediate school students may help improve the return rate.

Recommendation:
Continue to provide in-class opportunities to fill out the Scantron forms to boost program participation and teacher incentives. NEF is aware of the low return rate among secondary school students and is considering methods to increase the return rate. Encourage NEF to follow through and have secondary school students complete the Scantron forms in the classroom instead of at home. The in-classroom method will then be consistent across grade levels.

Conclusion:
The Student and Parent Energy-Efficiency Education Program's lift for other PPL Electric Utilities programs was minimal. Only 9% of parents reported participating in other PPL Electric Utilities energy-efficiency programs following their participation in this program. Of the 9%, most parents stated hearing about other kit-related school programs from PPL Electric, thus knowledge of PPL Electric Utilities programs outside of school is very low.

Recommendation:
With tens of thousands participating in the program, consider cross promoting other PPL Electric Utilities programs. Include additional materials and resources (inserts, website links, etc.) in the kit that will lead parents to other PPL Electric Utilities programs. The Student and Parent Energy-Efficiency Education Program would be a good choice to cross-promote other programs due to high program satisfaction and its considerable reach.

Conclusion:
PY5 CFL installation rates for the Take Action group were relatively low at 60%. Despite the change from CFLs to LEDs in PY6, savings from lighting measures will continue to be the single greatest contributor to overall program savings.

Recommendation:
During the classroom presentations, emphasize the savings potential and quality of lighting from LEDs, to promote higher LED installation rates. Consider mentioning that installing LED bulbs would be the single biggest energy-saving action they could take.

Recommendation:
Consider including a flyer in the take home kits that describes LED benefits in detail. Focus promotion efforts on Take Action, the group with the lowest PY5 installation rates.

Conclusion:
The PY5 installation rates for Take Action kitchen faucet aerators were low at 35%. The 2014 TRM, applicable to PY6, stipulates unit energy savings for kitchen faucet aerators are much higher than the 2013 stipulated savings. In 2014, unit savings range from 146.9 to 212.2 kWh, depending on housing type. In 2013, TRM unit savings for these aerators had a single value of 48 kWh regardless of housing type. This change could increase kitchen aerators' overall contribution to savings from less than 3% to

over 10%. Also, many respondents reported they did not install the aerators because they did not work with their faucets.

Recommendation:
Emphasize savings potential of kitchen faucet aerators to Take Action students during the classroom presentations. Mention water savings, plus energy savings if they have electric heat.

Recommendation:
Consider including two types of aerators in the kit to cover internally and externally threaded faucets, to promote higher installation rates.

Table A-5: Student and Parent Energy-Efficiency Education Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Provide safety and energy savings information on LEDs compared to CFLs and incandescent bulbs in the kits. Educating teachers and parents about the benefits of using LEDs over CFLs, especially when safety is of concern, should increase the use of LEDs.	Being considered. PPL agrees.
Consider adding another "plugged-in" measure (CFLs, LED bulbs, smart power strips, and nightlights) more than the "inspection" or "reminder" measures (shower flow test bag, furnace whistle, and light switch stickers) to Bright Kids kit or increasing the instructions and discussion.	Being considered.
Consider removing the furnace whistle from Take Action kit or providing additional installation instructions.	Being considered.
As a way to provide additional installation instructions, consider working with NEF on developing training and demonstration videos presented by classroom teachers that would be posted on the Think!Energy website for students, parents, and teachers to view.	Being considered.
Explore feasibility of customizing the kits or offering a choice of kits.	Being considered.
In secondary schools, fill out home energy Scantron forms in the classrooms.	Being considered.
Cross-promote other PPL Electric Utilities programs.	Being considered. PPL will consider this if it needs additional savings from other programs.
Emphasize savings potential and quality of lighting from LEDs during classroom presentations.	Being considered. PPL agrees.
Consider including a flyer in the take home kits that describes LED benefits in detail.	Being considered. PPL agrees.
Emphasize savings potential of kitchen faucet aerators to Take Action students during the classroom presentations.	Being considered. PPL agrees.
Consider including two types of aerators in the Take Action kit to cover internally and externally threaded faucets.	Being considered.

A.6 Custom Incentive Program

A.6.1 Impact Conclusions and Recommendations

Conclusion:
The Implementation CSP experienced turnover among key staff at the end of PY4, causing some disruption to program operations and recordkeeping. Some custom projects are complex, evolve slowly over time, and involve multiple iterations of calculations. As such, it is inevitable that some information will leave with personnel. However, data storage, document management, and project documentation processes can minimize the loss.

Recommendation:
PPL Electric Utilities could work with the implementer to improve their transition plan and recordkeeping so that changes in personnel are less disruptive to program operations. Carefully structured electronic directories and file naming conventions should be considered. Disruption can be minimized if the most current calculation can be clearly identified, if the project scope is updated in documents, and if next actions are clearly tracked.

Conclusion:
PPL Electric Utilities has taken steps in PY5 to reduce freeridership. Specifically, the pre-approval process was implemented for Phase II largely in order to reduce freeridership. Since participation was low and the survey sample size was small, it is too soon to determine whether changes to the program are necessary to address freeridership.

Recommendation:
The EM&V CSP will examine the need for additional program changes as part of the PY6 and PY7 evaluations in an effort to make recommendations that can be implemented in Phase III.

As part of the evaluation in PY6 and PY7, the EM&V CSP will focus on additional topics such as the effect of the pre-approval process, past participation, decision making, and project planning on freeridership. This will be completed through participant surveys.

Market effects research in PY6 will focus on the influence of trade allies on project development and decisions about energy-efficiency improvements. This will be completed through interviews with contractors and project development engineers.

A.6.2 Process Conclusions and Recommendations

Conclusion:
While satisfaction with the program processes and communication have improved over previous years, there are still some remaining opportunities for PPL Electric Utilities and EPower Solutions to enhance customer experience. These include the following items that are already being addressed.

- Companies with multiple facilities and multiple incentive projects find it difficult to verify for which project they received the incentive payment. This is because the payment is not labeled with an application number or brief description of the project.

- Based on an earlier recommendation from the EM&V CSP, PPL Electric Utilities is aware of this and has already begun including additional identifying information on the incentive check. This allows companies to match the incentive check with the application to verify which projects have been paid and follow up with PPL Electric Utilities when needed.

- There is concern regarding the amount of time it takes to calculate savings along with the amount of time and skill required to complete the application. A respondent whose company has multiple facilities in other utilities' regions or states perceived that the application process is not consistent across utilities when submitting applications.
  - PPL Electric Utilities and EPower Solutions have been working to improve communication with customers to clearly outline the expectations and requirements for participating in the program. They have developed a "Welcome Packet" that will provide additional information to customers about the nature of this type of measurement and verification program, the steps involved, and expectations. The Implementation CSP (and the EM&V CSP for large strata projects) is also working to develop draft SSMVPs very soon after the application is received so that customers can get an early sense of the project-specific M&V requirements.

Conclusion:
PPL Electric's Custom Incentive Program faces challenges that are universal among this program type, such as dissatisfaction with incentive levels and complicated application processes. It is important to note that PPL Electric Utilities is performing comparably with the other programs reviewed. Many of the programs reviewed noted customer complaints about onerous or confusing application processes, with recommendations including (1) for the program to convert to electronic applications and signatures, (2) for customers to use trade allies familiar with the application process, and (3) for a completed sample application to be provided.

Recommendation:
PPL Electric Utilities could provide an example application that demonstrates the appropriate level of detail and supporting documentation expected. To assist applicants, PPL Electric Utilities might supplement the current list of typical supporting documentation with a corresponding list of sources of the appropriate information or records.

Conclusion:
Participants in the Custom Incentive Program are relatively interested in and knowledgeable about energy efficiency. Most companies have various policies in place to reduce energy—whether through an explicit goal, purchasing policies, or strategic investments in energy management. Though these customers already have a strong knowledge base, respondents reported a high level of interest in further training from PPL Electric, as well as more information generally, on ways to save energy. This suggests that this population, while not participating in a formal energy management program, is moving in the direction of energy management as a strategy in making decisions about facility and company energy-efficiency improvements.

Recommendation:

Explore the creation of an energy management training initiative. PPL Electric Utilities could work with EPower Solutions to gather more information from the program participants about specific topics of interest and assess gaps in staff technical expertise that could inform the training focus. Energy management training could include training for executives on how program participation can advance company energy goals, developing and integrating an energy management plan as part of company policy, collecting and analyzing energy usage data, or building operator certification training. The EM&V CSP can assist with program planning and developing this training initiative but other resources are available as well. PPL Electric Utilities is currently working with Strategic Energy Group as part of the Continuous Energy Improvement Program and would be a good reference for planning and developing this training. Other resources include classes about building systems and principles of energy management taught to building operating engineers or Building Operator Certification training courses offered by Pennsylvania College of Technology.

Conclusion:

Several utilities found direct contact with utility staff such as account managers an effective way to raise awareness of the program, and PPL Electric Utilities survey results show that almost all customers are satisfied with the support KAMs provide. However, customer outreach through PPL Electric Utilities KAMs has declined in recent years which may have impacted participation of companies with large projects.

Recommendation:

PPL Electric Utilities may consider re-emphasizing direct outreach by an account manager or some other dedicated person to market the program. In addition, the account managers may be a good choice to become the primary resource for gathering information about barriers to participation as well as the types of training companies would like to receive as part of an energy management training initiative. By providing input into future energy management practices, process optimization, and energy upgrade decisions, ongoing engagement by account manager may also reduce program freeridership.

Conclusion:

Trade allies perform a critical role in many custom rebate programs in raising awareness of the program and helping their customers through the application and technical processes. PPL Electric's custom program participants, like those of DP&L and ComEd, cited trade ally-provided information as the most common introduction to the program. In addition, participants in the programs reviewed were widely satisfied and complimentary of the support they receive from trade allies. PPL Electric's current efforts to coordinate with trade allies active in the program is comparable to the efforts of the other programs the EM&V CSP reviewed.[51]

[51] ComEd's trade ally "bonus program" is an exception among the trade ally coordination activities conducted through the programs reviewed above. Efficacy of this direct trade ally incentive program has not yet be determined conclusively.

Conclusion:

Pre-participation technical audits offered through custom programs were often found to be an effective but underutilized resource. Customers who received technical audits through the programs reviewed indicated that they were more likely to pursue program participation as a result of these audits. Audits were found to be most effective when they were comprehensive and required payment of a nominal fee up front. However, limited customer awareness of these offerings may reduce their effectiveness. It can take several years for an audit to result in a project, so an assessment of study effectiveness that is conducted too early will tend to understate their effectiveness.

Table A-6: Custom Incentive Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Consider requiring the Implementation CSP develop a transition and change management plan to enhance project recordkeeping and continuation of established procedures when employees leave.	Implemented (in progress).
Consider providing an example application showing the level of detail required for supporting documentation.	Being considered
Explore the creation of an energy management training initiative.	PPL will consider this for Ph 3. PPL proposed this initiative in a revision to its Ph 2 EE&C Plan but it was rejected by the PaPUC.
Consider enlisting dedicated outreach personnel to promote program awareness and gather information about barriers to the program along	Being considered

A.7 Act 129 Low-Income Weather Relief Assistance Program

A.7.1 Impact Conclusions and Recommendations

Conclusion:

Act 129 WRAP was slightly behind its planned savings in PY5. At the close of PY5, the program had achieved 27% of its three-year energy target of 10,519 MWh. However, the revised plan filed in November 2013 and approved in April 2014 included savings and demand reductions from 200 full-cost job participants that did not occur in PY5 because the plan was approved late in the program year. PPL Electric Utilities reported a surplus of full-cost job candidates so it should get closer to meeting its participation and savings targets for PY6.

Difficulties identifying baseload job and HPWH candidates added to the challenge of meeting annual participation and savings targets. Many baseload job candidates had to be transferred to USP LIURP WRAP because they qualified for a new water heater, but did not qualify for a HPWH. PPL Electric Utilities is considering a revision to its EE&C plan to allow water heater replacement for Act 129 WRAP to avoid this issue in PY6 and PY7.

Recommendation:
Continue to monitor progress toward savings goals. PPL Electric Utilities may want to increase the number of full-cost jobs eligible for Act 129 WRAP services as one means to bring achieved savings in line with the goal.

PPL Electric Utilities may also want to consider adding low-cost jobs back into the Act 129 WRAP measure package. This would allow customers needing water heaters to be served under the Act 129 program rather than the USP.

Conclusion:
PPL Electric's Act 129 WRAP was cost-effective in PY4 and very close to cost-effective when considering Phase I in aggregate; however, its cost-effectiveness has declined from Phase I and its total TRC costs are the highest among the Pennsylvania EDCs. While other EDCs relied primarily on lighting measures to provide program savings, PPL Electric Utilities provided more comprehensive, weather-sensitive services to its customers. In addition, some jobs required health and safety repairs or upgrades before the weatherization job commenced, which could add to project cost.

Recommendation:
PPL Electric Utilities may want to examine the disaggregated costs by financial reporting category to explore strategies to reduce costs to improve Act 129 WRAP's cost-effectiveness.

A.7.2 Process Conclusion and Recommendation

Conclusion:
PPL Electric's EEMIS tracking system does not report the number of each measure installed, although the data are available in the WRAP V system. Other EDCs report this information in their annual or process reports and also report the percentage of savings attributable to each measure. These data are helpful when reviewing program savings and costs and may help PPL Electric Utilities understand the differences between its program and those of the other EDCs.

Recommendation:
PPL Electric Utilities is updating the USP WRAP data tracking system which will include measure quantities. While the tracking system is under development, PPL Electric Utilities could provide the measure quantities as part of an annual data request. With these data, the percentage of savings provided by each measure can be reported; this would enable the EM&V CSP to provide more insights into program cost-effectiveness.

Table A-7: Act 129 Low-Income Winter Relief Assistance Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
If PPL Electric Utilities is interested in a means to bring achieved savings closer to planning targets, consider increasing the number of full-cost jobs provided by the WRAP.	Implemented
PPL Electric Utilities could also consider adding back low-cost jobs to the WRAP.	Implemented
Review program costs to see the differences in cost reporting details with other Pennsylvania EDCs.	Implemented (in progress)
Review program costs to assess feasibility of cost reductions and whether improved cost efficiencies are possible.	Being Considered
Consider tracking measure quantities in the database for additional understanding of program services and impact on cost-effectiveness.	Being considered

A.8 Residential Home Comfort Program

A.8.1 Audit and Weatherization Conclusions and Recommendations

Conclusion:

PPL Electric's program design, which requires that customers pay the full cost of the comprehensive audit and then to apply separately for a rebate to cover part of the cost may present a participation barrier for customers who cannot afford the initial cost of the audit. While audit rebates are in with line those offered by the other Pennsylvania EDCs, PPL Electric's program is the only Pennsylvania program that requires customers to pay the full cost of the audit up front. Although customers with main source electric heat and central air conditioning ultimately can receive a rebate that covers 50% to 70% of the audit, depending on the contractor's audit price, the customer must still pay the total cost of the audit up front, which many customers may perceive as unaffordable. Thirty-seven percent of respondents who chose the $50 walk-through home energy survey said they chose that audit type because the cost of the comprehensive home energy audit was too high. In addition, the conversion rate for those who had a comprehensive audit was higher than the conversion rate for those who had a Home Energy Survey in PY5.

Recommendation:

To help customers overcome the high out-of-pocket cost of the comprehensive audit, PPL Electric Utilities could consider:

- Highlighting the lower cost audit alternative – the $50 Home Energy Survey – in marketing materials to emphasize that a low-cost option is available.
- If, in the future, PPL Electric Utilities wants to encourage customers to opt for the comprehensive audit, the Company may want to consider a different program design for the audit component, such as one where customers pay a low fixed fee (such as $50 - $99) directly

to the contractor at the time of the audit, and PPL Electric Utilities pays an additional amount negotiated with the contractors, payable upon satisfactory completion of the audit and submission of program paperwork.

Conclusion:
When given the choice, some participants choose the less comprehensive home energy survey due to cost, but some (16%) of the survey respondents were unaware of the comprehensive assessment.

Recommendation:
As PPL Electric Utilities was participants' primary source of information about the program, consider highlighting the comprehensive audit option in bill inserts, newsletters, and on the PPL Electric Utilities website in order to boost customer awareness of this audit option.

Conclusion:
The majority of survey respondents had no suggestions for improving their experience with the program; however, 14% of audit respondents mentioned that they would like to see increased rebates and/or better access to financing.

Recommendation:
PPL Electric Utilities may want to consider providing auditors with a list of financing options, such as contact information for local banks and credit unions, to share with customers to help them cover the cost of the comprehensive audit and any recommended upgrades. This would not require a financial commitment from PPL Electric; rather, it would provide a one-stop location for information about all options – such as rebates and loans – to assist customers in identifying strategies to finance the audit and any efficiency upgrades to their home.

