

# **Final Annual Report to the Pennsylvania Public Utility Commission**

**For the Period  
June 2012 through May 2013  
Program Year 4**

For Pennsylvania Act 129 of 2008  
Energy Efficiency and Conservation Plan

Prepared by The Cadmus Group, Inc.

For

PPL Electric

November 15, 2013

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## Acronyms

C&I	Commercial and Industrial
CATI	Computer-Aided Telephone Interview
CFL	Compact Fluorescent Lamp
CPITD	Cumulative Program/Portfolio Inception to Date
CPITD-Q	Cumulative Program/Portfolio Inception through Current Quarter
CSP	Conservation Service Provider or Curtailment Service Provider
CVR	Conservation Voltage Reduction
CVRf	Conservation Voltage Reduction factor
DLC	Direct Load Control
DR	Demand Response
EDC	Electric Distribution Company
EE&C	Energy Efficiency and Conservation
EM&V	Evaluation, Measurement, and Verification
GNI	Government, Non-Profit, Institutional
HVAC	Heating, Ventilating, and Air Conditioning
IQ	Incremental Quarter
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light Emitting Diode
LEEP	Low-Income Energy Efficiency Program
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and Verification
MW	Megawatt
MWh	Megawatt-hour
NTG	Net-to-Gross
PA PUC	Pennsylvania Public Utility Commission
PY1	Program Year 2009, from June 1, 2009 to May 31, 2010
PY2	Program Year 2010, from June 1, 2010 to May 31, 2011
PY3	Program Year 2011, from June 1, 2011 to May 31, 2012
PY4	Program Year 2012, from June 1, 2012 to May 31, 2013
PYX QX	Program Year X, Quarter X
PYTD	Program Year to Date
SEER	Seasonal Energy Efficiency Rating
SWE	Statewide Evaluator
TRC	Total Resource Cost
TRM	Technical Reference Manual

## Report Definitions

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

### REPORTING PERIODS

#### **Cumulative Program Inception to Date (CPITD)**

Refers to the period of time since the start of the Act 129 programs. CPITD is calculated by totaling all program year results, including the current program year to date results. For example, CPTID results for PY4 Q3 is the sum of PY1, PY2, PY3, PY4 Q1, PY4 Q2, and PY4 Q3 results.

#### **Incremental Quarter (IQ)**

Refers to the current reporting quarter only. Activities occurring during previous quarters are not included. For example, IQ results for PY4 Q3 will only include results that occurred during PY4 Q3 and not PY4 Q2.

#### **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 PY4 Q3 will only include results that occurred during PY4 Q1, PY4 Q2, and PY4 Q3. It will not include results from PY1, PY2 and PY3.

### 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 EDC or the program implementer). Also known as *ex-ante*, or “before the fact” (using the annual evaluation activities as the reference point).

#### **Verified Gross**

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



## **TRC COMPONENTS<sup>1</sup>**

### **Administration Costs**

Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical costs.

### **EDC Costs**

Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenditures only.

### **Management Costs**

Includes the EDC program management, CSP program management, general management oversight and major accounts.

### **Participant Costs**

Per the 2011 Total Resource Cost Test Order, the net participant costs are the costs for the end use customer.

### **Total TRC Costs**

Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.

### **Total TRC 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.

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<sup>1</sup> All TRC definitions are subject to the 2011 Total Resource Cost Test Order.

# 1 Overview of Portfolio

Pennsylvania Act 129 of 2008 signed on October 15, 2008 mandated energy savings and coincident peak demand reduction goals for the largest electric distribution companies (EDCs) in Pennsylvania. Each EDC submitted energy efficiency and conservation (EE&C) plans—which were approved by the Pennsylvania Public Utility Commission (PA PUC)—pursuant to these goals. This report documents the progress and effectiveness of the EE&C accomplishments for PPL Electric in Program Year 4 (PY4), defined as June 1, 2012 through May 31, 2013, as well as the cumulative accomplishments of the programs since inception.

The Cadmus Group, Inc. has evaluated the programs, which included measurement and verification of the savings. The final verified savings for PY4 and the cumulative verified savings since inception of the programs 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 towards compliance goals, energy and demand impacts, net-to-gross ratios, finances, and cost-effectiveness. The following sections include program specific details, including program updates, impact evaluation findings, and process evaluation findings.

In PY4, PPL Electric's portfolio included 12 active programs:

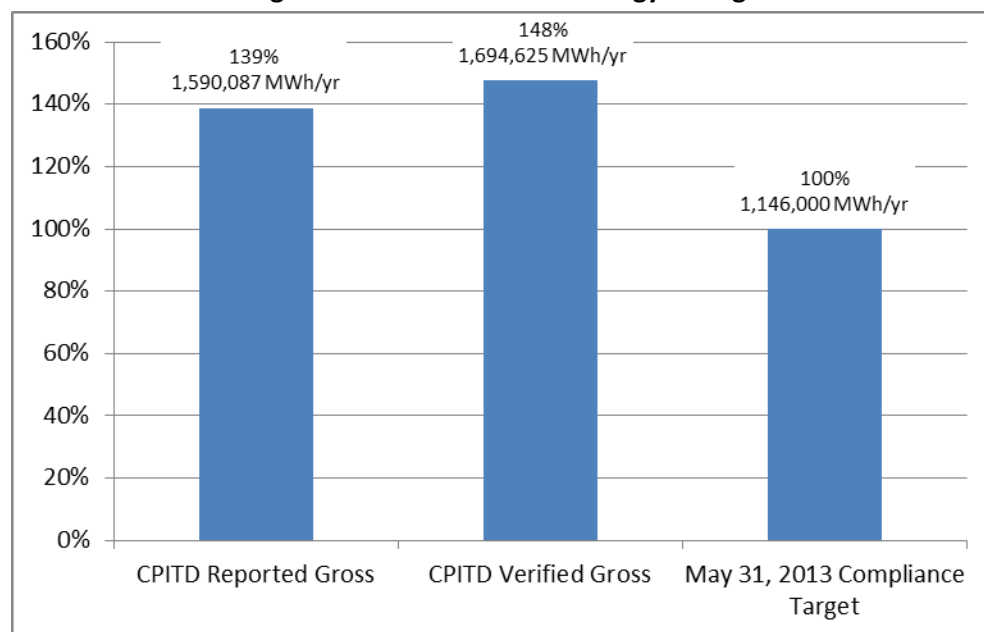
1. The Efficient Equipment Incentive Program offers prescriptive rebates to residential and nonresidential customers.
2. The Residential Lighting Program (formerly Compact Fluorescent Lighting [CFL] Campaign), an upstream program, offers incentives to manufacturers to buy down CFL costs; manufacturers and retailers then lower CFL costs to consumers.
3. The Custom Incentive Program offers custom incentives to nonresidential customers per kilowatt hour (kWh) saved during the first year of participation.
4. The Energy Efficiency Behavior & Education Program encourages customers to take energy-savings actions, providing periodic reports with energy-saving tips and usage comparisons to other peer customers.
5. The Appliance Recycling Program (ARP) offers customers incentives to have their outdated refrigerators, freezers, and air conditioners recycled.
6. The Act 129 Winter Relief Assistance Program (WRAP) provides weatherization to low-income customers, with Act 129 funding used to expand the existing Low-Income Usage Reduction Program.
7. The Home Energy Assessment & Weatherization Program provides residential customers with information about their homes' energy performance, and offers recommendations regarding the most effective, highest-priority, energy-efficiency actions they can take to save energy in their homes.
8. The E-Power Wise Program provides low-income customers with information about energy use, along with home energy kits.

9. The Direct Load Control Program achieved demand reductions in PY4 from June 1 through September 30, 2012, the only period when peak load reductions applied under Act 129.
10. The Load Curtailment Program achieved demand reductions in PY4 from June 1 through September 30, 2012, the only period when peak load reductions applied under Act 129.
11. The Renewable Energy Program encourages PPL Electric customers to install a solar photovoltaic array or ground-source heat pump through financial incentives, reducing upfront system costs. The program was closed to new participants. (The program closed to new applicants in PY3 but some projects completed in PY4.)
12. The HVAC Tune-Up Program offers services to all commercial and small industrial customers with existing split or packaged HVAC rooftop units.

## 1.1 Summary of Progress Toward Compliance Targets

The energy savings<sup>2</sup> compliance target for PPL Electric is 1,146,000 MWh/yr and must be achieved by May 31, 2013 per Act 129. Based on CPITD verified gross energy savings<sup>3</sup>, PPL Electric achieved 148 percent of the energy savings compliance target. These figures are shown in **Figure 1-1**. The PUC will determine compliance using CPITD verified gross energy savings.

**Figure 1-1: Portfolio CPITD Energy Savings**



<sup>2</sup> Herein, energy savings refers to annualized energy savings and is measured in kWh/year or MWh/year. Energy savings are reported at the meter.

<sup>3</sup> See the “Report Definitions” section for an explanation of how CPITD verified gross savings are calculated.

**Table 1-1** shows the line loss adjustment factors that were used to gross up demand reduction from the meter level to the system level.

**Table 1-1: Line Loss Factors**

Sector	Line Loss Factor Used
Government/Non-Profit	1.0833
Large C&I	1.041205
Low Income	1.0833
Residential	1.0833
Small C&I	1.0833

The system peak demand reduction<sup>4</sup> compliance target<sup>5</sup> for PPL Electric is 297 MW per Act 129 and must be achieved by May 31, 2013. PPL Electric achieved 116 percent of the demand reduction compliance target during the Top 100 Hours of 2012 based only on installations in place and generating demand reductions during those hours<sup>6</sup>. Including demand reductions occurring after the top 100 hours, PPL Electric achieved 139 percent of the demand reduction compliance target based on CPITD gross demand reduction<sup>7</sup> achieved through Quarter 4 (CPITD-Q), as shown in **Figure 1-2**. The PUC will determine compliance using CPITD verified gross demand reduction during the Top 100 Hours.

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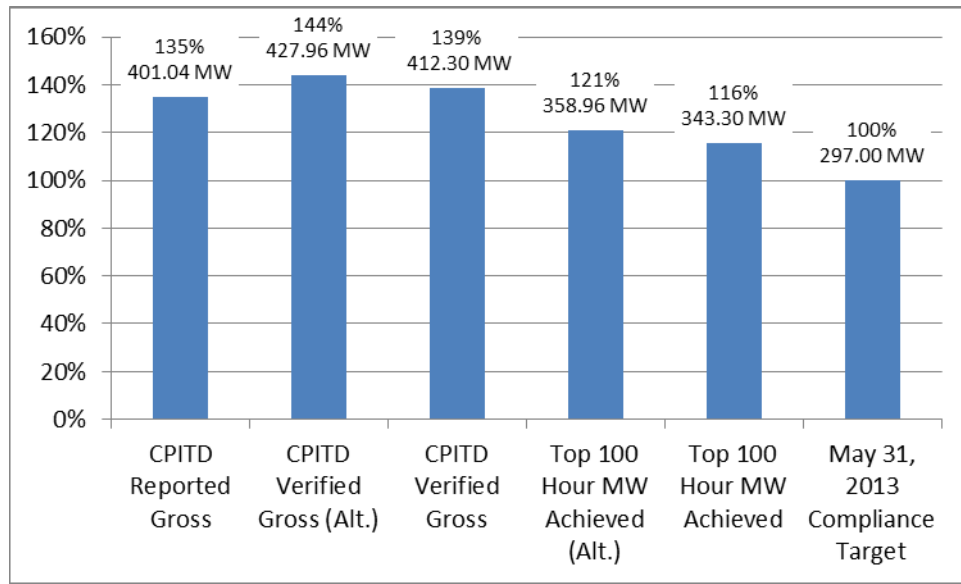
<sup>4</sup> Herein, demand reduction refers to the EDC's system peak demand reduction in the EDC's top 100 hours of highest demand, as defined by the PA PUC and is measured in kW or MW.

<sup>5</sup> The reported gross demand reductions from PPL Electric's Energy Efficiency Management Information System (EEMIS) reporting database are determined at the customer meter level, while the demand reduction compliance target was determined at the system or generation level. Therefore, a gross-up (1.041205% for the Large commercial and industrial (C&I) sector and 1.0833% for all other sectors) was applied to the reported gross demand reduction to reflect transmission and distribution (T&D) losses for useful comparison to the target

<sup>6</sup> All measures installed prior to the first peak load event are included in the demand reduction value. For energy efficiency measures installed (and operational) between PPL's first and last peak load reduction events, the peak load reductions are prorated by the portion of this period in which they were in place. For example, a measure with a kW savings estimate of .15 kW installed on July 30, 2012 was in place for 10 out of 50 of the days in the top 100 hours event period, thus, its estimated contribution to the peak demand reduction would be  $0.20 * 0.15 = .03$  kW.

<sup>7</sup> See the "Report Definitions" section for an explanation of how CPITD verified gross savings are calculated.

**Figure 1-2: Portfolio CPITD Peak Demand Reduction<sup>8,9</sup>**



Act 129 mandates that the number of measures offered to the low-income sector be proportionate to the low-income sector's share of total energy usage.<sup>10</sup> There are 52 measures available to the low-income sector. This includes measures that at least one person installed. There are 139 measures available to all customer sectors. The measures offered to the low-income sector through the two low-income specific programs (WRAP and E-Power Wise) comprise 37% of the total measures offered. As required by Act 129, this exceeds 8.64%, the fraction of the electric consumption of PPL Electric's low-income households divided by the total electricity consumption in the PPL Electric territory. These values are shown in **Table 1-2**.

<sup>8</sup> There are two bars for demand reductions. The bar marked "CPITD Verified Gross (Alt.)" and "Top 100 hour MW Achieved (Alt.)" utilizes PPL's analytic method for the Load Curtailment program. The bar marked "CPITD Verified Gross" and "Top 100 hour MW Achieved" utilizes the analytic method prescribed by the PUC and SWE for the Load Curtailment program. Refer to the Load Curtailment chapter (section 11.2.4) for more information.

<sup>9</sup> The reported gross demand reductions from PPL Electric's EEMIS reporting database are determined based at the customer meter level, while the demand reduction compliance target was determined at the system or generation level. Therefore, a gross-up was applied (1.041205% for Large C&I, and 1.0833% for all other sectors) to reported gross demand reductions to reflect transmission and distribution (T&D) losses for useful comparison to the target.

<sup>10</sup> Act 129 includes a provision requiring electric distribution companies to offer a number of energy conservation 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 legislation contains no provisions regarding targets for participation, or energy or demand savings. Refer also to Guidance Memo 17.

**Table 1-2: Low-Income Sector Compliance Metrics**

	Low-Income Sector	All Sectors	% Low-Income
# of Measures Offered	52	139	37%
Electric Consumption (MWh/yr)	3,376,606	39,090,157	8.64%

The CPITD reported gross energy savings for low-income sector programs (excluding low-income participation in non-low-income programs) is 23,727 MWh/yr; this is 1.5 percent of the CPITD total portfolio reported gross energy savings.

Including low-income customer participation in non-low-income programs, the CPITD reported gross energy savings achieved is 98,534 MWh/yr; this is 6.2 percent of the CPITD total portfolio reported gross energy savings.

The CPITD verified gross energy savings achieved for low-income programs (excluding low-income participation in non-low-income programs) is 23,180 MWh/yr; this is 1.4% percent of the CPITD total portfolio verified gross energy savings.<sup>11</sup>

Including low-income customer participation in non-low-income programs, the CPITD reported verified energy savings achieved is 88,556 MWh/yr; this is 5.2% percent of the CPITD total portfolio reported gross energy savings.<sup>12,13</sup>

Act 129 mandates that a minimum of 10% of the required energy and demand targets be obtained from units of federal, state and local governments, including municipalities, school districts, institutions of higher education and nonprofit entities. Herein, this group is referred to as the government, nonprofit and institutional (GNI) sector.

The energy savings compliance target for the GNI sector for PPL Electric is 114,600 MWh/yr, which must be obtained by May 31, 2013. Based on CPITD verified gross energy savings<sup>14</sup>, PPL Electric achieved 179 percent of the target. These values are shown in **Figure 1-3**.

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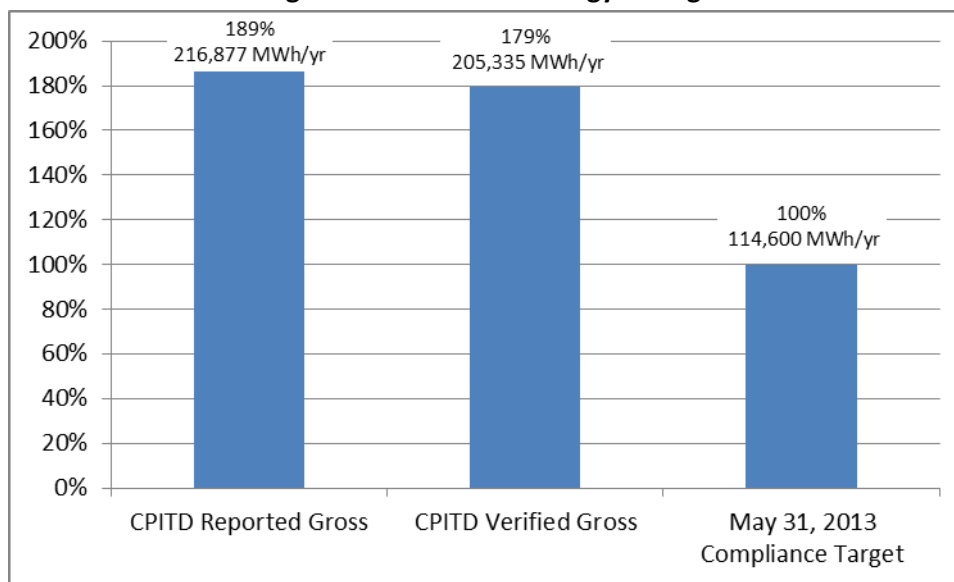
<sup>11</sup> See the "Report Definitions" section for an explanation of how CPITD verified gross savings are calculated.

<sup>12</sup> See Appendix J: Low-Income Participation in Non-Low-Income Programs for information about the method used to estimate low-income savings from non-low income programs.

<sup>13</sup> Guidance Memo 017 specifies that this report estimate the cost of low-income savings from non-low-income programs. The cost is determined by multiplying the percentage of CPITD total portfolio savings attributable to the low-income sector by the total CPITD portfolio costs to determine the cost of the savings attributable to the low-income population. The cost of low-income savings from non-low-income programs is \$12,585,000 (0.052\*\$242,014,000).

<sup>14</sup> See the "Report Definitions" section for an explanation of how CPITD verified gross savings are calculated.

**Figure 1-3: GNI CPITD Energy Savings**

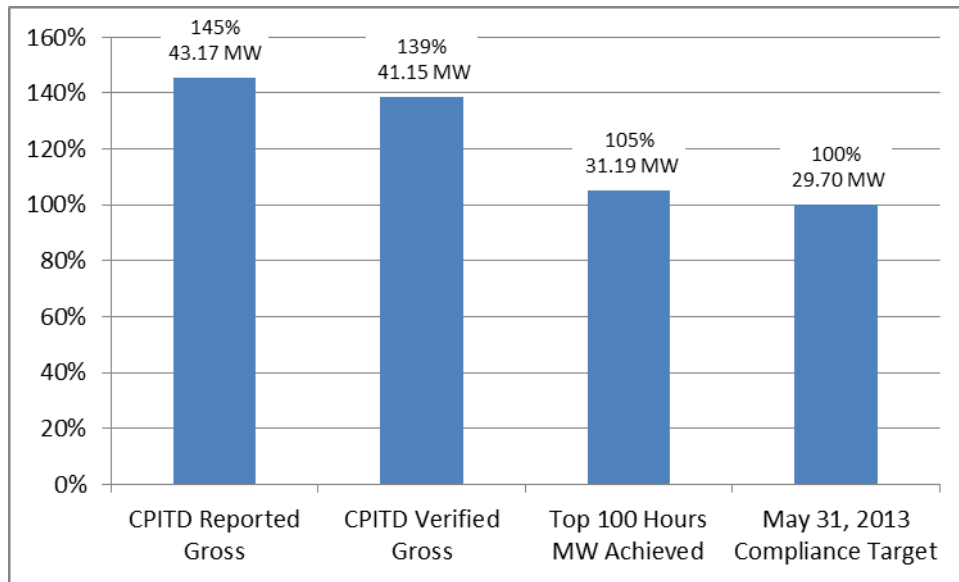


The peak demand reduction compliance target for the GNI sector for PPL Electric is 29.7 MW. Based on CPITD verified gross demand reduction<sup>15</sup>, PPL Electric achieved 105 percent of the target. These values are shown in **Figure 1-4**.

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<sup>15</sup> See the “Report Definitions” section for an explanation of how CPITD verified gross savings are calculated.

**Figure 1-4: GNI CPITD Peak Demand Reduction<sup>16</sup>**



According to the Phase II Implementation Order , PPL Electric is allowed by the PUC to “carry over” into Phase II the verified MWh/yr savings in excess of its Phase I compliance target. **Table 1-3** below shows how many MWh/yr of savings from PPL Electric will be carrying over into Phase II.

**Table 1-3: Savings from PY4 Carried into Phase II**

CPITD Verified Savings (MWh/Yr)	CPITD Unverified Savings (MWh/Yr)	Savings Carried into Phase II <sup>1</sup> (MWh/Yr)
1,694,625	5,058	548,625
<b>NOTES:</b> 1. The savings carried into Phase II do not include unverified gross energy savings of 5,058 MWh/yr (Efficient Equipment lighting and insulation projects). Once those are verified, they will be added to the carryover and shown in the Phase II Quarterly and Annual Reports.		

### 1.1.1 PY4 Sampling Plan

<sup>16</sup> The reported gross demand reductions from PPL Electric’s EEMIS reporting database are determined based at the customer meter level, while the demand reduction compliance target was determined at the system or generation level. Therefore, a gross-up was applied (1.041205% for Large C&I, and 1.0833% for all other sectors) to reported gross demand reductions to reflect transmission and distribution (T&D) losses for useful comparison to the target.



PY4 sampling plans were developed early in PY4 for each program, and are summarized in Appendix A: PY4 Verification Sampling. These sampling plans guided the sample selection for each quarter. The sampling plans reflect the SWE's guidelines and were based on the five following primary instructions and requirements:

1. 90/10 confidence and precision (C/P) for the residential portfolio.
2. 90/10 C/P for the non-residential portfolio.
3. 85/15 C/P for each program within each portfolio.<sup>17</sup>
4. The GNI sector and low-income sector populations should be treated as independent program populations (and sampled at 85/15 C/P) if their contribution to the respective sector-level portfolios is more than 20%.
5. All C/P levels are minimum. EDC evaluators are encouraged to exceed the minimum requirements.

Evaluation activities and measure verification include records reviews, participant surveys, site visits, and metering. The records reviews also play a primary role in quality assurance and quality control (QA/QC). Site visits, by their nature, include records reviews. Where metering is conducted, the sample is nested within site visits. Appendix A: PY4 Verification Sampling, includes additional details by program and sector, and provides phone survey call statistics. Phone survey results are discussed by program in the PY4 Process Evaluation (separate report).

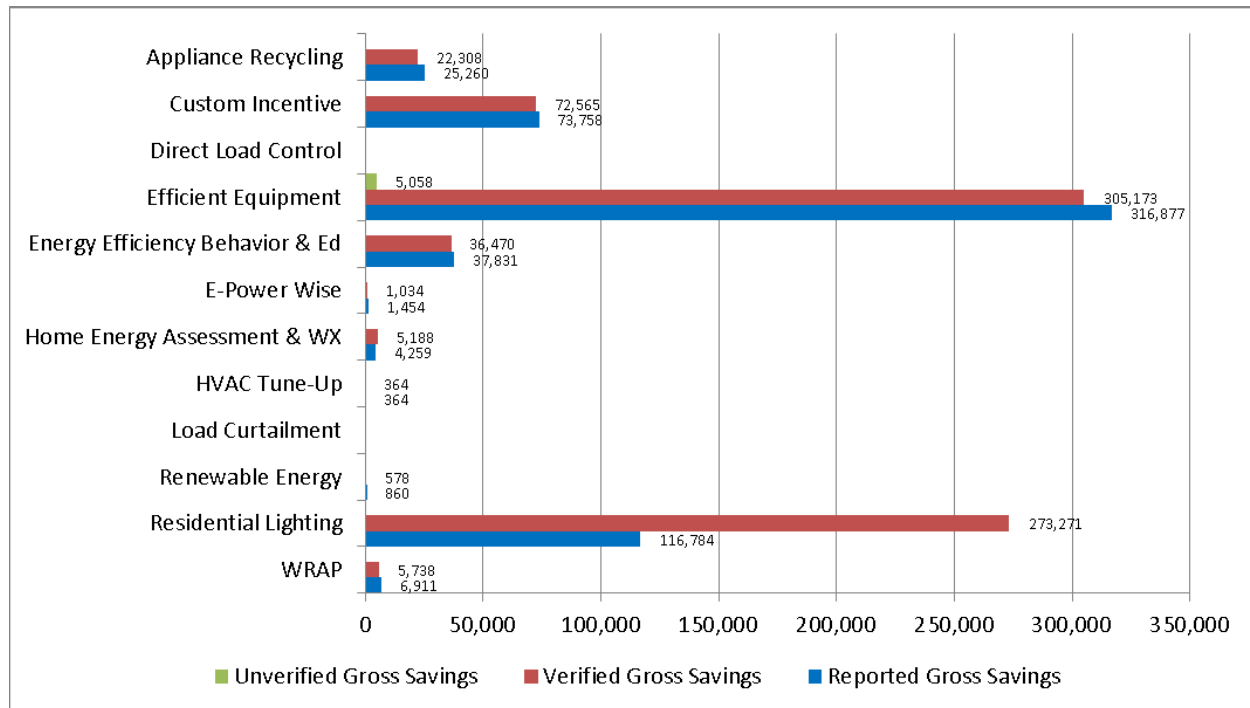
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<sup>17</sup> The exception is the Efficient Equipment Incentive Program's C&I lighting measures. Since C&I lighting contributes the majority of energy savings to the program and portfolio, this measure strata is sampled at the 90/10 levels of C/P.

## 1.2 Summary of Energy Impacts

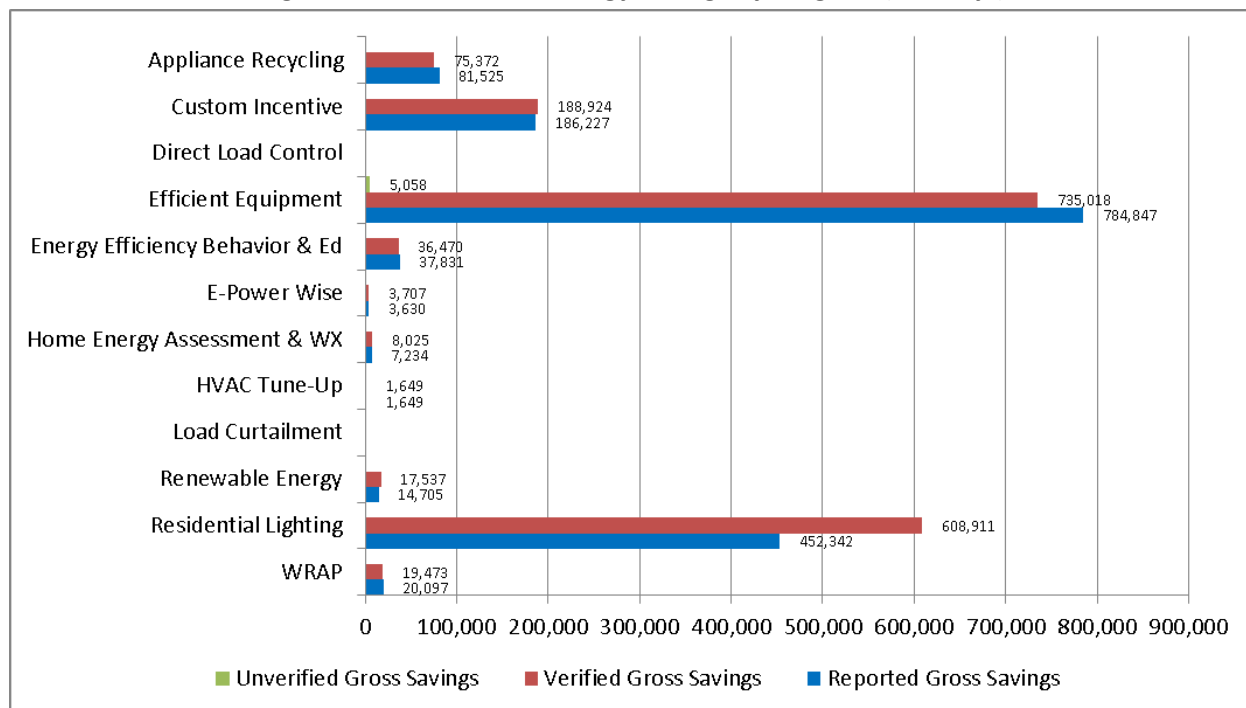
A summary of the reported, verified and unverified energy savings by program for Program Year 4 is presented in **Figure 1-5**. The “Unverified Gross Savings” values refer to projects that were reported in PY4, but have not been verified at the time of this report.

**Figure 1-5: PYTD Gross Energy Savings by Program (MWh/yr)**



A summary of the cumulative reported, verified and unverified energy savings by program is presented in **Figure 1-6**.

**Figure 1-6: CPITD Gross Energy Savings by Program (MWh/yr)**



A summary of energy impacts by program through the PY4 Q4 is presented in **Table 1-4** and **Table 1-5**.