Conclusion:
The PPL Electric Utilities and the Implementation CSP's program managers identified rebate processing time as a problem midway through the program year and worked to address the bottlenecks in the rebate payment process. Consequently, while there was some dissatisfaction with rebate processing times early in the program year, there were no complaints about rebate processing times from survey respondents with installation dates later in the program year.

Recommendation:
Continue monitoring the time from installation date to rebate payment, working to address any issues resulting in delayed rebate payment as soon as possible.

Conclusion:
The freeridership section of the survey did not provide information about the market cost of an audit. Sixty percent of respondents had a $50 home energy survey and may not have been aware that the market price of a home energy audit is approximately $400 to $500. These individuals may have assumed they could get an audit for $50 without PPL Electric's program. Additionally, the audit is a prerequisite to eligibility for rebates for attic and wall insulation, and duct sealing. Respondents may have had this requirement in mind when stating they would have had the audit anyway even if the PPL

Electric Utilities audit rebate were not available because they knew they needed an audit in order to take advantage of the weatherization rebate.

Recommendation:
Add an introduction to the freeridership section of the telephone survey that provides respondents with the estimated market price of a home energy audit, and asks them to answer the subsequent questions disregarding weatherization rebate.

A.8.2 Equipment Conclusions and Recommendations

Conclusion:
New federal standards taking effect in January 2015 will raise the baseline SEER from 13 to 14. This means that PPL Electric's current rebate structure will provide incentives for cooling equipment that is only 1 SEER higher than baseline. PPL Electric's current program encourages customers to install equipment that is significantly more efficient than the minimum required, although PPL Electric's incentives for ASHP are the lowest of the three Pennsylvania EDCs and low compared to other programs outside of PA.

Recommendation:
Consider revising the minimum eligibility requirements to SEER 16 to be in line with changing federal standards and provide more substantial incentives for SEER 16 and higher. This approach would maintain the program design of offering rebates for units that are 2 SEER levels above baseline and encouraging participants to install higher-efficiency HVAC units. Additionally, providing more substantial incentives for higher efficiency equipment would reduce freeridership in the program.

Conclusion:
Although PPL Electric Utilities provides a link to a list of participating contractors and information about eligible pumps on the main pool pump web page,[52] customers must click through to the energy-efficient equipment web page and scroll down to the bottom of the page to find the link to the list of qualifying pumps. It is possible that customers who fail to find the link may mistakenly install equipment that is ineligible for a rebate and be dissatisfied. These customers would also represent missed savings opportunities for PPL Electric. Also, the web page does not indicate that two-speed pumps installed after June 1, 2014 are no longer rebate-eligible and may lead customers to believe they can still receive a rebate for two-speed pumps.[53]

Recommendation:
PPL Electric Utilities may want to add a link to the qualifying pumps to the main pool pump web page where it is closer to the top of the page and easier to find. Also, PPL Electric Utilities should consider revising the web page to make it clearer that two-speed pumps installed after May 31, 2014, are not

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[52] PPL Electric. Accessed August 2014. https://www.pplelectric.com/save-energy-and-money/rebates-and-discounts/residential/rebates/pool-pumps.aspx

[53] PPL Electric. Accessed August 2014. http://www.eeprograms.net/ppl/energy-efficient-equipment/

eligible for a rebate. The Terms & Conditions section of the rebate form indicates that the rebate is for variable speed pumps; however, information on the web page is confusing and may lead to customer dissatisfaction.

Conclusion:
Knowledge of other PPL Electric's program offerings appears low. Only 30% of respondents to the efficient equipment survey were aware of any other PPL Electric Utilities rebate programs, and customers also demonstrated a lack of knowledge about other available rebates when specifying that they would like the program to rebate existing measure offerings (such as refrigerators, LEDs and heat pumps). Moreover, 11% of respondents noted they would like more information on programs and more general energy-efficiency topics from PPL Electric. Because contractors, installers, builders, remodelers, and retailers are a significant source of information about the programs, they present an opportunity to disseminate more information about PPL Electric's offerings.

Recommendation:
Continue working with trade allies to enhance how contractors, installers, builders, remodelers, and retailers can convey knowledge about all program offerings.

Conclusion:
Twelve percent of survey respondents were *not too satisfied* or *not at all satisfied* with the rebate forms they had to complete and submit to apply for ASHP, DHP and pool pump rebates. In addition, many of the suggestions from efficient equipment survey respondents for improved program experience were related to the rebate application.

Recommendation:
Because the rebate form requests technical information, and is best completed by someone with technical knowledge, consider:

- Recommending to trade allies that they assist customers.
- Adding a notice to the top of the form that a retailer, contractor, installer, builder, or remodeler should assist customers with completion of the rebate form.
- Provide an example on the website that shows a completed rebate application with instructions on how to fill it out.
- Or, designating a section of the rebate form that contractors are required to complete.

A.8.3 New Construction Conclusions and Recommendations

This section presents conclusions from the benchmarking research. The EM&V CSP will obtain more information by conducting trade ally interviews in PY6 to determine current standard practice in the Pennsylvania manufactured homes market. This research will produce the market's baseline conditions for manufactured homes at the advent of the PPL Electric's program. EM&V CSP will also conduct participant surveys to assess freeridership in the program.

Conclusion:

Although PPL Electric Utilities has a high rebate amount compared to the other manufactured home programs that provide downstream rebates, this amount is appropriate for a relatively new market. PPL Electric Utilities is the only Pennsylvania EDC addressing manufactured homes in PY6, and the higher rebate amount in the early stages of the program may be necessary to generate interest in efficient manufactured homes among homeowners and retailers.

Recommendation:

Using the findings from upcoming trade ally interviews, participant surveys, and initial participation rates, PPL Electric Utilities may want to consider lowering the rebate amounts for PY7 if these amounts appear higher than necessary. If interest in the program is low, PPL Electric Utilities may want to consider splitting the $1,200 incentive between the customer and the retailers as Idaho Power and Flathead Electric Co-Op have done, to provide motivation for retailers to upsell.

Table A-8: Residential Home Comfort Program Status Report on Recommendations

Recommendations	**EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)**
Residential Home Comfort Audit and Weatherization	
If, in the future, PPL Electric Utilities wants to encourage customers to opt for the comprehensive audit, the Company may want to consider a different program design for the audit component, such as one where customers pay a low fixed fee (such as $50 - $99) and PPL Electric Utilities pays an additional amount negotiated with the contractors	The reason PPL has structured the program the way it is currently set up is to minimize free ridership. Those customers that take action as a result of audit findings will get a full refund for the cost of the audit
Consider highlighting the comprehensive audit program in bill inserts, newsletters, and on the PPL Electric Utilities website in order to better boost customer awareness of the comprehensive audit.	Implemented
Consider providing auditors with a list of financing options to share with *customers to help them cover the cost of the comprehensive audit and any* recommended upgrades.	Being Considered
Continue monitoring the time from installation date to rebate payment, working to address any issues resulting in delayed rebate payment as soon as possible.	Implemented (PPL follows up with customers over the 6 month time period after the audit to receive a rebate)
Residential Home Comfort Program Equipment	
Consider revising the minimum eligibility requirements to SEER 16 for ASHP to be in line with changing federal standards and provide a more substantial incentive.	In Progress
Consider adding a link to the qualifying pumps to the main pool pump web page where it is closer to the top of the page and easier to find.	Being Considered
Update the web page to make it clearer that two-speed pumps installed after May 31, 2014, are not eligible for a rebate.	Being Considered
Continue working with trade allies to enhance how contractors, installers, builders, remodelers, and retailers can convey knowledge about all program offerings.	Being considered
Recommend that trade allies assist customers in completing the rebate forms, add a notice to the top of the form specifying that the trade ally should assist customers with completion of the rebate form, and provide an example on the website that shows a completed rebate application with instructions on how to fill it out.	Being Considered
Residential Home Comfort New Construction	
PPL Electric Utilities may want to consider lowering the manufactured homes rebate amounts for PY7 if these amounts appear higher than necessary, or if interest in the program is low, PPL Electric Utilities may want to consider splitting the $1,200 manufactured homes incentive between the customer and the retailers to provide motivation for retailers to upsell.	Being Considered

A.9 E-Power Wise Program

A.9.1 Process Conclusions and Recommendations

Conclusion:
Overall, participants and agency staff members are satisfied with the E-Power Wise Program. Agency staff members feel the program successfully serves their clients. Participants generate new distribution opportunities by talking to their neighbors about the energy savings kits. Agencies report that comments from participants about the program are almost always positive. Agencies are very satisfied with RAP and are able to get the resources they need to distribute kits in a timely manner. In addition, the coordination between RAP and PPL Electric's program manager is working well. Together they ensure that agencies are actively involved in the program and the program meets its participation goals. They successfully met the PY5 participation goals.

Conclusion:
RAP and PPL Electric Utilities have worked together to create a manageable system for tracking program participants. This method was successful in PY5 as only four duplicate accounts were found over the program year. The account number verification resource used by agencies to identify past participants has helped decrease the number of duplicate records.

Conclusion:
During the PY5 process map review, the EM&V CSP identified that the enrollment card for the direct mail delivery channel was missing details for housing type and number of occupants in the household. RAP created a new enrollment card that includes these details and plans to distribute them with direct mail kits in PY6.

Conclusion:
The agency training materials need more robust details so that agency staff can educate participants about the full benefits of installing the measures and changing their behaviors to use less energy. The agency training slides do not include enough information on each of the kit measures to effectively relay detailed specifics about the measures to participants. Increasing the amount of energy education that the agency staff members receive may increase the quality and quantity of energy education they pass on to the participants.

Recommendation:
Add additional details to the agency training slides to highlight the various benefits to installing the kit measures, especially for the water measures. This can include installation demonstrations, highlighting the interactive effects between the hot water temperature reduction with the water measure installation and the money a family can save when they install the measures and change their behavior. Using real-life examples that are applicable to low income families is an effective way of relaying information on the benefits of energy efficiency.

Conclusion:

The client facing energy education materials, such as the Quick Start Guide, could be updated to provide consistent information. These materials are valuable resources to clients and portray the importance of installing the kit measures to receive savings. In order for the energy education messages to influence installation decisions, the materials need to contain consistent and accurate information.

Recommendation:

Conduct a quality assurance review of the Quick Start Guide to ensure that all details, energy savings tips and dollar savings amounts are accurate and consistent throughout the document. When reviewing the materials for accuracy, make sure all energy savings tips are consistent with the end-use category in which they are presented.

Conclusion:

The kit measure installation rates dropped in PY5 compared to PY4. Participants may not be installing the measures at the expected rate based on a number of interrelated reasons, such as personal preference and not enough education or understanding about the benefits of the energy-efficiency measures. Water saving devices, especially showerheads, included in the energy-efficiency kits, have lower installation rates than other measures. Other program evaluations report participants often cited personal preference for not installing the showerheads. In PY5, participants told agency staff members that they have less interest in the furnace whistle than any of the other measures in the kit. Providing options for more than one kit that allow participants to select measures based on personal preferences may increase installation rates for all measures in the energy-efficiency kits.

Recommendation:

Explore the feasibility of offering different energy-efficiency kits with varied measures as a way to increase installation rates of water conservation and other measures. For example, Penelec provides different kit options based on the recipient's hot water fuel source. PPL Electric Utilities could institute a similar staged approach for kit distribution by first ascertaining the hot water fuel source from the client before offering a kit. The customized energy-efficiency kit could be offered when customers contact the customer service line and send in an enrollment card to RAP to receive a kit.

Recommendation:

PPL Electric Utilities could consider removing certain energy-efficiency kit items, such as furnace whistles, and adding another measure that piques the client's interest. More information is required to understand the client's interests; the EM&V CSP suggests adding questions to the PY6 participant phone survey to learn about other items clients want in the energy-efficiency kits. Based on the various kit items from other programs and online resources, air sealing measures may be an additional offering for the E-Power Wise Program kits. If the current measures do not appear in the Pennsylvania TRM, the EM&V CSP can create a savings protocol specifically for any additional measures considered for the kit.

Conclusion:

As more clients learn about the direct mail delivery path for kits, the requests for kits from agencies are decreasing. Agencies that utilize community outreach are more successful at kit distribution. Additional community outreach will increase awareness of energy-efficiency services at agencies and increase

word-of-mouth marketing between clients. Based on experience from other programs, RAP timed their outreach to correspond with the start of the summer season and saw an increase in program interest. Understanding when customers are most receptive to information will help drive participation. For direct mail kit, it is important that the kits carry the message of the program in a positive way as these participants do not receive any interaction or verbal education on the benefits of the kit items. Ensuring the direct mail kits are designed with effective visuals will carry the message of the program and its benefits to the participants.

Recommendation:

Encourage agencies to provide additional community outreach, such as distributing flyers that describe the agency's energy education services at churches, grocery stores, and food pantries. Timing the outreach at the start of summer or the start of fall (rather than the late fall and winter as in previous years) would help tie the energy education to seasons when the energy burden is at its peak.

Table A-9: E-Power Wise Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Add additional details to the agency training slides to highlight the various benefits to installing the kit measures. This can include installation demonstrations, highlighting the interactive effects between the hot water temperature reduction with the water measure installation and the money a family can save when they install the measures and change their behavior.	Being Considered
Conduct a quality assurance review of the Quick Start Guide to ensure that all details, energy savings tips, and dollar savings amounts are accurate and consistent throughout the document.	Implemented
Explore the feasibility of offering different kits with a variety of items as a way to increase installation rates.	In Progress
Consider removing certain kit items, such as furnace whistles, and adding another item that piques the client's interest.	In Progress
Encourage agencies to offer community outreach such as flyers on community bulletin boards in addition to the posters and flyers in agency waiting rooms.	*Being Considered*
Encourage agencies to time outreach to correspond to seasons when energy burden is at its peak, such as the start of summer.	Implemented

A.10 *Master Metered Low-Income Multifamily Housing Program*

A.10.1 Impact Conclusions and Recommendations

Conclusion:

Whole-building hours-of-use (HOU) and coincidence factor estimates should be used in common area lighting savings calculations rather than using area-specific estimates calculated for each retrofit from information provided by the customer, posted schedules, and other sources. The small size of the

projects, site contact uncertainty around HOU estimates, and feedback from the SWE confirm whole-building estimates from the TRM are more appropriate estimates to include in savings estimation.

Recommendation:
Defer to the Pennsylvania TRM whole-building HOU and coincidence factor estimates when calculating *savings for common area lighting projects.*

Conclusion:
Additional energy savings could be captured by measuring and documenting the ambient temperatures in locations with incented retrofits. While on site, the EM&V CSP found the interior, ambient temperature of most buildings satisfied the 2013 Pennsylvania TRM's definition of "Cooled Spaces" (60 °F to 79 °F).[54] In many cases, temperature in these locations (e.g., halls, stairwells, and common areas) was maintained either by a central air system or by space-cooling technologies (i.e., window air conditioners, packaged terminal air conditioners, etc.) installed in adjacent or nearby areas with connected airflows.

Recommendation:
Review energy audit and installation procedures to confirm they include measurement and documentation of area temperatures. Documented temperature readings will lead to more refined *space cooling estimates included in TRM Appendix C calculations.*

A.10.2 Process Conclusions and Recommendations

Conclusion:
SmartWatt's commitment to the customer experience and its development of strong relationships with PPL Electric's customers is clearly reflected in the satisfaction expressed by property decision-makers and tenants. All property decision-makers reported being *very satisfied* with the quality of the work performed by the contractor in common areas and tenant units and with the contractor's interaction with tenants. All but one tenant reported being *somewhat* or *very satisfied* with the installation contractors.

Conclusion:
As tenants do not directly benefit from energy conservation, i.e., lower energy costs, satisfaction depends entirely on the direct install measures' aesthetics and function. For example, a key area of customer dissatisfaction with CFLs was the bulbs' brightness compared to the bulbs they replaced.

Recommendation:
Develop installation procedures for direct install measures that include a review of the existing equipment and confirmation that the newly installed measures will provide the same level of service. *For example, when installing medium screw base LEDs, confirm that the lumen output for these* measures are equivalent to the bulbs they replace.

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[54] See page 188 of the 2013 Pennsylvania TRM: Table 3-5: Interactive Factors and Other Lighting Variables.

Conclusion:
Tenant attendance in energy-education seminars varies and is often lower than anticipated. No more than 50% of the tenants at any of the properties attended the seminars, and in some cases only 5% reportedly attended. Factors that might impact attendance include apathy, time constraints, mobility, and health.

Recommendation:
PPL Electric Utilities could consider several options to help increase the dissemination of energy education:

- If resources are available, offer snacks, prizes, or other activities that might encourage higher levels of participation at energy-education seminars.
- Consider conducting more than one seminar at properties, especially if the properties are larger or if the properties expect to participate in the program multiple times.
- Explore development and implementation of alternative methods of providing tenant energy education, such as leave-behind literature that tenants can review when convenient.