**Table 1-4: EDC Reported Participation and Gross Energy Savings by Program**

Program	Participants			Reported Gross Energy Savings (MWh/Year)		
	IQ	PYTD	CPITD	IQ	PYTD	CPITD
Appliance Recycling <sup>1</sup>	1,817	15,267	46,038	2,731	25,260	81,525
Custom Incentive <sup>2</sup>	30	83	441	42,761	73,758	186,227
Direct Load Control <sup>3</sup>	0	9,431	44,391	N/A	N/A	N/A
Efficient Equipment Incentive	10,429	27,833	211,819	147,936	316,877	784,847
Energy Efficiency Behavior & Education <sup>4</sup>	102,158	102,158	253,626	18,287	37,831	37,831
E-Power Wise	263	2,440	9,183	157	1,454	3,630
Home Energy Assessment & Weatherization	1,106	2,349	5,412	2,141	4,259	7,234
HVAC Tune-Up <sup>5</sup>	0	274	1,707	0	364	1,649
Load Curtailment <sup>3</sup>	0	201	298	N/A	N/A	N/A
Renewable Energy <sup>6</sup>	0	116	1,946	0	860	14,705
Residential Lighting <sup>7</sup>	66,628	338,457	1,427,761	23,151	116,784	452,342
WRAP	625	3,643	13,292	1,203	6,911	20,097
<b>TOTAL PORTFOLIO</b>	<b>183,056</b>	<b>502,252</b>	<b>2,015,914</b>	<b>269,363</b>	<b>584,358</b>	<b>1,590,087</b>

**NOTES:**

1. Appliance Recycling participants refer to the number of unique participants.
2. The cumulative number of Custom Incentive Program participants includes: those still in the technical study phase; those in progress; and those cancelled. Participants in these three categories do not contribute to achieved savings. Excluding these three categories provides the total number of completed projects; at the end of PY4 there were 274 projects that contributed to cumulative savings.
3. The demand reduction programs do not have any associated energy savings. However, the participants for these programs are reported here. The participation numbers shown are based on the date each unique account number is uploaded into EEMIS. Each unique account number is counted in the period it first appears in the EEMIS extract. Therefore, the counts do not reflect customers who opted out after enrollment. For the Direct Load Control program, since counts reflect unique account numbers, participants with two metered air conditioning units are only counted once. More detail is available in the program-specific sections of this report.
4. Participation for the Energy Efficiency Behavior & Education program is considered to be cumulative across program years. However, since the savings associated with this program have a one year measure life, the energy savings are not cumulative, and therefore PYTD energy savings are equal to CPITD energy savings. More detail is available in the program-specific section of this report. Participants are defined as distinct account numbers and will not match the number of CSP JOB numbers recorded in EEMIS. Participants who opted out of the program are included in the reported value.
5. Participants refer to the number of measures. 106 HVAC units received measures.
6. Participants refer to unique accounts.
7. As an upstream program, exact participation in the Residential Lighting Program is not known. The EM&V CSP estimated the number of program participants by dividing the total number of bulbs discounted by a CFL-per-participant value derived from the customer telephone survey data (7.0 bulbs in PY1, 6.7 bulbs in PY2, 6.04 in PY3, and 7.80 in PY4). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at giveaway events.

Table 1-5: Verified Gross Energy Savings by Program<sup>1</sup>

Program	PYTD Reported Gross Energy Savings (MWh/yr)	PYTD TRM Adjusted <i>Ex Ante</i> Energy Savings (MWh/Yr)	PYTD Energy Realization Rate <sup>2</sup>	PYTD Verified Gross Energy Savings (MWh/yr)	PYTD Unverified Gross Energy Savings (MWh/yr)	PYTD Achieved Precision <sup>3</sup>	CPITD Verified Gross Energy Savings (MWh/yr)	CPITD Unverified Gross Energy Savings (MWh/yr)	CPITD Achieved Precision <sup>3</sup>
Appliance Recycling	25,260	25,179	89%	22,308	--	2.8%	75,372	--	1.4%
Custom Incentive	73,758	73,758	98%	72,565	--	6.2%	188,924	--	2.5%
Direct Load Control <sup>4</sup>	--	--	--	--	--	--	--	--	--
Efficient Equipment Incentive	316,877	317,822	96%	305,173	5,058	4.2%	735,018	5,058	3.1%
Energy Efficiency Behavior & Education <sup>5</sup>	37,831	35,138	104%	36,470	--	N/A <sup>6</sup>	36,470	--	3.7%
E-Power Wise <sup>7</sup>	1,454	1,123	92%	1,034	--	5.3%	3,707	--	4.3%
Home Energy Assessment & Weatherization	4,259	5,201	100%	5,188	--	0.7%	8,025	--	1.4%
HVAC Tune-Up	364	364	100%	364	--	N/A <sup>6</sup>	1,649	--	N/A <sup>6</sup>
Load Curtailment <sup>4</sup>	--	--	--	--	--	--	--	--	--
Renewable Energy	860	798	72%	578	--	9.8%	17,537	--	1.0%
Residential Lighting	116,784	116,358	100% <sup>8</sup>	273,271 <sup>9</sup>	--	N/A <sup>6</sup>	608,911	--	N/A <sup>6</sup>
WRAP	6,911	5,827	98%	5,738	--	N/A <sup>6</sup>	19,473	--	N/A <sup>6</sup>
<b>TOTAL PORTFOLIO<sup>10</sup></b>	<b>584,358</b>	<b>581,568</b>	<b>97%<sup>8</sup></b>	<b>722,230<sup>9,11</sup></b>	<b>5,058</b>	<b>1.9%</b>	<b>1,694,625<sup>12</sup></b>	<b>5,058</b>	<b>1.4%</b>
<b>Compliance Target</b>							<b>1,146,431</b>		
<b>Carryover Savings to Phase II</b>							<b>548,625<sup>13</sup></b>		

**NOTES:**

- Values in this table refer to savings at the point of consumption. (Savings targets for MWh/yr refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
- The realization rates in this table are rounded to the nearest percentage point from the rates used to produce the *ex post* verified savings. Manually multiplying *ex ante* adjusted savings by the realization rate shown will not reproduce the exact verified savings shown in the table.
- At the 90% confidence level.
- The Direct Load Control and Load Curtailment program do not report energy savings.
- The Behavior & Education CPITD energy savings values reported exclude savings that occurred prior to the current program year. Annual savings in this program are not considered to be cumulative because the measure has a one-year measure life. Participants are considered to be cumulative.
- Because this program's evaluation did not include sampling precision is not meaningful.
- The E-Power Wise kit's education measure has a one year measure life. 1170.99 MWh and 0.13 MW reported in previous reports' CPITD calculations has expired.
- The realization rate for Residential Lighting and Total Portfolio does not incorporate the cross-sector sales adjustment.
- Includes the 157,367 MWh/yr for cross-sector sales adjustment referred to in section 3.2.4. See Appendix D: Cross-Sector Sales Analysis for details.
- The totals may not sum to the exact amount shown due to rounding.
- Double-counted savings from the Energy Efficiency Behavior & Education Program are removed from PYTD Total Portfolio savings. Refer to Appendix F: Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs for more information.

12. Double-counted savings from the Energy Efficiency Behavior & Education Program are removed from CPITD Total Portfolio savings. Refer to Appendix F: Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs for more information. Because of their one year measure life, education savings from prior years are also excluded from CPITD. This includes education measure savings from both the Energy Efficiency Behavior and Education and E-Power Wise programs.
13. The savings carried into Phase II do not include unverified gross energy savings of 5,058 MWh/yr. Once those are verified, they will be added to the carryover.

Table 1-6 shows CPITD energy and demand reduction by sector.

**Table 1-6: CPITD Verified Energy and Demand Reduction by Sector**

Sector	CPITD Verified Gross Energy Savings (MWh/Yr)	CPITD Verified Gross Demand Reduction (MW)	CPITD Verified Gross Demand Reduction (Alt) <sup>1</sup> (MW)	CPITD Top 100 Hours Verified Gross Demand Reduction (MW)	CPITD Top 100 Hours Verified Gross Demand Reduction(Alt) <sup>1</sup> (MW)
Government/Non-Profit	205,335	41.15	41.15	31.19	31.19
Large C&I	252,220	143.10	157.78	134.15	148.83
Low Income	23,180	2.95	2.95	2.47	2.47
Residential	597,896	26.55	76.18	26.24	66.30
Small C&I	615,994	198.56	149.90	149.25	110.17
<b>TOTAL PORTFOLIO</b>	<b>1,694,625</b>	<b>412.30</b>	<b>427.96</b>	<b>343.30</b>	<b>358.96</b>
<b>NOTES:</b>					
1. Utilizes PPL's analytic method for the Load Curtailment program. Refer to the Load Curtailment chapter (section 11.2.4) for more information.					

### 1.3 Summary of Fuel Switching Impacts

On October 26, 2009, the PA PUC entered an opinion and order approving PPL Electric's Act 129 plan. In the order, the PA PUC required PPL Electric to track and report the frequency of customers switching to electric appliances from gas appliances. In addition to reporting the frequency of these occurrences, PPL Electric is required to report replacement appliance and system information. The 2012 Technical Reference Manual (TRM) Order directed the EDCs to report fuel switching information in their annual reports beginning in PY3.<sup>18</sup>

In PY4, PPL Electric issued over 20,600 rebates to residential customers. Of those, only 163 (0.79%) customers reported replacing gas equipment on their rebate forms. The PPL Electric EM&V CSP conducted a survey with a sample of these participants. Fuel-switching questions were designed to determine whether gas devices were actually replaced as indicated on rebate forms, and if so, whether they were replaced with electric equipment. Of the 18 households surveyed, 17 (94%) confirmed that they replaced a total of 20 gas devices. One household surveyed did not replace any gas devices.

- Of these 20 replaced devices, 16 (80%) were replaced because they were broken, did not work correctly, or were old and in need of replacement.
- The 20 replaced devices consist of furnaces, gas water heaters, and a clothes dryer. Please note that PPL Electric does not provide Act 129 rebates for clothes dryers.
- Ten of the 17 respondents who confirmed replacing a gas device reported receiving a rebate for new equipment. Five of the ten respondents (50%) indicated that receiving a rebate was a high motivational factor for replacing devices.
- Only eight out of 17 respondents (equivalent to eight out of 20 replaced devices, or 40%) who confirmed replacing a gas device actually directly replaced gas equipment with electric equipment and received a rebate for the new electric device.

The full analysis of the fuel switching survey is included in Appendix B: Fuel Switching.

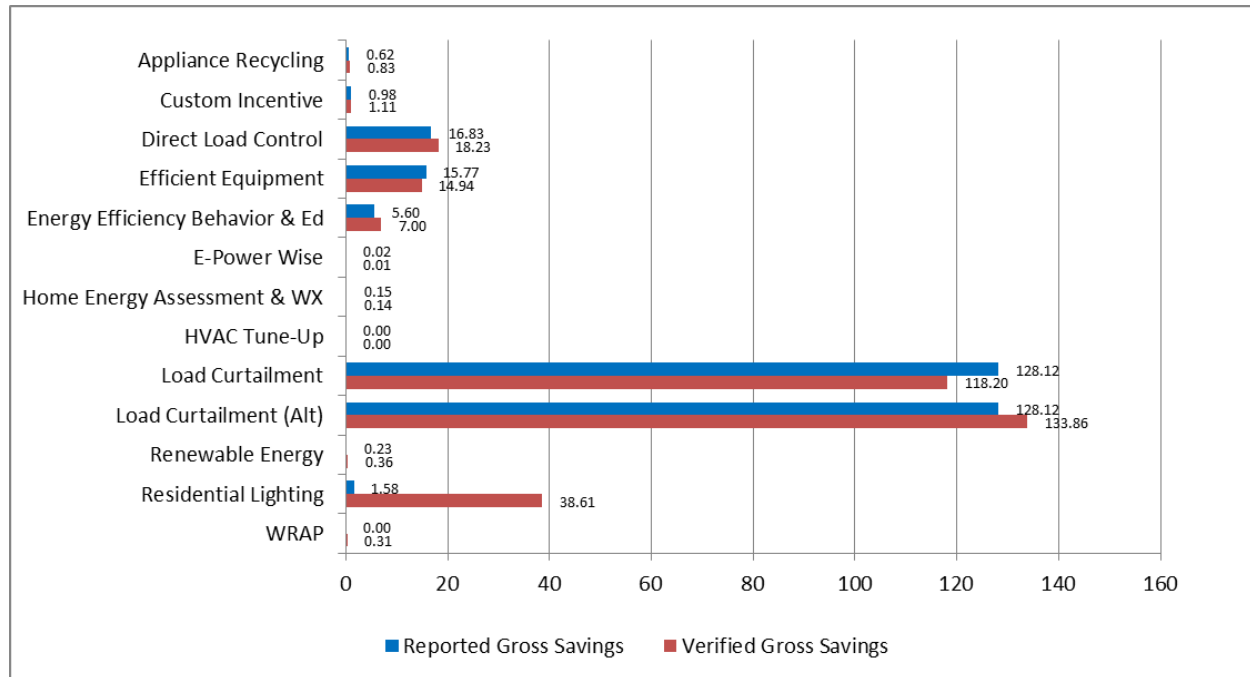
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<sup>18</sup> The 2012 TRM Order states (page 38) "UGI's assertion that Act 129 electric to non-electric fuel source reporting requirements are not being adhered to or enforced is incorrect. The EDCs have reported to the TWG that there have been no such switching and therefore, there is nothing to report. However, the Commission understands and agrees with UGI's request to have the amount of switching in writing, even if the answer is that no such switching has occurred. Therefore, the Commission directs the EDCs to report this information in their annual reports beginning with their program year three preliminary annual reports due July 15, 2012" (where TWG refers to the Technical Working Group, now called the Program Evaluation Group).

## 1.4 Summary of Demand Impacts

A summary of the reported and verified demand reduction by program within the top 100 hours for the program year is presented in **Figure 1-7**.

**Figure 1-7: PYTD Gross Demand Reduction (MW) by Program (Top 100 Hours)<sup>19,20</sup>**



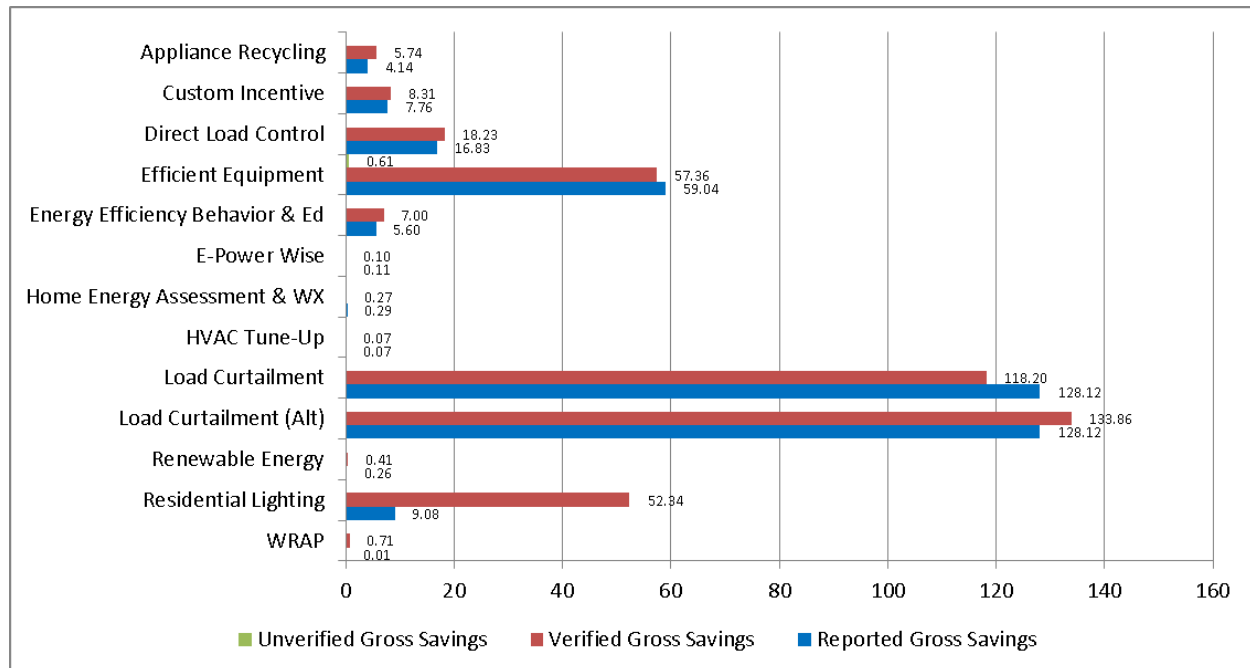
<sup>19</sup> The reported gross demand reduction from PPL Electric's EEMIS reporting database are determined at the customer meter level, reported gross demand reduction included in this figure does not include the gross-up for T&D losses. The EM&V CSP includes the T&D gross-up as an *ex ante* adjustment to the reported savings. Therefore, the Top 100 hours verified gross demand reduction does include the gross-up.

<sup>20</sup> The bar marked "Load Curtailment" utilizes the analytic method prescribed by the PUC and SWE for the Load Curtailment program. The bar marked "Load Curtailment (Alt)" utilizes PPL's analytic method for the Load Curtailment program. Refer to the Load Curtailment chapter (section 11.2.4) for more information.



A summary of the reported, verified and unverified demand reduction by program including all MW savings for the program year is presented in **Figure 1-8**. The impacts below reflect the line loss factors shown previously in **Table 1-1**.

**Figure 1-8: PYTD Gross Demand Reduction (MW) by Program (All MW Savings)<sup>21,22</sup>**

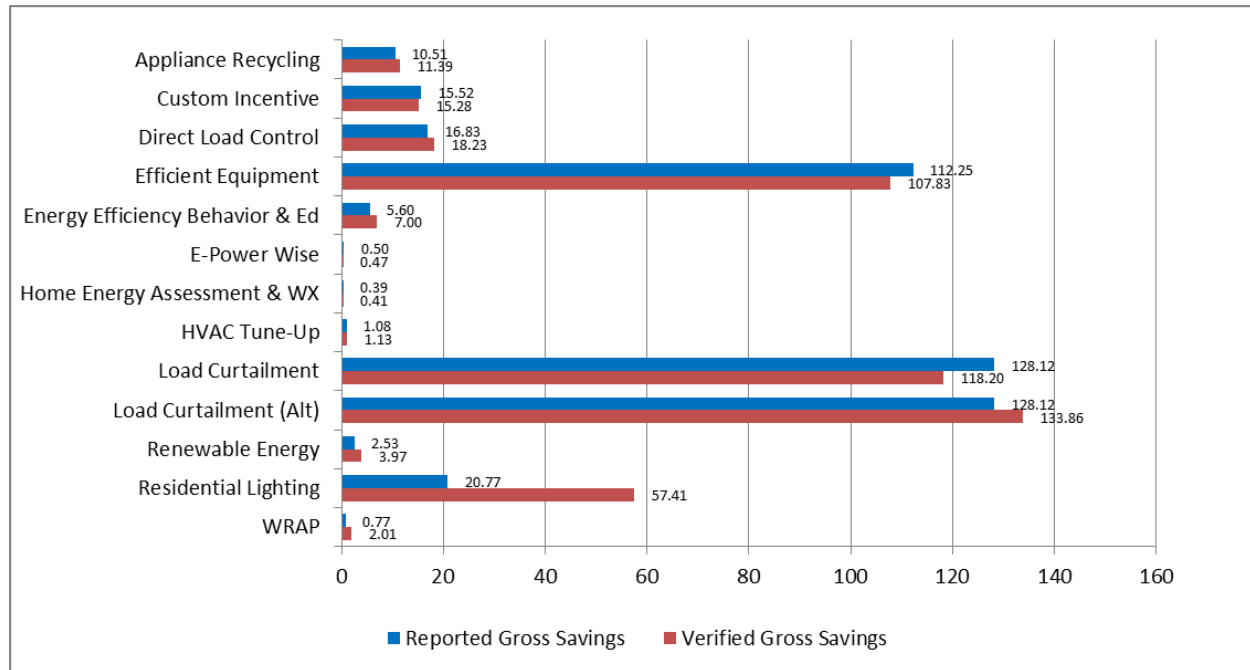


<sup>21</sup> The reported gross demand reduction from PPL Electric's EEMIS reporting database are determined at the customer meter level, reported gross demand reduction included in this figure does not include the gross-up for T&D losses. The EM&V CSP includes the T&D gross-up as an *ex ante* adjustment to the reported savings. Therefore, the Top 100 hours verified gross demand reduction does include the gross-up.

<sup>22</sup> The bar marked "Load Curtailment" utilizes the analytic method prescribed by the PUC and SWE for the Load Curtailment program. The bar marked "Load Curtailment (Alt)" utilizes PPL's analytic method for the Load Curtailment program. Refer to the Load Curtailment chapter (section 11.2.4) for more information.

A summary of the cumulative reported and verified demand reduction<sup>23</sup> by program within the top 100 hours is presented in **Figure 1-9**.

**Figure 1-9: CPITD Gross Demand Reduction (MW) by Program (Top 100 Hours)<sup>24</sup>**

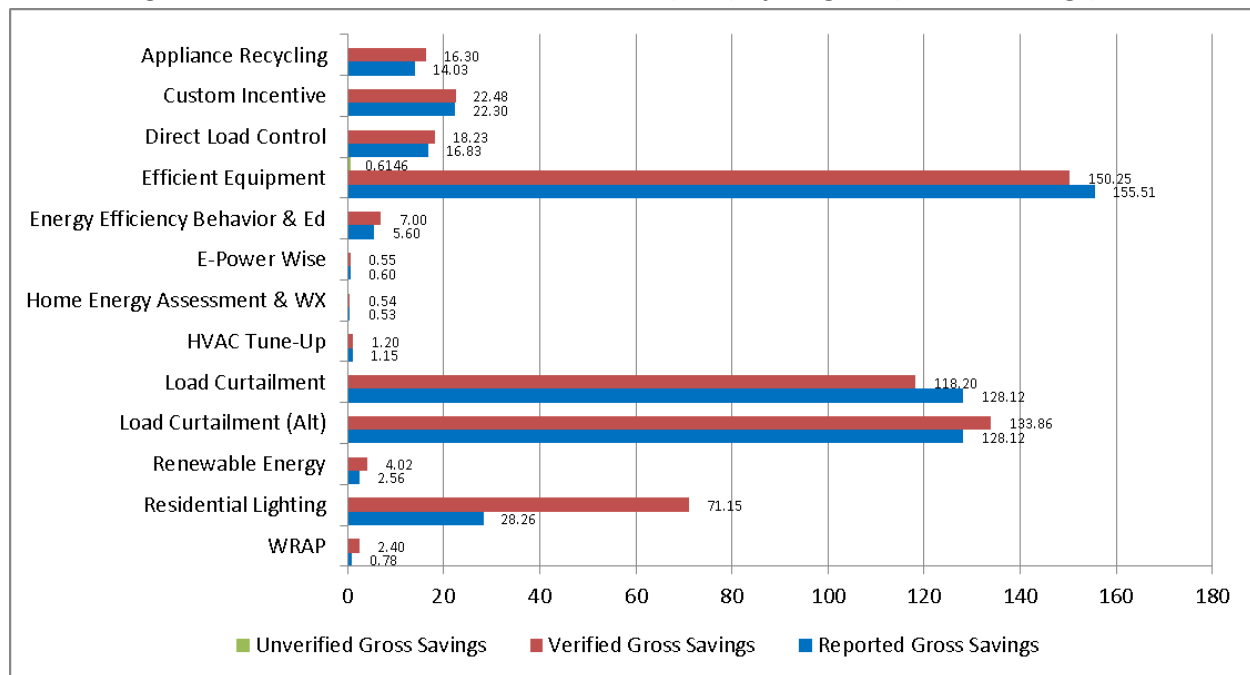


A summary of the cumulative reported, verified and unverified demand reduction by program including all MW savings for the program year is presented in **Figure 1-10**.

<sup>23</sup> For CPITD reported demand reduction, the MW values from PY1 and PY2 include the T&D gross-up, while PY3 values do not. Starting in PY3, PPL Electric removed the T&D gross-up from reported demand reduction to bring data into accordance with the EEMIS tracking database. The CPITD verified gross demand reduction includes the T&D gross-up for all program years.

<sup>24</sup> The bar marked “Load Curtailment” utilizes the analytic method prescribed by the PUC and SWE for the Load Curtailment program. The bar marked “Load Curtailment (Alt)” utilizes PPL’s analytic method for the Load Curtailment program. Refer to the Load Curtailment chapter (section 11.2.4) for more information.

**Figure 1-10: CPITD Gross Demand Reduction (MW) by Program (All MW Savings)<sup>25,26</sup>**



A summary of demand reduction impacts by program through PY4 Q4 is presented in **Table 1-7**, **Table 1-8** and **Table 1-9**.

<sup>25</sup> For CPITD reported demand reduction, the MW values from PY1 and PY2 include the T&D gross-up, while PY3 values do not. Starting in PY3, PPL Electric removed the T&D gross-up from reported demand reduction to bring data into accordance with the EEMIS tracking database. The CPITD verified gross demand reduction includes the T&D gross-up for all program years.

<sup>26</sup> The bar marked “Load Curtailment” utilizes the analytic method prescribed by the PUC and SWE for the Load Curtailment program. The bar marked “Load Curtailment (Alt)” utilizes PPL’s analytic method for the Load Curtailment program. Refer to the Load Curtailment chapter (section 11.2.4) for more information.

**Table 1-7: EDC Reported Participation and Gross Demand Reduction by Program**

Program	Participants			Reported Gross Demand Reduction <sup>1</sup> (MW)		
	IQ	PYTD	CPITD	IQ	PYTD	CPITD <sup>2</sup>
Appliance Recycling	1,817	15,267	46,038	0.45	4.14	14.03
Custom Incentive <sup>3</sup>	30	83	441	4.40	7.76	22.30
Direct Load Control <sup>4</sup>	0	9,431	44,391	0	16.83	16.83
Efficient Equipment Incentive <sup>5</sup>	10,429	27,833	211,819	27.67	59.04	155.51
Energy Efficiency Behavior & Education <sup>6</sup>	102,158	102,158	253,626	5.60	5.60	5.60
E-Power Wise <sup>7</sup>	263	2,440	9,183	0.01	0.11	0.60
Home Energy Assessment & Weatherization	1,106	2,349	5,412	0.15	0.29	0.53
HVAC Tune-Up <sup>8</sup>	0	274	1,707	0	0.07	1.15
Load Curtailment <sup>4</sup>	0	201	298	0	128.12	128.12
Renewable Energy <sup>9</sup>	0	116	1,946	0	0.26	2.56
Residential Lighting <sup>10</sup>	66,628	338,457	1,427,761	1.06	9.08	28.26
WRAP	625	3,643	13,292	0.00	0.01	0.78
<b>TOTAL PORTFOLIO<sup>11</sup></b>	<b>183,056</b>	<b>502,252</b>	<b>2,015,914</b>	<b>39.33</b>	<b>231.32</b>	<b>376.27</b>

**NOTES:**

- Reported gross demand reductions do not include the gross-up to reflect T&D losses.
- The CPITD MW values include the gross-up to reflect T&D losses for PY1 and PY2 only. Starting in PY3, the EM&V CSP changed the methodology and began applying the gross-up as an *ex ante* adjustment. The change was made to match data reported in PPL Electric's EEMIS tracking database.
- The cumulative number of Custom Incentive Program participants includes: those still in the technical study phase; those in progress; and those cancelled. Participants in these three categories do not contribute to achieved savings. Excluding these three categories provides the total number of completed projects; at the end of PY4 there were 274 projects that contributed to cumulative savings.
- The participation numbers shown are based on the date each unique account number is uploaded into EEMIS. Each unique account number is counted in the period it first appears in the EEMIS extract. Therefore, the counts do not reflect customers who opted out after enrollment. For the Direct Load Control program, since counts reflect unique account numbers, participants with two metered air conditioning units are only counted once. More detail is available in the program-specific sections of this report.
- Includes both the lighting and non-lighting measure results.
- Participation for the Energy Efficiency Behavior & Education program is considered to be cumulative across program years. However, since the savings associated with this program have a one year measure life, the energy savings are not cumulative, and therefore PYTD energy savings are equal to CPITD energy savings. More detail is available in the program-specific section of this report. Participants are defined as distinct account numbers and will not match the number of CSP JOB numbers recorded in EEMIS. Participants who opted out of the program are included in the reported value.
- The E-Power Wise kit's education measure has a one year measure life. 1170.99 MWh and 0.13 MW reported in previous reports' CPITD calculations has expired.
- Participants refer to the number of measures. 106 HVAC units received measures.
- Participants refer to unique accounts.
- As an upstream program, exact participation in the Residential Lighting Program is not known. The EM&V CSP estimated the number of program participants by dividing the total number of bulbs discounted by a CFL-per-participant value derived from the customer telephone survey data (7.0 bulbs in PY1, 6.7 bulbs in PY2, 6.04 in PY3, and 7.80 in PY4). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at giveaway events.
- The totals may not sum to the exact amount shown due to rounding.

Table 1-8: PYTD Verified Gross Demand Reduction in the Top 100 Hours by Program

Program	PYTD Reported Gross Demand Reduction <sup>1</sup> (MW)	PYTD TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	PYTD Demand Realization Rate <sup>3,4</sup>	PYTD Verified Gross Demand Reduction <sup>2</sup> (MW)	PYTD Unverified Gross Demand Reduction <sup>2</sup> (MW)	PYTD Achieved Precision <sup>3,5</sup>	CPITD Verified Gross Demand Reduction <sup>1</sup> (MW)	CPITD Achieved Precision <sup>3,5</sup>
Appliance Recycling	0.62	0.88	94%	0.83	--	2.5%	11.39	1.4%
Custom Incentive	0.98	1.02	102%	1.11	--	3.0%	15.28	0.8%
Direct Load Control	16.83	18.23	100%	18.23	--	9.3%	18.23	9.3%
Efficient Equipment Incentive	15.77	16.98	90%	14.94	0.33	3.3%	107.83	3.5%
Energy Efficiency Behavior & Education	5.60	6.06	116%	7.00	--	56.0%	7.00	56.0%
E-Power Wise <sup>6</sup>	0.02	0.02	92%	0.01	--	5.1%	0.47	1.6%
Home Energy Assessment & Weatherization	0.15	0.14	100%	0.14	--	0.5%	0.41	3.3%
HVAC Tune-Up	0.00	0.00	100%	0.00	--	N/A <sup>7</sup>	1.13	N/A <sup>7</sup>
Load Curtailment <sup>8</sup>	128.12	133.73	88%	118.20	--	N/A <sup>7</sup>	118.20	N/A <sup>7</sup>
Renewable Energy	0.23	0.47	78%	0.36	--	14.9%	3.97	2.0%
Residential Lighting	1.58	1.71	58% <sup>10</sup>	38.61 <sup>11</sup>	--	N/A <sup>7</sup>	57.41	N/A <sup>7</sup>
WRAP	0.00	0.32	98%	0.31	--	N/A <sup>7</sup>	2.01	N/A <sup>7</sup>
<b>TOTAL PORTFOLIO<sup>12</sup></b>	<b>169.91</b>	<b>179.55</b>	<b>90%<sup>10</sup></b>	<b>199.73<sup>11,13</sup></b>	<b>0.33</b>	<b>2.2%</b>	<b>343.30<sup>14</sup></b>	<b>1.6%</b>
<b>Compliance Target</b>							<b>297</b>	
<b>Over-compliance</b>							<b>46.30</b>	
<b>Load Curtailment Alternative Methodology<sup>9</sup></b>								
Load Curtailment (Alt) <sup>9</sup>	128.12	133.73	100%	133.86	--	N/A <sup>7</sup>	133.86	N/A <sup>7</sup>
<b>TOTAL PORTFOLIO (Alt)<sup>9,12</sup></b>	<b>169.91</b>	<b>179.55</b>	<b>92%<sup>10</sup></b>	<b>215.39<sup>11,13</sup></b>	<b>0.33</b>	<b>2.0%</b>	<b>358.96<sup>14</sup></b>	<b>1.5%</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. The realization rate and relative precision are implied from program level analysis. 4. The realization rates in this table are rounded to the nearest percentage point from the rates used to produce the <i>ex post</i> verified savings. Manually multiplying <i>ex ante</i> adjusted savings by the realization rate shown will not reproduce the exact verified savings shown in the table. 5. At the 90% confidence level. 6. The E-Power Wise kit's education measure has a one year measure life. 0.13 MW reported in previous reports' CPITD calculations has expired. 7. Because this program's evaluation did not include sampling precision is not meaningful. 8. Uses PUC/SWE methodology to determine Load Curtailment demand reduction. Refer to the Load Curtailment chapter (section 11.2.4) for more information. 9. Uses PPL's methodology to determine Load Curtailment demand reduction. Refer to the Load Curtailment chapter (section 11.2.4) for more information. 10. The realization rate for Residential Lighting and Total Portfolio does not incorporate the cross-sector sales adjustment.								

11. Includes the 34.86 MW cross-sector sales adjustment referred to in section 3.2.4. See Appendix D: Cross-Sector Sales Analysis for details.
12. The totals may not sum to the exact amount shown due to rounding.
13. Double-counted savings from the Energy Efficiency Behavior & Education Program are removed from PYTD Total Portfolio savings. Refer to Appendix F: Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs for more information.
14. Double-counted savings from the Energy Efficiency Behavior & Education Program are removed from CPITD Total Portfolio savings. Refer to Appendix F: Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs for more information. Because of their one year measure life, education savings from prior years are also excluded from CPITD. This includes education measure savings from both the Energy Efficiency Behavior and Education and E-Power Wise programs.

**Table 1-9: PYTD and CPITD Total Verified Gross Demand Reduction by Program**

Program	PYTD Reported Gross Demand Reduction <sup>1</sup> (MW)	PYTD TRM Adjusted <i>Ex Ante</i> Demand Savings <sup>2</sup> (MW)	PYTD Demand Realization Rate <sup>3</sup>	PYTD Verified Gross Demand Reduction <sup>2</sup> (MW)	PYTD Unverified Gross Demand Reduction (MW)	PYTD Achieved Precision <sup>4</sup>	CPITD Verified Gross Demand Reduction <sup>2</sup> (MW)	CPITD Unverified Gross Demand Reduction (MW)	CPITD Achieved Precision <sup>4</sup>
Appliance Recycling	4.14	6.13	94%	5.74	--	2.5%	16.30	--	1.3%
Custom Incentive	7.76	8.18	102%	8.31	--	3.0%	22.48	--	1.2%
Direct Load Control	16.83	18.23	100%	18.23	--	9.3%	18.23	--	9.3%
Efficient Equipment Incentive	59.04	63.83	90%	57.36	0.95	3.3%	150.25	0.95	2.5%
Energy Efficiency Behavior & Education	5.60	6.06	116%	7.00	--	56.0%	7.00	--	56.0%
E-Power Wise <sup>5</sup>	0.11	0.11	92%	0.10	--	5.1%	0.55	--	1.6%
Home Energy Assessment & Weatherization	0.29	0.27	100%	0.27	--	0.5%	0.54	--	2.5%
HVAC Tune-Up	0.07	0.07	100%	0.07	--	N/A <sup>6</sup>	1.20	--	N/A <sup>6</sup>
Load Curtailment <sup>7</sup>	128.12	133.73	88%	118.20	--	N/A <sup>6</sup>	118.20	--	N/A <sup>6</sup>
Renewable Energy	0.26	0.53	78%	0.41	--	14.9%	4.02	--	2.1%
Residential Lighting	9.08	9.81	58% <sup>9</sup>	52.34 <sup>10</sup>	--	N/A <sup>6</sup>	71.15	--	N/A <sup>6</sup>
WRAP	0.01	0.72	98%	0.71	--	N/A <sup>6</sup>	2.40	--	N/A <sup>6</sup>
<b>TOTAL PORTFOLIO<sup>10</sup></b>	<b>231.32</b>	<b>247.67</b>	<b>90%<sup>9</sup></b>	<b>268.73<sup>10,12</sup></b>	<b>0.95</b>	<b>1.7%</b>	<b>412.30<sup>13</sup></b>	<b>0.95</b>	<b>1.4%</b>
<b>Load Curtailment Alternative Methodology<sup>8</sup></b>									
Load Curtailment (Alt) <sup>8</sup>	128.12	133.73	100%	133.86		N/A <sup>6</sup>	133.86		N/A <sup>6</sup>
<b>TOTAL PORTFOLIO (Alt)<sup>8,11</sup></b>	<b>231.32</b>	<b>247.67</b>	<b>96%<sup>9</sup></b>	<b>284.39<sup>10,12</sup></b>	<b>0.95</b>	<b>1.6%</b>	<b>427.96<sup>13</sup></b>	<b>0.95</b>	<b>1.3%</b>

- 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. The realization rates in this table are rounded to the nearest percentage point from the rates used to produce the *ex post* verified savings. Manually multiplying *ex ante* adjusted savings by the realization rate shown will not reproduce the exact verified savings shown in the table.
  4. At the 90% confidence level.
  5. The E-Power Wise kit's education measure has a one year measure life. 0.13 MW reported in previous reports' CPITD calculations has expired.
  6. Because this program's evaluation did not include sampling precision is not meaningful.

7. Uses PUC/SWE methodology to determine Reported Gross Demand Reduction. Refer to the Load Curtailment chapter (section 11.2.4) for more information.
8. Uses PPL's methodology to determine Reported Gross Demand Reduction. Refer to the Load Curtailment chapter (section 11.2.4) for more information.
9. The realization rate for Residential Lighting and Total Portfolio does not incorporate the cross-sector sales adjustment.
10. Includes the 46.60 MW cross-sector sales adjustment referred to in section 3.2.4. See Appendix D: Cross-Sector Sales Analysis for details.
11. The totals may not sum to the exact amount shown due to rounding.
12. Double-counted savings from the Energy Efficiency Behavior & Education Program are removed from PYTD Total Portfolio savings. Refer to Appendix F: Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs for more information.
13. Double-counted savings from the Energy Efficiency Behavior & Education Program are removed from CPITD Total Portfolio savings. Refer to Appendix F: Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs for more information. Because of their one year measure life, education savings from prior years are also excluded from CPITD. This includes education measure savings from both the Energy Efficiency Behavior and Education and E-Power Wise programs.

## 1.5 Summary of PY4 Net to Gross Ratios

Per the 2011 TRC Order, EDCs are required to conduct Net-to-Gross (NTG) research. NTG ratios are not applied to gross savings and are not used for compliance purposes, but are used for future program planning purposes. **Table 1-10** presents a summary of NTG ratios by program.



**Table 1-10: PY4 NTG Ratios (NTGR) by Program**

Program	Total Survey Responses	Total Unique Spillover Respondents	Survey Sample Spillover kWh	Survey Sample Program kWh	Participant Spillover %	Freeridership	NTGR	NTG Precision
ARP	303	7	1,707	220,446	0.77%	33%	68%	5%
Audit Weatherization	71	1	147	162,441	0.09%	25%	75%	6%
Efficient Equipment (Residential)	77	6	3,761	63,712	5.90%	34%	72%	6%
Efficient Equipment (Commercial – Non-Lighting)	41	0	0	42,298	0.00%	77%	23%	9%
Efficient Equipment (Commercial – Lighting and Direct Install)	166	2	1,001	6,638,555	0.02%	23%	77%	4%
Custom <sup>1</sup>	72 <sup>3</sup>	0	0	36,422,684	0.00%	48%	52%	9%
Residential Lighting <sup>2</sup>	72	N/A	N/A	N/A	Range 61% - 69%	Range 31% - 47%	84%	8%
<b>NOTES:</b> 1. Custom Program: PY3 and PY4 data used for PY4 reporting. 2. See Appendix C: Residential Lighting Program Net to Gross Analysis for methodology used in Residential Lighting program 3. 72 projects were analyzed from the 70 survey completes with decision makers								

## 1.6 Summary of Portfolio Finances and Cost-Effectiveness

A breakdown of the portfolio finances is presented in **Table 1-11**. Please note that actual cost data are as of August 31, 2013. PPL Electric expects the following additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs:

- Reduce Design and Development costs by approximately \$1.2 million to reflect costs that were not charged to Act 129 EE&C but incorrectly showed as Act 129 costs on the accounting system report query used for Table 1-10 and in prior Quarterly and Yearly Reports.
- Relatively minor reclassification of costs to/from “incentives” from/to “management”.
- Relatively minor reclassification of costs from one program to another, or from/to GNI to/from small C&I or large C&I
- Additional EDC costs incurred after August 31, 2013 such as evaluation (likely to continue until the SWE issues their final report in February 2014 and the Commission issues their final determination of compliance (date TBD).

**Table 1-11: Summary of Portfolio Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$17,536	\$42,985	\$137,010
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$17,536</b>	<b>\$42,985</b>	<b>\$137,010</b>
Design & Development	\$0	-\$9	\$3,206
Administration <sup>1</sup>	\$350	\$1,549	\$9,163
Management <sup>2</sup>	\$2,970	\$27,161	\$67,184
Marketing <sup>3</sup>	\$297	\$1,881	\$12,035
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$3,618</b>	<b>\$30,581</b>	<b>\$91,588</b>
<b>EDC Evaluation Costs</b>	<b>\$1,176</b>	<b>\$3,546</b>	<b>\$11,236</b>
<b>SWE Audit Costs</b>	<b>\$226</b>	<b>\$537</b>	<b>\$2,180</b>
<b>Total EDC Costs<sup>4</sup></b>	<b>\$22,556</b>	<b>\$77,649</b>	<b>\$242,014</b>
<b>Participant Costs<sup>5</sup></b>	<b>N/A</b>	<b>\$161,583</b>	<b>\$451,974</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$239,232</b>	<b>\$598,292</b>
Total Lifetime Energy Benefits <sup>7,11,12</sup>	N/A	\$616,206	\$1,251,321
Total Lifetime Capacity Benefits <sup>7,11,12</sup>	N/A	\$43,063	\$75,901
<b>Total TRC Benefits<sup>8,7,12</sup></b>	<b>N/A</b>	<b>\$659,269</b>	<b>\$1,328,942</b>
<b>TRC Ratio<sup>9,7,12</sup></b>	<b>N/A</b>	<b>2.76</b>	<b>2.22</b>
<b>Load Curtailment Alternative Methodology<sup>10</sup></b>			
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$239,232</b>	<b>\$598,292</b>
Total Lifetime Energy Benefits <sup>7,11,12</sup>	N/A	\$616,206	\$1,251,321
Total Lifetime Capacity Benefits <sup>7,11,12</sup>	N/A	\$43,745	\$76,443
<b>Total TRC Benefits<sup>8,7,12</sup></b>	<b>N/A</b>	<b>\$659,951</b>	<b>\$1,329,484</b>
<b>TRC Ratio<sup>9,7,12</sup></b>	<b>N/A</b>	<b>2.76</b>	<b>2.22</b>

**NOTES**

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Includes the marketing CSP and marketing costs by program CSPs.
4. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
5. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
6. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.

7. CPITD value is discounted to PY1.
8. 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 capacity, transmission, distribution, and natural gas valued at marginal cost for periods when there is a load reduction.
9. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.
10. Uses PPL's interpretation of the TRM to determine reported gross demand reduction. Refer to discussion in section 11.2.4 for more information.
11. CPITD Total Lifetime Energy Benefits and Capacity Benefits will not equal Total TRC Benefits because energy benefits included gas benefits (high efficiency fuel switching measures only).
12. Due to double counting of savings in the Energy Efficiency Behavior & Education Program and other programs, the Total Portfolio TRC Discounted Benefits is less than the sum of the individual program TRC Discounted Benefits.

## 1.7 Summary of Cost-Effectiveness by Program

TRC ratios are calculated by comparing the total TRC benefits and the total TRC costs. **Table 1-12** shows the TRC ratios by program and other factors used in the TRC ratio calculation.

- Two TRC results are presented for Load Curtailment. The SWE methodology, listed in section 11.2.4, is used to determine the first TRC results. The PPL Methodology, also listed in section 11.2.4, is used to calculate the second set of cost-effective results, the (Alt) method.
- The TRC result for the Residential Lighting Program includes a cross-sector sales adjustment (see section 3.2.4). This adjustment accounts for lighting installations that occurred in *both* residential and small C&I sectors. PY4 and CPITD portfolio results account for the cross sector sales.
- No TRC benefit-cost ratio is listed for PY4's two demand response programs, Load Curtailment and Direct Load Control. To determine the proper benefit-cost ratio for demand response programs where all the benefits occur in one year but most of the costs occur in other years, total Phase I costs must be taken into account. Therefore, TRC benefit-cost ratios are presented at the CPITD level only.
- HVAC Tune-up has negative EDC costs due to accounting adjustments. Therefore, no TRC benefit-cost ratio is presented for PY4.

**Table 1-12: PYTD TRC Ratios by Program**

Program	TRC Benefits (\$1000)	TRC Costs (\$1000)	TRC Ratio	Discount Rate	Line Loss Factor <sup>1</sup>
Appliance Recycling	\$20,920	\$2,458	8.51	8.00%	Multiple
Custom Incentive	\$64,299	\$41,519	1.55	8.00%	Multiple
Direct Load Control	\$794	\$1,690	N/A	8.00%	N/A
Efficient Equipment Incentive	\$357,777	\$150,293	2.38	8.00%	Multiple
Energy Efficiency Behavior & Education	\$4,128	\$450	9.18	8.00%	8.33%
E-Power Wise	\$690	\$117	5.90	8.00%	8.33%
Home Energy Assessment & Weatherization	\$7,706	\$3,892	1.98	8.00%	8.33%
HVAC Tune-Up <sup>2</sup>	\$126	\$-27	N/A	8.00%	Multiple
Load Curtailment	\$5,149	\$5,980	N/A	8.00%	N/A
Renewable Energy	\$816	\$6,293	0.13	8.00%	Multiple
Residential Lighting	\$188,042	\$11,518	16.33 <sup>3</sup>	8.00%	8.33%
WRAP	\$8,872	\$7,008	1.27	8.00%	8.33%
Portfolio Level Costs <sup>4</sup>	N/A	\$8,041	N/A	8.00%	N/A
<b>TOTAL PORTFOLIO<sup>5</sup></b>	<b>\$659,269</b>	<b>\$239,232</b>	<b>2.76</b>	<b>8.00%</b>	Multiple
<b>Load Curtailment Alternative Methodology<sup>6</sup></b>					
Load Curtailment (Alt) <sup>6</sup>	\$5,831	\$5,980	N/A	8.00%	N/A
<b>TOTAL PORTFOLIO (Alt)<sup>6,5</sup></b>	<b>\$659,951</b>	<b>\$239,232</b>	<b>2.76</b>	<b>8.00%</b>	Multiple
<b>NOTES:</b> <ol style="list-style-type: none"> <li>1. Large C&amp;U line losses are 4.1205%, while all other sector line losses are 8.33%. If line loss factor is listed as 'Multiple' the program spans multiple sectors, one of which is Large C&amp;I.</li> <li>2. HVAC Tune-up has negative EDC costs due to accounting adjustments. Therefore, no TRC benefit-cost ratio is presented for PY4.</li> <li>3. Includes the cross-sector sales adjustment referred to in section 3.2.4. See Appendix D: Cross-Sector Sales Analysis for details.</li> <li>4. Consists of Design and Development, Management, Administration, Evaluation, Marketing and Audit costs that cannot be attributed to one program.</li> <li>5. Due to double counting of savings in the Energy Efficiency Behavior &amp; Education Program and other programs, the Total Portfolio TRC Discounted Benefits is less than the sum of the individual program TRC Discounted Benefits.</li> <li>6. Uses PPL's interpretation of the TRM to determine reported gross demand reduction. Refer to discussion in section 11.2.4 for more information.</li> </ol>					

## 2 Efficient Equipment Incentive Program

The Efficient Equipment Incentive Program promotes the purchase and installation of a wide range of high-efficiency equipment, including technologies appropriate to specific building types and specific sectors. Through the program, PPL Electric provides customers with financial incentives to offset the higher costs of energy-efficient equipment, and offers information on the features and benefits of energy-efficient equipment. Targeted equipment includes electric heating, cooling, lighting, water heating, appliances, and other measures (ENERGY STAR-labeled equipment is specified where available).

The objectives of the Efficient Equipment Incentive Program are to:

- Provide customers with opportunities to reduce their energy costs and increase the energy efficiency of their buildings.
- Encourage customers to install high-efficiency HVAC, lighting equipment, and electric appliances.
- Support the use of high-efficiency and ENERGY STAR-rated equipment.
- Encourage and support market transformation for high-efficiency appliances and equipment.
- Promote other PPL Electric EE&C programs.
- Achieve energy and demand reduction.

### 2.1 Program Updates

The program did not have any significant structural changes in PY4. Some measures were discontinued during the first two quarters as PPL Electric began concluding Phase I.

### 2.2 Impact Evaluation Gross Savings

#### 2.2.1 Reported Gross Savings

**Table 2-1** shows the cumulative reported results by quarter through the end of PY4 and includes all program measures, that is, both lighting and non-lighting measures.

**Table 2-1: Efficient Equipment Incentive Program Reported Results by Quarter**

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	7,784	51,367	9.33	10.47	\$5,935
PY4 Q2	5,354	70,370	3.86	12.62	\$6,876
PY4 Q3	4,266	47,205	0.57	8.28	\$6,416
PY4 Q4	10,429	147,936	2.01	27.67	\$12,828
<b>PY4 Total</b>	<b>27,833</b>	<b>316,877</b>	<b>15.77</b>	<b>59.04</b>	<b>\$32,056</b>
<b>CPITD Total</b>	<b>211,819</b>	<b>784,847</b>	<b>112.25</b>	<b>155.51</b>	<b>\$86,348</b>

**Table 2-2** breaks out the program’s PY4 participation, savings, and incentives paid by sector and includes all program measures.

**Table 2-2: Efficient Equipment Incentive Program Reported Results by Sector**

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	20,470	10,189	0.88	2.53	\$1,931
Small Commercial and Industrial	5,367	191,257	9.07	36.98	\$16,430
Large Commercial and Industrial	198	44,900	1.18	5.73	\$4,084
Government and Non-Profit	1,798	70,532	4.64	13.79	\$9,611
<b>PY4 Total</b>	<b>27,833</b>	<b>316,877</b>	<b>15.77</b>	<b>59.04</b>	<b>\$32,056</b>
<b>CPITD Total</b>	<b>211,819</b>	<b>784,847</b>	<b>112.25</b>	<b>155.51</b>	<b>\$86,348</b>

## 2.2.2 EM&V Sampling Approach

For verification activity sampling, measures were assigned to one of three strata for the residential and nonresidential sectors separately. For each sector, the three strata—large, medium, and small—were based on *ex ante* savings. In the nonresidential sector, commercial lighting defined the largest stratum, and those results are described separately in a subsequent section. The strata for the residential and nonresidential sectors are defined in **Table 2-3**.

**Table 2-3: Strata Definitions**

Sector	Stratum	Measure Groups Included
Nonresidential	Large	Commercial lighting
	Medium	VSD and ASD and refrigeration
	Small	All others: Motors, HVAC, appliances, office equip, other
Residential	Large	HVAC measures (ASHP, room AC, ductless mini-split, HPWH, RTS, commercial reach in refrigeration)
	Medium	ENERGY STAR Refrigerators
	Small	White goods, office equipment, air conditioners, other

### 2.2.2.1 Sampling Approach: Non-Lighting Measures

The sampling strategy for these strata is shown in **Table 2-4**. The EM&V CSP applied batch sampling to maximize resources. The sample plan for PY4 was based on the final number of measures installed in PY3, along with respective *ex post* verified savings and the coefficient of variation (CV). A stratified ratio approach was used for separate samples in the residential and nonresidential sectors.

- **For the residential records review**, 50 sample points were drawn from the large stratum, 10 sample points from the medium stratum, and 10 sample points from the small stratum. The phone survey sample was drawn independently of the records review sample. The medium stratum consisted solely of ENERGY STAR refrigerators because in PY3 they comprised the largest measure group (14,840 units) and 16% of the savings.
- **For nonresidential measures**, the EM&V CSP conducted site visits and records review. As noted, lighting makes up the largest stratum and is discussed separately. Within the non-lighting sample, the EM&V CSP conducted the records review for the same sites that were visited. The EM&V CSP originally planned to nest the site visits for the small stratum within the medium stratum; however, it was not possible to reach the small stratum quota with this strategy. Therefore, the EM&V CSP conducted additional record reviews for the small measures to meet the quota. The EM&V CSP did not visit sites that had measures only within the small stratum.
  - An equal number of sample points were originally included in the medium and small strata. That is, half of the sample points for records review, site visits, and surveys were drawn from the medium stratum, and half were drawn from the small stratum.
  - The phone survey sample was drawn randomly and independently of the records review and site visits sample.

At the end of the program year after receiving all records for PY4, the EM&V CSP adjusted the original sample plan to account for several issues:

- Many of the motors and VSD records in the randomly selected sample had been installed in 2010 and 2011 and savings were calculated according to the 2010 or 2011 TRM methodology.



The motors and VSD projects installed during PY4 had savings calculated according to the 2012 TRM methodology, and would therefore have a different realization rate than the 2010 and 2011 projects. The EM&V CSP added 12 VSD projects (medium stratum) and six motors projects (small stratum) to the records review sample so the EM&V CSP could calculate separate realization rates for the 2010-2011 and 2012 projects.

- The PY4 annual EEMIS extract contained new measures processed after Q4. Some measures were not in the previous EEMIS extract for Q1 through Q4 and other measures showed a large increase in the number of records. This changed the sample frame; therefore, the EM&V CSP drew an additional 11 measures from the medium stratum and 13 measures from the small stratum. The sample was chosen randomly from specific measures that were underrepresented in the original sample. The new sample included 11 evaporator fans from the medium stratum and two ASHPs, seven DX AC measures, and four chillers from the small stratum.
- The commercial insulation measures were originally part of the nonresidential small stratum, but were separated into their own stratum because savings and realization rates were highly variable for this measure. Their realization rates for the initial sampled projects were not representative of all insulation projects nor of the other measures within the commercial small stratum. The residential solar water heating measures were originally part of the residential small stratum, but were separated into their own stratum because the measures and their realization rates were not representative of other measures within the residential small stratum.

**Table 2-4: Efficient Equipment Incentive Program Non-Lighting Sampling Strategy for PY4**

Sector	Stratum	Strata Boundaries	Population Size	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence & Precision	Target Sample Size	Added Sample After Q4	Achieved Sample Size	Evaluation Activity		
Nonresidential	Medium	VSD and ASD and refrigeration	443	0.5	85/15 at program level	20	23	43	Records review		
						35	0	2	Surveys <sup>2,3</sup>		
						20	0	21	Site visits <sup>4</sup>		
	Small	All others: Motors, HVAC, appliances, office equip, insulation, other	1,270			20	19	39	Records review <sup>2</sup>		
						35	0	40	Surveys <sup>2,3</sup>		
						20	0	1	Site visits <sup>4</sup>		
Residential	Large	HVAC measures <sup>1</sup>	8,972	0.17	90/10 at sector level	50	0	50	Record review <sup>2</sup>		
						50	0	61	Surveys <sup>2</sup>		
	Medium	Energy Star Refrigerators	11,295			10	0	10	Records review <sup>2</sup>		
						10	0	10	Surveys <sup>2</sup>		
	Small	White goods, office equipment, air conditioners, SWHs, other	710			10	0	10	Records review <sup>2</sup>		
						10	0	5	Surveys <sup>2</sup>		

**NOTES:**  
1. ASHP, room AC, ductless mini-split heat pumps, HPWH, RTS.  
2. Samples are independent from desk audit/records review samples.  
3. The achieved sample reflects survey targets for Nonresidential Medium and Small strata that were modified from the original sample plan after analyzing the actual number of unique account holders in each stratum and removing accounts that had been contacted in the past year for EM&V efforts. These adjustments reduced the sample size of the Medium Stratum significantly. Sample points were reallocated to the Small stratum to achieve 90/10 for the non-lighting measure group. (The original sample targets were 35 in each stratum as shown in this table. The revised sample sizes were 2 and 50, respectively.)  
4. Site visits include records reviews (desk audits).  
5. This table excludes nonresidential large stratum discussed in section 2.2.2.2.

### 2.2.2.2 Sampling Approach: Nonresidential Lighting

The PY4 sampling strategy for nonresidential lighting is shown in **Table 2-6**. The EM&V CSP drew samples, conducted site visits and reviewed records quarterly. Quarterly sample sizes were 25% of the annual target. The PY4 sample plan was based on the number of nonresidential lighting projects installed in PY3, and their distribution between Direct Discount and Standard (Standard refers to prescriptive rebates; not the Direct Discount projects) delivery paths observed in PY4Q1. The error ratio was based on the PY3 impact evaluation analysis.

The PY4 sampling plan used a stratified ratio estimation approach with 4 strata;

- Direct Discount
- Standard Large, the largest standard prescriptive rebate projects that account for 50% of standard path savings
- Standard Medium, the next-largest standard prescriptive rebate projects account for 30% of standard path savings
- Standard Small, the remaining standard prescriptive rebate projects account for last 20% of standard path savings

Strata sample sizes were based on contribution to total reported kWh savings. Direct Discount projects accounted for 46% of PY4Q1 reported savings and were therefore 46% of the sample. By design Standard Large projects accounted for 50% of Standard savings, and therefore made up 27% (50% of the remaining 54% non-Direct Discount savings) of the sample. Standard Medium and Standard Small made up 16% and 11% respectively of the balance of the sample.

Stratified sampling results in smaller sample sizes and promotes evaluation efficiency compared to simple random sampling. This was the primary motivation for selecting the stratified approach. A secondary motive is that it can sometimes provide insights into the operations of individual strata (e.g. Direct Install, New Construction, Standard path), leading to improvements in program implementation.

**Table 2-5** shows the PY4 sampling plan by quarter.

**Table 2-5: PY4 Quarterly Efficient Equipment Nonresidential Large Stratum (Lighting) Site Visit Sampling Plan**

Sample Count Allocation	Q1	Q2	Q3	Q4	Total
Direct Discount (46%)	6	6	6	6	24
Standard Large (50%)	3	3	3	3	12
Standard Medium (30%)	2	2	2	2	8
Standard Small (20%)	2	2	2	2	8
<b>Total</b>	<b>13</b>	<b>13</b>	<b>13</b>	<b>13</b>	<b>52</b>

A fifth stratum comprised of all new construction nonresidential lighting projects was added after the close of PY4.

Due to rounding, the actual sample sizes for both Direct Discount and Standard projects were larger than planned. **Table 2-6** shows the counts of completed site visits and EM&V reviews for the PY4 nonresidential lighting sample.

In late August the EM&V CSP received data tracking records for PY4 projects that were processed after May 31, 2013. The ex-ante savings for this subpopulation accounted for 26% of the PY4 kWh/year ex-ante savings and 24% of the reported projects for the year. This large number of projects and their skew towards the Standard application path, accounts for the differences between the planned and achieved allocation of sample points between Direct Install and Standard projects.

**Table 2-6: PY4 Efficient Equipment Nonresidential Large Stratum  
(Lighting) Sampling**

Stratum	Percent of PY4Q1 Reported Savings	Actual Percent of PY4 Reported Savings	PY4 Site Visit and Records Review Sample <sup>1</sup>	Completed PY4 Site Visit and Records Review	Target Phone Survey Sample Size	Achieved Survey Sample Size
Direct Discount	46%	29%	24	25	70	77 <sup>2</sup>
Standard Large	27%	14%	12	8	70 <sup>3</sup>	95
Standard Medium	16%	20%	8	8		
Standard Small	11%	32%	8	18		
New Construction	--	5%	--	10	None	None
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>52</b>	<b>69</b>	<b>160</b>	<b>172</b>
<b>NOTES:</b> 1. Based on the percent of PY4Q1 reported savings. 2. The EM&V CSP conducted 71 telephone surveys and six on-site surveys during EM&V site-visits. 3. Survey targets for Commercial & Industrial small, medium and large strata were modified from the original sample plan after analyzing the number of unique account holders in each stratum and removing accounts that had been contacted in the past year for EM&V efforts. These adjustments reduced the sample size of the medium stratum significantly. Sample points were reallocated to the small and large strata to achieve 90/10 for the non-lighting measure group and at the program level. (The original sample target was 90 as shown in this table. The revised sample size was 90.)						

### 2.2.2.3 Program Measurement and Verification Methodology

#### 2.2.2.3.1 Measurement and Verification: Non-Lighting Measures

The EM&V CSP used various methods to verify the reported program savings, determine the savings attributable to the measures, and determine the realization rate of the measures installed. These methods included verification through surveys and a comparison of rebate records and documentation to EEMIS-reported values. The EM&V CSP also verified a sample of nonresidential measures through site visits.

The energy and demand *ex ante* gross savings for non-lighting measures reported in EEMIS for the Efficient Equipment Incentive Program underwent two levels of adjustment:

1. First, the EM&V CSP adjusted EEMIS-reported savings to bring the reported *ex ante* into alignment with the TRM algorithms, correcting the deemed savings used as placeholders in EEMIS. This resulted in the TRM-adjusted *ex ante* energy and demand reduction values. The *ex ante* adjustments were based on information about the systems installed through the program (configuration and geographic location). This adjustment accounts for differences between planning assumptions used in the EEMIS deemed savings and the installed equipment. The adjustments rely solely on information in the EEMIS tracking database and are made to the population before any verification work is conducted.
2. Second, the EM&V CSP made additional adjustments to the TRM-adjusted *ex ante* savings to compute the verified *ex post* savings. These adjustments reflect the results of M&V activities and data collected through surveys, site visits, and records reviews (accounting for such things as systems information, e.g., efficiency, tonnage, and features, installation rates, and equipment qualifications).