Conclusion:
Participating properties generally cater to more elderly tenants, a fact that may present unique challenges when identifying possible energy-efficient upgrades and designing program activities such as energy-education seminars. For example, attendance at an energy-education event may be less than expected if many tenants have mobility or health issues. But attendance may not be a significant factor for properties with different, perhaps younger, demographics.

Recommendation:
Collect data from participants with elderly tenants whose projects have been completed to ascertain which upgrades were well-received and which had issues. Incorporate this feedback into recommendations for future project audits and planned activities.

Conclusion:
Currently, the direct install component is a key driver of program participation. However, most properties rely on natural gas for space and water heating, which limits the number and types of direct install measures the program can offer building tenants and may limit the level of interest in program participation.

Recommendation:
Explore the cost-effectiveness of expanding the use of current measure offerings—such as smart strips and, as outlined in PPL Electric's revised EE&C plan, appliance recycling and replacement.[55]

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[55] *PPL Electric's Revised EE&C Plan (Docket No. M-2012-2334388) filed with the Pennsylvania PUC on April 7,* 2014, Table S6, pp. 154.

Conclusion:
The evaluability of the MMMF Program could be improved by taking steps to ensure consistency in reporting measure-level retrofit data (using the appropriate common area lighting or direct install table). Understanding which projects are planned for completion in stages will improve the efficiency of the evaluation activities and reduce customer fatigue with repeated verification site visits and phone calls.

Recommendation:
Review the steps taken in uploading data into EEMIS and ensure appropriate measures are being taken to ensure consistency in how measure-level project data are reported. It is recommended that PPL Electric Utilities track measures with deemed savings estimates (e.g., beverage machine controls, smart strips) in the "direct install" table and measures with savings derived from a specific calculations (e.g., T8 linear fluorescent fixtures) tracked in the common area lighting table. This way, the source of reported savings estimates will be more transparent.

Recommendation:
Review the EEMIS and SmartWatt tracking systems used to store MMMF Program data to explore the options for adding a flag to the project records to identify customers completing (or planning to complete) projects in stages.

Conclusion:
The evaluability of the MMMF Program could be improved by collecting additional information from building tenants regarding measure satisfaction and spillover actions taken. In PY5, EM&V CSP staff left postage-paid postcard surveys in tenant units selected for site visits. However, if the program Implementation CSP left these surveys in all units following the installation of measures, the amount of customer feedback would be significantly higher and collected with minimal additional cost or effort.

Recommendation:
Work with the EM&V CSP to leave building tenants with pre-paid surveys (addressed to the EM&V CSP) when installing direct install measures in tenant units.

Conclusion:
The MMMF Program offers PPL Electric's customers a comprehensive suite of measures and education opportunities that exceed those offered by other EDCs and comparable multifamily programs. Only one other Pennsylvania EDC (PECO Energy Company) currently implements a formal multifamily program. The MMMF Program is the only program among the multifamily programs reviewed to offer customers direct install T8 retrofits, exit signs, and vending machine controls. Only one other program—NYSEG and RG&E's Multifamily Direct Install Program—currently offers directly installed medium screw-base LED bulbs.

Conclusion:

SmartWatt's commitment to the customer experience and its development of strong relationships with PPL Electric's customers is clearly reflected in the satisfaction expressed by property owners and operators and by tenants and in the ways property owners and operators reported learning of the program. Responses to comparable questions posed during the PY5 process evaluation of the MMMF Program indicate PPL Electric Utilities customers are equally or more satisfied than customers in the other programs. This was true for customer satisfaction with the program overall as well as individual program components.

Conclusion:

The MMMF Program is unique in its commitment to tenant education, but customers might benefit from additional education content aimed specifically at multifamily property owners and operators—similar to PECO's Smart Multifamily Solutions Program.

Recommendation:

Explore the cost-effectiveness of expanding program training to target multifamily owners and operators. Include both training seminars as well as demonstration projects for potential participants.

Table A-10: Master Metered Low-Income Multifamily Housing Program
Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Defer to the Pennsylvania TRM whole-building HOU and coincidence factor estimates when calculating savings for common area lighting projects.	Implemented
Review energy audit and installation procedures to confirm they include *measurement and documentation of area temperatures. Documented* temperature readings will lead to more refined space cooling estimates included in TRM Appendix C calculations.	Being Considered
Consider customer feedback about lighting brightness in tenant units when transitioning to LEDs and install bulbs with equivalent-lumen output.	Being Considered
Review means to increase tenant participation at energy-education seminars, such as offering prizes, food, and other activities.	In Progress
Consider conducting more than one tenant energy-education seminar, especially at larger properties.	In Progress
Consider new ways to disseminate educational information to tenants, such as leave-behind literature.	*Implemented*
Collect anecdotal data about which upgrades were well-received by properties primarily housing seniors and which had issues. Incorporate this information when planning future projects and making audit recommendations.	Implemented
Explore the cost-effectiveness of expanding the use of current measure *offerings—such as smart strips and, as outlined in PPL Electric's revised* EE&C plan, appliance recycling and replacement.	Implemented
Review the steps taken in uploading data into EEMIS and ensure appropriate measures are being taken to ensure consistency in how measure-level project data are reported.	Implemented
Review the EEMIS tracking systems used to store MMMF Program data and *determine the feasibility of implementing a flag to identify customer* completing larger facility improvements as a series of individual projects (that is, in more than one phase).	Being Considered
Explore the cost-effectiveness of expanding program training to target multifamily owners and operators and include both training seminars as well as demonstration projects.	Being Considered

A.11 Residential Energy-Efficiency Behavior and Education Program

A.11.1 Process Conclusions and Recommendations

Conclusion:

Because the program will include customers who participated previously in Phase I, savings for Phase II may not be high or persistent among legacy participants and, as a result, may impact the overall savings

for the program. The EM&V CSP's benchmarking research suggests that high-energy users achieve the most savings, but high-energy users have also had difficulty sustaining savings as the program matures.

Recommendation:
Consider a persistence study that investigates how savings from legacy participants have changed from Phase I to Phase II. This study could reveal hidden attributes and trends among legacy participants who have shown strong, ongoing savings. These attributes and trends could help in the establishment of a savings persistence criterion for selecting new customers for the program because customers who are persistent with savings can boost program savings in the long run.

Conclusion:
PPL Electric's program in PY4 experienced a lower opt-out rate (0.3%) than other comparable programs. PPL Electric's program also experienced higher satisfaction with the home energy reports than did the other programs, and data suggest that participants find value in the reports. While distrust in the accuracy of neighbor comparisons is a common issue across all of these behavior programs, PPL Electric Utilities has already implemented solutions by more clearly describing the context and home features.

Conclusion:
The e-mail delivery channel is a work in progress. Concerns about messaging overload and the potential for messaging confusion between the e-mailed home energy reports and PPL Electric's quarterly energy-saving e-mails emerged. While the mailed reports will provide comprehensive information (consumption data, neighbor comparison, and energy-saving tips), e-mailed reports are currently planned to provide only the neighbor comparison. PPL Electric's PY4 evaluation and research of comparable program evaluations found that most participants distrust the accuracy of the neighbor comparisons.

Conclusion:
The EM&V CSP's benchmarking research found that the mailed home energy report delivery channel is, by far, the more effective method for engaging readers than a web portal. Participants from the comparison programs that we reviewed showed very little interest in the web portal. These comparison programs did not implement the e-mail delivery channel.

Recommendation:
Once distribution of the e-mailed reports begins, consider tracking the customers who receive the e-mail reports and monitoring the e-mail click rates in order to determine the impact of the new delivery channel and whether continuation of e-mailed reports is warranted. Consider allowing the EM&V CSP to explore readership and perceptions of the e-mailed reports as an area of investigation in the participant surveys to compare readership (mail vs. e-mail) and understand participant experiences with the different channels.

Table A-11: Residential Energy-Efficiency Behavior and Education Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Consider a persistence study that investigates how savings from legacy participants have changed over time from Phase I to Phase II.	Being Considered
Consider tracking and evaluating the e-mailed reports through click-rates and participant surveys.	Being Considered

A.12 Low-Income Energy-Efficiency Behavior and Education Program

A.12.1 Process Conclusions and Recommendations

Conclusion:
The e-mailed report delivery channel is still under development, but according to the benchmarking findings this delivery channel may not be the best fit for the low-income segment (although the EM&V CSP found no specific data about e-mailed report readership and engagement). The findings revealed that mailed home energy reports engage and inform participants more effectively than a web portal. Mailed reports also equalize access to energy-efficiency information across income levels. Because low-income customers likely have less access to the Internet and Internet-enabled devices than non-low-income customers, they are hard to reach and engage through e-mailed reports.

Recommendation:
Discuss the fit of the e-mail delivery channel to low-income customers with the Implementation CSP. Consult other PPL Electric's low-income programs that have implemented an e-mail delivery channel to understand the delivery channel's challenges and solutions.

Recommendation:
Assess the availability of e-mail addresses and verify the number of valid customer e-mail addresses currently available. A low number could indicate an Internet accessibility issue. Decide if the program should make the effort to collect more e-mail addresses. If more e-mail addresses are deemed necessary, then consider collecting e-mail addresses from other low-income programs that offer online enrollment.

Conclusion:
Program participation and energy savings do not appear to differ by income level. Low-income participants also demonstrated the same opt-out rate as an Opower behavior program with mixed-income participants.

Conclusion:
According to the Implementation CSP's recent white paper, low-income utility customers face challenges accessing information and learning about energy efficiency. Low-income customers were

found to be less aware about energy-efficiency programs than the general population. The white paper stated this was typical of households with English as a second language and limited access to the Internet. These barriers can hinder low-income participants' ability to engage in energy-efficiency opportunities.

Recommendation:

PPL Electric Utilities should consider researching the prevalence of non-English speakers among low-income households in their region to determine the need for home energy reports in other languages. PPL Electric Utilities can explore the availability of demographic information collected from other low-income programs. For example, WRAP and On-Track programs may collect participant data useful to reaching and serving this program's participants.

Recommendation:

Consider including an introduction in prevalent languages in the welcome letter that is to accompany the first home energy reports mailed out to customers. Within the introduction, provide contact information if customers would like to request reports in other languages. Responses will determine the need for home energy reports in other languages.

Recommendation:

To reach out to customers with limited access to the Internet, host free Wi-Fi community events to provide customers access to energy-efficiency information on the web. Using the Apple Store as a prototype for the free Wi-Fi community event, consider setting up the event in a way where customers can learn about and gain interest in energy-efficiency through one-on-one, interactive sessions.

Table A-12: Low-Income Energy-Efficiency Behavior and Education Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Consider discussing the fit of the e-mail delivery channel with the Implementation CSP by consulting other low-income programs that have implemented an e-mail delivery channel.	Being Considered
Assess the availability of, and verify the number of valid customer e-mail addresses currently available to determine if an effort to collect more e-mail addresses is needed.	Implemented
Consider looking into the prevalence of non-English speakers to determine the need to offer multi-lingual home energy reports or newsletters.	Being considered
Consider including an introduction in prevalent languages in the welcome letter. Provide contact information in the introduction for customers to request reports in other languages.	Being Considered
Consider developing targeted outreach activities through offering materials on energy efficiency in various languages and by hosting free Wi-Fi events in the community. For example, review existing date to determine if language preference already exists. If not, collect primary data regarding language preference, possibly through bill inserts or PPL's website.	Being Considered

A.13 Participant Definitions

Participant definitions discussed in each of the program chapters are summarized below.

Table A-13: Program Year 5 Participant Definition by Program

Program	Participant Definition	Can there be more than one measure per participant?	Sample Defined By:
Appliance Recycling	Unique CSP Job ID	Yes	Freezer and Refrigerators
Continuous Energy Improvement	CSP Job ID unique to each project	Yes	Projects
Custom Incentive	C&I job that received an incentive payment between June 1, 2013 and May 31, 2014	Yes	Large stratum are projects with reported savings > 500,000 kWh/year Small stratum are projects with reported savings <= 500,000 kWh/year
E-Power Wise	Unique CSP Job ID (receive 1 energy conservation kit per income eligible household)	No	Delivery method (agency or direct mail)
Low-Income Energy-Efficiency Behavior and Education	Low-income Household	No	All participants
Low-Income WRAP	Income eligible household; identified with unique CSP Job ID	Yes	Job type (baseload, full cost, heat pump water heater)
Master Metered Multi-Family	CSP Job ID unique to each project	Yes	Random sample of projects (target 85/15)
Prescriptive Equipment -- Non-lighting subcomponent	CSP Job ID unique to each project	Yes	Random sample of projects (target 90/10)
Prescriptive Equipment -- Lighting subcomponent	CSP Job ID unique to each project	Yes	Defined kWh thresholds (target 90/10)
Residential Energy-Efficiency Behavior and Education	Household	No	All participants
Residential Home Comfort	Unique CSP Job ID	Yes	Subprograms: audits, weatherization measures, equipment rebates, manufactured housing, new construction
Residential Retail -- Equipment subcomponent	Unique CSP Job ID	Yes	Desk review of random sample of rebate forms, prorated by rebated equipment based on reported savings
Residential Retail -- Upstream Lighting subcomponent	Jobs are reported as weekly bulb sales by bulb type. Number of participants determined by dividing the total number of bulbs sold or distributed by a bulbs-per-participant estimate derived from general residential and small C&I population survey respondents who reported having purchased bulbs.	NA	All records
School Benchmarking	CSP Job ID unique to each project	Yes	Projects
Student and Parent Energy Efficiency Education	Classroom	Yes	3 classroom cohorts, 1 teacher cohort, 1 parent workshop cohort

A.14 Program Year 5 Actual Evaluation Activities

Table A-14 summarizes actual evaluation activities completed in PY5.

Table A-14: Program Year 5 Participant Definition by Program

Programs and Sub Programs	Sectors	Records Review	Participant Surveys	Nonparticipant Surveys	Site Visits	Metering
Appliance Recycling	All sectors	All records	140 (prorated by refrigerators & freezers)	11	NA	NA
Continuous Energy Improvement	GNI	Evaluation planned for PY6		NA	NA	NA
Custom Incentive	C&I, GNI	2 (all) in large strata; 17 in small stratum	11 unique decision makers	2 *partial* participants	2 large *stratum;* 17 small stratum	3
E-Power Wise	*Low Income*	*All records*	*All available returned paper surveys (387)*	NA	NA	NA
Low-Income Energy-Efficiency Behavior and Education	Low Income	Program to launch in PY6		NA	NA	NA
Low-Income WRAP	Low Income	25 baseload jobs 25 HPWH	NA	NA	NA	NA
Master Metered Multi-Family	*GNI*	*All records*	8 unique decision makers (building *owners/managers)* 42 tenants	NA	17	NA
Prescriptive Equipment -- Non-lighting *subcomponent*	Small C&I, large C&I, and GNI	21 *(All records)*	0 (Attempted 9 unique decision makers)	NA	16	0
Prescriptive Equipment -- Lighting subcomponent		34	75 Direct Discount 75 Prescriptive Rebates	NA	34	1
Residential Energy-Efficiency Behavior and Education	Residential	Program to launch in PY6		NA	NA	NA
Residential Home Comfort	Residential	172	164	NA	NA	NA
Residential Retail – Equipment subcomponent	Residential	82	150	NA	NA	NA
Residential Retail -- Upstream Lighting subcomponent	Residential Small C&I	*All records*	General population surveys with 301 residential and 392 small C&I customers	NA	NA	NA
School Benchmarking	GNI	Activities will occur in PY6		NA	NA	NA
Student & Parent Education	Residential	90	All available returned paper surveys (15,941) 561 phone and on-line surveys	NA	NA	NA

Appendix B: Net-to-Gross Analysis

B.1 Introduction

On August 2, 2011, the Pennsylvania PUC's issued the Total Resource Cost Test (TRC) Order, directing electric distribution companies (EDCs) to collect the data necessary to determine a net-to-gross (NTG) ratio for each program and to apply that ratio to determine the cost-effectiveness of future modifications to existing program. The method for incorporating NTGR in cost-effectiveness calculation has been described in the *California Standard Practice Manual*[56] but has not been defined in the Act 129 TRC Order.

The Pennsylvania PUC Implementation Order specifies that the NTG for Phase II of Act 129 is to be treated in the same way as for Phase I. Specifically, for compliance purposes the NTG ratios for Phase II programs continues to be set a 1.0—basing compliance with energy and demand reduction targets on gross verified savings. However, the PUC order also states that the EDCs should continue to use net verified savings to inform program design and implementation. "Specifically, the Commission [PA PUC] proposed that NTG research be used to direct Act 129 program design and implementation, but not for compliance purposes."[57] Their reasons for this are: "One, if a NTG ratio of less than 1.0 is used, this will raise the acquisition cost per annual kilowatt-hour (KWh) saved to the EDC, which will result in a lower target, due to the 2% budget cap. The current targets include an assumed NTG ratio of 1.0. Two, the Commission recognizes that the calculation of NTG ratios is inexact at best. "Free riders" are difficult and expensive to calculate, but even more difficult and costly to calculate is "spillover."[58]

The *Evaluation Framework*[59] and the SWE recommended the EDCs use standard approaches to NTG studies. As a result, the SWE team proposed a common approach to estimate freeridership and spillover for downstream (prescriptive rebate) programs, and for appliance recycling programs. The SWE and EDCs collaborated on the final methodologies. The *Evaluation Framework* provides detailed methods.