#### 2.2.2.3.2 Measurement and Verification: Nonresidential Lighting Measures

The M&V activities for nonresidential lighting measures included in the sample were:

1. Review application files for data accuracy and compliance with TRM requirements.
2. Conduct on-site reviews at customer facilities for a sample projects to determine the as-built conditions for the project.
3. Conduct metering studies or interval data analysis at selected facilities to determine actual lighting operating hours.
4. Conduct interviews with customers to determine baseline and retrofit fixtures and estimate operating hours.
5. Revise the 2011 TRM's Appendix C inventory based on the findings from the previous steps.
6. Recalculate the project savings to determine the *ex post* savings for the sampled projects.

The EM&V CSP metered a building's lighting operating hours if the site visit revealed that the true hours of operation for the lighting project were  $\pm 50\%$  of the TRM value. The EM&V CSP conducted metering studies so results could be reported within a given building at the 90/20 levels of confidence and precision. To determine appropriate locations for meter placement, the EM&V CSP used a stratified sample approach for selecting fixtures within a building's lighting inventory to meter. The EM&V CSP based *ex post* savings on metering studies when the data were available.

The same approach was used to select a random sample of fixtures to verify in buildings where hours of use were not metered.

### 2.2.3 Ex Ante Adjustment Methodology and Findings

### **2.2.3.1 Ex Ante Adjustment Methodology: Non-lighting Measures**

*Ex ante* savings reported in EEMIS were adjusted based on actual participation data captured in EEMIS (as discussed in section 2.2.2.3.1). These adjustments were applied to the population and accounted for TRM savings calculations that vary by location, configuration, water-heating fuel, or equipment information such as size or efficiency. In addition, these adjustments accounted for any updates in savings calculations made to the TRM since EEMIS was last updated, including changes to TRM algorithms. The adjustments were based solely on information provided by participants and reported in EEMIS, such as zip code (for location adjustments to heating and cooling degree days), manufacturer and model information, water-heating or space-heating fuel type, or equipment capacity.

For some measures, the variables needed to calculate savings in accordance with the TRM were not available in the EEMIS tracking database, and so the *ex ante* savings cannot be adjusted. For those measures, all changes to energy or demand reduction were made to the *ex post* savings when more data were collected through records review and site visits. Such measures were motors, variable speed drives (VSDs), and commercial refrigeration measures.

**Table 2-7** outlines the factors adjusted in PY4 to calculate TRM-adjusted *ex ante* savings using EEMIS reported information. Adjustments were made to the population; all records were assigned an *ex ante* adjusted savings.

**Table 2-7: Summary of PY4 TRM *Ex Ante* Adjustments to Reported Savings**

Measure	Factors
Room Air Conditioners	Location (EFLH)
Central Air Conditioning	Location (EFLH), capacity, SEER, EER
Air Source Heat Pumps	Location (EFLH), capacity, SEER, EER, HSPF/COP
(DX) Packaged AC	Location (EFLH), capacity, EER
Ductless Heat Pumps	Location (EFLH), capacity, SEER, EER, HSPF, Room
Air-Cooled Chillers	Location (EFLH), capacity, full-load efficiency (kW per ton)
Programmable Thermostats	Location (EFLH), sector, heating system type
Faucet Aerators	Fixed value, sector
High-Efficiency Gas Furnaces	Deemed savings based on PY2 billing analysis results
ENERGY STAR Refrigerators	Configuration
ENERGY STAR Clothes Washers	Water heating fuel
Heat Pump Hot Water Heaters	Energy factor
ENERGY STAR Computers	Fixed value
ENERGY STAR Monitors	Fixed value
ENERGY STAR Fax Machines	Fixed value
ENERGY STAR Copiers	Images per minute
ENERGY STAR Scanners	Images per minute
ENERGY STAR All-in-Ones	Images per minute
ENERGY STAR Printers	Images per minute
ENERGY STAR Ice Makers	Ice and compressor types
Wall Insulation	Location (HDD and CDD), building space type, project construction type, heating system type and capacity, cooling system type and capacity, initial R-value, final R-value
Ceiling Insulation	Location (HDD and CDD), building space type, project construction type, heating system type and capacity, cooling system type and capacity, initial R-value, final R-value
Solar Water Heaters	Fixed value

#### 2.2.3.1.1 Adjustments beyond the TRM

Several measures had other adjustments beyond the TRM factors. These measures were high-efficiency gas furnaces, faucet aerators, and programmable thermostats.

To accurately capture the savings associated with high-efficiency gas furnaces, the EM&V CSP conducted a billing analysis after PY2 for the census of Residential Thermal Storage (RTS) customers who received rebates for that measure in PY2. The average savings from customers in PY2 was applied to the PY4 customers as the *ex ante* adjustment value (a billing analysis has not been conducted for PY3 or PY4 customers).

The EM&V CSP assigned zero savings to faucet aerators in nonresidential settings during the TRM adjusted *ex ante* review, as faucet aerators are not in the TRM. If a nonresidential customer installed the faucet aerators in a residential setting (e.g., university dormitories) then residential savings were assigned per the TRM.

#### 2.2.3.1.2 Approach when TRM Variables Are Not Provided

In some cases, the data needed for calculating *ex ante* savings were not available in EEMIS because they were not provided on the participant's application, but the EM&V CSP was able to make assumptions based on data from other sources.

For clothes washer records where the participants did not provide water heating information, the EM&V CSP used data from the 2013 TRM for the distribution of water heater fuel types to calculate a weighted average savings, which were applied to the measure.

When space heating type or capacity information was not provided by the participants, the EM&V CSP used data from the Residential Appliance Saturation Survey (RASS) or from the participants who did provide the information, to calculate a weighted average savings. This weighted average savings was applied to those participants for whom the necessary information was missing. The EM&V CSP employed these methods for residential thermostats and commercial insulation, as described further below.

For residential thermostats, if the rebate form did not capture the heating system type, the EM&V CSP used the RASS data to determine the number of customers who qualified for the thermostat incentive had heat pumps, as these systems do not have heating savings. The EM&V CSP then applied an average savings, weighted by heating system type, across all residential customers.

For the commercial insulation measures, many of the fields needed for calculating savings were blank in EEMIS, requiring the EM&V CSP to make assumptions. The assumptions made were as follows:

- **Project Construction Type.** When the project construction type (new construction or retrofit) was unknown, the EM&V CSP assumed retrofit.
- **Building Type.** The building type was unknown for all projects, so the EM&V CSP looked up the business name to determine the building type.
- **Existing R-value.** When the existing R-value was unknown or less than 2, the EM&V CSP assumed the R-value was 2, as this is default value in the TRM.
- **Cooling and Heating System Types.** If the cooling system type was missing, the EM&V CSP assumed there was not a cooling system and therefore no cooling savings. When the heating system type was missing, the EM&V CSP assumed electric resistance heat. However, it is possible that the heating system type was actually gas (not electric) and more effort should be made to collect this information. When the cooling system type or heating system type was



populated, but the cooling system size or heating system size was blank, the EM&V CSP assumed an average size based on other customer data.

#### 2.2.3.1.3 Incorrect Calculations or Deemed Values in EEMIS

The EM&V CSP found that the calculations or deemed values in EEMIS did not follow the TRM for commercial central air conditioning and air source heat pumps less than 5.4 tons, air-cooled chillers, residential computers, and residential monitors. All *ex ante* adjustments are made to the population before verification activities as explained in section 2.2.3.1.

Some commercial central air conditioning measures and the commercial air source heat pump measures were less than 5.4 tons. The EM&V CSP discovered that the EER field in EEMIS actually contained SEER values for systems less than 5.4 tons and that the SEER field, which was calculated using a conversion factor and relied on the value in the EER field, was incorrect for these systems. For the demand reduction, EER is used in the TRM calculation. The EM&V CSP found that EEMIS was using a baseline SEER value instead of the correct baseline EER value for the kW calculation for all HVAC measures.

For chillers, the energy and demand reduction in EEMIS were calculated using the IPLV efficiency; however, the full-load efficiency should have been used. This was corrected in the *ex ante* adjustment.

Computers were assigned a deemed savings value of 151 kWh and 0.0203 kW in EEMIS, which does not match with TRM values. Additionally, the 2011 TRM has no residential value for rebated computers, only deemed savings values of 133 kWh and 0.018 kW for commercial customers. The 2012 TRM has both commercial and residential customer savings values; residential computers have deemed savings values of 77 kWh and 0.01 kW. The EM&V CSP applied 2012 TRM residential value for all residential rebated computers, including those from 2011.

Monitors were assigned deemed savings values of 156 kWh and 0.021 kW in EEMIS, which does not match with TRM values. Similar to computers, the 2011 TRM has no residential value for monitors, only deemed savings values of 15 kWh and 0.002 kW for commercial customers. The 2012 TRM has both commercial and residential customer savings values; residential monitors have deemed savings values of 14 kWh and 0.0019 kW. The EM&V CSP applied 2012 residential value for all residential rebated monitors, including those from 2011.

Fax machines were assigned deemed savings values of 14 kWh and 0.0019 kW in EEMIS, and the TRM value is 78 kWh and 0.0105 kW.

#### 2.2.3.2 *Ex Ante Adjustment Methodology: Nonresidential Lighting Measures*

There were no *ex ante* adjustments to the energy savings for the nonresidential lighting measures in PY5.

#### 2.2.4 *Ex Post Adjustment Methodology and Findings*

#### **2.2.4.1 Ex Post Adjustment Methodology: Non-Lighting Measures**

The realization rates incorporate installation rates, adjustments for nonqualifying equipment, and adjustments for equipment details determined through the sample of projects selected for records review, surveys, and site visits.

The records review involved verifying information from EEMIS using rebate application forms, customer-submitted supporting documentation, CSP recorded information, and databases from ENERGY STAR or the Air-Conditioning, Heating, and Refrigeration Institute (AHRI). The EM&V CSP reviewed the installation addresses and quantities of each measure in the sample. Records review also verified whether the rebated measure qualified for the program. Over the course of PY4, the EM&V CSP conducted site visits of nonresidential customers for verification purposes. These site visits, along with records review, confirmed open variables necessary for calculating savings. In a separate sample, the EM&V CSP used telephone surveys to verify the number of units installed and the addresses at which the units were installed. For selected measures, the EM&V CSP also used surveys to collect information about open variables.

**Table 2-8** shows elements verified or validated for each measure as part of records verification, surveys, and site visits. The EM&V CSP verified installation and qualification rates for all sampled measures, and so these are not included in the table below. Some variables are not possible to verify during the survey, as customers do not typically remember certain equipment details (e.g., SEER and EER). Some variables are not possible to verify during the site visit, as the information is not readily available by inspecting the equipment.

**Table 2-8: Summary of Verification Elements**

Measure	Record Verified Elements	Survey Verified Elements	Site Visit Verified Elements <sup>1</sup>
Central Air Conditioners	SEER, capacity (tons), EER	Replaced cooling equipment type	SEER, capacity (tons), building type
Air Source Heat Pumps	SEER, capacity (tons), HSPF	Replaced cooling and heating equipment types	SEER, capacity (tons), HSPF, building type
Heat Pump Water Heaters	Energy factor	None	None
Room Air Conditioners	None	None	None
(DX) Packaged AC	Capacity (tons), EER	Replaced cooling equipment type	EER, capacity (tons), building type
Air-Cooled Chiller	Capacity (tons), Efficiency (kW per ton)	Replaced cooling equipment type	Capacity (tons), Efficiency (kW per ton), building type
ENERGY STAR Clothes Washers	Hot water fuel type	Hot water heater fuel type	Hot water fuel type
Programmable Thermostats	Heating fuel	Equipment controlled by thermostat, heating system type	None
Faucet Aerators	Sector	None	None
ENERGY STAR Refrigerators	Configuration	None	Configuration
ENERGY STAR Office Equipment	Fixed value or images per minute	None	Fixed value or images per minute
ENERGY STAR Ice Makers	ice harvest rate, compressor types	None	ice harvest rate, compressor types
Motors and VFDs	Horsepower, efficiency, motor type (ODP/TEFC), operating hours	Quantity of new and replaced equipment	Horsepower, efficiency, motor type (ODP/TEFC), operating hours
Commercial Refrigeration Measures	Volume, horsepower, case length, case type (refrigerator/freezer), tonnage	Case type (refrigerator/freezer), approximate case volume, door type, fan motor information	Volume, horsepower, case type (refrigerator/freezer), door type, tonnage, horsepower, size, fan motor information
Ductless Heat Pumps	SEER, capacity (tons)	room type, replaced heating and cooling equipment type	SEER, capacity (tons), indoor and outdoor unit information
Wall Insulation	Location (HDD and CDD), Building space type	Location (HDD and CDD), Building space type, heating system type, cooling system type	Location (HDD and CDD), Building space type, heating system type, cooling system type
Ceiling Insulation	Location (HDD and CDD), Building space type	Location (HDD and CDD), Building space type, heating system type, cooling system type	Location (HDD and CDD), Building space type, heating system type, cooling system type
Solar Water Heater	None	None	None
<b>NOTES:</b>			
1. Site visits only verify nonresidential measures.			

#### **2.2.4.2 Ex Post Adjustment Methodology: Nonresidential Lighting Measures**

The EM&V CSP computed savings as described below. *Ex post* adjustments were made for verified fixture quantity, fixture types, operating hours, coincidence factors, and controls.

The following factors and independent variables affect the realization rate for Efficient Equipment Incentive Program non-residential lighting projects:

- Lighting operating hours (effective full load hours; EFLH)
- Fixture quantity
- Fixture type
- Interactive and coincidence factors
- Control factors

### **2.2.5 Savings Realization Rate Methodology**

Using information and data collected from site visits, records reviews, and surveys, the EM&V CSP developed verified savings for each project in the evaluation sample. The ratio of the EM&V CSP *ex-post* (verified) savings to the adjusted savings for the sample of projects is the program realization rate. The EM&V CSP determined *ex post* savings by multiplying *ex ante* adjusted savings by the realization rate.

### **2.2.6 Summary of Evaluation Results**

The following tables summarize the realization rate for each stratum (excluding nonresidential lighting), as well as reported savings, TRM adjusted *ex ante* savings, and verified (*ex post*) savings for each defined stratum in the Efficient Equipment Incentive Program. More detailed breakdowns of commercial lighting savings are provided in the next section.

**Table 2-9** provides energy savings results by sample stratum.

**Table 2-9: PY4 Efficient Equipment Incentive Program Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation ( $C_v$ ) or Proportion or Error Ratio	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
Residential Small	6	5	100.55%	0.23	10.21%	5	--
Residential Small (Solar Water Heaters)	4	4	294.19%	N/A <sup>2</sup>	N/A <sup>2</sup>	12	--
Residential Medium	1,137	1,285	105.35%	0.17	6.30%	1,354	--
Residential Large	8,761	9,606	92.16%	0.73	13.11%	8,853	--
Nonresidential Small	5,655	3,886	51.85%	2.38	48.59%	2,015	--
Nonresidential Small (Insulation)	125	1,847	5701.63% <sup>3</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	2,633	1,801
Nonresidential Medium, Small (Motors/VSDs from 2010 and 2011)	3,270	3,270	33.06%	0.31	6.98%	1,081	--
Nonresidential Medium	12,565	12,565	99.57%	0.86	21.15%	12,511	--
Nonresidential Large (Lighting)	285,353	285,353	98.09% <sup>3</sup>	0.19	4.54%	276,709	3,257
<b>Program Total</b>	<b>316,877</b>	<b>317,822</b>	<b>96.02%<sup>3</sup></b>	<b>0.49</b>	<b>4.24%</b>	<b>305,173</b>	<b>5,058</b>
<b>NOTES:</b> 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. Because these strata did not include sampling, $C_v$ and precision are not meaningful. 3. <i>Ex Ante</i> values include unverified projects. Dividing verified by TRM adjusted <i>ex ante</i> will not result in the stated realization rate.							

The Efficient Equipment program offers a diverse range of measures across all sectors. Therefore, **Table 2-10** below shows PY4 demand reduction by strata.

**Table 2-10: PY4 Efficient Equipment Incentive Program Summary of Evaluation Results for Demand**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion or Error Ratio	Relative Precision	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
Residential Small	0.0008	0.0007	100.59%	0.23	10.30%	0.0007	--
Residential Small (Solar Water Heaters)	0.0008	0.0008	236.80%	N/A <sup>3</sup>	N/A <sup>3</sup>	0.002	--
Residential Medium	0.14	0.15	100.00%	0.00	0%	0.15	--
Residential Large	2.34	2.70	40.52%	1.84	33.13%	1.09	--
Nonresidential Small	1.62	1.39	55.71%	2.10	42.74%	.78	--
Nonresidential Small (Insulation)	0.08	0.39	273.20% <sup>4</sup>	N/A <sup>3</sup>	N/A <sup>3</sup>	0.13	0.34
Nonresidential Medium, Small (Motors/VSDs from 2010 and 2011)	0.27	0.29	110.93%	0.67	15.19%	0.32	--
Nonresidential Medium	1.16	1.25	136.23%	0.75	18.47%	1.71	--
Nonresidential Large (Lighting)	53.43	57.65	92% <sup>4</sup>	0.17	1%	53.18	0.61
<b>Program Total</b>	<b>59.04</b>	<b>63.83</b>	<b>89.89%<sup>4</sup></b>	<b>0.39</b>	<b>3.33%</b>	<b>57.36</b>	<b>0.95</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. Because these strata did not include sampling, C <sub>v</sub> and precision are not meaningful. 4. <i>Ex Ante</i> values include unverified projects. Dividing verified by TRM adjusted <i>ex ante</i> will not result in the stated realization rate.							

Demand reduction for the top 100 hours is provided in **Table 2-11**.

**Table 2-11: PY4 Efficient Equipment Incentive Program Summary of Evaluation Results for Demand (Top 100 Hours) Stratum<sup>1</sup>**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Savings <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion <sup>3</sup> or Error Ratio	Relative Precision <sup>3</sup>	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction <sup>4</sup> (MW)
All	15.77	16.98	89.89%	0.39	3.33%	14.94	0.33
<b>Program Total</b>	<b>15.77</b>	<b>16.98</b>	<b>89.89%</b>	<b>0.39</b>	<b>3.33%</b>	<b>14.94</b>	<b>0.33</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses 3. The realization rate, coefficient of variation, and relative precision are implied from program level analysis. 4. The two unverified lighting projects were installed after the top 100 hours.							

### 2.2.6.1 Summary of Evaluation Results: Non-Lighting Measures

The records review and site visits for PY4 measures showed differences between the *ex ante* adjusted savings and the *ex post* savings within each stratum. The measures that had the largest influence on the realization rates for each stratum are discussed below.

#### 2.2.6.1.1 Residential Small Stratum Measures

The residential small stratum includes office equipment. The realization rate was 101% for energy savings and 101% for demand reduction. There are no major differences to report for this stratum.

#### 2.2.6.1.2 Residential Solar Water Heaters

Two solar water heater projects were provided rebates in PY4. The realization rate was 294% for energy savings and 237% for demand reduction. Both projects were found to be ground source heat pumps, therefore, the EM&V CSP used the GSHP algorithms from the 2012 TRM and information from the AHRI database to calculate the *ex post* energy and demand reduction for these projects. Energy and demand reduction for ground source heat pumps are higher than for solar water heaters.

#### 2.2.6.1.3 Residential Medium Stratum Measures

The residential medium stratum includes ENERGY STAR refrigerators. The realization rate was 105% for energy savings and 100% for demand reduction. The difference between *ex ante* adjusted and *ex post* savings were due to differences found in model configurations when the manufacturer and model numbers in the records were verified.

#### 2.2.6.1.4 Residential Large Stratum Measures

The residential large stratum includes HVAC measures. The realization rate was 92% for energy savings and 41% for demand reduction.

The EM&V CSP verified 13 residential air source heat pump measures and found variation between the *ex ante* adjusted and *ex post* demand reduction. The EM&V CSP found during record review that one measure was actually a ductless heat pump, and calculated energy savings for this measure using the ductless heat pump algorithms in the TRM. For the other measures, the EM&V CSP found a difference in the EER values used to calculate savings in EEMIS (which are derived from the SEER value by assuming 13 SEER is equivalent to 11 EER) and those verified using the AHRI database. The AHRI values were lower, resulting in lower demand reduction than the *ex ante* adjusted values.

The EM&V CSP verified five central air conditioner measures. The *ex post* energy savings decreased for two measures and the demand reduction decreased for all five measures because the verified cooling capacity and verified efficiency per the AHRI database were lower than that reported in EEMIS.

For ductless heat pumps, one reviewed record had an incorrect room type in EEMIS which impacted the energy savings. The EM&V CSP also verified the capacity and efficiency values by looking up the manufacturer and model number in the AHRI database. For some cases, this resulted in negative demand reduction as the EER values found in AHRI were lower than those in EEMIS, which are calculated by converting SEER to EER.

Lastly, the EM&V CSP found that several of the heat pump water heater measures were not actually heat pump water heaters. One measure was a ductless heat pump, two were air source heat pumps, three were ground source heat pumps, three were regular water heaters, and two were natural gas tankless water heaters. The standard water heaters and the natural gas tankless water heaters were assigned zero savings as they are ineligible for rebates. The other measures were assigned measures per the algorithms in the TRM.

#### 2.2.6.1.5 Nonresidential Small Stratum Measures

The nonresidential small stratum measures include motors, office equipment, HVAC equipment, and heat pump water heaters. The realization rate was 52% for energy savings and 56% for demand reduction. The motors installed prior to 2011 were treated as a separate stratum and had a realization rate of 33% for energy savings and 111% for demand reduction.

The EM&V CSP visited two sites with HVAC premium motors within the PY1-PY2 motors stratum and verified six sites from the medium stratum (installed after 2011) through record review. The primary reason for the difference between the reported and verified savings for the two verified sites was that incorrect efficiencies were recorded for the efficient motors. The primary reason for the difference between reported and verified savings for the six sites verified through record review was that the 2012 TRM motors workbook incorrectly calculated efficient motor consumption as the savings for VFD installation in the Motor and Variable Frequency Drive Inventory Form. One application had two motors installed that were the same efficiency as the NEMA premium baseline. There should have been no savings for these motors, but due to the incorrect calculation of motor savings, VFD savings were applied as motor savings.



#### 2.2.6.1.6 Nonresidential Insulation Measures

The realization rates were 5,702% for energy savings and 273% for demand reduction. The EM&V CSP visited two buildings that installed insulation. These buildings were large and used electric chillers for cooling which is not covered in the TRM. The EM&V CSP collected key inputs to model the energy use of these buildings using eQuest to calculate the energy savings. The model results showed a large increase in both energy and demand reduction for both buildings.

The EM&V CSP does not believe the results for the two verified insulation projects were representative of the 30 remaining insulation projects. The remaining projects are small C&I projects, the majority of which were in buildings with ASHP or CAC units. Therefore, these projects are considered unverified for this PY4 annual report. These projects will be verified and savings reported in the final Phase I report and/or PY5 annual report, as SWE directs.

#### 2.2.6.1.7 Nonresidential Medium Stratum Measures

The nonresidential medium stratum measures include ASD/VSDs and commercial refrigeration. The realization rates were 100% for energy savings and 136% for demand reduction.

For VSDs, the EM&V CSP visited eleven sites and verified twelve sites through record review. For the visited sites, all 11 sites had submitted applications in 2010 and used the 2010 TRM algorithm, which was incorrect and overestimated energy savings. The EM&V CSP used the corrected algorithm from the 2012 TRM to calculate *ex post* energy and demand reduction for these sites. For the record review sites, one applicant listed all baseline conditions as “Constant Volume” which is used to look up the ESF and DSF used to calculate VFD savings. For pump motors, constant volume is not an appropriate baseline condition, as can be seen in the TRM. Another applicant replaced the TRM default motor run-time (RHRS) with custom hours of use, which cannot be verified without metering. To maintain consistency, the RHRS values in the evaluation analysis reflect those in the PY4 TRM. Finally, the HP of one motor was incorrectly entered into EEMIS and was corrected in the evaluation analysis.

The EM&V CSP visited three sites with display cases. *Ex post* savings differed from the reported savings because the reported values in EEMIS were based on assumptions and the data required to look up savings in the TRM were not collected. The EM&V CSP collected these data during the site visit to update the *ex post* savings, and the collected data resulted in larger energy and demand reduction.

The EM&V CSP visited four sites with evaporator fans and verified 11 records through record review. For three of the visited sites, the *ex post* savings differ from the reported savings because the reported values in EEMIS were based on assumptions and the data required to look up savings in the TRM were not collected. During the site visit, the EM&V CSP collected the case temperature (freezer or refrigerator), old motor type, and new motor type, and then used these data to update the *ex post* savings. For the record review sample measures, the *ex post* savings were equivalent to the reported savings because data collection had improved and all needed variables were collected in EEMIS.

The EM&V CSP visited three sites with case fans. *Ex post* savings differed from the reported savings because the reported values in EEMIS were based on assumptions and the data required to look up savings in the TRM were not collected. The EM&V CSP collected these data during the site visit to update the *ex post* savings, and the collected data resulted in smaller energy and demand reduction.

The EM&V CSP visited two sites with floating head pressure controls. The verified savings were found to be lower than the reported savings at both sites because the capacity of the refrigeration system was incorrectly reported in horsepower and should have been reported in tons.

### ***2.2.6.2 Summary of Evaluation Results: Nonresidential Lighting Measures***

The EM&V CSP conducted file reviews and site visits for 59 nonresidential lighting retrofit projects and 10 new construction projects for a total gross impact sample size of 69 completes. Differences between the reported and *ex post* savings result from corrections to independent variables made by the EM&V CSP, including lighting annual hours of use (HOU), presence or absence of cooling in spaces involved in the project, fixture counts, and fixture quantities. In some instances where HOU values were stipulated by building type, the building type designation was corrected if needed. The kWh realization rate differed from 1.0, primarily because of corrections to the HOU, with additional differences due to corrections to cooling classifications, fixture counts, and fixture wattages. The factors affecting the kW realization rate were corrections to cooling classification, building types, and fixture types.

The EM&V CSP conducted a desk review with phone interviews for selected sites for a sample of ten projects reported after May 31. The review found no significant differences between Q1-Q4 sampled projects and those in the post-Q4 sample. The EM&V CSP therefore applied the realization rate obtained through the four quarterly samples to the entire PY4 ex-ante savings, including savings for the post-Q4 projects.

Two post-Q4 projects (project went in-service before May 31, 2013 but the transactions was recorded in EEMIS after May 31) with a change in connected load greater than 200 kW had not been metered by the program CSP to determine site-specific annual hours of lighting use, as required by the 2012 TRM. These two projects have been recorded as “unverified” for PY4. The EM&V CSP is in the process of metering hours and will report verified savings for these two projects in 2014.

Nonresidential lighting energy savings are shown in **Table 2-12**.

**Table 2-12: PY4 Efficient Equipment Incentive Program Detailed Results for Nonresidential Large Stratum (Lighting) Energy Savings<sup>1</sup>**

Stratum	Reported Gross Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Savings (MWh/yr)	Energy Realization Rate <sup>2</sup>	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion or Error Ratio <sup>2</sup>	Relative Precision <sup>2</sup>	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
Large	91,135	91,135	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	89,394	--
Medium	57,365	57,365	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	56,269	--
Small	38,069	38,069	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	37,342	--
Direct Discount	81,928	81,928	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	80,364	--
New construction	13,600	13,600	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	13,340	--
Unverified	3,257	3,257	N/A	N/A	N/A	0	3,257
<b>Nonresidential Lighting Strata Total</b>	<b>285,353</b>	<b>285,353</b>	<b>98.09%</b>	<b>0.19</b>	<b>4.54%</b>	<b>276,709</b>	<b>3,257</b>

**NOTES:**

1. Values in this table refer to savings at the point of consumption. Due to line losses, savings at the point of generation are systematically larger.
2. 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.

## 2.3 Impact Evaluation Net Savings

### 2.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP determined the NTG ratio through self-report surveys with a sample of participants. The EM&V CSP conducted three separate surveys, one with residential participants, one with nonresidential lighting participants, and one with nonresidential non-lighting participants. The surveys included questions to identify spillover and freeridership.

In each of the three surveys, the freeridership survey questions were tailored to the measures installed by participants of the Efficient Equipment Incentive Program. These questions were used to develop a freeridership score by using a scoring matrix. More detail about the freeridership analysis and the scoring matrix is included in **Table 2-13**. No adjustments for the NTG ratio were applied to savings, as specified by the Pennsylvania PUC. Information obtained by computing the NTG ratio will be used only to refine and improve program delivery.

Spillover refers to reductions in energy consumption or demand caused by the presence of and participation in the energy-efficiency program. Participant spillover refers to additional savings achieved because the participant was influenced by the program. These are savings for measures that are not rebated by the program.

Participant survey respondents were asked if they installed any other energy-efficiency measures without receiving a rebate. They were also asked if program participation influenced their decision to install the additional measures. Spillover findings are presented in the next section.

### 2.3.2 Net-to-Gross Ratio Findings

**Table 2-13** shows the results of a freeridership analysis for the Efficient Equipment Incentive Program based on a sample of participants in each of four groups. The EM&V CSP used residential survey responses for an overall program-sector estimate, and analyzed nonresidential customers in two separate groups. The first nonresidential group included customers who received incentives for commercial lighting projects, the second group included all other nonresidential participants. Residential freeridership was 34% during PY4. Nonresidential freeridership was 77% for non-lighting measures and 23% for lighting measures.

**Table 2-13: Summary of Freeridership Scores in the Efficient Equipment Incentive Program**

Participant Group	Respondents	Freeridership Score
Residential	77	34%
Nonresidential (non-lighting)	41	77%
Nonresidential (lighting)	166	23%

The analysis of responses yielded an overall score of 0.56% for residential spillover. The summary of NTG results is presented in **Table 2-14**. The residential and nonresidential (non-lighting) analyses were calculated at the 90% confidence level.