This Appendix summarizes the general approach to estimating freeridership and spillover for the following downstream rebate and incentive programs.

- Prescriptive Equipment
- Custom Incentive Program

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[56] CPUC. *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects*. 2001. Available at: http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

[57] Pennsylvania Public Utility Commission, Energy Efficiency and Conservation Program Implementation Order, at page 82, at Docket No M-2012-2289411, (Phase II Implementation Order), entered August 3, 2012.

[58] Ibid., page 83.

[59] SWE Team. Evaluation Framework for Pennsylvania Act 129 Phase II Energy Efficiency and Conservation Programs. June 30, 2013. Page 61.

- Multifamily Master Metered Program (low income)
- Residential Home Comfort
- Residential Retail (rebated equipment)
- Appliance Recycling (SWE method based on the Uniform Methods Project)

There is no freeridership and spillover expected in the targeted low-income programs E-Power Wise and WRAP. No freeridership is expected in the Student and Parent Energy Education Program which gives away energy conservation kits as one component of classroom training; therefore, freeridership was not estimated. The Multifamily Master Metered Program offered to buildings housing low income tenants offers some program measures for free and installs these measures at no cost to the participant. No freeridership is expected nor estimated for the free measures directly installed in this program.

Freeridership is estimated for the residential upstream lighting component of the Residential Retail program through an econometric price response model. No spillover was estimated for this program.

B.2 Definition and Components of NTG

The PY5 *Evaluation Framework* defines net savings and the NTGR as follows:

- **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 free-drivers, free-riders, energy-efficiency standards, changes in the level of energy service, participant and nonparticipant spillover, and other causes of changes in energy consumption or demand.
- **Net-to-Gross Ratio (NTGR)**: 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.[60]

As noted in the *Evaluation Framework*, there are two primary factors that differentiate net savings from gross savings, free-ridership and spillover, defined below.

- **Free Rider**: A program participant who would have implemented the program measure or practice in the absence of the program.
- **Partial Free Rider**: A program participant who would have implemented, to some degree, the program measure or practice in the absence of the program (For example: a participant who may have purchased an ENERGY STAR® appliance in the absence of the program, but because of the program bought an appliance that was more efficient).

[60] While the definition in the Audit Plan glossary does not state that gross savings are evaluated savings, the definition implies these are adjusted gross savings, that is, *ex post* gross verified savings. Adjustments are made, for example, for installation rates, failure, and site specific conditions.

- **Spillover**: Reductions in energy consumption and/or demand caused by the presence of the energy-efficiency program, beyond the program-related gross savings of the participants. There can be participant and/or nonparticipant spillover.
  - **Participant spillover (SO_P):** The adoption of measures by participants in addition to those incented by the program that are attributable to the program's presence.
  - **Nonparticipant spillover (SO_{NP}):** The adoption of measures by eligible customers who did not participate in the program.
- **Market Effects Evaluation:** The evaluation of the change in the structure/functioning of a market or the behavior of participants in a market that result from one or more program efforts. Typically the resultant market or behavior change leads to an increase in the adoption of energy-efficient products, services, or practices.

B.3 PY5 NTG Methodology

The general form of the equation used to determine the NTG ratio for downstream rebated measures is:

$$NTG = 1 - FR + SO$$

Where:

FR = Free-ridership quantifies the percentage of savings (reduction in energy consumption or demand) from participants who would have implemented the measure in the absence of the EDC program.

SO = Spillover quantifies the percentage reduction in energy consumption or demand (that is, additional savings) caused by the presence of the EDC program. Spillover savings happen when customers invest in additional energy-efficient measures or activities without receiving a financial incentive from the program.

B.4 Freeridership

Self-report surveys are used to estimate freeridership in downstream rebate programs. Freeridership estimates reflect the respondents' perception of program influence and intention on their participation decisions.

- **Intention** determines what would most likely have occurred if the respondent did not receive program assistance; intention assesses the likelihood of purchasing and installing the energy efficient equipment without the program's support.
- **Influence** assesses factors that may have influenced respondents' decisions to take energy efficient actions.

The freeridership score is computed by summing intention score and the influence score to determine a single score ranging from 0 (no freeridership) to 1 (100% program free rider).

The general method described below is summarized from the SWE's memos describing *Common Approach for Measuring Free-riders for Downstream Programs*. The general method is meant to be tailored to each Act 129 program. The method differs for downstream prescriptive rebates, upstream programs, and direct installation programs. Appliance recycling programs uses a different NTG method described by the SWE.

The general method for prescriptive rebate programs is summarized in this appendix. **Table B-1** summarizes the possible response combinations to the questions assessing a respondent's intention and the *intention* score assigned to each unique response combination.

Table B-1. General Free-Ridership Intention Component Scoring

Question	Response	Intention Score
1. Which of the following is most likely what would have happened if you had not received [the program assistance]?	Postponed/cancelled	0
	Reduced size, scope, efficiency	Based on response to Q2
	No change	Based on response to Q3
	Don't know	25*,**
2. By how much would you have reduced the size, scope, or efficiency?	Small amount	37.5
	Moderate amount	25
	Large amount	12.5
	Don't know	25*
3. *Would your business have paid the entire cost of* the upgrade?	*Yes*	50
	Don't know	37.5*
	No	25**

* Represents the midpoint of possible values for this question.

** Infrequent response.

The program's influence score is equal to the maximum influence rating for any program element rather than the mean influence rating. The rationale is that if any given program element had a great influence on the respondent's decision, then the program itself had a great influence, even if other elements had less influence.

In this example, the highest score (a 5 for the *influence* of the audit/study) is used to assign the *influence* component of the freeridership score. High program *influence* and freeridership have an inverse relationship – the greater the program *influence*, the lower the freeridership, as see in **Table B-2**.

Table B-2. General Free-Ridership Influence Component Scoring

Program Influence Rating	Influence Score
1 – not at all influential	50
2	37.5
3	25
4	12.5
5 – extremely influential	0
DK	25

Total freeridership is the sum of the *intention* and *influence* components, resulting in a score ranging from 0 to 100. This score is multiplied by .01 to convert it into a proportion for application to gross savings values.

B.5 Spillover

Described in the memo prepared by SWE, residential and nonresidential sectors, participant spillover approach will assess, for each participant:

- The number and description of non-incented energy-efficiency measures taken since program participation.
- Non-incented energy-efficiency measures may include all energy-efficiency measures, even if not eligible for program incentives. EDCs should distinguish between program-eligible and other types of measures (including measures that are in the TRM but not eligible for a specific program and energy efficient measures not in the TRM) in their analyses.
- An estimate of energy savings associated with those energy-efficiency measures.
- The program's influence on the participant's decision to purchase and install the identified measures, assessed with a rating scale and converted to a proportion, with possible values of 0, 0.5, and 1.0.

The specific methods for the residential and nonresidential sector may differ somewhat in details of program influence assessment and estimation of the measure-specific energy savings. Program influence is assessed as the maximum influence rating given to program elements asked about in the participant survey.

The maximum influence rating is assigned a value that determines what proportion of the relevant measures' savings is attributed to the program:

- A rating of 4 or 5 = 1.0 (full savings attributed to the program).
- A rating of 2 or 3 = 0.5 (half of the savings attributed to the program).
- A rating of 0 or 1 = 0 (no savings attributed to the program).

At the evaluator's discretion, to provide additional relevant feedback to the program, the survey may ask participants whether there was a reason that they did not receive an incentive for the additional energy efficient technologies.

B.6 Market Effects

Market effects can include changes in retail stocking practices. For example, a program can influence market practices such as the SEER level of stocked heat pumps, home building practices, and the availability of products without the consumer's knowledge. If utility programs are successful and influence market practices (transform the market), the NTGR naturally declines over time as market transformation increases. Therefore, in addition to non-participants who are aware of a program, SONP may also include savings from purchases of energy equipment by non-participants from retailers who stock the energy efficient measure due to a program's influence. These upstream market transformation impacts are generally difficult, if not impossible, to measure with any reasonable level of accuracy. However, these impacts could be substantial. For this report, market effects are not quantified nor included in the NTG ratio. The EM&V CSP began conducting small market effects studies and will include results in future reports.

Appendix C: Low-Income Participation in Non-Low-Income Programs

PPL Electric Utilities determined the number of low-income households participating in programs that are open to *all* residential customers—that is, low-income participation in non-low income programs. These were the Appliance Recycling, Residential Home Comfort, Residential Retail – Equipment, Residential Retail – Upstream Lighting, and Student and Parent Energy-Efficiency Education programs. Participant numbers were obtained according to the methodology approved by the Pennsylvania Public Utility Commission and described in the PPL Electric Utilities memo, *Method to Estimate Low-Income Savings in Non-Low-Income Programs*, dated June 1, 2011.

This analysis used survey data that included responses from participants who answered questions regarding the number of individuals in their household and estimated annual household income. **Table C-1** lists the number of respondents in four programs and whether they answered income and household questions.

Table C-1: PY5 Percentage of Respondents Answering Income and Household Questions

Program	Completed Surveys	Income/Household Questions	
		Total Respondents	Percentage Who Refused to Answer
Appliance Recycling	140	98	30%
Residential Home Comfort	164	118	28%
Residential Retail – Equipment	150	109	27%
Residential Retail – Upstream Lighting	301	129	57%
Total	**755**	**454**	**40%**

The Student and Parent Energy-Efficiency Education program was offered to schools in PPL Electric's service territory that offer free lunches to children from households with income below 120% of the federal poverty level (FPL), which is more conservative than 150% of the FPL. The Pennsylvania Department of Education publishes the percentage of student enrollment that qualifies for free lunches. The published data were used to determine the percentage of low income participants in this program. The EM&V CSP assumes that the percentage of students enrolled in the school is representative of the percentage within any particular classroom participating in the program. Across all participating schools with available data, the average percentage of students receiving free lunches in the 2013 – 2014 school district was 33%. There were 17 schools, all private religious schools, which were not included in the PA Dept. of Education database. The estimate of energy savings attributable to low-income students may be biased by excluding these 17 schools, but the direction of the possible bias is not known.

In PY5, participants below 150% of the FPL were associated with verified gross savings of 14,002 MWh/year in non-low-income programs. The participation by program and PY5 savings are summarized in **Table C-2**. Federal poverty guidelines are shown in **Table C-3**.

Table C-2: PY5 Verified Gross Savings Attributable to Low-Income Participation in Non-Low-Income Programs

Program	Total Survey Respondents	Respondents Meeting FPL Guidelines	Percentage of Total Respondents	PY5 Verified Gross Impact (MWh/yr)	Savings Associated with FPL Population (MWh/yr)
Appliance Recycling	98	9	9%	9,255	850
Residential Home Comfort	118	4	3%	2,410	82
Residential Retail – Equipment	*109*	13	12%	2,875	343
Residential Retail – Upstream Lighting	129	12	9%	65,356[1]	6,080
Student and Parent Energy-Efficiency Education	N/A	N/A	33%	5,147	1,699
Total	**641**	**84**	**N/A**	**85,043**	**9,053**

NOTES:
[1] Does not include verified savings for small C&I upstream lighting component (cross sector sales).

Table C-3. Federal Poverty Guidelines

Persons in Family	PY1	PY2	PY3	PY4	PY5
	2010 Continental U.S.[1]	2011 Continental U.S.[2]	2012 Continental U.S.[3]	2013 Continental U.S.[4]	2014 Continental U.S.[5]
1	$10,830	$10,890	$11,170	$11,490	$11,670
2	$14,570	$14,710	$15,130	$15,510	$15,730
3	$18,310	$18,530	$19,090	$19,530	$19,790
4	$22,050	$22,350	$23,050	$23,550	$23,850
5	$25,790	$26,170	$27,010	$27,570	$27,910
6	$29,530	$29,990	$30,970	$31,590	$31,970
7	$33,270	$33,810	$34,930	$35,610	$36,030
8	$37,010	$37,630	$38,890	$39,630	$40,090
For Each Additional Person Add	$3,740	$3,820	$3,960	$4,020	$4,020

NOTES:
[1] U.S. Department of Health and Human Services. "The HHS Poverty Guidelines for the Remainder of 2010 (August 2010)." Available at: http://aspe.hhs.gov/poverty/10poverty.shtml
[2] *U.S. Department of Health and Human Services. "The 2011 HHS Poverty Guidelines." Available at:* http://aspe.hhs.gov/poverty/11poverty.shtml
[3] U.S. Department of Health and Human Services. "The 2012 HHS Poverty Guidelines." Available at: http://aspe.hhs.gov/poverty/12poverty.shtml
[4] *U.S. Department of Health and Human Services. "2013 Poverty Guidelines." Available at:* http://aspe.hhs.gov/poverty/13poverty.cfm
[5] U.S. Department of Health and Human Services. "2014 Poverty Guidelines." Available at: http://aspe.hhs.gov/poverty/14poverty.cfm

C.1 PY5 Survey Questions for Federal Poverty Level Guidelines

These questions were used to collect number of people in the household and household income. These data were used to determine low-income participation in non-low-income programs. (The letter and number sequence is taken directly from the survey instrument.)

D1. Including yourself, how many people lived in your home full-time during the past 12 months? (If Necessary: full-time is considered more than 9 months in the past year)

01. (1)
02. (2)
03. (3)
04. (4)
05. (5)
06. (6)
07. (7)
08. (8)
09. (9)
10. (10)
11. (11)
12. (12)
13. (Thirteen or more)
98. (Don't Know)
99. (Refused)

D2. In 2013, was your annual household income before taxes above or below $50,000?

1. (Below $50,000)
2. (Above $50,000) [SKIP TO D6]
3. (Exactly $50,000) [SKIP TO CLOSING]
98. (Don't Know) [SKIP TO CLOSING]
99. (Refused) [SKIP TO CLOSING]

[ASK IF D2=1]

D3. Was your annual household income before taxes above or below $25,000?

1. (Below $25,000)
2. (Above $25,000) [SKIP TO D5]
3. (Exactly $25,000) [SKIP TO CLOSING]
98. (Don't Know) [SKIP TO CLOSING]
99. (Refused) [SKIP TO CLOSING]

[ASK IF D3=1]

4. Please stop me when I read your category. Was it ... [READ LIST]:

1. Under $10,000 [SKIP TO CLOSING]
2. $10,000 to under $15,000 [SKIP TO CLOSING]
3. $15,000 to under $20,000 [SKIP TO CLOSING]
4. $20,000 to under $25,000 [SKIP TO CLOSING]

98. (Don't Know) [SKIP TO CLOSING]

99. (Refused) [SKIP TO CLOSING]

[ASK IF D3=2]

D5. Please stop me when I read your category. Was it ... [READ LIST]

1. $25,000 to under $30,000 [SKIP TO CLOSING]
2. $30,000 to under $35,000 [SKIP TO CLOSING]
3. $35,000 to under $40,000 [SKIP TO CLOSING]
4. $40,000 to under $45,000 [SKIP TO CLOSING]
5. $45,000 to under $50,000 [SKIP TO CLOSING]

98. (Don't Know) [SKIP TO CLOSING]

99. (Refused) [SKIP TO CLOSING]

[ASK IF D2=2]

6. Please stop me when I read your category. Was it ... [READ LIST]

1. $50,000 to under $60,000
2. $60,000 to under $75,000
3. $75,000 to under $100,000
4. $100,000 to under $150,000
5. $150,000 to under $200,000
6. $200,000 or more

98. *(Don't know)*

99. (Refused)

Appendix D: Econometric Study

To provide estimates of freeridership for the upstream lighting component of the Residential Retail program, the EM&V CSP conducted demand modeling using bulb sales information from the program's implementation CSP, Ecova.

D.1 Introduction

Lighting products that incur price changes and promotion over the program period provide valuable information regarding the correlation between sales and prices. Using the price elasticity to estimate freeridership is the same principle in willingness-to-pay analyses using self-report survey responses as in Phase I. However, rather than relying on self-report data, elasticities are based on actual observed changes in purchasing behavior in response to program activity.

Demand elasticity modeling is based on the same economic principle driving program design: that a change in price and promotion generates a change in quantities sold (i.e., the upstream buy-down approach). Demand elasticity modeling uses sales and promotion information to achieve the following:

- Quantify the relationship of price and promotion to sales;
- Determine the likely sales level without the program's intervention (baseline sales); and
- Estimate freeridership by comparing modeled baseline sales with actual sales.