**Table 2-14: Summary of NTG for Efficient Equipment Incentive Program**

Participant Group	Respondents	Freeridership Score	Participant Spillover <sup>1</sup>	NTGR	NTG Precision
Residential	77	34%	5.9%	72%	5.9%
Nonresidential (non-lighting) <sup>2</sup>	41	77%	0.0%	39%	9.3%
Nonresidential (lighting) <sup>2</sup>	166	23%	0.0%	77%	4%
<b>NOTES:</b> 1. Spillover was identified only in the residential sector. 2. Results weighted by program energy savings.					

## 2.4 Process Evaluation

The process evaluation methods and findings are described in Appendix K: Process Evaluation.

## 2.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 2-15**.

**Table 2-15: Summary of Efficient Equipment Incentive Program Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$12,828	\$32,056	\$86,348
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$12,828</b>	<b>\$32,056</b>	<b>\$86,348</b>
Design and Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2</sup>	\$2,325	\$6,216	\$13,260
Marketing <sup>3</sup>	\$0	\$22	\$53
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$2,325</b>	<b>\$6,237</b>	<b>\$13,313</b>
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
<b>Total EDC Costs<sup>4</sup></b>	<b>\$15,152</b>	<b>\$38,293</b>	<b>\$99,662</b>
<b>Participant Costs<sup>5</sup></b>	<b>N/A</b>	<b>\$112,000</b>	<b>\$272,312</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$150,293</b>	<b>\$317,759</b>
Total Lifetime Energy Benefits <sup>7</sup>	N/A	\$340,105	\$668,540
Total Lifetime Capacity Benefits <sup>7</sup>	N/A	\$17,672	\$42,376
<b>Total TRC Benefits<sup>8,7</sup></b>	<b>N/A</b>	<b>\$357,777</b>	<b>\$712,636</b>
<b>TRC Ratio<sup>9,7</sup></b>	<b>N/A</b>	<b>2.38</b>	<b>2.24</b>

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Includes the marketing CSP and marketing costs by program CSPs.
4. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
5. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
6. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.

7. CPITD value is discounted to PY1.
8. 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.
9. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.

### 3 Residential Lighting Program

The Residential Lighting Program has two components:

1. An upstream retail lighting component that provides incentives to compact fluorescent lamp (CFL) and light-emitting diode (LED) manufacturers. The upstream incentives effectively buy down the retail price of ENERGY STAR® CFL and LED bulbs. The majority of program-discounted CFLs and LEDs are sold in retail brick-and-mortar stores, although PPL Electric also offers program-discounted CFLs through an online retail store accessed through its website.<sup>27</sup>
2. A giveaway component that provides customers with ENERGY STAR CFLs free of charge at events sponsored by PPL Electric.

The objectives of the Residential Lighting Program are to:

- Develop and execute strategies aimed at transforming the market for ENERGY STAR-qualified CFLs and LEDs, with a goal of increasing the number of qualified products purchased and installed in PPL Electric's service territory.
- Provide a mechanism for customers to easily obtain discounted ENERGY STAR-qualified CFLs and LEDs in the retail market.
- Provide opportunities that encourage customers to obtain and try CFLs free of charge through PPL Electric-sponsored giveaway events and activities.
- Increase consumer awareness and understanding of CFL and LED energy efficiency and use in various lighting applications.
- Promote consumer awareness and understanding of the ENERGY STAR label.
- Promote other PPL Electric EE&C programs to customers.

This program launched in January 2010. By the end of PY4, the Residential Lighting Program had exceeded its planned bulb quantity, energy, and capacity savings.

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<sup>27</sup> See: <https://www.pplelectric.com/save-energy-and-money/rebates-and-discounts/residential/rebates/lighting.aspx>

### 3.1 Program Updates

Program promotions at participating retailers began to ramp down during PY4. While the program offered a limited number of incentives for LEDs in PY3, none were offered in PY4. The program CSP began working with retailers to educate them on Phase II offerings, which will include more LEDs.

### 3.2 Impact Evaluation Gross Savings

#### 3.2.1 Reported Gross Savings

**Table 3-1** breaks out the program's PY4 participation, savings, and incentives by quarter. Table 3-2 shows the cumulative reported results by sector through the end of PY4.

**Table 3-1: Residential Lighting Program Reported Results by Quarter**

Reporting Period	Participants <sup>1</sup>	Number of Bulbs	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	66,544	519,046	23,183	1.51	4.80	\$350
PY4 Q2	96,943	756,156	33,397	0.00	1.52	\$1,189
PY4 Q3	108,343	845,075	37,054	0.07	1.69	\$1,035
PY4 Q4	66,628	519,702	23,151	0.00	1.06	\$1,060
<b>PY4 Total</b>	<b>338,457</b>	<b>2,639,979</b>	<b>116,784</b>	<b>1.58</b>	<b>9.08</b>	<b>\$3,635</b>
<b>CPITD Total</b>	<b>1,427,761</b>	<b>9,706,923</b>	<b>452,342</b>	<b>20.77</b>	<b>28.26</b>	<b>\$11,096</b>
<b>NOTES:</b> 1. As an upstream program, exact participation in the Residential Lighting Program is not known. The EM&V CSP estimated the number of program participants by dividing the total number of bulbs discounted by a CFL-per-participant value derived from the customer telephone survey data (7.0 bulbs in PY1, 6.7 bulbs in PY2, 6.04 in PY3, and 7.80 in PY4). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at giveaway events.						



**Table 3-2: Residential Lighting Program Reported Results by Sector (excludes the cross-sector sales adjustment described in Appendix D)**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	338,457	116,784	1.58	9.08	\$3,635
<b>PY4 Total</b>	<b>338,457</b>	<b>116,784</b>	<b>1.58</b>	<b>9.08</b>	<b>\$3,635</b>
<b>CPITD Total</b>	<b>1,427,761</b>	<b>452,342</b>	<b>20.77</b>	<b>28.26</b>	<b>\$11,096</b>
<b>NOTES:</b> 1. As an upstream program, exact participation in the Residential Lighting Program is not known. The EM&V CSP estimated the number of program participants by dividing the total number of bulbs discounted by a CFL-per-participant value derived from the customer telephone survey data (7.0 bulbs in PY1, 6.7 bulbs in PY2, 6.04 in PY3, and 7.80 in PY4). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at giveaway events.					

### 3.2.2 EM&V Sampling Approach

The EM&V CSP reviewed a census of Residential Lighting Program records to ensure that the gross energy and demand reduction in EEMIS were computed using the algorithms specified in the 2012 TRM, including verification of differential wattage, ISR, HOU, and CF. This is illustrated in **Table 3-3**, where the population size, target sample size, and achieved sample size are all 49,484 records.

**Table 3-3: Residential Lighting Program Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
All	None	49,484	NA <sup>2</sup>	NA <sup>2</sup>	Census	49,484	Full database review
<b>Program Total</b>	<b>None</b>	<b>49,484</b>	<b>NA<sup>2</sup></b>	<b>NA<sup>2</sup></b>	<b>Census</b>	<b>49,484</b>	
<b>NOTES:</b> 1. Population size is defined as the number of records in the EEMIS database; these records are comprised of CSP workpackages by date, store, and SKU and include multiple bulbs. 2. Since this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful.							

### 3.2.3 Ex Ante Adjustment Methodology and Findings

The Residential Lighting Program's *ex ante* adjustments reflect corrections made to gross savings values that were not derived using assumptions in accordance with the 2012 TRM. The EM&V CSP checks to make sure that incandescent and CFL measure wattages are in concordance (i.e., assumptions regarding

measure and baseline wattages are reasonable) to ensure that the CSP data are reasonably accurate. The EM&V CSP reviewed a census of program records to make this correction.

The EM&V CSP found that, in Q1 and Q2, adjustments were needed to the EEMIS reported savings due to the reduction in the baseline-wattage assumption for 100W-equivalent bulbs from 100W to 72W. The EM&V CSP also found one SKU with an incorrect incandescent wattage equivalent (a 10W CFL had a reported baseline assumption of 100W instead of the correct equivalent of 40W). In Q3, the baseline assumption for 100W-equivalent bulbs had been corrected, but the one SKU still had an incorrect baseline wattage. In Q4, some 75W-equivalent bulbs had begun to use the 2013 baseline of 53W. As the EM&V CSP is following the baseline wattage table in the 2012 TRM for all of PY4, it was not yet appropriate to adjust the baseline wattage for these bulbs. The *ex ante* adjustments corrected for these discrepancies in baseline wattages.

#### **3.2.4 Ex Post Adjustment Methodology and Findings**

*Ex post* verified gross savings for the Residential Lighting Program reflect discrepancies identified through the records review but not attributable to assumptions out of concordance with the TRM, as well as adjustments due to cross-sector sales. The EM&V CSP computed the *ex post* savings based on differences identified between the energy and demand reduction recorded in EEMIS and the energy and demand reduction the EM&V CSP computed using the deemed savings algorithms given in the TRM for residential measures. This methodology is explained in greater detail in the Savings Realization Rate Methodology section below. The EM&V CSP then adjusted *ex post* savings based on the estimated proportion of discounted bulbs sold to small-commercial customers. This adjustment involved moving savings from the residential to the small-commercial sector and grossing up the savings attributable to the small-commercial sector based on differences in hours of use, coincidence factors and installation rates. The estimation of sales to small-commercial customers and savings adjustment methodologies are detailed in Appendix D: Cross-Sector Sales Analysis.

The EM&V CSP found, in Q1, relatively few discrepancies for energy savings, but significant discrepancies for demand reduction. For both energy and demand reduction, the discrepancies were due to errors in the program CSP's files that were imported into EEMIS.

#### **3.2.5 Savings Realization Rate Methodology**

The realization rate for PY4 was calculated based on the findings from the records review, after all *ex ante* adjustments were made to reported savings. The realization rate is the ratio of *ex post* verified gross savings to *ex ante* adjusted savings, prior to making the adjustment for cross-sector sales.

The EM&V CSP derived the realization rate for the Residential Lighting Program by conducting a thorough review of the program records. The Residential Lighting Program CSP works directly with bulb manufacturers to implement lighting promotions in retail stores, but does not have any direct contact with participating retailers' sales data for energy-efficient lighting. Thus, on a monthly basis,

participating manufacturers collect bulb sales data on the approved program-discounted energy-efficient bulbs from participating retailers. The manufacturers then send their sales data to the program CSP, and the program CSP reformats these datasets and uploads them to its own internal program database. Finally, the program CSP uploads the monthly (participation) sales data from its database to EEMIS. Only data from the Residential Lighting Program CSP's database and from EEMIS are available for the EM&V CSP to review.

The EM&V CSP compared the energy and demand reduction for each record in EEMIS to its own computed energy and demand reduction. These computations apply the bulb-specific inputs associated with each record (which originated from the CSP's database) to the current TRM savings equations.

Prior to PY4 Q2, record-level savings were computed by the CSP and delivered to PPL Electric via spreadsheets, for import into EEMIS. Over time, it became apparent that this approach was prone to error. In fact, in PY3 Q4 and PY4 Q1, the errors in the MW calculations provided by the CSP were significant. Therefore, beginning in PY4 Q2, EEMIS savings values have been computed using the same approach the EM&V CSP uses: EEMIS now applies bulb-specific inputs (from the CSP's database) to the current TRM savings equations.

Due to the upstream nature of the Residential Lighting Program, PPL Electric and the program CSP do not know which PPL Electric customers purchased bulbs that were discounted through the program. For the Residential Lighting Program, EEMIS (and the program CSP's database) was therefore designed to capture information about the program-discounted light bulbs themselves; no data are collected (or analyzed) about participating Residential Lighting Program customers.

Following the process described above, the EM&V CSP reviewed a census of PY4 Residential Lighting Program records from EEMIS.

### **3.2.6 Summary of Evaluation Results**

The EM&V CSP did not find any discrepancies between reported and calculated savings other than TRM *ex ante* adjustments in Q2 through Q4.

The few mismatched energy savings values from Q1 did not affect the overall PY4 energy savings realization rate, as shown in **Table 3-4**. The large number of mismatched savings values for demand in Q1 resulted in a PY4 realization rate for demand reduction of 58%, as shown in **Table 3-5**.

**Table 3-4: PY4 Residential Lighting Program Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Energy Savings (MWh/yr)	Energy Realization Rate <sup>2</sup>	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion	Relative Precision	Verified Gross Energy Savings Without Cross-Sector Sales Adjustment (MWh/yr)	Verified Gross Energy Savings With Cross-Sector Sales Adjustment <sup>4</sup> (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
Residential	116,784	116,358	99.6%	N/A <sup>3</sup>	N/A <sup>3</sup>	115,904	60,087	--
Small Commercial and Industrial	--	--	N/A	N/A	N/A	--	213,184	--
<b>Program Total</b>	<b>116,784</b>	<b>116,358</b>	<b>99.6%</b>	<b>N/A<sup>3</sup></b>	<b>N/A<sup>3</sup></b>	<b>115,904</b>	<b>273,271</b>	<b>--</b>
<b>NOTES:</b> 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. The realization rate does not incorporate the cross-sector sales adjustment. 3. Because this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful. 4. The Cross Sector Sales adjustment applied to PY4 includes all Phase I bulb sales.								

**Table 3-5: PY4 Residential Lighting Summary of Evaluation Results for Demand (Top 100 Hours)**

**Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion	Relative Precision	Verified Gross Demand Reduction Without Cross-Sector Sales Adjustment <sup>2</sup> (MW)	Verified Gross Demand Reduction With Cross-Sector Sales Adjustment <sup>4</sup> (MW)	Unverified Gross Demand Reduction (MW)
All	1.58	1.71	58%	N/A <sup>5</sup>	N/A <sup>5</sup>	1.00	38.61	--
<b>Program Total</b>	<b>1.58</b>	<b>1.71</b>	<b>58%</b>	<b>N/A<sup>5</sup></b>	<b>N/A<sup>5</sup></b>	<b>1.00</b>	<b>38.61</b>	<b>--</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. The realization rate for demand is based on analysis of all records in PY4 and does not incorporate the cross-sector sales adjustment. 4. Verified savings includes cross-sector sales adjustment referred to in section 3.2.4; the total verified demand for the top 100 hours is comprised of -1.27 MW from the residential sector and 37.13 MW from the small commercial sector. 5. Because this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful.								

### 3.3 Impact Evaluation Net Savings

#### 3.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP conducted an NTG analysis based on findings from 301 customer telephone surveys conducted in PY4. The analysis incorporated all 154 respondents who had purchased one or more CFLs in the past three months, including those who were aware of the Residential Lighting Program and those who were not.

#### 3.3.2 Net-to-Gross Ratio Findings

Based on participants responses to freeridership questions, the weighted mean freeridership rate for CFLs purchased by respondents who **aware** of the program was 39%, with an upper bound of 47% and a lower bound of 31%.

The EM&V CSP then concluded that, at most, freeridership among recent purchasers who were **unaware** of the program was 39% (the average of those who were aware of the program). That is, purchasers who were unaware of the program would not be more likely to be free riders than purchasers who were aware of program (if anything, they would be less likely to be free riders). At the low end, freeridership for recent purchasers who were **unaware** of the program is likely 31% (the same lower bound as for recent purchasers who were aware of the program). For this group of customers unaware of the program, an estimated 69% of purchases are considered spillover (100%-39% freeridership).

The EM&V CSP NTG methods compute combined freeridership and spillover rates for recent purchasers who were and who were not aware of the program to derive an overall NTG ratio of 84%.

The Residential Lighting Program's freeridership and NTG methodologies and findings are discussed in more detail in Appendix C: Residential Lighting Program Net to Gross Analysis.

### 3.4 Process Evaluation

The process evaluation methods and findings are described in Appendix K: Process Evaluation.

### 3.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 3-6**.

**Table 3-6: Summary of Residential Lighting Finances<sup>10</sup>**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$1,060	\$3,635	\$11,096
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$1,060</b>	<b>\$3,635</b>	<b>\$11,096</b>
Design and Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2</sup>	\$145	\$2,013	\$6,029
Marketing <sup>3</sup>	\$4	\$40	\$207
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$148</b>	<b>\$2,052</b>	<b>\$6,236</b>
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
<b>Total EDC Costs<sup>4,7</sup></b>	<b>\$1,209</b>	<b>\$5,688</b>	<b>\$17,333</b>
<b>Participant Costs<sup>5,7</sup></b>	<b>N/A</b>	<b>\$5,830</b>	<b>\$23,719</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$11,518</b>	<b>\$36,113</b>
Total Lifetime Energy Benefits <sup>7</sup>	N/A	\$173,343	\$322,709
Total Lifetime Capacity Benefits <sup>7</sup>	N/A	\$14,699	\$16,055
<b>Total TRC Benefits<sup>8,7</sup></b>	<b>N/A</b>	<b>\$188,042</b>	<b>\$338,765</b>
<b>TRC Ratio<sup>9,7</sup></b>	<b>N/A</b>	<b>16.33</b>	<b>9.38</b>

**NOTES:**

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Includes the marketing CSP and marketing costs by program CSPs.
4. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
5. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
6. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.

7. CPITD value discounted to PY1.
8. 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.
9. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.
10. TRC benefits (due to energy and demand reduction) reflect the cross sector sales adjustment. Cross sector sales adjustment allocated 12.4% of program cost to the Small C&I sector, in proportion to the percentage of bulbs installed by small C&I customers.

## 4 Custom Incentive Program

The Commercial and Industrial (C&I) Custom Incentive Program provides financial incentives to customers installing extensive energy-efficiency projects, conducting retro-commissioning, making repairs, performing equipment optimization, installing individual equipment measures or systems that are not covered by the Prescriptive Equipment Program, and making operational and process improvements that result in cost-effective energy savings. To qualify for financial incentives, eligible customers are required to submit documentation that their proposed efficiency upgrades pass the program's cost-effectiveness threshold and program requirements. Pre-approval is required prior to installation.

PPL Electric provides reimbursement following successful implementation of a cost-effective project. These reimbursements may vary depending on type or size of the measure. The program offers performance-based incentives for the avoided or reduced kilowatt hours (kWh/yr) resulting from the project. Incentives are subject to an annual cap for each project and for each participating customer. Incentives cannot exceed 50% of the project's incremental cost. Prior to PY4, the program also provided incentives for a portion of the cost of a technical study, but no technical study incentives were provided in PY4.

### 4.1 Program Updates

There were no major changes to the program in PY4. Phase I of Act 129 ended May 31, 2013, but PPL Electric instituted earlier deadlines for submission of applications. The application submission deadline was March 31 for projects that required pre-installation to verify energy savings and April 30 for those that did not. A waitlist was started in PY3 for large C&I customers. Throughout PY4, PPL Electric both added new projects to the waitlist and removed projects from the waitlist.

### 4.2 Impact Evaluation Gross Savings

#### 4.2.1 Reported Gross Savings

**Table 4-1** breaks out the program's PY4 participation, savings, and incentives by quarter.



**Table 4-1: Custom Incentive Program Reported Results by Quarter**

Reporting Period	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	21	15,920	0.98	1.7	\$1,414
PY4 Q2	16	9,263	0	1.0	\$680
PY4 Q3	16	5,813	0	0.7	\$457
PY4 Q4	59	42,761	0	4.4	\$3,609
<b>PY4 Total</b>	<b>112</b>	<b>73,758</b>	<b>0.98</b>	<b>7.8</b>	<b>\$6,161</b>
<b>CPITD Total</b>	<b>274</b>	<b>186,227</b>	<b>15.52</b>	<b>22.3</b>	<b>\$13,255</b>
<b>NOTES:</b> 2. The participant counts shown here include only paid projects for which savings have been claimed and exclude those still in the technical study phase, those in progress, and those cancelled. Including these categories produces a cumulative participation count of 441 projects.					

As can be seen in **Table 4-2**, the sector with the highest savings is the large C&I sector. The large C&I and the small C&I sectors together accounted for 90% of the program savings in PY4. This is a significant change from PY3, when the government, non-profit, and institutional (GNI) sector contributed nearly as much savings as the large C&I sector due to inclusion of two very large combined heat and power projects in GNI facilities.

**Table 4-2: Custom Incentive Program Reported Results by Sector**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Small Commercial and Industrial	42	17,065	0.05	1.7	\$1,673
Large Commercial and Industrial	45	48,896	0.89	5.5	\$3,744
Government, Non-Profit, Institutional	25	7,796	0.04	0.6	\$744
<b>PY4 Total</b>	<b>112</b>	<b>73,758</b>	<b>0.98</b>	<b>7.8</b>	<b>\$6,161</b>
<b>CPITD Total</b>	<b>274</b>	<b>186,227</b>	<b>15.52</b>	<b>22.3</b>	<b>\$13,255</b>
<b>NOTES:</b> 1. The participant counts shown here include only paid projects for which savings have been claimed and exclude those still in the technical study phase, those in progress, and those cancelled. Including these categories produces a cumulative participation count of 441 projects.					

#### 4.2.2 EM&V Sampling Approach

The EM&V CSP defined two strata to evaluate savings for the Custom program: a large stratum and a small stratum. Each custom project was defined as being large or small. Large projects were identified in real time and are all included in the impact evaluation sample. These projects generally have a high level of savings (currently defined as reserved (*ex ante*) savings greater than 500,000 kWh/yr). However, projects with savings below this threshold can also be included in the large stratum. The EM&V CSP verified the entire population of projects in this stratum and did not extrapolate the results to other sites through a realization rate.

The EM&V CSP selected a sample of small projects for verification at the close of PY4 Q2 and again at the close of PY4 Q3. The EM&V CSP verified savings for this sample and determined a realization rate based on the sample. The EM&V CSP applied the realization rate to the population of the projects in the small project stratum.

PPL Electric paid incentives for 112 projects in the Custom Incentive Program in PY4. Of these, 41 were placed in the large stratum and were verified. The remaining projects were defined as small projects. There were a total of 71 small projects in PY4, from which the EM&V CSP selected and verified a sample of eight.

**Table 4-3** shows the sampling strategy for PY4.

**Table 4-3: Custom Incentive Program Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size	Assumed Coefficient of Variation ( $C_v$ ) or Proportion in Sample Design <sup>1</sup>	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Large	>500,000 kWh/yr	41	N/A <sup>2</sup>	N/A <sup>2</sup>	41	41	Onsite EM&V
Small	<500,000 kWh/yr	71	0.5	80/20	10	8	Onsite EM&V
<b>Program Total</b>		<b>112</b>			<b>51</b>	<b>49</b>	
<b>NOTES:</b>							
1. Since the realization rate (for the small stratum) was calculated with a ratio estimator, the error ratio is reported instead of the coefficient of variation. The error ratio is used in place of the coefficient of variation in sample planning.							
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 $C_v$ and confidence and precision do not apply to the large stratum.							

Surveys were conducted to collect data to inform the process evaluation and the net to gross ratio. Because no phone surveys were conducted in PY3, the evaluation CSP contacted both PY3 and PY4 participants. The survey sample plan is provided in **Table 4-4**.

**Table 4-4: Custom Incentive Program Survey Sampling Strategy, PY3-PY4**

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Projects Represented	Evaluation Activity
PY4						
Completed Projects	45 unique decision-makers <sup>1</sup>	90/10	21	21	23	Process evaluation & NTG ratio
Technical Study and Project			3	3	3	
Cancelled Projects			3 (1 technical study)	3	4	Process evaluation
PY3						
Completed Projects	84 unique decision-makers	90/10	34	33	41	Process evaluation & NTG ratio
Technical Study and Project			5	4	5	
Cancelled Projects			4	6	5	Process evaluation
Program Total	129 unique decision-makers	90/10	70	70	81	
NOTES:						
1. PY4 population based on Q1-Q3 participation.						

#### 4.2.3 Ex Ante Adjustment Methodology and Findings

Projects in the Custom Incentive Program do not typically include measures found in the TRM. The exception is custom lighting projects<sup>28</sup>. However, the EM&V CSP does not make any *ex ante* adjustments for these projects.

#### 4.2.4 Ex Post Adjustment Methodology and Findings

For all verified projects, the EM&V CSP created a final savings calculation and prepared a *Project Verification Report* that documented the findings. The EM&V CSP prepared calculations in accordance with the site-specific evaluation, measurement, and verification plan (SSEMVP) that was prepared for each project. Where deviations from the SSEMVP were required, they were documented in the *Project Verification Report*.

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<sup>28</sup> Such as LEDs that are covered in the TRM but, since PPL does not offer a prescriptive rebate for LEDs, PPL allows customers to apply for LED rebates through the Custom Incentive Program. The savings for LEDs is determined using the method specified in the TRM. The rebate for LEDs is determined using the Custom Program's incentive of \$0.10 per annual kWh saved.

This process involved developing a site-specific measurement and verification (M&V) plan (typically in coordination with the C&I CSP). The EM&V CSP performed post-installation inspections. The EM&V CSP also conducted pre-installation inspections whenever possible.

For the Custom Incentive Program, the EM&V CSP was involved early in the application process. The C&I CSP informed the EM&V CSP when an application was received that was likely to fall into the large strata. This enabled the EM&V CSP to evaluate large projects at a high level of rigor, often collecting pre-installment measurements without duplication of effort by customers, the C&I CSP, trade allies, and the EM&V CSP.

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

#### **4.2.5 Savings Realization Rate Methodology**

Verified savings for all projects in the large stratum and a sample of projects in the small stratum were determined by following Site Specific Evaluation Measurement and Verification Plans (SSEMVPs). In some cases, PPL Electric delays full or partial incentive payment until the verified (evaluated) savings are known, and will pay customer incentives based on these evaluated savings. In other cases, PPL Electric pays incentives based on *ex ante* savings estimates or interim *ex post* results.

When full or partial payment is delayed until the verified (evaluated) savings are known, reported savings equal verified savings. For this group of 31 large-strata projects (50% of total savings), the realization rate is 100%.

For the remaining ten large-strata projects (36.6% of total savings), PPL Electric paid the incentive and claimed savings before verification was complete. Verification has since been completed. The average realization rate for these projects is between 90% and 100% for energy, indicating that the claimed savings were reasonable on average. This category includes two large combined heat and power (CHP) projects (Projects 199 and 359). The risk to PPL Electric that the realization rate would be substantially different from 1.0 as a result of these two projects was mitigated by the EM&V CSP's involvement in reviewing interim savings estimates.

The large stratum in PY4 made up a slightly larger portion of total savings than in PY3. In PY4, the large stratum comprised 86% of program savings. This category accounted for 44% of total savings in PY3 and 73% of savings in PY2.

There were 71 projects in the small strata. The EM&V CSP verified a sample of eight. A slightly larger sample was envisioned, but the projects in the large strata exceeded the sampling target of contributing at least 80% of claimed savings. The small projects contributed only 14% of program savings in PY4, so they have a relatively modest impact on the program realization rate.

The EM&V CSP calculated the realization rate as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

#### 4.2.6 Summary of Evaluation Results

As can be seen in **Table 4-5**, the realization rate for energy savings was lower for large-strata projects (96.9%) than for small-strata projects (107.7%). The total program realization rate for energy savings is 98.4% in PY4.

**Table 4-5: PY4 Custom Incentive Program Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Savings <sup>2</sup> (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion or Error Ratio	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
Large	63,646	63,646	96.9%	39% <sup>3</sup>	Census	61,672	--
Small	10,111	10,111	107.7%	27.1%	13.6%	10,893	--
<b>Program Total</b>	<b>73,758</b>	<b>73,758</b>	<b>98.4%</b>	<b>33.2%</b>	<b>6.2%</b>	<b>72,565</b>	<b>--</b>
<b>NOTES:</b> 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. No TRM <i>ex ante</i> adjustments are made for the Custom Program evaluation. Very few of the projects involve measures that are included in the TRM. 3. This coefficient of variation only reflects the 10 projects for which PPL Electric paid the incentive prior to verification.							

The demand realization rate for the program was 101.5% as shown in **Table 4-6**. The relative precision is low (i.e., the results are very precise) because the EM&V CSP evaluated a census of large projects and this strata accounted for a very high (86%) percentage of savings in PY4.

**Table 4-6: PY4 Custom Incentive Program Summary of Evaluation Results for Demand (Top 100 Hours)**  
Stratum

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion or Error Ratio <sup>3</sup>	Relative Precision <sup>3</sup>	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
All	0.98	1.02	101.5%	16%	3.0%	1.11	--
<b>Program Total</b>	<b>0.98</b>	<b>1.02</b>	<b>101.5%</b>	<b>16%</b>	<b>3.0%</b>	<b>1.11</b>	<b>--</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. The realization rate, coefficient of variation, and relative precision are implied from program level analysis.							

## 4.3 Impact Evaluation Net Savings

### 4.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP determined the NTG ratio through 70 self-report surveys with a sample of 43 PY3 and 27 PY4 participants. These participants represented 26 projects in PY4 and 46 projects in PY3. No PY3 surveys were conducted since many projects have long lead times and long periods to closure; therefore data from the two program years were combined. Samples were drawn from customers completing projects in PY3 and in PY4. Samples were also drawn from customers completing both a technical assessment and a project. The surveys included questions to assess spillover and freeridership.

Survey questions were used to develop a freeridership score by using a scoring matrix. Partial FR scores were assigned to participants who had plans to install the measure prior to the program, but for whom the program or other market characteristics exerted some influence over their decision. Freeridership scores were weighted by the verified project savings.

Spillover refers to reductions in energy consumption or demand caused by the presence of and participation in the energy-efficiency program. Participant spillover refers to additional savings achieved because the participant was influenced by the program. These are savings for measures that are not rebated by any Act 129 program.

No adjustments for the NTG ratio were applied to verified savings, as specified by the Pennsylvania PUC. Information obtained by computing the NTG ratio will be used only to refine and improve program delivery.

### 4.3.2 Net-to-Gross Ratio Findings

Custom program participants responding to the survey completed projects ranging in size from 4,079 kWh/yr to 8,137,050 kWh/yr (larger than all other projects by 5,000 MWh/yr; the next largest project was 3,900 MWh/yr). The weighted mean freeridership score for PY3 and PY4 survey respondents was 48% +/- 9% (for a range from 39% to 56% freeridership). The PY3 respondents' freeridership score was 46% and PY4 was 49%. Responses to spillover questions show that four respondents reported installing additional energy efficiency equipment without a rebate as shown in **Table 4-7**. For all installations, the Custom Incentive program was *very important* in the decision to install additional equipment. Two installed equipment at another location within PPL Electric's service territory and two installed additional equipment at the same location. These respondents reported three lighting projects, one removed four cooling towers, and one installed five VSD, and one installed refrigeration equipment. Savings were not estimated for these projects.

**Table 4-7: PY4 Custom Spillover Responses**

<b>Respondent</b>	<b>Projects Installed</b>	<b>Location</b>
1	Removed 4 cooling towers, installed lighting	Same location
2	Lighting, 5 VSD, 1 refrigeration measure.	Different location in PPL Electric's territory
3	Lighting	Different location in PPL Electric's territory
4	Lighting	Same location

#### **4.4 Process Evaluation**

The process evaluation is included in a separate document, *PY4 Process Evaluation*. Findings, recommendations, and the status of follow-up on recommendations are included in the evaluation.

## 4.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 4-8**.

**Table 4-8: Summary of Custom Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$3,609	\$6,161	\$13,255
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$3,609</b>	<b>\$6,161</b>	<b>\$13,255</b>
Design and Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2</sup>	\$441	\$971	\$3,902
Marketing <sup>3</sup>	\$0	\$0	\$8
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$441</b>	<b>\$971</b>	<b>\$3,909</b>
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
<b>Total EDC Costs<sup>4</sup></b>	<b>\$4,050</b>	<b>\$7,131</b>	<b>\$17,164</b>
<b>Participant Costs<sup>5</sup></b>	<b>N/A</b>	<b>\$34,387</b>	<b>\$82,405</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$41,519</b>	<b>\$83,269</b>
Total Lifetime Energy Benefits <sup>7</sup>	N/A	\$61,733	\$144,687
Total Lifetime Capacity Benefits <sup>7</sup>	N/A	\$2,566	\$6,091
<b>Total TRC Benefits<sup>8,7</sup></b>	<b>N/A</b>	<b>\$64,299</b>	<b>\$150,778</b>
TRC Ratio <sup>9,7</sup>	N/A	1.55	1.81

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Includes the marketing CSP and marketing costs by program CSPs.
4. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
5. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
6. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.



7. CPITD value is discounted to PY1.
8. 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.
9. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.

## 5 Energy Efficiency Behavior & Education Program

PPL Electric’s Energy Efficiency Behavior & Education Program sends Home Energy Reports to residential customers to educate them about their energy use and opportunities to save energy. Opower is the implementation CSP. The program started in spring 2010 and targeted homes with above-average energy use. In June 2011, PPL Electric expanded the program to include additional homes with higher energy use and homes that previously participated in a PPL Electric energy-efficiency program.

The program has an experimental design. The program’s implementation CSP randomly assigned eligible homes to program treatment and control groups. Homes in the treatment group received Home Energy Reports, while homes in the control group did not.

### 5.1 Program Updates

In PY4, the Energy Efficiency Behavior & Education Program sent Home Energy Reports to 93,924 homes. Approximately 44,000 of these homes had received their first reports in PY2 (the legacy group). The remaining homes received their first reports in PY3 (the expansion group). Each legacy and expansion group home that did not opt out of the program and whose account remained active in PY4 received six reports during PY4. There were no significant changes to the program in PY4.

### 5.2 Impact Evaluation Gross Savings

#### 5.2.1 Reported Gross Savings

**Table 5-1** shows the PY4 reported gross savings and number of participants by quarter. The quarterly results reflect a reporting convention, as participants enrolled in the program in PY4 Q1 but savings are reported only semiannually.

**Table 5-1: Energy Efficiency Behavior & Education Program Reported Results by Quarter**

Reporting Period	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	93,924	0	0	0	\$0
PY4 Q2	0	14,312	0	0	\$0
PY4 Q3	0	5,233	0	0	\$0
PY4 Q4	0	18,287	5.6	5.6	\$0
<b>PY4 Total</b>	<b>93,924</b>	<b>37,831</b>	<b>5.6</b>	<b>5.6</b>	<b>\$0</b>
<b>CPITD Total<sup>2</sup></b>	<b>93,924</b>	<b>37,831</b>	<b>5.6</b>	<b>5.6</b>	<b>\$0</b>

**NOTES:**

1. The participant count shown excludes accounts closed during the program. The count only includes records used in the analysis.
2. The CPITD energy savings values reported exclude savings that occurred prior to the current program year. Annual savings in this program are not considered to be cumulative because the measure has a one-year measure life. Participants are considered to be cumulative.

The implementation CSP reported gross *ex ante* savings in PY4 of 37,831 MWh/yr. **Table 5-2** shows the cumulative reported results through the end of PY4.

**Table 5-2: Energy Efficiency Behavior & Education Program Reported Results by Sector**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction <sup>2</sup> (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	93,924	37,831	5.6	5.6	\$0
<b>PY4 Total</b>	<b>93,924</b>	<b>37,831</b>	<b>5.6</b>	<b>5.6</b>	<b>\$0</b>
<b>CPITD Total<sup>3</sup></b>	<b>93,924</b>	<b>37,831</b>	<b>5.6</b>	<b>5.6</b>	<b>\$0</b>

**NOTES:**

1. The participant count shown excludes accounts closed during the program. The count only includes records used in the analysis.
2. The implementation CSP reported gross savings for the top 100 hours of PPL Electric system demand in PY4.
3. The CPITD demand reduction values reported exclude savings that occurred prior to the current program year. Annual savings in this program are not considered to be cumulative because the measure has a one-year measure life. Participants are considered to be cumulative.

### 5.2.2 EM&V Sampling Approach

To estimate the energy savings, the EM&V CSP analyzed monthly PPL Electric bills (showing monthly consumption) of the census of program treatment group and control group homes. The EM&V CSP

analyzed legacy group energy use between June 2009 and May 2013 and expansion group energy use between June 2010 and May 2013.

**Table 5-3** shows the number of homes in the legacy and expansion treatment groups.

**Table 5-3: Energy Efficiency Behavior & Education Program Energy Savings Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Legacy Group	Received first home energy report in PY2	43,768	N/A <sup>2</sup>	N/A <sup>2</sup>	Census	43,768	Difference-in-differences regression analysis of monthly Average Daily Consumption
Expansion Group	Received first home energy report in PY3	50,156	N/A <sup>2</sup>	N/A <sup>2</sup>	Census	50,156	Difference-in-differences regression analysis of monthly Average Daily Consumption
<b>Program Total</b>		<b>93,924</b>	<b>N/A<sup>2</sup></b>	<b>N/A<sup>2</sup></b>	<b>Census</b>	<b>93,924</b>	
<b>NOTES:</b> 1. Population counts exclude homes for which it was not possible to generate or deliver a report, homes occupied by a PPL Electric employee, or homes with accounts that became inactive before June 1, 2012. 2. This evaluation was done on a census of program treatment group and control group homes. As a result, the final savings estimate is not subject to sampling error.							

The impact analysis energy savings estimation included homes that opted out of the program, but omitted those whose accounts became inactive during the treatment period.<sup>29</sup> **Table 5-4** shows the numbers of treatment and control group homes in the estimation sample.

<sup>29</sup> Savings before account closures in homes with accounts that became inactive during PY4 were included in the estimate of program savings.

**Table 5-4: Final Estimation Sample: Number of Homes by Group**

Sample	Legacy Group	Expansion
Treatment Group Homes	41,896	48,026
Control Group Homes	41,833	21,711
<b>Total Homes<sup>1</sup></b>	<b>83,729</b>	<b>69,737</b>
<b>NOTES:</b> 1. The EM&V CSP analyzed the monthly energy consumption bills of the census of program treatment and control group homes that received (or would have received) Home Energy Reports and whose accounts remained active in PY4. The EM&V CSP accounted for savings in months before the account became inactive in the homes with inactive accounts. See Appendix E: Additional Energy-Efficiency Behavior & Education Program Impact Analysis.		

To estimate demand impacts, the EM&V CSP analyzed hourly energy use between June 15, 2012 and September 15, 2012 for a random sample of 5,000 treatment group homes and 5,000 control group homes from each of the legacy and expansion groups. The energy use data were obtained from AMI meters. Homes included in the estimation had active accounts as of September 30, 2012.

**Table 5-5: Energy Efficiency Behavior & Education Program Demand Reduction Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size	Coefficient of Variation (C <sub>v</sub> ) Assumed in Sample Design	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Legacy Group Treatment	Received first home energy report in PY2	43,768	0.3	90/10	5,000	5,000	Regression analysis of treatment and control group hourly energy use
Legacy Group Control	Eligible for legacy group but did not receive a report	43,669	0.3	90/10	5,000	5,000	
Expansion Group Treatment	Received first home energy report in PY3	50,156	0.3	90/10	5,000	5,000	Regression analysis of treatment and control group hourly energy use
Expansion Group Control	Eligible for expansion group but did not receive a report	22,690	0.3	90/10	5,000	5,000	
<b>Program Total</b>		<b>160,283</b>	<b>0.3</b>	<b>90/10</b>	<b>20,000</b>	<b>20,000</b>	

The EM&V CSP also surveyed treated and control homes from the legacy and expansion groups. **Table 5-6** shows the survey sampling strategy. The EM&V CSP analyzed the survey data for the process but not the impact evaluation.

**Table 5-6: Energy Efficiency Behavior & Education Program Survey Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size	Coefficient of Variation (C <sub>v</sub> ) Assumed in Sample Design	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Legacy Group Treatment	Received first home energy report in PY2	43,768	0.5	90/10	75	75	Analysis of treatment and control group survey responses for process evaluation
Legacy Group Control	Eligible for legacy group but did not receive a report	43,669	0.5	90/10	75	75	
Expansion Group Treatment	Received first home energy report in PY3	50,156	0.5	90/10	75	75	Analysis of treatment and control group survey responses for process evaluation
Expansion Group Control	Eligible for expansion group but did not receive a report	22,690	0.5	90/10	75	77	
Opt-outs	Received a home energy report and opted out of the program in PY4	291	0.5	80/20	40	25	Analysis of opt-out survey responses for process evaluation
<b>Program Total</b>		<b>160,283</b>	<b>0.5</b>	<b>90/10</b>	<b>340</b>	<b>327</b>	

### 5.2.3 *Ex Ante* Adjustments Methodology and Findings

The implementation CSP was responsible for reporting gross savings estimates. Total reported gross savings in PY4 were 37,831 MWh/yr and 5.6 MW based on an analysis of the monthly and hourly energy use of program treatment and control group homes.

The EM&V CSP made an *ex ante* adjustment to the implementation CSP's reported gross energy savings because the CSP's report included savings for 13 months between May 2012, the last month of PY3, and May 2013. The EM&V CSP subtracted the May 2012 savings from the reported gross savings.

### 5.2.4 *Ex Post* Adjustment Methodology and Findings

This EM&V methodology is based on Option C, Whole Facility of the International Performance Measurement and Verification Protocol (IPMVP; section 3.4.3, Billing Regression Analysis) for annual

energy and demand reduction.<sup>30</sup> Billing analysis—using data on hourly energy use and average daily energy use in treatment group and control group homes before and after the treatment—was used to estimate the program savings. The EM&V CSP conducted separate regression analyses of legacy and expansion group homes.

To estimate the program energy savings, the EM&V CSP employed difference-in-differences regression of monthly average daily electricity consumption with customer fixed effects. The details of the regression analysis are fully described in Appendix E: Additional Energy-Efficiency Behavior & Education Program Impact Analysis. To estimate the average demand reduction in the top 100 hours of PPL Electric’s system demand, the EM&V CSP used regression analysis of hourly electricity use with hour fixed effects.

Identification of the program energy and demand reduction derives from the random assignment of eligible homes to treatment and control groups. The large size of the treatment and control groups and the availability of measurements of consumption before and after the treatment mean that even small average treatment effects (< 1%) can be detected.

#### **5.2.5 Savings Realization Rate Methodology**

The EM&V CSP calculated the realization rate as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

#### **5.2.6 Summary of Evaluation Results**

**Table 5-7** shows the program realization rate in PY4. The implementation CSP reported program gross energy savings of 37,831 MWh/yr. The reported gross savings included savings for 13 months between May 2012, the last month of PY3, and May 2013. The EM&V applied an Ex Ante Adjustment to remove the May 2012 savings, resulting in 35,138 MWh/yr. The *ex post* verified savings were estimated as 36,470 MWh/yr, which provides a realization rate of 103.8% in PY4.

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<sup>30</sup> Efficiency Valuation Organization. *International Performance Measurement & Verification Protocol (IPMVP); Concepts and Options for Determining Energy and Water Savings: Volume 1*. September 2009. EVO 10000 – 1:2009. Available online: [www.evo-world.org](http://www.evo-world.org).

**Table 5-7: PY4 Energy Efficiency Behavior & Education Program, Evaluation Results for Energy Savings<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Savings <sup>2</sup> (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
Legacy Group	15,838	14,729	102%	N/A <sup>3</sup>	N/A <sup>3</sup>	15,072	--
Expansion	21,993	20,409	105%	N/A <sup>3</sup>	N/A <sup>3</sup>	21,399	--
<b>Program Total</b>	<b>37,831</b>	<b>35,138</b>	<b>104%</b>	<b>N/A<sup>3</sup></b>	<b>N/A<sup>3</sup></b>	<b>36,470</b>	<b>--</b>
<b>NOTES:</b> 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. An <i>Ex Ante</i> adjustment to reported gross savings was undertaken because the Reported Gross Savings included savings between May 2012, which is the last month of PY3, and May 2013. The <i>Adjusted Ex Ante</i> Gross Energy Savings are PY4 Reported Gross Savings between June 2012 and May 2013. 3. This evaluation included a census of program treatment and a sample selected for the comparison group. As a result, the final savings estimate is not subject to sampling error. Verified gross energy savings based on OLS estimation of difference-in-differences regression of monthly average daily consumption. Standard errors were adjusted for correlation over time in a customer's consumption using Huber-White robust standard errors.							

**Table 5-8** shows the program realization rate for Behavior & Education program peak demand reduction in PY4. The implementation CSP reported *ex ante* program savings of 5.6 MW/yr. The *ex post* verified savings were estimated as 6.47 MW/yr. This implies a demand reduction realization rate of 115%.

**Table 5-8: PY4 Energy Efficiency Behavior & Education Program Summary of Evaluation Results for Demand (Top 100 Hours) Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion <sup>3</sup>	Relative Precision <sup>3</sup>	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
All	5.60	6.06	115.5%	0.82	56.0%	7.00	--
<b>Program Total</b>	<b>5.60</b>	<b>6.06</b>	<b>115.5%</b>	<b>0.82</b>	<b>56.0%</b>	<b>7.00</b>	<b>--</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. This evaluation analyzed a sample of treatment and control group homes. Verified net energy demand reduction was based on OLS estimation of hourly energy use. Standard errors were adjusted for within-home correlation using Huber-White method.							



## **5.3 Impact Evaluation Net Savings**

### **5.3.1 Net-to-Gross Ratio Methodology**

No separate NTG calculation is required. The savings estimates, which are based on analysis of a randomized control trial, account for freeridership and spillover in program homes.

Spillover in treated homes would include the adoption of energy-efficiency measures or behaviors above and beyond those encouraged by the program. As the Home Energy Reports encourage energy conservation generally, in addition to promoting the adoption of energy-efficiency measures, spillover savings in treated homes are not well defined. Spillover in non-program homes would be the adoption of energy-efficiency measures based on the influence of Home Energy Reports.

The regression methodology does not capture spillover from treated to non-treated homes. Such spillover would lower the consumption of non-treated homes and potentially bias down the Energy Efficiency Behavior & Education Program impact estimates to the extent that neighboring homes were included in the control group. However, as of yet, there is no evidence that spillover from treated to non-treated homes in information programs is significant; therefore, the EM&V CSP did not account for this type of spillover.

## 5.4 Process Evaluation

The process evaluation is included in a separate document, *PY4 Process Evaluation*. Findings, recommendations, and the status of follow up on recommendations are included in the evaluation.

## 5.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 5-9**.

**Table 5-9: Summary of Energy Efficiency Behavior & Education Program Finances**

	IQ (\$1,000)	PYTD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$0	\$0	\$0
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
Design and Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2</sup>	\$111	\$450	\$2,544
Marketing <sup>3</sup>	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$111</b>	<b>\$450</b>	<b>\$2,544</b>
<b>EDC Evaluation Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>SWE Audit Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total EDC Costs<sup>4</sup></b>	<b>\$111</b>	<b>\$450</b>	<b>\$2,544</b>
<b>Participant Costs<sup>5</sup></b>	<b>N/A</b>	<b>\$0</b>	<b>\$0</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$450</b>	<b>\$2,229</b>
Total Lifetime Energy Benefits <sup>7</sup>	N/A	\$3,823	\$6,680
Total Lifetime Capacity Benefits <sup>7</sup>	N/A	\$305	\$242
<b>Total TRC Benefits<sup>8,7</sup></b>	<b>N/A</b>	<b>\$4,128</b>	<b>\$6,922</b>
<b>TRC Ratio<sup>9,7</sup></b>	<b>N/A</b>	<b>9.18</b>	<b>3.11</b>

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Includes the marketing CSP and marketing costs by program CSPs.
4. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
5. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
6. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.
7. CPITD value discounted to PY1.
8. 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.
9. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.

## 6 Appliance Recycling Program

The 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 energy-efficiency programs.
- Collecting and recycling no fewer than 56,908 appliances through 2013, with a total energy reduction of 73,842 MWh/yr and demand reduction of 9.4 MW.

### 6.1 Program Updates

There were no significant permanent design changes in the program in PY4. However, in November and December of PY4 PPL Electric increased the incentive from \$35 to \$50 per appliance for refrigerators and freezers in order to increase participation during traditionally slow months.

In PY4, the program achieved 110% of its MWh/yr gross verified savings goal, 200% of its MW goal, and 103% of its participation target.

### 6.2 Impact Evaluation Gross Savings

#### 6.2.1 Reported Gross Savings

**Table 6-1** breaks out the program's PY4 participation, savings, and incentives by quarter.

**Table 6-1: Appliance Recycling Program Reported Results by Quarter**

Reporting Period	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	3,707	6,460	.62	1.02	\$92
PY4 Q2	4,642	7,643	0	1.24	\$219
PY4 Q3	5,101	8,427	0	1.42	\$292
PY4 Q4	1,817	2,731	0	0.45	\$26
<b>PY4 Total</b>	<b>15,267</b>	<b>25,260</b>	<b>.62</b>	<b>4.14</b>	<b>\$628</b>
<b>CPITD Total</b>	<b>46,038</b>	<b>81,525</b>	<b>10.51</b>	<b>14.03</b>	<b>\$1,907</b>
<b>NOTES:</b>					
1. Participant refers to the number of unique participants.					

**Table 6-2** shows the cumulative reported results by sector through the end of PY4. As expected, the vast majority of participants were in the residential sector. The results also included a limited number of small commercial and industrial; large commercial and industrial; and government, non-profit, and institutional participants.

**Table 6-2: Appliance Recycling Program Reported Results by Sector**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	14,887	24,561	.61	0	\$628
Small Commercial and Industrial	378	696	.02	0	\$0
Large Commercial and Industrial	1	2	0	4.01	\$0
Government, Non-Profit, and Institutional	1	2	0	.13	\$0
<b>PY4 Total</b>	<b>15,267</b>	<b>25,260</b>	<b>.62</b>	<b>4.14</b>	<b>\$628</b>
<b>CPITD Total</b>	<b>46,038</b>	<b>81,525</b>	<b>10.51</b>	<b>14.03</b>	<b>\$1,907</b>
<b>NOTES:</b>					
1. Participant refers to the number of unique participants.					

### 6.2.2 EM&V Sampling Approach

The EM&V CSP inspected a census of PY4 annual participant records from EEMIS as shown in **Table 6-3**. All ARP data in EEMIS were compared to the ARP CSP records to verify whether all units reported as recycled were consistently recorded in both databases.

**Table 6-3: Appliance Recycling Program Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
All	None	18,081	N/A <sup>1</sup>	N/A <sup>1</sup>	Census	18,081	Records Review
<b>Program Total</b>	<b>None</b>	<b>18,081</b>	<b>N/A<sup>1</sup></b>	<b>N/A<sup>1</sup></b>	<b>Census</b>	<b>18,081</b>	
<b>NOTES:</b>							
1. Total number of appliances.							
2. Since this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful.							

The EM&V CSP also selected a random sample of participants for telephone survey verification to exceed 90/10 confidence and precision for the program year (n=140) as shown below in **Table 6-4**. The quantity and type of units collected, the operational condition of each unit, and whether appliances were replaced were all verified via the phone surveys. In addition, the survey included questions to inform NTG calculations.

**Table 6-4: Appliance Recycling Program Phone Survey Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1,2</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
All	None	8,168	0.5	10%	140	142	Process and Impact
<b>Program Total</b>		<b>8,168</b>	<b>0.5</b>	<b>10%</b>	<b>140</b>	<b>142</b>	
<b>NOTES:</b>							
1. Total number of unique participants.							
2. The sample for the participant survey was drawn in PY4 Q3 so the full participant population of 15,267 was not yet available. However, the sample is representative of the full population since there were no significant differences in participants from the first half of the year and the second half.							

### 6.2.3 Ex Ante Adjustment Methodology and Findings

Savings for recycled appliances are deemed on a per-unit basis, in accordance with the 2012 TRM. The EM&V CSP made no TRM *ex ante* adjustments for refrigerators or freezers, as none were required to be in line with the TRM. The EM&V CSP made adjustments to *ex ante* reported savings, to make room air conditioner savings values meet 2012 TRM specifications. For room air conditioners, the 2012 TRM savings were based on the geographic location of each participant's home and the corresponding savings assumption in the TRM. The savings were then weighted by the relative distribution of ZIP codes that correspond to units in the EEMIS database. The EM&V CSP adjusted savings to reflect the distribution observed in the EEMIS database, producing a final weighted savings value of 270 kWh/yr per unit for room air conditioners. **Table 6-5** details the TRM savings assumptions for each city represented in the PY4 participant population, as well as the number of room air conditioning units picked up from each city. The table also provides the overall weighted average savings value.

**Table 6-5: Room Air Conditioner Retirement – Savings Assumptions and Participation by City**

Measure	City	EFLH <sup>1</sup> (Hrs)	Capacity (BTUH)	EER <sup>1</sup>	Energy Impact (kWh/yr)	CF <sup>1</sup>	Demand Impact (kW)	Effective Useful Life (Years)	Frequency - PY4 Annual Participants
Room Air Conditioner Retirement	Allentown	243	10,000	9.07	268	0.58	0.64	4	503
	Erie	149	10,000	9.07	164	0.58	0.64	4	0
	Harrisburg	288	10,000	9.07	318	0.58	0.64	4	454
	Philadelphia	320	10,000	9.07	353	0.58	0.64	4	127
	Pittsburgh	228	10,000	9.07	251	1.58	1.74	5	0
	Scranton	193	10,000	9.07	213	2.58	2.84	6	393
	Williamsport	204	10,000	9.07	225	3.58	3.95	7	197
Weighted average per-unit savings					270 kWh/yr				
<b>NOTES:</b> 1. See Acronyms. EFLH stands for Effective Full Load Hours; EER stands for Energy Efficiency Rating; CF stands for Coincidence Factor.									

### 6.2.4 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 number of refrigerators or freezers reported as replaced.

The EM&V CSP survey verification revealed that no discrepancies existed for the quantity, type, or operational condition of appliances. However, discrepancies were found between replacements reported in the EEMIS database (data uploaded by the ARP CSP) and the survey responses. Survey

results show that significantly more customers reported replacing a refrigerator or freezer (a reported 63% replacement rate) than reported to the ARP CSP through the sign-up process (a reported 31% replacement rate).

The survey responses indicate that 4% of the units reported as replaced were replaced with non-ENERGY STAR® appliances, and 96% were replaced with ENERGY STAR appliances. The EM&V CSP adjusted the savings using appropriate TRM values to reflect the allocation of replaced units. **Table 6-6** summarizes the survey results and the energy and demand adjustments.

**Table 6-6: PY4 Appliance Recycling Program Summary of Survey Verification Results**

Measure Category	Percent of Sample in Category – EEMIS Reported	Percent of Sample in Category – Survey Verified	kWh/yr Per Unit	KW Per Unit
Refrigerators and Freezers – Not Replaced	82%	37%	1,659	0.21
Refrigerators and Freezers – Replacement with ENERGY STAR	9%	60%	1,205	0.15
Refrigerators and Freezers – Replacement with Standard Efficiency	9%	3%	1,091	0.14

### 6.2.5 Savings Realization Rate Methodology

The EM&V CSP calculated the realization rate for PY4 based on the findings from the surveys and the records reviews, after all *ex ante* adjustments were made to reported savings. The realization rate was calculated as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings within the survey sample, which was then applied to the whole of PY4. For refrigerators and freezers, the *ex post* adjustments were based on survey results, and indicated a discrepancy between the replacement status reported in EEMIS and participant survey responses. For room air conditioners, the adjustments were *ex ante* adjustments based on the savings assumptions from the TRM that corresponded to the ZIP code of the location where the unit was picked up.

### 6.2.6 Summary of Evaluation Results

The survey responses regarding appliance replacement were the only finding that had a substantial impact on the PY4 program realization rate.

In the EM&V CSP survey results, significantly more customers reported replacing a refrigerator or freezer than was reported in EEMIS (as reported by the ARP CSP during the customer sign-up process). The difference had a significant impact on the program realization rate, as savings associated with replaced units are lower. As a result, the ARP PY4 MWh/yr realization rate was 89%. Program energy savings results are provided in **Table 6-7**.



**Table 6-7: PY4 Appliance Recycling Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Energy Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation ( $C_v$ ) or Proportion or Error Ratio	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
All	25,260	25,179	89%	0.20	2.8%	22,308	--
Program Total	25,260	25,179	89%	0.20	2.8%	22,308	--
<b>NOTES:</b> 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.							

Top 100 hour demand reduction results are provided in **Table 6-8**.

**Table 6-8: PY4 Appliance Recycling Program Summary of Evaluation Results for Demand (Top 100 Hours) Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Savings <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Coefficient of Variation ( $C_v$ ) or Proportion or Error Ratio <sup>3</sup>	Relative Precision <sup>3</sup>	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
All	.62	.88	94%	0.18	2.5%	.83	--
Program Total	.62	.88	94%	0.18	2.5%	.83	--
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. The realization rate, coefficient of variation, and relative precision are implied from program level analysis.							

## 6.3 Impact Evaluation Net Savings

### 6.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP conducted an NTG analysis based on findings from customer telephone surveys conducted in PY4. The EM&V CSP used the same methodological approach to determine net savings as in the 2004–2005 and 2006–2008 California residential ARP evaluations. This methodology has gained acceptance as the industry standard for assessing ARP NTG. Specifically, NTG was calculated by determining the percentage of participants who would have, in the absence of the program, disposed of their appliances in a manner leading to the appliances' discontinued use. Computing net savings for the ARP requires knowing whether the appliance would have continued to operate without program

involvement. If it would have continued to operate, the program should get credit for savings equal to the consumption of that appliance. If it would not have continued to operate, the program should get zero credit. This adjustment is applied through an NTG ratio.

Independent of program intervention, participating appliances would have been subject to one of four potential scenarios:

1. The appliance would have been kept in use by the participating household;
2. The appliance would have been kept by the participating household, but stored unused;
3. The appliance would have been discarded or sold by the participating household in a manner leading to its continued operation; or
4. The appliance would have been discarded by the participating household in a manner leading to its eventual destruction.

Of these scenarios, two indicate freeridership: instances where the appliance would have been kept and stored unused (number 2 above), or discarded and destroyed (number 4 above). Both of those scenarios would have the same impact on energy consumption, independent of program participation. The participant and nonparticipant surveys collected customer behavior data around these four scenarios to compute the NTG ratio.

In other evaluations, the EM&V CSP has found that the majority of participants in most ARPs report they would have discarded the participating appliance even if they had not participated in the program. Therefore, it is critical that the evaluation focus on changes at the service territory level, rather than changes within a participating home. This evaluation aims to understand whether the discarded appliance would have remained in use within PPL Electric's service territory, either inside or outside the participating home. This critical concept is different from most demand-side management programs, and does not lend itself to standard evaluation methods.

### **6.3.2 Net-to-Gross Ratio Findings**

Freeridership decreased between PY3 and PY4 from 39% to 33%.

#### **6.3.2.1 Spillover Methodology**

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

No adjustments will be made to the *ex post* savings to incorporate spillover, in accordance with direction from the SWE. Spillover estimates will be used to inform program planning.

### **6.3.2.2 *Spillover Findings***

Some ARP survey respondents stated that they had made energy-efficiency improvements without receiving a rebate. Survey respondents reported installing CFLs, windows, central air conditioning (CAC), and insulation. An analysis of these responses resulted in 0.77% spillover for ARP. The overall NTG ratio is 68%.

## **6.4 Process Evaluation**

The process evaluation methods and findings are described in Appendix K: Process Evaluation.

## **6.5 Financial Reporting**

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 6-9**.

**Table 6-9: Summary of Appliance Recycling Program Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$26	\$628	\$1,907
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$26</b>	<b>\$628</b>	<b>\$1,907</b>
Design & Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2</sup>	\$169	\$1,492	\$4,524
Marketing <sup>3</sup>	\$12	\$337	\$1,198
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$181</b>	<b>\$1,830</b>	<b>\$5,722</b>
<b>EDC Evaluation Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>SWE Audit Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total EDC Costs<sup>4</sup></b>	<b>\$207</b>	<b>\$2,458</b>	<b>\$7,629</b>
<b>Participant Costs<sup>5</sup></b>	<b>N/A</b>	<b>\$0</b>	<b>\$0</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$2,458</b>	<b>\$6,618</b>
Total Lifetime Energy Benefits <sup>7</sup>	N/A	\$19,500	\$53,076
Total Lifetime Capacity Benefits <sup>7</sup>	N/A	\$1,421	\$3,983
<b>Total TRC Benefits<sup>8,7</sup></b>	<b>N/A</b>	<b>\$20,920</b>	<b>\$57,059</b>
<b>TRC Ratio<sup>9,7</sup></b>	<b>N/A</b>	<b>8.51</b>	<b>8.62</b>
<b>NOTES:</b> <i>Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.</i> <ol style="list-style-type: none"> <li>Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.</li> <li>Includes EDC program management, CSP program management, general management oversight, and major accounts.</li> <li>Includes the marketing CSP and marketing costs by program CSPs.</li> <li>Per the 2011 <i>Total Resource Cost Test Order</i>, the Total EDC Costs refer to EDC incurred expenses only.</li> <li>Per the 2011 <i>Total Resource Cost Test Order</i>, the net Participant Costs are the costs for the end-use customer.</li> <li>Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.</li> <li>CPITD value is discounted to PY1.</li> <li>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.</li> <li>TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.</li> </ol>			

## 7 Winter Relief Assistance Program (WRAP)

The PPL Electric Universal Services Program (USP) WRAP, designed for income-qualified customers, existed prior to Act 129 and has offered services since 1985. WRAP is designed to reduce electricity consumption and improve living comfort for low-income customers. Eligible customers receive a free energy audit, in which their home is evaluated for eligible energy-saving measures. A preapproved list of cost-effective measures is used, along with other criteria, to determine whether appliances and other larger equipment can be cost-effectively replaced. Implementing agencies either use in-house contractors or contract out installation of the energy-saving measures. Outdated and inefficient equipment in customer homes is replaced with energy-efficient equipment. Energy education is also offered through the Low-Income WRAP to encourage customers to conserve energy.