After estimating variable coefficients, the EM&V CSP used the resulting model to predict: sales that would occur without the program's price impact; and, sales that would occur with the program (and should be close to actual sales with a representative model). Freeridership is then calculated using this formula:

$$FR\ Ratio = \left(\frac{Savings\ without\ Program}{Savings\ with\ Program}\right)$$

D.2 Input Data

As the demand elasticity approach relies exclusively on program data, a model's robustness depends on data quality. Overall, available data achieved a sufficient quality to support the analysis; however, the data also presented several issues of note.

D.2.1 Data Quality Issues

Because price is the primary factor that represents program activity in the model it is critical that prices are measured consistently and accurately. The EM&V CSP conducted preliminary modeling to verify the quality of the data and identify potential issues. The results of the preliminary modeling indicated several anomalies.

- The relationship shown in the data between price and sales was positive for many products, which is the opposite of expectations absent some other factor, for instance merchandising events (prices and sales could increase together) or product being out of stock (prices and sales could fall together).
- Erratic price changes, for example, prices changed for a product within a subset of retail locations rather than across all locations. Because the price comes from the manufacturer rather than the retailer, we expect price changes to occur across all locations simultaneously.
- Numerous price changes up and down, sometimes fluctuating frequently across many months. We expect manufacturers to be somewhat restrained in how frequently they change prices. In similar evaluations the price absent the program rarely changes more than once within a given program period.
- If manufacturers change their price absent the program, the prices typically change not only across all retail locations simultaneously but also across products.
- In some instances the incentive amount per bulb doubled, and, rather than the promotional price decreasing to reflect the increase in the incentive, the original price increased to reflect the increase in the incentive.

After bringing these observations to the implementation CSP, they reported that the prices, other than the incentive amounts, were entered into the database manually and likely contained data entry errors, rendering many observed price changes suspect.

The implementation CSP worked with manufacturers in PY5 to automate tracking prices. The manufacturers will be uploading data to eliminate the manual process to limit the potential for errors associated with manual data entry. Data anomalies should be largely eliminated in PY6.

The EM&V CSP tried several methods to identify and remove some of the anomalous price changes from the analysis. However, the model was still very unstable while using the raw data. Ultimately the analysis was limited to the price changes known to be due to changes in the incentive level.

D.2.2 Price Variation

Due to the data quality issues the EM&V CSP created an assumed price absent the program that was *equal to the mean price for a given retail location/store in keeping with the unit (SKU) combination. The* promotional price the consumer faced was assumed to be the price absent the program less the incentive. In this way, the analysis was limited to only products for which the incentive level changed *within* the program year.

This change in the way the price was calculated decreased the number of products with which to estimate the price elasticities and therefore limits the representativeness of the sample to apply to the program in its entirety. Overall, the sample with price variation accounted for 12% of CFL products and 20% of LED products. These products represented 14% of CFL sales and 20% of LED sales.

It is important to note the limitations of the sample of products with variation in prices, particularly for the LEDs. Unfortunately the sample with varied prices was not very representative of these products. The products with variation were primarily flood lamps and spotlights whereas the products accounting for the majority of LED sales were general purpose a-lamps with a price around one-third that of the specialty products. It is very likely the model is underestimating the price response for program LEDs.

D.2.3 Mass Marketing

Because of the limited sample of products with price variation mass marketing was not included in the analysis as there was no discernable impact.

D.2.4 Promotional Displays

No promotions or merchandising data was provided in PY5 for specific products. However, the data for specific products and events in PY6 will be available and included in future evaluations.

D.2.5 Seasonality Adjustment

In economic analysis, it is critical to separate data variations resulting from seasonality from those resulting from relevant external factors. For example, suppose prices had been reduced on umbrellas at the beginning of the rainy season. Any estimate of this price shift's impact would be skewed if the analysis did not account for the natural seasonality of umbrella sales.

To adjust for seasonal variations in sales, the EM&V CSP used a monthly seasonal trend provided by a major national lighting manufacturer via the implementer for another recent evaluation. This represented national sales of CFLs. Ideally, a trend would derive from historical data on aggregate sales of lighting products (e.g., inefficient and efficient, program and non-program). Such data would represent overall trends in lighting product sales and would not suffer from potential confounding with

programmatic activity to the same degree as CFL sales.[61] However, the trend provided represented aggregated, nationwide CFL sales for a specific manufacturer.

Presumably, the trend includes some activity from various programs across the nation which could affect the sales trend, potentially leading to underestimated program impacts. However, we assume that program activity is somewhat random across all of the programs that could be included in the sales *data used to develop the trend. In that case, program activity would be spread through the year and the* variation between months would be driven primarily by non-program factors. Nevertheless, not controlling for seasonal variations could lead to program impact being overestimated by falsely attributing seasonal trends to price impacts (to the degree that they co-varied), or vice versa.

For example, July tends to be a month with lower sales (presumably due to longer daylight hours) so if program activity increased sales in July, not controlling for seasonal variation would underestimate the program's impact. October, on the other hand, is a month with higher sales, and no control for seasonality would likely overestimate the impact of program activity occurring in that month.

Another option to account for seasonality considered was to use monthly fixed effects to control for differences between months and results were compared to the model using the trend. In the fixed effects case, however, some price changes were concentrated within the same month, and using fixed effects attributed program impacts to monthly averages, therefore underestimating the program impacts. And using how well the model predicted actual sales as a criteria, the model using the trend better fit the program sales data.

D.2.6 Model Specification

The EM&V CSP team modeled bulb and pricing data using an econometric model. The study modeled these data as a panel, with a cross-section of program package quantities for each unique retail location/SKU combination modeled over time as a function of price and bulb type (CFL or LED). This involved testing a variety of specifications to ascertain price impacts—the main instrument affected by the program—on the demand for bulbs. The team estimated the basic equation for the model as follows (for cross-section *i*, in month *t*):

Equation 1

$$\ln(Q_{it}) = \sum_{\pi}(\beta_{\pi} ID_{\pi,i}) + \sum_{\theta,\delta}(\beta_{\theta 1,\delta 1}[ln(P_{it}) * (Bulb\ Type_{\delta})]) + \alpha Time\ Trend_t + \varepsilon_{it}$$

Where:

- ln = Natural log

[61] This assumes aggregate lighting sales did not change due to promotions; that is, customers simply substituted an efficient product for an inefficient one. While bulb stockpiling could occur during programmatic periods, this should smooth out over time, as the program would not affect the number of sockets in the home.

- Q = Quantity of bulb packs sold during the month
- *P = Retail price in that month*
- Bulb Type = Product category (CFL or LED)
- *ID = Dummy variable equaling 1 for each unique retail location and SKU; 0 otherwise*
- Time Trend = Quantitative trend representing the impact of secular trends not related to the program[62]
- ε_{it} = Cross-sectional random-error term in time period *t*

The model specification assumed a lognormal distribution. This distribution serves as the best fit of the plausible distributions (negative binomial, poisson, negative binomial, or gamma).

The EM&V team ran numerous model scenarios to identify the model with the best parsimony and explanatory power using the following criteria:

- Model coefficient p-values (keeping values less than <0.1);[63]
- Explanatory variable cross-correlation (minimizing where possible);
- Model AIC (minimizing between models);[64]
- Utilizing the heteroskedastic consistent covariance matrix and clustered standard errors to account for hetroskedasticity;
- Minimizing multicollinearity; and
- Optimizing model fit.

The fit of the model can be examined by comparing the model-predicted sales with the actual sales. As can be seen in **Error! Reference source not found.**, the model-predicted sales match very closely the actual sales with no persistent bias in a single direction (over or under-predicting), indicating that the model is fitting the data well. The model does over predict in month five and under predict in months six and seven, but overall the predictions fit actual sales well.

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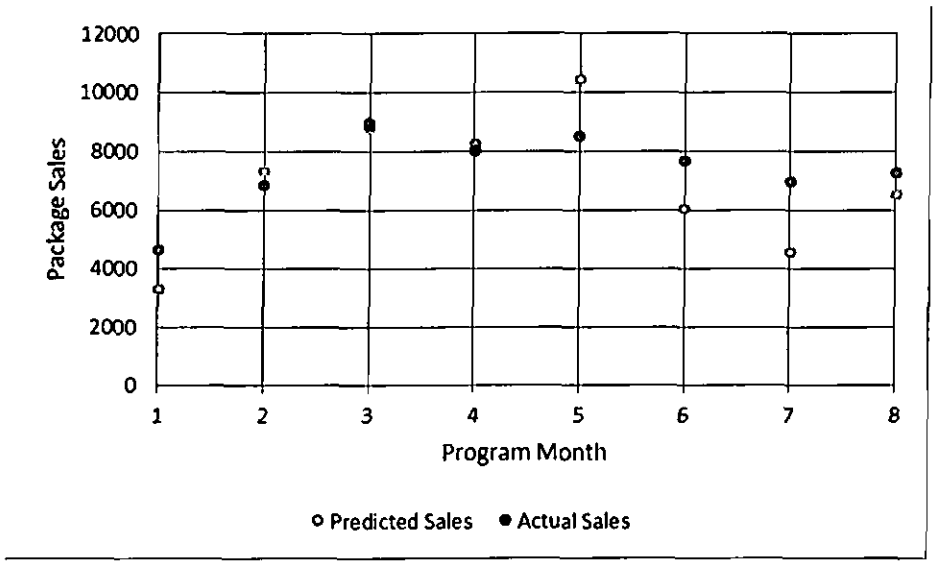
62 The time trend for this analysis represents shifts in sales due to non-program related seasonality.

63 Where a qualitative variable had many states (such as bulb type), the EM&V CSP team did not omit variables if one of the states was not significant, but rather considered the joint significance of all states. The team used robust estimation of model standard errors to properly represent model accuracy and to guide the specification process. The error structure involved clustering around cross-sectional units.

64 Akaike's Information Criteria (AIC) was used to assess model fit, as the R-square statistic is undefined for nonlinear models. AIC also has the desirable property that it penalizes overly complex models, similar to the adjusted R-square.

Figure 8. Predicted and Actual Sales by Month



D.3 Findings

The EM&V Team estimated an overall net of freeridership ratio of 0.84 (Table 2).

Table 21: Modeling Results by Product Type

Bulb Type	Net of Freeridership	Freeridership
CFL	0.88	0.12
LED	0.40	0.60
Overall	**0.84**	**0.16**

The model estimated freeridership to be only 12% for CFLs and 60% for LEDs.

As mentioned in the discussion in the Price Variation section, the LED sample with price variation was not representative of the top selling LED products therefore the elasticity estimates of are likely underestimated. This means the freeridership is likely overestimated for LEDs.

The CFL estimates are also extrapolated from a relatively small sample so we recommend against drawing firm conclusions about the low freeridership for CFLs observed in PY5.

The elasticity model does not allow for the estimation of spillover, so no spillover was estimated for the upstream lighting component of this program in PY5.

Appendix E: Methodology for Determining Savings from Energy-efficiency Kits

This appendix provides the criteria used to assign survey *ex post* savings for kit measures and behaviorally based energy savings for the E-Power Wise Program and the Student and Parent Energy-Efficiency Education Program in PY5.

E.1 Introduction

The EM&V CSP revised the methodology for calculating program savings from a survey response in-service rate (ISR; this is the same as the installation rate) methodology to an individual respondent-level savings methodology. With the individual respondent method, only respondents who answered survey questions about installing each measure and who met certain fuel type criteria received survey-verified savings. The EM&V CSP applied the respondent-level savings methodology in order to calculate the savings associated with both behavior change components and non-behavior-based measures.

The methodology uses individual respondent-level information available from the returned surveys and the enrollment cards. The EM&V CSP assigned specific survey *ex ante* and survey-verified savings values to each respondent for each measure based on these variables:

- Whether or not the respondent answered the measure-specific question (regardless of the answer)
- Home characteristics recorded on the respondent's enrollment card (i.e., gas versus electric heat)
- How the respondent answered the installation and behavior questions

Measure-level survey *ex ante* savings were equal to the 2013 Pennsylvania Technical Reference Manual (TRM in effect in PY5) adjusted *ex ante* savings for all measure-specific questions answered except for energy education. The survey *ex ante* calculation procedure for energy education and the updated behavior savings custom measure protocol (CMP) for the E-Power Wise Program can be found in ***Appendix F: E-Power Wise Behavior Savings Calculations.***

Table E-1 and **Table E-2** contain examples of kit survey questions used to calculate survey-verified *ex post* savings.

Table E-1: Example Kit Survey Questions for Measures

Measure	Survey Question	Possible Responses
Furnace Whistle	Did you install your new FilterTone Alarm from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No
Smart Strip	Did you install the Advanced Power Strip from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No
CFL	How many CFLs from your Kit did you install?	Both
		One
		None
Faucet Aerator	Which Faucet Aerator did you install?	Installed Both
		Plan to install Kitchen only
		Plan to install Bathroom only
		Plan to install both
		Installed Bathroom only
		None
		Installed Kitchen only
Low-Flow Showerhead	Did you install the new High-Efficiency Showerhead from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No
LED Nightlight	Did you install the LED Night Light from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No

Table E-2: Example Kit Survey Questions for Behavior Change

Behavior	Survey Question	Possible Responses
Home Thermostat Change	Did you lower your thermostat in winter?	Yes, I lowered it
	Did you raise your air conditioner thermostat in summer?	Yes, I plan to lower it
		No
Change in laundry volume washed in cold water	BEFORE the energy-efficiency education, what percent of your laundry was washed in cold water only?	None
		25%
	AFTER the energy-efficiency education, what percent of your laundry is washed in cold water only?	50%
		75%
		100%
Water Heater Temperature Change	Did you change the setting of your electric water heater?	Yes, I raised it (warmer)
		Yes, I lowered it (cooler)
		Yes, I plan to raise it
		Yes, plan to lower it
		No

Survey *ex ante* savings for measures corresponding to questions that the respondents did not answer were not included in the calculation of the overall realization rate. For example, one survey respondent answered some but not all of the survey questions. **Table E-3** illustrates how the EM&V CSP used this information to assign survey *ex ante* and survey-verified savings to this respondent.

Table E-3: Example of PY5 Survey Verification Methodology for E-Power Wise

Sector	*Measure*	Question *Answered?* (Yes/No)	Survey *Ex Ante Savings* (kWh/yr)	*Response*	Survey-Verified *Savings* (kWh/yr)
Low-Income	Furnace Whistle	Yes	Varies based on TRM adjusted *ex ante* values	Installed	Equal to TRM-Adjusted *ex ante* savings
	Smart Strip	Yes	184	Not installed	0
	CFL	No	N/A	N/A	N/A
	Faucet Aerator-Bath	Yes	25	Installed	25
	Faucet Aerator - kitchen	No	N/A	N/A	N/A
	Low-Flow Showerhead	Yes	Varies based on TRM adjusted *ex ante* values	Not installed	0
	Energy Education (Initial)	Yes	Varies based on TRM adjusted *ex ante* values	Installed	Each respondent received savings for behavior change that reflected their self-reported activities
	LED Nightlight	Yes	24	Installed	24

In the **Table E-3** example, the total survey *ex ante* and the total survey-verified savings equal the sum of the values in each column after omitting items that are not applicable (N/A).

The revised PY5 methodology also calculates the variation among program participants by applying specific values to each survey respondent's answers to measure-specific questions and about home characteristics. The resulting realization rate reflects this variation and the precision captures any uncertainty associated with the participant level variation and sampling.

E.2 Kit Measure Savings Methodology

The PY5 survey-verified savings depend on various criteria for each measure group.

For **CFLs, LED nightlights, and smart strips**, survey-verified savings depends on these criteria; an example is shown in **Table E-4**.

1. The respondent returned a survey.
2. The respondent answered the measure question.
3. The respondent answered the question on the kit survey with an affirmation of installing the measure.

Table E-4: PY5 Methodology – CFL Example

Question from Kit Survey	Question Answered? (Yes/No)	Possible Answers	Verification Action Conducted
How many CFLs from your kit did you install?	Yes	Both	Respondent receives survey-verified savings for both CFLs
		One	Respondent receives survey-verified savings for one CFL
		None	Respondent survey-verified savings of zero for both CFLs
	No	N/A	N/A; Respondent does not receive survey-verified savings

For **furnace whistles**, survey-verified savings depends on these criteria, as shown in **Table E-5**:

1. The respondent returned a survey.
2. The respondent answered the measure question.
3. The respondent is categorized into 2013 TRM deemed heating load hours by zip code of the city provided on the enrollment card.
4. The respondent answered the question on the kit survey about installing the measure.