PPL Electric’s WRAP now includes two participant paths: USP WRAP and Act 129 WRAP. The two paths are largely the same, are “invisible” to the customer, but PPL Electric tracks them separately for funding and compliance purposes.

Act 129 WRAP targets customers with incomes at or below 150% of the federal poverty level. The program is available to customers in existing single-family housing and existing multifamily housing with three or more dwelling units where 50% or more of the tenants are low-income qualified. Act 129 WRAP seeks to reach new participants, as well as PPL Electric customers who received WRAP assistance in the past and may be in need of further WRAP services. WRAP also seeks to reach customers who may not have been eligible for low-income assistance in the past due to eligibility rules, such as requiring at least one year of pre-participation kWh usage data.

### 7.1 Program Updates

There were no changes to the program in Program Year 4.

### 7.2 Impact Evaluation Gross Savings

#### 7.2.1 Reported Gross Savings

**Table 7-1** shows the cumulative reported results by quarter through the end of PY4. **Table 7-2** shows the PY4 program participation and savings claimed by sector.

**Table 7-1: WRAP Reported Results by Quarter**

Reporting Period	Participants	Reported Gross Energy Savings <sup>1</sup> (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction <sup>2</sup> (MW)	Incentives <sup>3</sup> (\$1,000)
PY4 Q1	1,115	2,097	0.002	0.002	\$0
PY4 Q2	1,067	2,046	0.001	0.003	\$0
PY4 Q3	836	1,566	0	0.003	\$0
PY4 Q4	625	1,203	0	0.003	\$0
<b>PY4 Total</b>	<b>3,643</b>	<b>6,911</b>	<b>0.003</b>	<b>0.012</b>	<b>\$0</b>
<b>CPITD Total</b>	<b>13,292</b>	<b>20,097</b>	<b>0.772</b>	<b>0.781</b>	<b>\$18,182</b>
<b>NOTES:</b> 1. PY4 values include savings for heat pump water heaters. 2. Total Reported Gross Demand represents only heat pump water heaters. Demand reductions for job types are calculated as an <i>ex ante</i> adjustment. 3. Beginning in PY3 Q4, the cost of the weatherization measures (given to participants for free) was no longer classified as an incentive, consistent with the PA PUC's directive. Those costs were classified as "management." Prior period charges were not reclassified.					

**Table 7-2: WRAP Reported Results by Sector**

Sector	Participants	Reported Gross Energy Savings <sup>1</sup> (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction <sup>2</sup> (MW)	Incentives (\$1,000) <sup>3</sup>
Low-Income	3,643	6,911	0.003	0.012	\$0
<b>PY4 Total</b>	<b>3,643</b>	<b>6,911</b>	<b>0.003</b>	<b>0.012</b>	<b>\$0</b>
<b>CPITD Total</b>	<b>13,292</b>	<b>20,097</b>	<b>0.772</b>	<b>0.781</b>	<b>\$18,182</b>
<b>NOTES:</b> 1. PY4 values include savings for heat pump water heaters. 2. Total Reported Gross Demand represents only heat pump water heaters. Demand reductions for job types are calculated as an <i>ex ante</i> adjustment. 3. Beginning in PY3 Q4, the cost of the weatherization measures (given to participants for free) was no longer classified as an incentive, consistent with the PA PUC's directive. Those costs were classified as "management." Prior period charges were not reclassified.					

### 7.2.2 EM&V Sampling Approach

The EM&V methodology includes records verification. PPL Electric records WRAP participant data in its "WRAP V" database. Participant data include the job type, measures installed, and materials and labor costs. Data is uploaded from WRAP V to EEMIS.

Sampling to meet EM&V requirements was designed to meet the target for all programs in the low-income sector of the Act 129 portfolio (Act 129 WRAP and E-Power Wise Program); that is, 90/10 for the

low-income sector as a whole. The EM&V requirements target 85% confidence and 15% precision at the program level.

In accordance with the PY4 Sampling Plan, the PY4 sample size for the Act 129 WRAP records reviews is 24 records, or approximately six records per quarter. In Q1, prior to approval of the PY4 Sampling Plan, the EM&V CSP selected a sample of four baseload jobs, four low-cost jobs, and four full-cost jobs for review from a population of 374 baseload jobs, 194 low-cost jobs, and 547 full-cost jobs, in accordance with the sampling plan in effect at that time. After approval of the PY4 Sampling Plan, the EM&V CSP selected six records per quarter from the population of the remaining three quarters. Each quarterly sample was stratified as shown in **Table 7-3**.

**Table 7-3: WRAP Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision <sup>1</sup>	Target Sample Size	Achieved Sample Size	Evaluation Activity
Baseload	Received Field Inspection	4	0.5	N/A	4	3	Records Review
Baseload	Did Not Receive Field Inspection	1,299	0.5	N/A	4	4	Records Review
Low Cost	Received Field Inspection	91	0.5	N/A	4	5	Records Review
Low Cost	Did Not Receive Field Inspection	616	0.5	N/A	4	4	Records Review
Full Cost	Received Field Inspection	594	0.5	N/A	4	10	Records Review
Full Cost	Did Not Receive Field Inspection	1,039	0.5	N/A	4	4	Records Review
<b>Program Total</b>		<b>3,643</b>		<b>85/15</b>	<b>24</b>	<b>30</b>	
<b>NOTES:</b>							
1. 90/10 at the low-income sector level as a whole.							

### 7.2.3 Ex Ante Adjustment Methodology and Findings

Act 129 WRAP PY4 savings are reported using evaluated savings, deemed by job type, as reported by The Pennsylvania State University's (Penn State) Consumer Service Information System (CSIS) project submitted to and approved by the PA PUC's Bureau of Consumer Services. This method is consistent with discussions between the PA EDCs and the SWE, in which the parties decided that Act 129 WRAP savings will be deemed values based on the most recent PA PUC-approved savings for each USP WRAP job type from a prior period (based on customer usage analysis).

During PY3 Q4, Penn State's CSIS calculated savings for USP WRAP using a customer usage analysis of USP WRAP participants. The results of this analysis were recorded in EEMIS and used as the deemed savings per job type for Act 129 WRAP participants with installation dates occurring in PY4.

During PY4 Q4, Penn State's CSIS project submitted updated savings estimates by job type based on USP WRAP customer usage data from customers participating during 2010. PPL Electric noted that Penn State's updated estimates differed greatly from the previous year's estimates and requested that the EM&V CSP produce comparison estimates. The savings estimates per job type calculated by the EM&V CSP and Penn State were quite different. In the ensuing discussion about the differences, PPL Electric and the EM&V CSP noted a difference in weather-normalization methodologies. Penn State does not weather-normalize the customer usage data it receives from the utilities as part of its estimation process; instead, each utility is expected to provide weather-normalized customer usage data to Penn State for use in its analyses.

PPL Electric reviewed both sets of estimates and the weather-normalization methodologies. PPL Electric elected to use the estimates produced by the EM&V CSP because:

- The EM&V CSP's weather-normalization methodology produced results that more accurately reflect the effect that differences from normal weather have on load.
- The EM&V CSP's estimates exhibit less-extreme year-to-year fluctuation.
- The weather-normalization methodology conforms to approaches described in *Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol of The Uniform Methods Project*.<sup>31</sup>

At the close of PY4, all PY4 jobs with installation dates in PY4 received an *ex ante* TRM adjustment so that savings for all jobs were deemed using the estimates produced by the EM&V CSP. These estimates are provided in **Table 7-4** below, along with the deemed savings estimates for previous program years. PY4 savings for all three job types decreased from PY3 deemed savings.

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<sup>31</sup>Agnew, Ken and M. Goldberg. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol*. U.S. Department of Energy, National Renewable Energy Laboratory. April 2013. (NREL/SR-7A30-53827) Available online: [http://www1.eere.energy.gov/office\\_eere/de\\_ump\\_protocols.html](http://www1.eere.energy.gov/office_eere/de_ump_protocols.html).



**Table 7-4: WRAP Savings Estimates Used During PY4**

Job Type	Installed During PY1 (kWh/yr)	Installed During PY2 (kWh/yr)	Installed During PY3 (kWh/yr)	PY4 EM&V CSP Savings Estimates (kWh/yr)
Baseload	1,042	1,042	1,312	969
Low Cost	1,588	1,588	1,604	1,143
Full Cost	1,306	1,306	2,496	1,992

The EM&V CSP calculated savings for all jobs using the deemed savings per job in effect during the program year in which the measures were installed. Of all jobs claimed in PY4, 22% had installation dates in PY3, 1% had installation dates in PY2, and 0.5% had installation dates in PY1; therefore, savings for these jobs were calculated using the deemed savings estimates in effect at the close of PY3, PY2, and PY1, respectively.

PPL Electric claims savings of 1,896 kWh/yr (in accordance with the 2012 TRM) per heat pump water heater installed in addition to the savings per job. Of the 70 heat pump water heaters reported in PY4, 15 were installed in PY3. Savings of 1,914 kWh/yr (in accordance with the 2011 TRM) per heat pump water heater were claimed for these units.

#### **7.2.4 Ex Post Adjustment Methodology and Findings**

PY4 EM&V included data review and verification of a random sample of contractor reports, WRAP V records, and EEMIS data. In PY4, the EM&V CSP selected a random sample of records from PY4 participants. Discussed in more detail in Section 7.2.2, the sample was stratified by job type and whether a field inspection took place. PPL Electric provided copies of all supporting documents to the EM&V CSP for each participant in the sample, including contractor reports, invoices, and PPL Electric's WRAP V summary reports. The EM&V CSP compared information within the supporting documents to values recorded in the EEMIS tracking database. The EM&V CSP reviewed the job type and measures installed to determine that the correct job type was recorded. The review confirmed that PPL Electric correctly reported measures and assigned job types in EEMIS, based on comparisons with the contractor reports and the WRAP V database.

Additionally, program installations for some sites required multiple, separate visits from the installation contractor and were recorded as separate jobs in the PPL Electric WRAP V database and the EEMIS database. Because savings are deemed by job type, the EM&V CSP reviewed accounts in each EEMIS extract with those recorded in previous quarters and program years, and adjusted the counts per job type so that single sites (physical location) would not be counted more than once.

For sites with multiple records spread over different quarters within the same program year, the records with the least comprehensive job types were deleted from the job counts. **Table 7-5** shows that there were 70 jobs at 35 sites with measures installed in more than one quarter in PY4.

**Table 7-5: Adjustments for Sites With Records Entered In Multiple Quarters In the Same Program Year**

Job 1		Job 2		Number of Jobs	Number of Jobs Excluded from Counts
Measure Installation Year	Measure Code	Measure Installation Year	Measure Code		
PY3	Low Cost	PY3	Full Cost	2	2
		PY4	Full Cost	1	1
	Full Cost	PY3	Low Cost	2	0
		PY4	Low Cost	1	0
PY4	Baseload	PY4	Low Cost	1	1
			Full Cost	10	10
	Low Cost	PY3	Full Cost	1	1
		PY4	Baseload	1	0
			Full Cost	19	19
	Full Cost	PY3	Low Cost	1	0
		PY4	Baseload	10	0
			Low Cost	19	0
			Full Cost	2	1
Total				70	35

For sites with multiple records spread over different program years, the EM&V CSP reviewed the records at the end of PY4, examining the job types recorded at each site. If the same or a less-comprehensive job type was recorded in PY4, the EM&V CSP excluded that job type from the counts, as the maximum savings were already claimed for that job. If a more-comprehensive job type was recorded in PY4, the EM&V CSP added the incremental savings over those already claimed in the prior program year. Where that was the case, incremental savings for the most comprehensive job type was added. These adjustments and the incremental kWh/yr are shown in the tables below. **Table 7-6** details the incremental adjustments to savings for 34 households where work spanned multiple years.

**Table 7-6: Incremental kWh Adjustment for Sites With Records Entered Over Multiple Years**

Reported in PY4		Reported in Prior Year		Number of Jobs Excluded from Counts	Incremental kWh Per Job	Total Incremental kWh	
Installation Year	Job Type	Installation Year	Job Type				
PY2	Baseload	PY2	Full Cost	1	0	0	
	Low Cost	PY2	Full Cost	1	0	0	
		PY3	Full Cost	1	0	0	
	Full Cost	PY2	Baseload	1	264	264	
PY3	Baseload	PY2	Baseload	1	0	0	
		PY3	Full Cost	3	0	0	
	Low Cost	PY3	Full Cost	4	0	0	
	Full Cost	PY2	Baseload	2	1,454	2,908	
			Low Cost	5	892	4,460	
			PY3	Full Cost	1	0	0
PY4		Low Cost	PY2	Low Cost	1	0	0
	PY3		Full Cost	5	0	0	
	Full Cost		Baseload	1	950	950	
			Low Cost	3	404	1,212	
			Baseload	1	680	680	
			Low Cost	2	388	776	
			PY3	Full Cost	1	0	0
Total				34		11,250	

### 7.2.5 Savings Realization Rate Methodology

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

### 7.2.6 Summary of Evaluation Results

In PY4, Act 129 WRAP realized 98% of the *ex ante* adjusted energy savings, as shown **Table 7-7**. This includes savings of 133 MWh/yr associated with the installation of 70 heat pump water heaters through the WRAP, as well as incremental adjustments to kWh/yr made for sites with jobs occurring in more than one program year.

**Table 7-7: PY4 WRAP Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Energy Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
Baseload	1,730	1,355	99%	N/A <sup>2</sup>	N/A <sup>2</sup>	1,338	--
Low Cost	1,149	895	95%	N/A <sup>2</sup>	N/A <sup>2</sup>	851	--
Full Cost	3,899	3,444	99%	N/A <sup>2</sup>	N/A <sup>2</sup>	3,416	--
Heat Pump Water Heater	133	133	100%	N/A <sup>2</sup>	N/A <sup>2</sup>	133	--
<b>Program Total</b>	<b>6,911</b>	<b>5,827</b>	<b>98%</b>	<b>N/A<sup>2</sup></b>	<b>N/A<sup>2</sup></b>	<b>5,738</b>	<b>--</b>
<b>NOTES:</b> 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. Because this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful.							

For Act 129 WRAP, demand reductions are not deemed per job type like energy savings. Instead, demand values are calculated as follows:

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

Where:

kWh = Deemed kWh per job type

CF = Coincidence factor; 0.99693903

Hours Per Year = 8,760

Savings for heat pump water heaters are credited separately from the savings by job type and have a deemed demand reduction of 0.174 kW per measure for installations occurring in PY4 and 0.175 kW per measure for installations occurring in PY3.

**Table 7-8: PY4 WRAP Summary of Evaluation Results for Demand (Top 100 Hours) Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion	Relative Precision	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
All	.003	.318	98%	N/A <sup>4</sup>	N/A <sup>4</sup>	.312	--
<b>Program Total</b>	<b>.003</b>	<b>.318</b>	<b>98%</b>	<b>N/A<sup>4</sup></b>	<b>N/A<sup>4</sup></b>	<b>.312</b>	<b>--</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. The realization rate is implied from program level analysis. 4. Because this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful.							

## **7.3 Impact Evaluation Net Savings**

### **7.3.1 Net-to-Gross Ratio Methodology**

Freeridership or spillover are not assumed for this low-income weatherization program. Measures are installed at no cost to income-eligible customers.

## **7.4 Process Evaluation**

PPL Electric regularly conducts a process evaluation for the existing USP WRAP, in compliance with the PA PUC. Act 129 WRAP processes and projects do not significantly diverge from the existing USP WRAP processes and projects. The EM&V CSP focused its limited process evaluation on documenting any changes to Act 129 WRAP. This avoided duplication of efforts. There were no changes to Act 129 WRAP in PY4.

## 7.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 7-9**.

**Table 7-9: Summary of WRAP Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants <sup>1</sup>	\$0	\$0	\$18,182
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$18,182</b>
Design & Development	\$0	\$0	\$0
Administration <sup>2</sup>	\$0	\$0	\$0
Management <sup>3</sup>	\$140	\$7,008	\$11,039
Marketing <sup>4</sup>	\$0	\$0	\$1
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$140</b>	<b>\$7,008</b>	<b>\$11,040</b>
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
<b>Total EDC Costs<sup>5</sup></b>	<b>\$140</b>	<b>\$7,008</b>	<b>\$29,222</b>
<b>Participant Costs<sup>6</sup></b>	<b>N/A</b>	<b>\$0</b>	<b>\$0</b>
<b>Total TRC Costs<sup>7,8</sup></b>	<b>N/A</b>	<b>\$7,008</b>	<b>\$25,631</b>
Total Lifetime Energy Benefits <sup>8</sup>	N/A	\$8,653	\$23,808
Total Lifetime Capacity Benefits <sup>8</sup>	N/A	\$218	\$698
<b>Total TRC Benefits<sup>9,8</sup></b>	<b>N/A</b>	<b>\$8,872</b>	<b>\$24,506</b>
<b>TRC Ratio<sup>10,8</sup></b>	<b>N/A</b>	<b>1.27</b>	<b>0.96</b>

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

- Beginning in PY3 Q4, the cost of the weatherization measures (given to participants for free) was no longer classified as an incentive, consistent with the PA PUC's directive. Those costs were classified as "management." Prior period charges were not reclassified.
- Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
- Includes EDC program management, CSP program management, general management oversight, and major accounts.
- Includes the marketing CSP and marketing costs by program CSPs.

5. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
6. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
7. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.
8. CPITD value is discounted to PY1.
9. 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.
10. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.

## 8 Home Energy Assessment and Weatherization Program

The Home Energy Assessment and Weatherization Program is designed to provide PPL Electric residential customers with information on their homes' energy performance, along with recommendations on the most effective, highest-priority energy-efficiency actions they can take in their homes. Eligible customers must live in single-family residences. Recognizing the varying economic conditions, ages of homes, and interest levels among PPL Electric residential customers, the program provides two tracks:

1. **Home Energy Survey:** The customer pays \$50 for a walk-through home energy survey.
2. **Comprehensive Audit:** A comprehensive energy audit is conducted with diagnostic testing, including a blower door test (to measure infiltration) and a combustion efficiency test. Customers are eligible for a rebate of \$150 if the home has either main-source electric heating *or* central air conditioning (CAC), or \$250 if the home has both main-source electric heating *and* CAC.

This program is limited to customers in the residential sector. The objectives of the Home Energy Assessment and Weatherization Program are:

- Providing customers with the opportunity to participate in a walk-through home energy survey or comprehensive energy audit.
- Providing customers with opportunities to reduce their energy costs and increase their energy efficiency.
- Encouraging customers to weatherize their homes by providing rebates for related measures.
- Installing low-cost, energy-saving measures as part of both the survey and the audit, which may result in immediate savings. These energy-saving measures are free of charge to the customer and are installed by the auditor at the time of the audit.
- Promoting other PPL Electric energy-efficiency programs.
- Obtaining participation of no fewer than 4,277 customers through 2013, with a total reduction of 2,607 MWh/yr and 1.471 MW based on planning estimates for the measures claiming savings.

### 8.1 Program Updates

There were no changes to the program in program year 4.



## 8.2 Impact Evaluation Gross Savings

### 8.2.1 Reported Gross Savings

**Table 8-1** shows the CPITD reported gross energy savings and incentives paid, and **Table 8-2** presents PY3 participation and savings by sector. PPL Electric paid no bonus rebates and no duct sealing rebates in PY4. Participant numbers include counts for both audit and weatherization participation.

**Table 8-1: Home Energy Assessment and Weatherization Reported Results by Quarter**

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	800	1,453	0.10	0.10	\$38
PY4 Q2	352	610	0.03	0.04	\$3
PY4 Q3	91	54	0.00	0.00	\$10
PY4 Q4	1,106	2,141	0.02	0.15	\$13
<b>PY4 Total</b>	<b>2,349</b>	<b>4,259</b>	<b>0.15</b>	<b>0.29</b>	<b>\$64</b>
<b>CPITD Total</b>	<b>5,412</b>	<b>7,234</b>	<b>0.39</b>	<b>0.52</b>	<b>\$296</b>

**Table 8-2: Home Energy Assessment and Weatherization Reported Results by Sector**

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	2,349	4,259	0.15	0.29	\$64
<b>PY4 Total</b>	<b>2,349</b>	<b>4,259</b>	<b>0.15</b>	<b>0.29</b>	<b>\$64</b>
<b>CPITD Total</b>	<b>5,412</b>	<b>7,234</b>	<b>0.39</b>	<b>0.52</b>	<b>\$296</b>

### 8.2.2 EM&V Sampling Approach

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

The EM&V CSP used the telephone surveys to assess participant satisfaction with the program, as well as to verify the measures and measure quantities recorded in EEMIS. The EM&V CSP designed the survey instruments to capture information unique to the measures installed by both audit and weatherization participants.

### 8.2.2.1 Telephone Surveys

In accordance with the PY4 sampling plan, the PY4 sample size for Home Energy Assessment and Weatherization Program telephone surveys was 140 completed surveys. The EM&V CSP stratified participants into two distinct sampling frames:

- Audit participants: PY4 participants receiving a walk-through energy survey or comprehensive audit.
- Weatherization participants: PY4 participants installing weatherization measures.

The EM&V CSP set targets for completed surveys to meet specifications of the PY4 sampling plan; that is, confidence and precision of 90/10. While the PY4 sampling plan calls for a sample of 70 audit participants and 70 weatherization participants to meet the targeted confidence and precision for each group, walk-through survey and comprehensive audit participation was lower than expected in PY4. Therefore, the EM&V CSP revised the survey target for this group to 50 completed surveys, which meets the EM&V sampling requirements. The EM&V CSP stratified the audit participant target further, to 25 completed surveys with walk-through participants and 25 completed surveys with comprehensive audit participants.

The EM&V CSP conducted telephone surveys with 121 randomly selected customers who participated in PY4. The EM&V CSP completed surveys with 29 walk-through survey participants, 21 audit participants, and 70 weatherization participants, as shown in **Table 8-3**.

**Table 8-3: Home Energy Assessment and Weatherization Telephone Survey Sampling Strategy for PY4**

Stratum	Population Size	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Home Energy Survey	135	0.5	90/10	25	29	Telephone Survey
Comprehensive Audit	113	0.5		25	21	Telephone Survey
Weatherization Rebate	793	0.5	90/10	70	71	Telephone Survey
<b>Program Total</b>	<b>1,039</b>	<b>0.5</b>	<b>90/10</b>	<b>120</b>	<b>121</b>	

### 8.2.2.2 Records Verification

The PY4 sampling plan limits records verification to investigation of a census of weatherization records with out-of-range values. In Q1, the EM&V CSP selected a sample of 15 audit participants and 30 rebate records from 20 weatherization participants for review in accordance with the sampling plan in effect at that time. The EM&V CSP stratified records by audit type: walk-through survey, comprehensive audit of main-source electric heat and CAC, comprehensive audit of main-source electric heat or CAC, and comprehensive audit with neither main source electric heat nor CAC. The EM&V CSP allocated the 15 sample points proportionally and selected six of the sample points from records that had walk-through

surveys, five sample points from audit participants with all-electric heating and cooling equipment, three sample points from audit participants who had either main-source electric heat or CAC, and one sample point from audit participants with neither main-source electric heat nor CAC.

Additionally, the EM&V CSP selected for review a sample of 44 records with out-of-range R-values or high square footage installed from the Q1 and Q2 insulation records.

The EM&V CSP selected a second random sample of an additional 26 weatherization rebate records from 16 participants recorded in Q4, stratified by weatherization type (ceiling or wall) and by heating and cooling fuel and equipment configuration. No rebates were recorded for bonus rebates or duct sealing in PY4, and only two weatherization rebates were recorded in Q3.

The targeted level of confidence and precision for savings verification is 85/15 at the program level. **Table 8-4** shows the annual sample size allocations for each stratum within the program for the records review samples. Confidence and precision targets were not set for each stratum.

**Table 8-4: Home Energy Assessment and Weatherization Program Records Review**  
**Sampling Strategy for PY4**

Stratum	Population Size	CV Assumed in Sample Design	Target Levels of C/P	Target Sample Size	Achieved Sample Size	Evaluation Activity
Home Energy Survey	173	0.5	--	0	6	Records review
Comprehensive Audit – MSEH <sup>1</sup> and CAC	111	0.5	--	0	5	Records review
Comprehensive Audit – MSEH or CAC	69	0.5	--		3	Records review
Comprehensive Audit – No MSEH or CAC	3	0.5	--		1	Records review
Weatherization Rebate	1,994	0.5	N/A	0	56	Records review
<b>Program Total</b>	<b>2,350</b>	<b>0.5</b>	<b>85/15</b>	<b>0</b>	<b>71</b>	
<b>NOTES:</b>						
1. MSEH stands for Main Source Electric Heat.						
2. A sample of 44 records with out-of-range final R-value and square footage installed were also reviewed.						

### 8.2.3 Ex Ante Adjustments Methodology and Findings

Savings for the low-cost, direct-install measures are deemed on a per-unit basis for each unit installed, using deemed savings estimates published in the TRM in effect at the time of measure installation. Savings are claimed and reported by PPL Electric via information captured in the EEMIS database. *Ex ante* adjustments account for differences between how savings are calculated in the tracking system and how savings are specified in the TRM, and for systematic data recording errors. *Ex ante* adjustments are made to the population, prior to verification activities.

Some records in the PY4 tracking data have installation dates that occurred during previous program years. The EM&V CSP reviewed the installation dates to ensure that the savings claimed reflect the TRM that was in effect at the time of measure installation.

The EM&V CSP found that the per-unit savings used to determine demand reduction for aerators in EEMIS and in the 2011 TRM—0.056 kW—was too high by a factor of 10. While the text of the 2011 TRM states, “the deemed energy savings for the installation of a low flow aerator compared to a standard aerator is  $ISR \times 61 \text{ kWh/year}$  with a demand reduction of  $ISR \times 0.056 \text{ kW}$ , with  $ISR$  determined through data collection,”<sup>32</sup> the value produced by the algorithm is 0.0056 kW. For faucet aerators installed during the PY3, the EM&V CSP adjusted the *ex ante* deemed savings value for aerators to be 0.0056 kW. This error was corrected in the 2012 TRM, so no adjustment was necessary for faucet aerators installed during PY4.

All but four weatherization rebates reported in PY4 were installed during PY3 and PY4. Savings must be calculated in accordance with the TRM in effect at the time a measure was installed; therefore, the EM&V CSP calculated savings for the 1,018 weatherization measures installed in PY4 in accordance with the algorithms found in the 2012 TRM.<sup>33</sup> The EM&V CSP calculated savings for the 972 weatherization measures installed in PY3 in accordance with the algorithms found in the 2011 TRM, and calculated savings for the four weatherization measures installed in PY2 in accordance with the 2010 TRM.<sup>34</sup> While reported savings for these measures were deemed on a kWh and kW per-installed-square-foot basis, the savings algorithms in the 2011 TRM and 2012 TRM include parameters for the climate zone of each home, the change in R-value, and the heating and cooling equipment efficiencies and configuration. For wall insulation, the savings calculated using the TRM algorithms were 86% of the savings deemed per square foot of insulation installed. For ceiling insulation, the savings calculated using the TRM algorithms were 185% of the savings deemed per square foot of insulation installed.

#### **8.2.4 Ex Post Adjustment Methodology and Findings**

The EM&V CSP accounted for the in-service rate (ISR) during the *ex post* verification activities. The ISR is reflected in the realization rate calculation. The EM&V CSP calculated these values using information collected and analyzed from phone surveys of 50 participants in the PY4 home energy survey and comprehensive audit (referred to in the TRM as ‘EDC data gathering’).

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<sup>32</sup> Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2011. p. 44. Available online: [http://www.puc.pa.gov/electric/docs/Act129/Act129\\_TRM-2011.doc](http://www.puc.pa.gov/electric/docs/Act129/Act129_TRM-2011.doc)

<sup>33</sup> Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2012. Available online: [http://www.puc.pa.gov/electric/docs/Act129/Act129\\_TRM-2012.doc](http://www.puc.pa.gov/electric/docs/Act129/Act129_TRM-2012.doc)

<sup>34</sup> Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2010. Available online: [http://www.puc.pa.gov/electric/docs/Act129/Act129\\_TRM-2010.doc](http://www.puc.pa.gov/electric/docs/Act129/Act129_TRM-2010.doc)

The EM&V CSP used responses captured through telephone surveys to calculate an evaluated ISR for CFLs (99%) and faucet aerators (100%). This evaluated ISR for CFLs in PY4 is higher than the rate used in the 2012 TRM (84%), and higher than the value found in the phone surveys of PY3 participants (95%) and PY2 participants (85%). Adjusting the ISR for CFLs raises the deemed value for this measure from 50 kWh/yr to 59 kWh/yr and from 0.002 kW to 0.003 kW.

The evaluated ISR for faucet aerators—100%—is the same as the default value employed in the 2012 TRM. Using the algorithm in the 2012 TRM and the evaluated ISR of 100%, the evaluated energy savings from faucet aerators is 61 kWh and the demand reduction is 0.0056 kW.

For all records selected into the representative review sample, the EM&V CSP compared the measure quantities in the EEMIS extract to the values in the implementation CSP's tracking database, and to the values recorded on the original household survey, audit intake, and weatherization rebate forms. The EM&V CSP found no differences among the data sources for the home energy survey/comprehensive audit sample, so no adjustments to measure counts were necessary as a result of the records review.

For participants responding to the telephone survey, the EM&V CSP compared measure quantities recorded in EEMIS to those provided by the survey respondents. The EM&V CSP adjusted the measure quantities for the difference between the measure quantities recorded in EEMIS and the values provided by the survey respondents.