Table E-5: PY5 Methodology – Furnace Whistle Example

Question from Kit Survey	Question Answered? (Yes/No)	ZIP Code Mapping (by City) to Determine Heating Load Hours	Possible Answers	Verification Action Conducted
Did you install your new FilterTone Alarm from your Kit?	Yes	Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton, Williamsport	Yes, I installed it	Respondent receives survey-verified savings based on zip code mapping to closest city
			Yes, I plan to install it	Respondent receives survey-verified savings of zero[1]
			No	Respondent receives survey-verified savings of zero
	No		N/A	N/A; Respondent does not receive survey-verified savings

NOTE:
[1] Respondents receive survey-verified savings of zero for planned actions because timing for installation is unverified and may occur outside of program year.

For **bathroom and kitchen aerators**, survey-verified savings depends on these criteria (**Table E-6**):

5. The respondent returned a survey.
6. The respondent answered the measure question.
7. The respondent indicated that the home has electric water heat on the enrollment card.
8. The respondent answered the kit survey question about faucet aerators with an affirmation of installing the kitchen and/or bathroom aerator.

Table E-6: PY5 Methodology – Faucet Aerator Example

Question from Kit Survey	Question Answered? (Yes/No)	Water Heating Fuel Type (Enrollment Card Information)	Possible Answers	Verification Action Conducted
Which faucet aerator did you install?	Yes	Electric[1]	Installed both	Respondent receives survey-verified savings for both kitchen and bathroom aerators
			Installed kitchen only	Respondent receives survey-verified savings for kitchen aerator only
			Installed bathroom only	Respondent receives survey-verified savings for bathroom aerator only
			Plan to install kitchen only	Respondent receives survey-verified savings of zero [2]
			Plan to install bathroom only	Respondent receives survey-verified savings of zero [2]
			Plan to install both	Respondent receives survey-verified savings of zero [2]
			None	Respondent receives survey-verified savings of zero
	No		N/A	N/A; Respondent does not receive survey-verified savings

Notes:
[1] Savings were only assigned to respondents with electric water heating type.
[2] Respondents receive survey-verified savings of zero for planned actions as timing for installation is unverified and may occur outside of program year.

For **low-flow showerheads**, survey-verified savings for an *agency* participant depends on these criteria (**Table E-7**):

9. The respondent returned a survey.
10. The respondent answered the measure question.
11. The respondent indicated that the home has electric water heat on the enrollment card.
12. The respondent's housing type designation on the enrollment survey (different savings levels applied to single-family and multifamily households).
13. The respondent answered the survey question affirming installation of the showerhead.

For **low-flow showerheads**, survey-verified savings for a *direct mail* participant depends on these criteria:

14. The respondent returned a survey.
15. The respondent answered the survey question affirming installation of the showerhead.
16. The respondent indicated on the enrollment card that the home had electric water heat.

Table E-7: PY5 Methodology – Showerhead Example for Agency Delivery

Question from Kit Survey	Question Answered? (Yes/No)	Water Heating Fuel Type (Enrollment Card Information)	Housing Type (Enrollment Card Information)	Possible Answers	Verification Action Conducted
Did you install the new high-efficiency showerhead from your kit?	Yes	Electric[1]	Single-family, multifamily	Yes, I installed it	Respondent receives survey-verified savings based on single-family housing type
					Respondent receives survey-verified savings based on multifamily housing type
				Yes, I plan to install it	Respondent receives survey-verified savings of zero[2]
				No	Respondent receives survey-verified savings of zero
	No			N/A	N/A; respondent does not receive survey-verified savings

Notes:
[1] Savings were only assigned to respondents with electric water heating type.
[2] Respondents do not receive savings for planned actions as timing for installation is unverified and may occur outside of program year.

Appendix F: E-Power Wise Behavior Savings Calculations

This appendix provides the inputs and calculations used to determine behaviorally based energy savings for the E-Power Wise Program in PY5. The methodology to calculate savings associated with measures included in the energy conservation kit is discussed in **Appendix E: Methodology for Determining Savings from Energy-efficiency Kits**. This appendix describes the methodology for calculating the behaviorally based savings resulting from energy education.

F.1 Behavior Savings Methodology

Electric consumption impacts associated with the behavior changes customers made as a result of participation in the program are estimated based on calculations presented in the custom measure protocol (CMP) prepared in 2012.[65] These savings calculations utilize a combination of engineering estimates, secondary research, and surveys for the purpose of assigning savings resulting from the actual steps taken by the program participants.

On the paper survey distributed inside the energy-efficiency kit, there are questions that apply to the three main components of the overall savings from behavior change: adjusting the temperatures on the water heater; changing the amount of laundry washed in cold water; and adjusting the home temperature based on the heating/cooling season. It is possible for a respondent to perform one behavior change activity and not another. For example, a respondent may lower the temperature on the home's water heater but not raise the home temperature setting in the summer so the savings would be lower than a respondent who performed both actions.

If required, phone surveys can be used to determine baseline conditions for behaviors that require established baselines from which to calculate savings; these are generally behaviors for which deemed savings estimates require certain baseline conditions.

The following savings were calculated based on behaviors reported by the PY5 E-Power Wise Program participants:

- **Water Heater Energy Savings:** Savings achieved by participants who reduced the temperature setpoint of their water heater and/or increased the number of clothes washer loads using cold water.
- **Home Temperature Settings Savings:** Savings achieved by participants who lowered their heating temperature setpoint and/or raised their cooling temperature setpoint.

The engineering algorithms to calculate verified savings for each of the behaviors are provided below, along with a description of the interactions that take place between some of the behaviors. Each survey

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[65] Cadmus. *Final Annual Report to the Pennsylvania Public Utility Commission for the Period June 2011 through May 2012 - Program Year 3*; Appendix I - Custom Measure Protocol Measuring Impacts of Behaviorally Based Activities in Low-Income Energy Education/Energy Kit Programs. Prepared for PPL Electric and approved by the SWE. 2012.

respondent receives a unique behavior savings value based on the combination of behavior change activities.

F.2 Water Heater Energy Savings

Water heater energy savings are estimated for participants who elect to reduce the temperature of their water heater and reduce the water heater temperature when washing clothes. The equation to calculate water heater energy savings is represented as:

$$Electricity\ Impact\ (kWh) = kWh_{wh} + kWh_{wm}$$

Where:

kWh_{wh} = Energy savings of water heater

kWh_{wm} = Energy savings of washing machine

The first component of this equation (kWh_{wh}) is the energy savings achieved by a reduction in the temperature setting of the water heater. If the participant indicated that he or she reduced the water heater temperature, than these savings were applied. The second component of the equation (kWh_{wm}) represents the energy savings from reducing the water heater temperature when washing clothes. *These savings can only be applied if the participant indicates the presence of clothes washing equipment* in the household.

The energy savings for the reduction in the temperature setting of the electric water heater component of the water heater energy savings is calculated using the fixed savings variables from the "Water Heater Setting Savings" algorithm provided in the CMP. Savings are applied when respondents meet the following criteria:

1. The respondent returned a survey.
2. The respondent has an electric water heater.
3. The respondent has a washing machine in the household.
4. The respondent indicated he or she turned down the temperature on the water heater.

Table F-1 provides the savings assignment criteria based on respondent-level survey answers:

Table F-1: Water Heater Setting Savings Assignment Criteria

Question from Kit Survey	Question Answered? (Yes/No)	Water Heating Fuel Type (Enrollment Card Information)	Washing Machine On-site? (Yes/No)	Possible Answers	Verification Action Conducted
Did you change the setting on your water heater?	Yes	Electric	Yes	Lowered it	Respondent receives survey-verified savings for behavior change
	Yes		Yes	Raised it	Respondent receives survey-verified savings of zero for behavior change
	Yes		Yes	No Change	Respondent receives survey-verified savings of *zero for behavior change*
	Yes		No	N/A	N/A; Respondent does not receive survey-verified savings
	No		N/A	N/A	N/A; Respondent does not receive survey-verified savings

The savings algorithm is as follows:

$$Water\ Heater\ Setting\ Savings\ (\Delta kWh_{wh}) = (kWh_f + (kWh_{cw} X\ CW))\ X\ ISR_{wh} X\ ISR_{ewh}$$

The assumptions for variables used in this equation are provided in **Table F-2**. Showerheads do not produce additional water heater savings because it is expected that participants will use more of the *hottest water setting while showering to arrive at the same temperature they had been accustomed to* using prior to making the water heater adjustment. The kWh values are fixed assumptions, determined through calculations using CMP inputs and updates described in Section 14.2F.3 Custom Measure Protocol: Behavior Saving Inputs and Calculations.

Table F-2: Water Heater Setting Savings (kWh_{wh}) Calculation Inputs

Parameter	Description	Type	Inputs	Source
kWh_f	Energy Savings from Water Heater Temperature Reduction on Faucet Hot Water Use	Fixed	227 kWh	CMP (Section F.3)
kWh_{cw}	Energy Savings from Water Heater Temperature Reduction on Clothes Washer Use	Fixed	45 kWh	CMP (Section F.3)
CW	Respondent Verified Clothes Washing Equipment On-site	Variable	Variable	Kit Surveys
ISR_{wh}	ISR: Respondent Reported Water Heater Temperature Reduction	Variable	Variable	Kit Surveys
ISR_{ewh}	ISR: Respondent Reported Electric Water Heater	Variable	Variable	Kit Surveys

The second component of the water heater energy savings equation is washing machine savings (kWh_{wm}). These savings are achieved when participants wash their clothes in cold water. However, washing machine energy savings contain the potential for interactive effects, which are accounted for in

the calculation. This is accomplished by applying one of two calculations, depending on whether the participant indicated reducing the temperature of the water heater.

- If the participant did not reduce the water heater temperature and increased the number of loads washed in cold water, they receive the washing machine savings. The calculation applies fixed energy savings of 209 kWh (**Table F-4**). This parameter assumes a water heater temperature of 125 degrees Fahrenheit.
- If the participant reduced the water heater temperature and increased the percentage of laundry loads washed in cold water, they receive washing machine savings of 45 kWh (**Table F-4**). The washing machine savings are lower for these participants because the water heater savings are already accounted for in the first component of the water heater savings equation.
- If the participant reduced the water heater temperature, but already washed the same number of laundry loads in cold water, there are no additional washing machine savings. This is because the participant's laundry behavior did not change and the water heater savings are already accounted for in the first component of the water heater savings equation.

For respondents who switch from **washing clothes in hot water to washing clothes in cold water,** a respondent can receive two tiers of savings: (1) by reducing the home's water heater temperature, and (2) by washing clothes in cold water instead of hot water. A respondent receives survey-verified savings under one of the following two scenarios.

Scenario with a water heater adjustment:

5. The respondent returned a survey.
6. The respondent had an electric water heater.
7. The respondent had a washing machine in the household.
8. The respondent turned down the temperature on the water heater.
9. The respondent indicated a change in the percentage of laundry loads washed in cold water after participating in the program. The respondent's assigned savings (positive or negative) are determined by the increase or decrease.

Scenario without a water heater adjustment:

10. The respondent returned a survey.
11. The respondent has an electric water heater.
12. The respondent has a washing machine in the household.
13. The respondent indicated a change in the percentage of laundry loads washed in cold water after participating in the program. The respondent's assigned savings (positive or negative) are determined by the increase or decrease.

Table F-3 provides examples of the savings assignment criteria based on respondent-level survey answers.

Table F-3. PY5 Methodology – Examples for Clothes Washing Behavior Change

Example Respondent	Water Heating Fuel Type (Enrollment Card Information)	Does the respondent have a washing machine on-site? (Yes/No)	Did you change the setting on your water heater? (Yes Raised it/Yes Lowered it/No Change)	Change in loads washed in cold water (before to after participation)[1]	Verification Action Conducted
Respondent 1	Electric	Yes	Lowered it	25%	Respondent receives survey-verified savings for behavior change WITH water heater temperature reduction
Respondent 2			Lowered It	75%	Respondent receives survey-verified savings for behavior change WITH water heater temperature reduction
Respondent 3			No Change	50%	Respondent receives survey-verified savings for behavior change WITHOUT water heater temperature reduction
Respondent 4		No	N/A	N/A	Respondent does not have a washer in the home and does not receive survey-verified savings
Respondent 5	Gas	N/A	N/A	N/A	Respondent heats water with gas and does not receive survey-verified savings

NOTES:
[1] Delta change is calculated by subtracting the survey reported value for laundry washed in cold water AFTER program participation from the survey reported value for laundry washed in cold water BEFORE program participation.

The energy savings for the washing machine setting component of the water heater energy savings is calculated by inputting the respondent-level in-service rate (ISR). This is determined by the participant kit surveys in one of two "Water Heater Setting Savings" algorithms provided in the CMP, as follows:

$$\textit{Washing Machine Setting Savings, } \underline{\textit{Without}} \textit{ Water Heater Temperature Adjustment } (\Delta kWh_{wm}) = ISR_{wm} \; X \; ((CW\%_{post} - CW\%_{pre}) \; X \; kWh_{cw2})) \; X \; ISR_{ewh}$$

$$\textit{Washing Machine Setting Savings, } \underline{\textit{With}} \textit{ Water Heater Temperature Adjustment } (\Delta kWh_{wm}) = ISR_{wm} \; X \; ((CW\%_{post} - CW\%_{pre}) \; X \; kWh_{trcw}) - kWh_{cw}) \; X \; ISR_{ewh}$$

The assumptions for variables used in this equation are provided in

Table F-4. The kWh values are fixed assumptions, determined through calculations using CMP inputs and updates described in Section 14.2F.3 Custom Measure Protocol: Behavior Saving Inputs and Calculations.

Table F-4: Washing Machine Setting Calculation Inputs (kWh_{wm})

Parameter	Description	Type	Inputs	Source
ISR_{wm}	ISR: Respondent Reported Water Heater Temperature Reduction	Variable	Variable	Kit Surveys
$CW\%_{post}$	Respondent Reported: Percent of Clothes Washing Loads Washed in Cold Water Post-participation	Variable	Variable	Kit Surveys
$CW\%_{pre}$	Respondent Reported: Percent of Clothes Washing Loads Washed in Cold Water Pre-participation	Variable	Variable	Kit Surveys
kWh_{cw2}	Energy Savings from Laundering in Cold Water Without Reducing Water Heater Setting	Fixed	254 kWh	CMP (Section F.3)
kWh_{trcw}	Energy Savings from Laundering in Cold Water After Reducing Water Heater Setting	Fixed	209 kWh	CMP (Section F.3)
kWh_{cw}	Energy Savings from Water Heater Temperature Reduction on Clothes Washer Use	Fixed	45 kWh	CMP (Section F.3)
ISR_{ewh}	Installation Rate: Respondent Reported of Electric Water Heater	Variable	Variable	Kit Surveys

The savings are applied to each respondent based on their survey answers confirming they performed the behavior saving action and that they had an electric water heater in their home.

F.2.1 Water Heater Temperature Adjustment Demand Savings

Respondents receive demand savings if they decrease the temperature on their water heater. Demand savings are calculated by applying a kW ratio to the respondent-level kWh savings. The demand ratio for water heater temperature adjustment is the calculation of the kitchen faucet aerator kW divided by the kitchen faucet aerator kWh, as follows:

$$(\Delta kW_{wh}) = kW_{Kitchen}/kWh_{kitchen}$$

The demand ratio is calculated using the kitchen aerator savings because the water heater temperature adjustment will affect how the participant adjusts the temperature of water in their kitchen sink. There is no longer a bathroom aerator offered in the energy conservation kit and therefore the kitchen aerator is the best measure for the demand ratio calculations.

The variables used in this equation are provided in **Table F-5.**

Table F-5: Water Heater Setting Demand Savings Calculation Inputs (kW_{wh})

Parameter	Description	Type	Inputs	Source
$kW_{kitchen}$	kW for kitchen faucet aerators calculated from TRM	Fixed	0.0023 kW	2013 PA TRM Section 2.9
$kWh_{kitchen}$	kWh for kitchen faucet aerators calculated from TRM	Fixed	25 kWh	2013 PA TRM Section 2.9

F.2.2 *Adjust Home Temperature Energy Settings*

Participants are encouraged to reduce the heating temperature in the winter and increase the cooling temperature in the summer. Surveys provide data to determine if these changes were made based; respondents provide a yes/no response. Because the savings for this behavior utilizes deemed values based on documented research, the survey questions are designed simply to determine whether the heating and cooling temperature settings were adjusted for the purpose of establishing the respondent-level ISR.

For the **home temperature setting** behavior change, a respondent can receive savings for changing the home's heating temperature, cooling temperature, or a combination of both actions. A respondent receives survey-verified savings for a heating change if:

14. The respondent returned a survey.
15. The respondent has electric space heat.
16. The respondent reported turning down the heating temperature on the thermostat in winter.

A respondent receives survey-verified savings for a cooling change if:

17. The respondent returned a survey.
18. *The respondent has air conditioning (not including ceiling fans).*
19. The respondent reported turning up the cooling temperature on the thermostat in summer.

Table F-6 provides the savings assignment criteria based on respondent-level survey answers:

Table F-6. PY5 Methodology – Examples of Home Temperature Behavior Change Savings

Example Respondent	Does the respondent have electric heat? (Yes/No)	Did you lower your heating temperature in the winter? (Yes/No)	Heating Verification Action Conducted	Does the respondent have AC? (Yes/No)	Did you raise your cooling temperature in the summer? (Yes/No)	Cooling Verification Action Conducted	Final Verification Action Conducted
Respondent 1	Yes	Yes	Respondent receives survey-verified savings for behavior change	Yes	Yes	Respondent receives survey-verified savings for behavior change	Respondent receives survey-verified savings for heating and cooling change
Respondent 2	Yes	Yes	Respondent receives survey-verified savings for behavior change	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Respondent receives survey-verified savings for heating change
Respondent 3	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Yes	Yes	Respondent receives survey-verified savings for behavior change	Respondent receives survey-verified savings for cooling change
Respondent 4	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Respondent receives survey-verified savings of zero for behavior change
Respondent 5	No	N/A	No electric heat; Respondent does not receive survey-verified savings	No	N/A	No AC; Respondent does not receive survey-verified savings	Respondent does not receive survey-verified savings

Energy savings are achieved by reducing heating temperature settings and raising air conditioning *temperature settings are calculated using the following algorithm:*

$$Home\ Temperature\ Setpoint\ Savings\ (kWh_{temp}) = HT_{kWh}\ X\ ISR_{HT} + AC_{kWh}\ X\ ISR_{AC}$$

The variables used in this equation are provided in **Table F-7**. The kWh values are fixed assumptions, determined through calculations using CMP inputs and updates described in Section 14.2F.3 Custom Measure Protocol: Behavior Saving Inputs and Calculations.

Table F-7: Adjust Home Temperature Settings Energy Savings (kWh_{temp}) Calculation Inputs

Parameter	Description	Type	Inputs	Source
HT_{kWh}	kWh of Heating Temperature Reduced	Fixed	709 kWh	CMP (Section F.3)
ISR_{HT}	ISR: Respondent Reported Heating Temperature Reduction	Variable	Variable	Kit Surveys
AC_{kWh}	kWh of Cooling Temperature Increased	Fixed	118 kWh	CMP (Section F.3)
ISR_{AC}	ISR: Respondent Reported Cooling Temperature Increase	Variable	Variable	Kit Surveys

F.2.3 Adjust Home Temperature Demand Savings

Respondents receive temperature adjustment demand reduction if they increase the cooling temperature on their air conditioning unit in the summer. Demand savings are calculated by applying a kW ratio to the respondent-level kWh savings. The demand ratio for the home temperature cooling adjustment is the calculation of the average amount of EFLH cooling hours from survey respondents divided by the cooling factor from the Central A/C and Air Source Heat Pump (ASHP) (High Efficiency Equipment Only) algorithm in the 2013 Pennsylvania TRM (section 2.1), as follows:

$$(\Delta kW_{temp}) = CF/EFLH_{avgcool}$$

The variables used in this equation are provided in **Table F-8.**

Table F-8: Home Temperature Cooling Setting Demand Savings Calculation Inputs (kW_{temp})

Parameter	Description	Type	Inputs	Source
CF	Demand Coincidence Factor	Fixed	0.70	2013 PA TRM Table 2-1
$EFLH_{avgcool}$	Average EFLH cooling hours from survey population	Variable	435 hours	Kit Surveys; 2013 PA TRM Table 2-1

F.3 Custom Measure Protocol: Behavior Saving Inputs and Calculations

This section provides the inputs and calculations used to determine energy savings for the behavior change component of the E-Power Wise Program. This CMP was originally approved by SWE in 2011. This section describes the updates to the CMP to conform to the 2013 TRM.

F.3.1 Water Heater Temperature Setback

Table F-9: Water Heater Temperature Setback Specifications

Measure Name	Water Heater Temperature Setback
Target Sector	Residential
Measure Unit	Home
Unit Energy Savings	Varies by presence of clothes washer in home and water temperature for washing clothes
Unit Peak Demand Reduction	None
Measure Life	1 year

This measure is for setting back the temperature on an electric water heater from 140 degrees to 125 degrees Fahrenheit (°F). This results in savings from using the faucet aerator and from washing clothes in warm or hot water.

F.3.2 Eligibility

This protocol documents the energy savings attributed to setting back the temperature on an electric water heater from 140 °F to 125 °F. This results in energy savings even when the faucet is on and water is being wasted. Energy savings also occur when washing clothes in warm or hot water.

This protocol assumes that there are no savings attributed to showering due to the water heater setback. The reasoning is that the user will adjust the hot water flow to compensate for the reduced temperature.

F.3.3 Algorithms

The measure savings algorithm is:

$$Total\ Savings = kWh_f \times kWh_{cw}$$

The faucet savings (kWh_f) and clothes washer savings (kWh_{cw}) are calculated by the following algorithms:

$$kWh_f = F \times T_{Person-Day} \times N_{per} \times 365 \times \Delta T \times U_H \times U_E \times RE \times DF$$

$$kWh_{cw} = Gal \times Cycles \times \Delta T \times U_H \times U_E \times RE$$

F.3.4 Definition of Terms

The parameters in the above equations are listed in **Table F-10**.

Table F-10: Calculation Assumptions for Water Heater Temperature Setback

Component	Type	Values	Source
F, flow rate in gallons per minute	Fixed	1.2 gpm	1
$T_{Person-Day}$, Average time of hot water usage per person per day in minutes	Fixed	9.85 minutes	2
N_{per}, Average people per household	Fixed	2.6	3
365 days per year	Fixed	365 days per year	Convention
ΔT, change in water heater temperature due to the setback	Fixed	15 degrees	Program Design
U_H, Unit Conversion: 8.33Btu/(Gallons °F)	Fixed	8.33	Convention
U_E, Unit Conversion: 1 kWh/3413 Btu	Fixed	1/3413	Convention
RE, Recovery efficiency of electric water heater	Fixed	0.90	4
DF, Percentage of wasted hot water	Fixed	50%	4
Gal, gallons of hot water used per washer cycle	Fixed	4	5
$Cycles$, washer cycles per year	Fixed	276	6

F.3.5 Default Savings

Table F-11: Energy Savings for Water Heater Reduction

Component	Energy Savings (kWh)
kWh_f	227
kWh_{cw}	45

F.3.6 Evaluation Protocols

The most appropriate evaluation protocol for this measure is the paper kit survey or a phone survey verifying that the water heater temperature was set back and that the household has a washing machine.

F.3.7 Sources

1. *Illinois TRM*. Effective June 1, 2012. Maximum rated flow rates of 2.2 gpm and 1.5 gpm are not an accurate measurement of actual average flow rates over a period of time because of throttling. These flow rates represent an average flow consumed over a period of time and take occupant behavior (not always using maximum flow rates) into account. Based on results from various studies.

2. *Illinois TRM.* Effective June 1, 2012. Based on various studies with flow rates that ranged from 6.74 min/person/day to 13.4 min/person/day.
3. *Pennsylvania 2012 Residential Baseline Study.*
4. *CL&P and UI Program Savings Documentation for 2008 Program Year.* See Section 5.5.1 Water Heater Thermostat. Setting. http://cbey.yale.edu/uploads/Environmental%20Venture%20Prize/Burke_Workshop_Program%20Savings%20Document_Assessing%20Environmental%20Benefit.pdf
5. Korn, D. and Mattison, L. "Do Savings Come Out in the Wash?" *Home Energy* January/February 2012. http://www.cadmusgroup.com/wp-content/uploads/2013/02/Home-Energy-Magazine-January-2012-Mattison-Korn-article.pdf
6. Based on weighted average number of loads from EIA 2009 Residential Energy Consumption Survey (RECS) appliance data for the state of Pennsylvania. http://www.eia.gov/consumption/residential/index.cfm

F.3.8 Washing Clothes in Cold Water

Table F-12: Washing Clothes Behavior Change Specifications

Measure Name	Water Heater Temperature Setback
Target Sector	Residential
Measure Unit	Home
Unit Energy Savings	209 kWh without water heater temperature reduction 45 kWh with water heater temperature reduction
Unit Peak Demand Reduction	None
Measure Life	1 year

This measure is for switching from washing clothes in hot or warm water to washing clothes in cold water. Washing machine energy savings contain the potential for interactive effects with water heater temperature reduction. Therefore, two savings values are calculated to account for the water heater temperature reduction scenarios.

F.3.9 Eligibility

This protocol documents the energy savings attributed to switching from washing clothes in hot or warm water to washing clothes in cold water. This measure could interact with setting back the temperature on an electric water heater from 140 °F to 125 °F.

F.3.10 Algorithms

The measure savings algorithm is:

$$Total\ Savings = kWh_{trcw} \times kWh_{cw}$$

The savings from washing clothes in cold water (kWh_{trcw}) and clothes washer savings from setting back the temperature on an electric water heater (kWh_{cw}) are calculated by the following algorithms:

$$kWh_f = Gal \times Cycles \times \Delta T_{cold} \times U_H \times U_E \times RE$$

$$kWh_{cw} = Gal \times Cycles \times \Delta T_{WH} \times \mathrm{U_H} \times \mathrm{U_E} \times \mathrm{RE}$$

F.3.11 Definition of Terms

The parameters in the above equations are listed in **Table F-13**.

Table F-13: Calculation Assumptions for Water Heater Temperature Setback

Component	Type	Values	Source
Gal, gallons of hot water used per washer cycle	Fixed	4 gallons	1
$Cycles$, washer cycles per year	Fixed	276 cycles	2
ΔT_{cold}, difference between hot water heater temperature setting and supply water temperature	Fixed	70 degrees	3
ΔT_{WH}, difference between the old and new hot water heater temperature settings	*Fixed*	*15 degrees*	*Program Design*
U_H, Unit Conversion: 8.33 Btu/(Gallons-°F)	Fixed	8.33 Btu	Convention
U_E, Unit Conversion: 1 kWh/3413 Btu	Fixed	1/3413	Convention
RE, Recovery efficiency of electric water heater	Fixed	0.90	4

F.3.12 Default Savings

Table F-14: Energy Savings for Water Heater Reduction

Component	Energy Savings (kWh)
kWh_{trcw}	209
kWh_{cw}	45

F.3.13 Evaluation Protocols

The most appropriate evaluation protocol for this measure is to use self-report data collected in the paper survey included within the kit or a phone survey of participants verifying that the water heater temperature was set back and that the household has a washing machine.

F.3.14 Sources

1. Korn, D. and Mattison, L. "Do Savings Come Out in the Wash?" *Home Energy*. January/February 2012. http://www.cadmusgroup.com/wp-content/uploads/2013/02/Home-Energy-Magazine-January-2012-Mattison-Korn-article.pdf

2. Based on weighted average number of loads from *EIA 2009 Residential Energy Consumption Survey* (RECS) appliance data for the state of Pennsylvania. http://www.eia.gov/consumption/residential/index.cfm
3. Many states have plumbing codes that limit shower and bathtub water temperature to 120 °F. *The temperature of the cold water supply is 55 °F (Mid-Atlantic TRM, footnote #24).*
4. *CL&P and UI Program Savings Documentation for 2008 Program Year.* See Section 5.5.1 Water Heater Thermostat Setting. http://cbey.yale.edu/uploads/Environmental%20Venture%20Prize/Burke_Workshop_Program%20Savings%20Document_Assessing%20Environmental%20Benefit.pdf

F.4 Thermostat Setting Adjustment

Table F-15: Home Temperature Setting Change Specifications

Measure Name	Thermostat
Target Sector	*Residential*
Measure Unit	Home
Unit Energy Savings	Varies by location and by thermostat adjustment during the cooling season or the heating season, or both
Unit Peak Demand Reduction	None
Measure Life	1 Year

This measure is for adjusting the temperature downward in the heating season and upward in the cooling season. This results in savings from the heating and/or cooling systems.

F.4.1 Eligibility

This protocol documents the energy savings attributed to changing thermostat settings downward during the heating season and upward during the cooling season. This results in savings from the heating and/or cooling systems.

F.4.2 *Algorithms*

The measure savings algorithm is:

$$Total\ Savings = \Delta kWh_{heat} \times \Delta kWh_{cool}$$

The heating and cooling savings are calculated by the following algorithms:

$$\Delta kWh_{heat} = \frac{CAP_{heat}}{1000} \times \left(\frac{1}{HSPF \times EFF_{duct}}\right) \times EFLH_{heat} \times SAV_{heat}$$

$$\Delta kWh_{cool} = \frac{\mathrm{CAP_{cool}}}{1000} \times \left(\frac{1}{\mathrm{SEER} \times \mathrm{EFF}_{duct}}\right) \times \mathrm{EFLH_{cool}} \times \mathrm{SAV_{cool}}$$

F.4.3 Definition of Terms

The parameters in the above equations are listed in **Table F-16.**

Table F-16: Calculation Assumptions for Water Heater Temperature Setback

Component	Type	Values	Source
CAP_{heat}, capacity of the heating system in Btuh	Fixed	36,000 Btuh	1
CAP_{cool}, capacity of the cooling system in Btuh	Fixed	36,000 Btuh	1
HSPF, Heating seasonal performance factor of the heating unit.	Fixed	3.413 HSPF (equivalent to electric furnace COP of 1)	2
SEER, Seasonal energy-efficiency ratio of the cooling unit.	Fixed	10 SEER	2
EFF_{duct}, duct system efficiency	Fixed	0.8	3
$EFLH_{heat}$, equivalent full load hours for heating	Variable	Allentown Heating = 1,193 Hours Erie Heating = 1,349 Hours Harrisburg Heating = 1,103 Hours Philadelphia Heating = 1,060 Hours Pittsburgh Heating = 1,209 Hours Scranton Heating = 1,296 Hours Williamsport Heating = 1,251 Hours	4
$EFLH_{cool}$, equivalent full load hours for cooling	Variable	Allentown Cooling = 487 Hours Erie Cooling = 389 Hours Harrisburg Cooling = 551 Hours Philadelphia Cooling = 591 Hours Pittsburgh Cooling = 432 Hours Scranton Cooling = 417 Hours Williamsport Cooling = 422 Hours	4
SAV_{heat}, energy savings factor for heating	Fixed	4.88%	5
SAV_{cool}, energy savings factor for cooling	Fixed	4.78%	5

F.4.4 Default Savings

There are no default savings for this measure.

F.4.5 Evaluation Protocols

The most appropriate evaluation protocol for this measure is self-report data collected on the paper survey included within the kit or a phone survey verifying that the thermostat temperature was changed during the heating season and/or during the cooling season.

F.4.6 Sources

1. Average size of residential air conditioner or furnace.
2. Minimum federal standard for new central air conditioners/heat pumps between 1990 and 2006.
3. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Measures in Commercial and Industrial Programs.* September 1, 2009.
4. Based on REM/Rate modeling using models from the Pennsylvania 2012 Potential Study. EFLH calculated from kWh consumption for cooling and heating. Models assume 50% over-sizing of air conditioners and 40% oversizing of heat pumps.[66]
5. Based on the energy savings for thermostat setting changes from the Iowa Energy Wise program evaluation reports from 2010 – 2013. The savings factors were calculated by taking the average percentage of savings for heating or cooling during 2010, 2011, 2012, and 2013. (Cadmus. *Iowa 2013 Energy Wise Program.* Prepared for Iowa Utility Association. 2013.)

[66] Neme, Proctor, and Nadal. "National Energy Savings Potential From Addressing Residential HVAC Installation Problems." ACEEE, February 1, 1999. Confirmed also by Energy Center of Wisconsin. *Central Air Conditioning in Wisconsin, a compilation of recent field research.* May 2008, amended December 15, 2010). Model assumes 40% oversizing of heat pumps (ACCA. "Verifying ACCA Manual S Procedures." Available online: http://www.acca.org/Files/?id=67).

Appendix G: Act 129 WRAP Billing Analysis

As per the PA Mass Market Protocol, evaluated savings for each job type are based on a customer usage analysis of the previous years' Act 129 WRAP participants. To estimate the *ex post* evaluated savings per baseload job for the PY5 evaluation, the EM&V CSP conducted a customer usage analysis of Phase I PY2 and PY3 participants. The EM&V CSP requested the customer usage history for the period of January 2009 through February 2014 for the PY2 and PY3 program participants and received customer usage histories for 3,546 accounts for which a baseload job had been provided.

The EM&V CSP reviewed the customer usage data for these 3,546 accounts and excluded records for 1,316 accounts for reasons that are listed in **Table G-1**. To conduct a customer usage analysis, it is necessary to have a minimum of nine months of pre- and post-installation energy consumption data.

Nearly two-thirds (63%) of the 1,316 excluded accounts had insufficient pre- or post-installation energy consumption data. The EM&V CSP performed a customer usage history screen examining the monthly usage history for each customer, plotting each participant's monthly pre- and post-installation usage. To avoid confounding the customer usage analysis, the EM&V CSP removed any accounts with outliers, vacancies, seasonal usage, and equipment changes in the pre- or post-installation periods. The remaining 37% of the excluded accounts were removed from the analysis as a result of the customer usage history screening.

Finally, the EM&V CSP confirmed that no HPWHs were installed at any of the baseload accounts (there were none) so that the savings would represent only baseload measures. The final dataset for the customer usage analysis had 2,230 participants.

Table G-1. Attrition Table

Attrition Reason	Number of Sites	Full Participant Number (%)
Full Participant Dataset	**3,546**	**100%**
Insufficient Pre-/Post-Installation Usage Data	834	24%
Low Usage (annual usage < 1,200 kWh)	17	0%
Account Changed Usage by more than 70%	31	1%
Outliers	434	12%
Final Analysis Dataset	**2,230**	**63%**

The EM&V CSP weather-normalized each customer's monthly kWh consumption for both the pre- and post-installation periods following these steps.

1. Obtained daily average temperature data from January 2009 through March 2014 for the National Oceanic and Atmospheric Administration (NOAA) weather stations that represented all the zip codes associated with PPL Electric's service territory.

2. From daily temperatures, determined the 65 °F reference temperature heating degree days (HDDs) and cooling degree days (CDDs) for each station.
3. Determined the nearest station for each zip code using a zip code mapping for all United States weather stations.
4. Matched billing data periods with the CDDs and HDDs from the associated stations.

The EM&V CSP used both a monthly fixed-effects model and customer-specific models to estimate overall savings for all homes receiving baseload jobs. These models produced similar savings estimates, but the estimate produced by the monthly fixed-effects model had slightly better precision. Therefore, the EM&V CSP used this estimate as the *ex post* evaluated savings per baseload job.

Details of the fixed-effects model are presented in the next section. The estimates from the customer-specific model are provided in the section after that, along with additional details about the modeling approaches.

G.1 Fixed-Effects Overall Models

Fixed effects modeling is a method of estimating parameters from a panel dataset. Panel data is taken from a (usually small) number of observations over time on a (usually large) number of cross-sectional units, such as individuals, households, firms, or governments. The fixed-effects estimator is obtained by ordinary least squares on the deviations from the means of each unit or time period. This approach is relevant when one expects the averages of the dependent variable to be different for each cross-sectional unit, or for each time period, but expects the variance of the errors to be similar.[67] To obtain overall model savings for the direct install measures and major measure groups, the EM&V CSP used the following fixed-effects model specification:

$$ADC_{it} = \alpha_i + \beta_1 * HDD_{it} + \beta_2 * CDD_{it} + \beta_3 * POST_{it} + \varepsilon_{it}$$

Where, for customer 'i' in billing month 't':

ADC_{it} = the average daily kWh consumption in the pre- and post-installation period

α_i = the average pre-installation period base load kWh usage for each customer; this is part of the fixed-effects specification

β_1 = the average pre-installation period kWh usage per HDD

HDD_{it} = the average daily base-65 HDD for the nearest weather station based on location

β_2 = the average pre-installation period kWh usage per CDD

CDD_{it} = the average daily base-65 CDD for the nearest weather station based on location

β_3 = the average daily kWh savings for the direct install measure or major measure group

[67] More details about this concept can be found online: http://economics.about.com/library/glossary/bldef-fixed-effects-estimation.htm.

$POST_{it}$ = an indicator variable that is 1 in the post-installation period and 0 in the pre-installation period

ε_{it} = the model error term

The following calculation shows the derivation of the final savings estimates from the model coefficients:

$\theta_3 * 365$ = Annual overall kWh savings for direct install or major measures

The model parameters and parameter estimates for the direct install measures' overall model are provided in **Table G-2.**

Table G-2. Fixed-Effects Model Parameters and Estimates

Variable	Degrees of Freedom	Parameter Estimate	Standard Error	t Value	Pr > |t|
Average Intercept	2,230	17.83	0.03	656.85	<.0001
HDD	1	0.61	0.02	32.51	<.0001
CDD	1	1.47	0.03	46.73	<.0001
POST	**1**	**-2.50**	**0.14**	**-18.49**	**<.0001**

The EM&V CSP estimated a separate intercept for each customer; because of space constraints, only the average of the intercepts is provided in **Table G-2.**

G.2 Customer-Specific Models

The EM&V CSP used customer-specific models to develop a second set of estimates. These models provide an alternative weather-normalization methodology to compare with the fixed-effects savings estimates. In general, the customer-specific models provided savings estimates that were very similar to those produced by the fixed-effects models.[68]

The advantage of the customer-specific models (also known as the PRinceton Scorekeeping Method, or PRISM models) is that they weather-normalize the pre- and post-installation periods for each customer. The disadvantage of the models is that they do not provide easily-obtained measure-level savings estimates.

The EM&V CSP fixed the heating and cooling reference temperatures (τ or tau) at 65 °F. In this approach, account-level models are run for the pre- and post-installation periods.

[68] The PRISM model savings were less than 1% different than the fixed-effects model estimates.

The EM&V CSP specified the heating and cooling PRISM model as follows:

$$ADC_{it} = \alpha_i + \beta_1 * AVGHDD_{it} + \beta_2 * AVGCDD_{it} + \varepsilon_{it}$$

Where for each customer 'i' and month 't':

ADC_{it}	=	the average daily kWh consumption in the pre- or post-installation program period
α_i	=	the participant intercept; this represents the average daily kWh Baseload
β_1	=	the model space heating slope
$AVGHDD_{it}$	=	the base-65 average daily HDDs for the specific location
β_2	=	the model space cooling slope
$AVGCDD_{it}$	=	the base-65 average daily CDDs for the specific location
ε_{it}	=	the error term

From the model above, the EM&V CSP computed the weather-normalized annual consumption (NAC) as follows:

$$NAC_i = \alpha_i * 365 + \beta_1 * LRHDD_i + \beta_2 * LRCDD_i + \varepsilon_i$$

Where for each customer 'i':

NAC_i	=	the normalized annual kWh consumption
α_i	=	the intercept that is the average daily or Baseload for each participant; this represents the average daily baseload from the model
$\alpha_i * 365$	=	the annual baseload kWh usage (non-weather sensitive)
β_1	=	the heating slope; in effect, this is the usage per heating degree from the model above
$LRHDD_i$	=	the annual, long-term HDDs of a typical month year (TMY3) in the 1991-2005 series from NOAA, based on home location
$\beta_1 \cdot LRHDD_i$	=	the weather-normalized, annual weather-sensitive (heating) usage, also known as HEATNAC
β_2	=	the cooling slope; in effect, this is the usage per cooling degree from the model above
$LRCDD_i$	=	the annual, long-term CDDs of a TMY3 in the 1991-2005 series from NOAA, based on home location
$\beta_2 \cdot LRCDD_i$ =		the weather-normalized, annual weather-sensitive (cooling) usage, also known as COOLNAC
ε_i =		the error term

A NAC is modeled for both the pre- and post-installation period, and these values are denoted as PRENAC and POSTNAC, respectively. From these values, the customer-specific savings, or DNAC, is given by:

$$DNAC = PRENAC - POSTNAC$$

The EM&V CSP calculated an overall average savings for baseload jobs and compared this to the estimate calculated using the fixed-effects panel model. The comparison estimates are provided in **Table G-3.**

Table G-3. PY5 WRAP Comparison of Model Estimates

Analysis Group	Number of Sites in the Analysis	Fixed-Effects Model		Customer-Specific Model	
		Average Annual kWh Savings	Precision at 90% Confidence Level	Average Annual kWh Savings	Precision at 90% Confidence Level
PY2 and PY3 Baseload Participants	2,230	911	8.9%	882	9.3%

Appendix H: Fuel Switching

H.1 Fuel Switching Reporting and Results

On October 26, 2009, the Pennsylvania PUC entered an opinion and order approving PPL Electric Utilities' Act 129 plan. In the order, the PUC required PPL Electric Utilities to track and report the frequency of customers switching to electric appliances from non-electric appliances. In addition, PPL Electric Utilities offered a fuel switching pilot program for the first time, offering rebates to the first 100 applicants (residential and nonresidential) in three programs—Residential Home Comfort, Residential Retail, and Prescriptive Equipment.

This appendix summarizes results from these two analyses. The first analyzes data collected by PPL Electric Utilities from PY5 rebate forms and presents additional research about fuel switching undertaken by the EM&V CSP. The second analysis summarizes results from the pilot program.

H.2 Fuel Switching Reported on Rebate Forms

The independent evaluation concludes about 1.0% of rebated appliances in the Residential Retail program indicated fuel switching. Note that many customers left the fuel switching data fields blank on the rebate form. If these customers are added, the maximum count of fuel switchers increases to 4.5%. However, many of the blank responses likely indicate non-fuel switching actions.

Due to data tracking issues, the calculated frequency of fuel switchers in the Residential Home Comfort program was not completed in time for the PY5 annual report. The analysis will be completed when data are available.

H.2.1 Residential Retail

In PY5, PPL Electric Utilities issued 908 rebates for heat pump water heaters, the only available fuel-switching measure. Of those, only nine (1.0%) were reported by customers as replacing non-electric equipment. The number of fuel switchers was calculated by first determining the count of customers with a natural gas distribution system. Of these customers, the number of applicants indicating non-electric equipment replacement was recorded.

Note that many customers left the fuel switching data fields blank on the rebate form. If these customers are added to the analysis as fuel switchers, the count of fuel switchers increases to 41 (4.5%). The EM&V CSP fielded a survey to these 41 customers to confirm whether they replaced a non-electric water heater and why.

Table H-1 summarizes the count of non-electric equipment replaced.

Table H-1: PY5 Fuel Switching Rebate Forms: Summary of Non-Electric Equipment Replaced

Non-Electric Equipment	Non-Electric Equipment Replaced	Percentage of Total Replacement Units
Oil Water Heater	16	39%
No Response on Rebate Form	13	32%
Natural Gas Water Heater	5	12%
Other	3	7%
Propane Water Heater	2	5%
No Previous Water Heating	2	5%
TOTAL	**41**	**100%**

Most customers replaced an oil system and only five customers (0.56% of the 908 rebates) replaced a natural gas water heater.

Table H-2 shows the population, completions, and reasons for incomplete surveys of customers who replaced a non-electric water heater. Seven of 41 customers completed the survey.

Table H-2: Residential Retail Fuel Switching Customer Survey Disposition

Disposition Description	Frequency
Population (number of rebates)	41
Removed: already contacted for another PPL Electric Utilities survey	8
Removed: inactive account	3
Survey sample frame (records sent to survey subcontractor)	30
Records attempted	30
Nonworking number	3
Wrong number, business	2
Refusal	5
No answer/answering machine/phone busy	9
Non-specific or specific callback scheduled	3
Partial complete	1
Completed survey	7
TOTAL	**41**

Five of the seven respondents confirmed that a non-electric unit was replaced. One said an electric device was removed and one said the new rebated equipment was "an addition." **Table H-3** compares survey responses on equipment type replacement to information recorded on the rebate form. With the exception of one blank rebate form, most responses matched.

Table H-3: Survey Response Compared to Rebate Response: Equipment Type Replaced

Survey Respondent	Survey Response: Equipment Type Replaced	Rebate Response: Equipment Type Replaced	Survey Response and Rebate Forms Match?
Survey Respondent 1	Other: New equipment was "an addition"	Oil Water Heater	No
Survey Respondent 2	Oil Water Heater	Oil Water Heater	Yes
Survey Respondent 3	Oil Water Heater	Oil Water Heater	Yes
Survey Respondent 4	Propane Water Heater	Propane Water Heater	Yes
Survey Respondent 5	Electric Water Heater	No response on rebate form	No
Survey Respondent 6	Oil Water Heater	Oil Water Heater	Yes
Survey Respondent 7	Oil Water Heater	Oil Water Heater	Yes

Although responses varied, most survey participants said they replaced broken and old units, with the intent to obtain efficient equipment (**Table H-4**).

Table H-4: Summary of Reasons for Replacing Equipment[1]

Gas Device	Number Replaced
Broken/Failed	3
To get more efficient equipment	3
Cost of Oil	2
Availability of Rebate	1
Other[1]	2
NOTES: [1] N=7, multiple responses allowed. Other reasons include: "didn't replace [equipment], but bypassed it" and "did not want to put oil back in there."	

Corroborating the results above, the four respondents who said the old equipment was *not* in need of repair also said the replaced device was in working conditioning when replaced.

In general, the EM&V CSP found that survey results matched responses on the rebate form. On the application for a heat pump water heater rebate, about 1.0% of customers reported they switched fuel. If blank responses are added, the percentage of fuel switchers increases to 4.5%. However, many of the blank responses likely indicate non-fuel switching actions.

H.3 Fuel Switching Pilot Program

In PY5, PPL Electric Utilities offered a fuel switching pilot program for the first time. This program offered rebates to customers who used electric space or water heat and installed new efficient non-electric space or water heating. These rebates were limited to the first 100 applicants (residential and nonresidential) in three programs—Residential Home Comfort, Residential Retail, and Prescriptive Equipment. Only three customers in the Residential Retail Program participated in the pilot program and only two of these were available for a follow-up phone survey.

Two of the three fuel switching pilot participants were available for a follow-up phone survey. One installed a propane water heater and one installed a natural gas water heater. The participant who did not complete the follow-up phone survey installed a natural gas water heater.

One survey respondent first learned of the pilot program from his or her contractor. The other first learned of the program from the PPL Electric Utilities' website and then called a contractor. Both survey *participants gave these two reasons for replacing the equipment:*

1. Although still functioning, the equipment was old and in need of repair.
2. They wished to save money.

One participant even noted that the contractor suggested switching to a propane water heater in order reduce the electric bill.

These responses largely match replacement reasons listed in the three rebate form. See below.

Table H-5: Summary of Reasons for Replacing Equipment[1]

Replacement Reason	Count
Less costly to operate	2
Electric equipment did not work/was too costly to repair	2
Better comfort/convenience/features	1
NOTES: [1] N=3, multiple responses allowed	

Lastly, *one customer said the pilot's rebate availability was very influential* in the decision to switch fuels; the other said the rebate was only *somewhat influential* in the decision to switch fuels. See **Table** H-6 for further detail on PPL Electric Utilities' influence on the customers' decision. However, all three customers stated on the actual rebate form that they would have still purchased the equipment regardless of an available rebate.

Table H-6: PPL Electric Utilities' Influential on Replacement Decision

Level of Influence	PPL Electric Utilities' Marketing	PPL Electric Utilities' Information About Energy Efficiency
1 – No Influence	1	
2		1
3	1	1
4		
5 – Extremely Influential		

The analysis concludes that the availability of the pilot program has a very minimal impact on the customer decision to switch from an electric to non-electric counterpart.

Appendix I: TRC Incremental Costs

Table I-1. TRC Incremental Costs

Program	Measure	Incremental Cost	Incremental Cost Source
Residential Retail	CFL Reflectors	$1.42	EEMIS CFL retail cost minus EM&V CSP research. The EM&V CSP researched 41 reflector bulbs from different retailers and brands (3/20/2014).
Custom Incentive	All	$1,525,727	Program verification of total project costs.
Prescriptive Equipment	New Construction Lighting: Small C&I	$461,204	Energy Trust of Oregon's average cost per square foot of $0.35 for 20% LPD reduction (used in EE&C Plan) adjusted linearly for project specific LPD reductions. Exterior lights used SWE incremental costs for LED street lighting and HID installations.
Prescriptive Equipment	New Construction Lighting: Large C&I	$280,018	Energy Trust of Oregon's average cost per square foot of $0.35 for 20% LPD reduction (used in EE&C Plan) adjusted linearly for project specific LPD reductions. Exterior lights used SWE incremental costs for LED street lighting and HID installations.
Prescriptive Equipment	New Construction Lighting: Gov't/Non-Profit	$197,324	Energy Trust of Oregon's average cost per square foot of $0.35 for 20% LPD reduction (used in EE&C Plan) adjusted linearly for project specific LPD reductions. Exterior lights used SWE incremental costs for LED street lighting and HID installations.
Prescriptive Equipment	Retrofit Cut Sheet Lighting Fixtures (Early Replacement)	$140.00	Invoice review of 20 projects with 1,168 unique measures ($35.84 labor and $104.16 fixture).
Prescriptive Equipment	Retrofit Cut Sheet Lighting Controls (Early Replacement)	$107.41	Invoice review of 20 projects with 1,168 unique measures ($56.63 labor and $50.78 materials).

The EM&V CSP used the SWE's Incremental Cost database for all rebated measures with the exception of those listed in **Table I-1**. These measures were not included in the SWE's database. These incremental costs were used in the TRC calculations.