The review of the sample with high R-values and square footage was not designed to be representative of the population; rather, it was used to identify problem trends in data entry or with rebate application completion. The EM&V CSP found that rebate forms contained only one available entry line per insulation type (ceiling or wall). Contractors installing different amounts of weatherization in separate areas found it difficult to record each area's square footage and R-values accurately. The EM&V CSP presented these findings to PPL Electric, and the findings were used to improve the design of Phase II rebate forms, which included additional rows per insulation type on which to record information on the rebate form.

### **8.2.5 Savings Realization Rate Methodology**

The EM&V CSP calculated the realization rate using findings from the sample of projects chosen for telephone verification and from the results of the records reviews. The realization rate determined from the sample was applied to the population and was calculated as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

### **8.2.6 Summary of Evaluation Results**

The EM&V CSP's final estimate of program-wide savings for the audit segment of the program employed a single realization rate, 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 EM&V CSP's final estimate of program-wide savings for the weatherization segment of the program also employed a single realization rate, 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.

**Table 8-5** shows the realization rates for energy savings for the Home Energy Assessment and Weatherization Program.

**Table 8-5: PY4 Home Energy Assessment and Weatherization Summary  
of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Energy Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion or Error Ratio	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
Home Energy Survey / Audit <sup>2</sup>	215	215	104.3%	0.13	2.8%	224	--
Weatherization	4,044	4,986	99.5%	0.05	0.7%	4,964	--
<b>Program Total</b>	<b>4,259</b>	<b>5,201</b>	<b>99.7%</b>	<b>0.06</b>	<b>0.7%</b>	<b>5,188</b>	<b>--</b>
<b>NOTES:</b> 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. Savings for the Home Energy Survey /Audit accrue from the direct install measures provided at the time of the survey or audit.							

Top 100 hour demand reduction is shown in **Table 8-6**.

**Table 8-6: PY4 Home Energy Assessment and Weatherization Summary of Evaluation Results for Demand (Top 100 Hours) Stratum**

Stratum	Reported Gross Demand Savings <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion or Error Ratio <sup>3</sup>	Relative Precision <sup>3</sup>	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
All	0.15	0.14	100.4%	0.04	0.5%	0.14	--
<b>Program Total</b>	<b>0.15</b>	<b>0.14</b>	<b>100.4%</b>	<b>0.04</b>	<b>0.5%</b>	<b>0.14</b>	<b>--</b>
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses 3. The realization rate, coefficient of variation, and relative precision are implied from program level analysis.							

### 8.3 Impact Evaluation Net Savings

#### 8.3.1 Net-to-Gross Ratio Methodology

Energy audits are not like some other measures in which the customer might install the measures in the absence of a program, for example, with high-efficiency HVAC or ENERGY STAR appliances. It is unlikely that a customer would pay for an audit in the absence of the program; therefore, the EM&V CSP did not assess freeridership for the audit option of the Home Energy Assessment and Weatherization Program. Freeridership may exist for customers installing recommended measures, however. The EM&V CSP used participant surveys to assess freeridership for these customers.

To estimate spillover, the Home Energy Assessment and Weatherization participant surveys included questions to determine whether customers took additional energy-efficiency actions as a result of program participation.

#### 8.3.2 Net-to-Gross Ratio Findings

The EM&V CSP conducted surveys with 70 participants who installed weatherization measures, to collect data to inform the NTG ratio. The surveys asked respondents about the projects they had completed, including whether they would have installed the same measures without the weatherization rebate. Once the freeridership scores were determined for each participant, the EM&V CSP computed a savings-weighted score, in which scores for very large projects carry greater weight than scores for much smaller projects. To determine a savings-weighted score, the EM&V CSP multiplied the individual score by the participants' verified savings. The savings-weighted freeridership score was 25% for this program, and the NTG ratio prior to adjustment for spillover for the program was 75%.

**Table 8-7** presents the spillover kWh/yr savings as a percentage of total program savings for these respondents.

**Table 8-7: Home Energy Assessment and Weatherization Program Spillover Savings**

Program	Spillover Savings (kWh/yr)	Program Savings (kWh/yr)	Spillover
Home Energy Assessment and Weatherization	147	162,441	0.09%

The analysis of responses yielded an overall spillover of 0.09%. **Table 8-8** provides a summary of the NTG results adjusted for spillover. The analysis was calculated at the 90% confidence level.

**Table 8-8: Summary of NTG for Home Energy Assessment and Weatherization Program**

Program	Freeridership Score	Participant Spillover	NTG	NTG Precision
Home Energy Assessment and Weatherization	25%	0.09%	75%	±6.3%

## 8.4 Process Evaluation

The process evaluation methods and findings are described in Appendix K: Process Evaluation.



## 8.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 8-9**.

**Table 8-9: Summary of Home Energy Assessment and Weatherization Program Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$13	\$64	\$296
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$13</b>	<b>\$64</b>	<b>\$296</b>
Design and Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2</sup>	\$101	\$340	\$1,428
Marketing <sup>3</sup>	\$0	\$0	\$31
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$101</b>	<b>\$340</b>	<b>\$1,459</b>
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
<b>Total EDC Costs<sup>4</sup></b>	<b>\$114</b>	<b>\$404</b>	<b>\$1,754</b>
<b>Participant Costs<sup>5</sup></b>	<b>N/A</b>	<b>\$3,489</b>	<b>\$5,342</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$3,892</b>	<b>\$5,904</b>
Total Lifetime Energy Benefits <sup>7</sup>	N/A	\$7,624	\$8,911
Total Lifetime Capacity Benefits <sup>7</sup>	N/A	\$82	\$140
<b>Total TRC Benefits<sup>8,7</sup></b>	<b>N/A</b>	<b>\$7,706</b>	<b>\$9,051</b>
TRC Ratio <sup>9,7</sup>	N/A	1.98	1.53

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Includes the marketing CSP and marketing costs by program CSPs.
4. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
5. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
6. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.

7. CPITD value is discounted to PY1.
8. 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.
9. TRC Ratio equals Total TRC Benefits divided by Total TRC 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 customers with incomes at or below 150 percent 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 9,048 customers and achieve energy savings of 4,268 MWh/yr.

### 9.1 Program Updates

PPL Electric did not make any changes to the program in PY4.

### 9.2 Impact Evaluation Gross Savings

#### 9.2.1 Reported Gross Savings

**Table 9-1** shows the program participation and reported gross savings by quarter for PY4.

**Table 9-1: E-Power Wise Reported Results by Quarter**

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives <sup>1</sup> (\$1,000)
PY4 Q1	604	359.98	0.016	0.027	\$0
PY4 Q2	858	511.37	0	0.039	\$0
PY4 Q3	715	426.14	0	0.032	\$0
PY4 Q4	263	156.75	0	0.012	\$0
<b>PY4 Total</b>	<b>2,440</b>	<b>1,454.24</b>	<b>0.016</b>	<b>0.110</b>	<b>\$0</b>
<b>CPITD Total<sup>2</sup></b>	<b>9,183</b>	<b>3,630.49</b>	<b>0.546</b>	<b>0.595</b>	<b>\$429</b>
<b>NOTES:</b> 1. Beginning in PY3 Q3, the value of the free home energy kits and education are not classified as an incentive, consistent with the PA PUC's August 2011 TRC Order. These costs are treated as direct program costs in the "Management" category. Prior period charges were not reclassified.. 2. The E-Power Wise kit's education measure has a one year measure life. 1170.99 MWh and 0.13 MW reported in previous reports' CPITD calculations has expired.					

Table 9-2 shows the cumulative reported results by sector.

**Table 9-2: E-Power Wise Reported Results by Sector**

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives <sup>1</sup> (\$1,000)
Low-Income	2,440	1,454.24	0.016	0.110	\$0
<b>PY4 Total</b>	<b>2,440</b>	<b>1,454.24</b>	<b>0.016</b>	<b>0.110</b>	<b>\$0</b>
<b>CPITD Total<sup>2</sup></b>	<b>9,183</b>	<b>3,630.49</b>	<b>0.546</b>	<b>0.595</b>	<b>\$429</b>
<b>NOTES:</b> 1. Beginning in PY3 Q3, the value of the free home energy kits and education are not classified as an incentive, consistent with the PA PUC's August 2011 TRC Order. These costs are treated as direct program costs in the "Management" category. Prior period charges were not reclassified. 2. The E-Power Wise kit's education measure has a one year measure life. 1170.99 MWh and 0.13 MW reported in previous reports' CPITD calculations has expired.					

### 9.2.2 EM&V Sampling Approach

The EM&V CSP conducted a quality-assurance and quality-control (QA/QC) review on a census of EEMIS records each quarter and included all written surveys returned by participants in the analysis. Record reviews and phone surveys were not conducted in PY4.

### 9.2.2.1 QA/QC Review Sample Sizes

The E-Power Wise Program conducted QA/QC reviews on a census of EEMIS records, as presented in **Table 9-3**.

**Table 9-3: E-Power Wise Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
All	None	2,440	N/A <sup>1</sup>	N/A <sup>1</sup>	Census	2,440	QA/QC
Program Total	None	2,440	N/A <sup>1</sup>	N/A <sup>1</sup>	Census	2,440	
<b>NOTES:</b>							
1. Since this program's evaluation did not include sampling, Cv and precision are not meaningful.							

### 9.2.2.2 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 PY4.

Of the 1,735 participants who entered the program through the agency-based delivery channel, 86 returned kit surveys. 705 participants entered through the direct-mail delivery channel, and 90 of these participants returned kit surveys. All of the kit surveys returned by PY4 participants were included in the program evaluation. **Table 9-4** presents the delivery method, sample size, and functions of each of the surveys used in this evaluation.

**Table 9-4: 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	86 (all)	Yes	No
Direct-Mail Participant Kit	Included in kit	All quarters	90 (all)	Yes	No

### 9.2.3 Ex Ante Adjustment Methodology and Findings

Two savings adjustments were necessary to calculate the E-Power Wise Program realization rate.

3. The first, which adjusts the reported savings (presented in **Table 9-5**) from EEMIS to align with assumptions specified in the TRM and the characteristics of the kit items themselves, results in adjusted *ex ante* savings.
4. The second adjustment incorporates the results of the program's QA/QC reviews, the measure installation rates, and behavioral change findings. Results are reflected in the *ex post* savings and results in the savings realization rate.

Both methodologies, the *ex ante* adjustment and the savings realization rate adjustment, are explained in more detail below.

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 measure. This adjustment 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 are the adjusted *ex ante* savings. These are the *ex ante* savings used in the equation to determine the program's realization rate.

**Table 9-5** shows the results of the TRM-adjusted *ex ante* calculations for the seven measures included in each kit.

**Table 9-5: Reported and Adjusted Ex Ante Savings per Technology and per Unit**

Sector	Measure	Reported Ex Ante Savings (kWh/yr)	Adjusted Ex Ante Savings (kWh/yr)	Factors
Low-Income	Energy Education	146	146	Behavior-based CMP
	Faucet Aerator – Bath	60	31 <sup>1</sup>	2012 TRM value (1.5 gpm) <sup>2</sup>
	Faucet Aerator – Kitchen	60	31 <sup>1</sup>	2012 TRM value (1.5 gpm) <sup>2</sup>
	Low-Flow Showerhead	217	120 <sup>1</sup>	2012 TRM adjusted value (2 gpm) <sup>3</sup>
	CFL 15W	41	41	2012 TRM adjusted value (15W CFL)
	CFL 20W	50	51	2012 TRM adjusted value (20W CFL)
	Electroluminescent Nightlight	22	26	2012 TRM value of 26 kWh/unit
<b>NOTES:</b> 1. Showerhead and aerator kit measure savings were adjusted by 52% to reflect RAS estimates of electric water heater saturation. 2. The kitchen and bath aerators have rated gpm (kitchen = 2.0 gpm, bath = 1.0 gpm) that differ from the gpm provided in the 2012 TRM. To maintain consistency with the TRM and reduce confusion between the aerator types, savings were based on the rated gpm provided in the TRM (1.5 gpm). 3. An adjustment was made to the 'GPMlow' variable of the calculation provided in the 2012 TRM for calculating low-flow showerhead energy savings. The TRM assumed a GPMlow value of 1.5, whereas the gpm of the low-flow showerhead included in the E-Power Wise Program kit was rated at 2.0. The calculation for savings attributed to this measure in the E-Power Wise Program kit used 2.0 gpm.				

#### 9.2.4 Ex Post Adjustment Methodology and Findings

This savings adjustment modifies the *ex ante* savings in two ways. First, it incorporates the results of quantity adjustments resulting from QA/QC review activities. Second, this adjustment modifies the kit item and energy education savings to reflect the installation rates determined through the participants' returned surveys and the proportion of participants from the agency-based or direct-mail delivery channels. Both are *ex post* adjustments.

##### 9.2.4.1 QA/QC Records Review

The EM&V CSP derived the final QA/QC PY4 realization rate from a review of all PY4 participant records in EEMIS. Participants' PPL Electric 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 was counting only one kit per customer. 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 and to verify that the program was counting only one kit per household.

A total of 2,440 participants were listed in EEMIS prior to the QA/QC records reviews. Through the records reviews, the EM&V CSP identified and removed accounts that received multiple kits through the program or were not traceable between databases. As a result of the QA/QC records reviews findings, the total number of participants in the program was reduced to 2,427. This represents a 99.5% QA/QC realization rate for the program.

**Table 9-6** shows the QA/QC realization rates for the number of kits verified in the PY4 analysis. Because the QA/QC realization rate is applied at the kit level, each of the seven measures distributed in the kit has the same QA/QC realization rate.

**Table 9-6: QA/QC Realization Rate for PY4 E-Power Wise Program**

Sector	Measure	Kits in EEMIS	QA/QC Realization Rate	Kits Counted for Savings
Low-Income	Kit (including all measures)	2,440	99.5%	2,427

##### 9.2.4.2 Participant Surveys Methodology

The EM&V CSP used customer-returned survey results to calculate *ex post* per-unit savings for each of the measures contained in the kit. For measure savings, installation rates were included as inputs to the algorithms specified in the TRM. Energy savings attributed to behavior changes were calculated in PY2 and PY3 using the SWE-approved custom measure protocol (CMP) for this program. PY4 agency-based participants were estimated to save 146 kWh based on the behavior savings calculated for the agency-based delivery channel in PY2. PY4 direct-mail participants were estimated to save 208 kWh based on behavior savings calculated for the direct mail delivery channel in PY3.

### 9.2.4.3 Participant Kit Surveys

Each kit distributed through the program included the participant survey (with text reviewed and approved by PPL Electric). These surveys were used to collect 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 realization rate of the program. In total, 86 mail-in surveys were returned by the participants who received the kit from the CBO agency, and 90 were returned by direct-mail participants, for a total of 176 mail-in surveys included in the program evaluation.

### 9.2.4.4 Summary of Survey Findings

Program participants returned a total of 176 participant kit surveys. **Table 9-7** presents the PY2, PY3, and PY4 installation rates (ISR) for each of the energy saving kit items. ISRs are presented as a percent of participants who answered the question, and not a percent of the total number of people surveyed.

**Table 9-7: Installation Rates for Kit Measures Distributed Through E-Power Wise Program**

Measure Installed	Kit Delivery Method									
	PY2 CBO Agency-		PY3 CBO Agency		PY3 Direct Mail		PY4 CBO Agency		PY4 Direct Mail	
	Sample Count (n)	ISR	Sample Count (n)	ISR	Sample Count (n)	ISR	Sample Count (n)	ISR	Sample Count (n)	ISR
Bathroom Aerator	782	72%	246	70%	100	67%	81	65%	89	79%
Kitchen Aerator	782	86%	246	81%	100	81%	81	88%	89	89%
Showerhead	829	86%	248	80%	109	80%	83	82%	87	93%
20W CFL <sup>1</sup>	812	94%	242	94%	100	89%	83	94%	90	92%
15W CFL <sup>1</sup>	819	96%	244	96%	99	95%	83	96%	90	94%
Nightlight <sup>1</sup>	832	95%	247	96%	109	94%	86	94%	88	93%
<b>NOTES:</b> 1. The TRM provides an ISR of 84% for ENERGY STAR CFL bulbs and the nightlight. However, because the ISRs determined through the surveys for this program are more specific to this population, these ISRs were used in place of the ISR provided in the TRM.										

The EM&V CSP determined relative per-unit savings for each of the items included in the kits using installation rates determined through the participant surveys and TRM algorithms. **Table 9-8** shows the savings attributable to each of the measures. These savings may be used to inform discussions that do not rely on precision estimates for program-wide savings.



**Table 9-8: E-Power Wise Program Measure Savings per Distributed Unit<sup>1</sup>**

Measure Installed	PY2 Per-Unit Savings (kWh/yr)	PY3 Agency-Based Per-Unit Savings (kWh/yr)	PY3 Direct Mail Per-Unit Savings (kWh/yr)	PY4 Agency-Based Per-Unit Savings (kWh/yr)	PY4 Direct Mail Per-Unit Savings (kWh/yr)
Bathroom Aerator	44	49	49	21	29
Kitchen Aerator	52	42	41	28	33
Showerhead	199	184	184	99	131
20W CFL	54	55	52	57	56
15W CFL	46	46	45	47	47
Nightlight	25	25	24	29	28
<b>NOTES:</b> 1. These savings values account for installation rates. The savings per distributed unit is equal to the savings per installed unit times the installation rate.					

### 9.2.5 Savings Realization Rate Methodology

Because of the relatively small savings impact of the program compared to the overall consumption of the participant group, the EM&V CSP estimated savings for measure installations and behaviors using engineering calculations rather than using a billing analysis. (That is, because savings are small, it is likely that they cannot be seen in customer billing histories.)

Electric impacts associated with measures installed through the program were estimated based on partially deemed savings values included in the TRM. The engineering algorithms for each of the measures for which the program claimed electric energy savings are provided in Appendix G: E-Power Wise Program Savings Calculations.

The adjustment for a savings realization rate was derived from two components: the QA/QC records reviews (quantity) and participant surveys (installation rates and quantity). QA/QC reviews were conducted on a quarterly basis.

Paper surveys were distributed to the participants in the program kits and mailed back to the implementation CSP. These kit-based surveys were completed throughout PY4. Kit survey data were used to determine measure installation rates. These installation rates and manufacturer labeled measure characteristics were used in the algorithms to calculate verified savings for each measure.

Phone surveys used to calculate energy education savings were conducted with agency-based participants one time in PY2 Q3, and with direct-mail participants one time in PY3 Q4. These energy education savings were assumed in PY4.

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

### 9.2.6 Summary of Evaluation Results

Program saving results are provided in **Table 9-9** and **Table 9-10**.

**Table 9-9: PY4 E-Power Wise Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Energy Savings (MWh/yr)	Energy Realization Rate	Observed Error Ratio, Coefficient of Variation ( $C_v$ ), or Proportion	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
All	1,454	1,123	92.1%	0.45	5.3%	1,034	--
<b>Program Total</b>	<b>1,454</b>	<b>1,123</b>	<b>92.1%</b>	<b>0.45</b>	<b>5.3%</b>	<b>1,034</b>	<b>--</b>
<b>NOTES:</b>							
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.							

**Table 9-10: PY4 E-Power Wise Summary of Evaluation Results for Demand (Top 100 Hours) Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Error Ratio, Coefficient of Variation ( $C_v$ ), or Proportion	Relative Precision <sup>3</sup>	Verified Gross Demand Reduction (MW)	Unverified Gross Demand Reduction (MW)
All	0.016	0.015	91.7%	0.42	5.1%	0.014	--
<b>Program Total</b>	<b>0.016</b>	<b>0.015</b>	<b>91.7%</b>	<b>0.42</b>	<b>5.1%</b>	<b>0.014</b>	<b>--</b>
<b>NOTES:</b>							
1. Reported gross demand reductions do not include the gross-up to reflect T&D losses.							
2. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses.							
3. The realization rate, coefficient of variation, and relative precision are implied from program level analysis.							

#### 9.2.6.1 Behavior Savings

Behavior savings estimates were determined for participants entering the program through the agency-based and direct-mail delivery channels in PY2 and PY3, respectively. These values were used for agency-based and direct-mail kits delivered in PY4, and a weighted average was calculated based on the number of participants entering the program from each delivery channel. The overall savings for the behavior changes are shown in **Table 9-11**.

**Table 9-11: E-Power Wise Program Behavior Savings**

Behavior Savings	Per-Unit Savings (kWh/yr)	PY4 Weighted Average Per-Unit Savings (kWh/yr)
Agency-Based <sup>1</sup> (Participants receiving the kit from CBO agency)	146	164
Direct-Mail <sup>2</sup> (Participants receiving the kit through direct mail)	208	
<b>NOTES:</b>		
1. Behavioral savings were determined through participant phone surveys conducted one time in PY2.		
2. Direct-mail behavior savings were determined through participant phone surveys conducted one time in PY3.		

### 9.2.6.2 Savings from Home Energy Kit Measures

The EM&V CSP calculated a weighted-average, survey-verified savings value for each kit item and behavior change based on the number of kits distributed through each delivery channel. The EM&V CSP multiplied the total number of kits contained in the EEMIS database by the QA/QC realization rate, and then by the survey-verified, per-unit savings value to calculate a unit-level energy realization rate based on the ratio between *ex post* and *ex ante* savings, as shown in **Table 9-12**.

**Table 9-12: PY4 Summary of Savings and Realization Rates for E-Power Wise Program Measures**

Sector	Measure	Kits in EEMIS	QA/QC Realization Rate	Survey Verified Savings Per Unit <sup>1</sup> (kWh/yr)	Energy Realization Rate <sup>2</sup> (%)
Low-Income	Energy Education	2,440	99.5%	164 <sup>2</sup>	102%
	Faucet Aerator – Bath	2,440	99.5%	23	73%
	Faucet Aerator – Kitchen	2,440	99.5%	29	92%
	Low-Flow Showerhead	2,440	99.5%	108	90%
	CFL 15W	2,440	99.5%	47	113%
	CFL 20W	2,440	99.5%	56	111%
	Electroluminescent Nightlight	2,440	99.5%	29	111%
<b>NOTES:</b> 1. This survey-verified value includes the sum of behaviors for which the program is claiming energy savings: water heater plus home temperature energy savings. 2. These realization rates reflect ratio between adjusted <i>ex ante</i> and <i>ex post</i> verified savings.					

The realization rates in **Table 9-12** can be calculated for each measure using standard methods (including stratification weighting). Realization rates can be rolled-up across measures to obtain an overall realization rate, provided stratification weights are applied (using the same methods as are used for the overall realization rate). However, because the sample was drawn at the kit/customer-level, the measure level estimates above are not independent. Because the same customers were queried to verify the savings associated with several measures, the measure level estimates are correlated. Program-level precision estimates, therefore cannot be obtained by simply combining measure level precision estimates without accounting for this correlation. In order to account for the correlation, the

EM&V CSP's final estimate of program-wide savings was calculated by first rolling up savings to the kit/customer level (for TRM-adjusted *ex ante* and for *ex post*) which produced independent observations across kits/customers. The independent observations were then used to calculate the precision of the overall realization rate using standard variance calculations.

### **9.3 Impact Evaluation Net Savings**

This program targets the low-income community, and no freeriders 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**

The process evaluation methods and findings are described in Appendix K: Process Evaluation.

## 9.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 9-13**.

**Table 9-13: Summary of E-Power Wise Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants <sup>1</sup>	\$0	\$0	\$429
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$429</b>
Design and Development	\$0	\$0	\$0
Administration <sup>2</sup>	\$0	\$0	\$0
Management <sup>3</sup>	\$11	\$117	\$321
Marketing <sup>4</sup>	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$11</b>	<b>\$117</b>	<b>\$321</b>
<b>EDC Evaluation Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>SWE Audit Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total EDC Costs<sup>5</sup></b>	<b>\$11</b>	<b>\$117</b>	<b>\$750</b>
<b>Participant Costs<sup>6</sup></b>	<b>N/A</b>	<b>\$0</b>	<b>\$0</b>
<b>Total TRC Costs<sup>7,8</sup></b>	<b>N/A</b>	<b>\$117</b>	<b>\$667</b>
Total Lifetime Energy Benefits <sup>8</sup>	N/A	\$673	\$2,555
Total Lifetime Capacity Benefits <sup>8</sup>	N/A	\$17	\$143
<b>Total TRC Benefits<sup>9,8</sup></b>	<b>N/A</b>	<b>\$690</b>	<b>\$2,698</b>
<b>TRC Ratio<sup>10,8</sup></b>	<b>N/A</b>	<b>5.90</b>	<b>4.04</b>

**NOTES:**

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Beginning in PY3 Q3, the value of the free home energy kits and education are not classified as an incentive, consistent with the PA PUC's August 2011 TRC Order. These costs are treated as direct program costs in the "Management" category. Prior period charges were not reclassified..
2. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
3. Includes EDC program management, CSP program management, general management oversight, and major accounts.

4. Includes the marketing CSP and marketing costs by program CSPs.
5. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
6. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
7. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.
8. CPITD value is discounted to PY1.
9. 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.
10. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.

## 10 Direct Load Control Program

PPL Electric designed the Direct Load Control (DLC) program (also called the Peak Saver Program) to reduce peak demand through control devices installed on customers' central air conditioners or heat pump units. The devices allow the units to cycle off during peak periods by a method and frequency determined by the program's implementation CSP (Comverge). The EM&V CSP determined the savings allowed under this program in accordance with PJM direct load control protocols and standards found in PJM Manual 19, Attachment B, which were in effect for the PJM planning year 2012 and the 2013 delivery year.

The DLC program was available to residential and small commercial and industrial customer sectors and was put into practice by the implementation CSP as a turnkey program. Participant recruitment and enrollment commenced in the first quarter of 2011. During the summer of 2011, the program conducted a trial to meter usage from a sample of participants in preparation for 2012. During the summer of 2012, the program generally operated on weekdays between noon and 7:00 p.m. (from June 1 through September 30).

As currently structured in Act 129, peak load reduction compliance targets applied only for summer 2012. As such, the DLC program had a measure life of one-year.

The primary objective of the DLC program was to reduce electric demand during the top 100 hours of PPL Electric's system peak between June 1 and September 30, 2012. Specifically, the program's goals were to:

- Encourage customers, through education and incentives, to reduce their energy consumption during summer peak hours.
- Educate customers about energy efficiency and peak periods.
- Obtain participation of approximately 50,000 customers during summer 2012 (approximately 45,693 digital cycling units), with a total load reduction of 36 MW in summer 2012.

### 10.1 Program Updates

The program was enrolled in PY3 but open to participation only in PY4. Events were called during Q1 and Q2. The program was implemented as designed.

A total of 44,391 customers participated in the DLC program, including 43,637 residential customers and 754 small commercial customers. Some customers had active control devices (also known as digital control units) installed on more than one air conditioning unit at their residence or business. Comverge refers to the active control devices as "active end points." At the end of September 2012, Comverge

reported the net number of installations was 41,461 active end points.<sup>35</sup> The majority of air conditioning units with active control devices were between 2 and 3 ton units.

The program called 21 events during the months of June, July, August, and September of 2012. The number of active end points varied during each event, averaging 40,924 end points per event. Customers could opt out of any individual event, or opt out of the program. These opt outs and equipment operating issues (temporary or permanent malfunctions in the signal or curtailment device) account for the fluctuation in the number of active end points in each event. **Table 10-1** displays the number of active meters per event date.

**Table 10-1: Active End Points per Event**

DLC Event Dates	Active End Points
6/20/2012	41,607
6/21/2012	41,615
6/29/2012	40,838
7/3/2012	40,678
7/5/2012	40,692
7/6/2012	40,657
7/16/2012	40,458
7/17/2012	40,457
7/18/2012	40,370
7/23/2012	40,166
7/24/2012	40,250
7/26/2012	40,381
8/1/2012	40,585
8/2/2012	40,667
8/3/2012	40,718
8/8/2012	41,045
8/9/2012	41,203
8/17/2012	41,299
8/27/2012	41,960
8/28/2012	41,940
9/7/2012	41,810

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<sup>35</sup> Internal and confidential report from Converge to PPL Electric.



## 10.2 Impact Evaluation Gross Savings

### 10.2.1 Reported Gross Savings

For the Direct Load Control program, participant counts reflect unique account numbers; participants with two metered air conditioning units are counted only once. **Table 10-2** breaks out the program's PY4 participation, savings, and incentives by quarter. **Table 10-3** breaks out the program's PY4 participation, savings, and incentives by sector.

**Table 10-2: Direct Load Control Reported Results by Quarter**

Reporting Period <sup>1</sup>	Participants <sup>2</sup>	Reported Gross Energy Savings <sup>3</sup> (MW/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction <sup>4</sup> (MW)	Incentives (\$1,000)
PY4 Q1 – Q2	44,391	N/A	16.83	16.83	\$0
PY4 Q3	--	N/A	--	--	\$0
PY4 Q4	--	N/A	--	--	\$0
<b>PY4 Total</b>	<b>44,391</b>	<b>N/A</b>	<b>16.83</b>	<b>16.83</b>	<b>\$0</b>
<b>CPITD Total</b>	<b>44,391</b>	<b>N/A</b>	<b>16.83</b>	<b>16.83</b>	<b>\$0</b>
<b>NOTES:</b> 1. Events were called during Q1 and Q2, June–September 2012. 2. Participants are defined as the number of unique customer accounts that enrolled in the program. The PY4 participant total consists of 9,431 participants who enrolled in PY4 and all participants who enrolled prior to PY4. The total does not exclude permanent and event opt-outs. 3. The Direct Load Control Program did not report energy savings. 4. The Direct Load Control Program did not report demand reduction outside the top 100 hours.					

**Table 10-3: Direct Load Control Reported Results by Sector**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings <sup>2</sup> (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction <sup>3</sup> (MW)	Incentives (\$1,000)
Residential	43,637	N/A	16.43	16.43	\$0
Small Commercial	754	N/A	0.40	0.40	\$0
<b>PY4 Total</b>	<b>44,391</b>	<b>N/A</b>	<b>16.83</b>	<b>16.83</b>	<b>\$0</b>
<b>CPITD Total</b>	<b>44,391</b>	<b>N/A</b>	<b>16.83</b>	<b>16.83</b>	<b>\$0</b>
<b>NOTES:</b> 1. Participants are defined as the number of unique customer accounts that enrolled in the program. The PY4 participant total consists of 9,431 participants who enrolled in PY4 and all participants who enrolled prior to PY4. 2. The Direct Load Control Program did not report energy savings. 3. The Direct Load Control Program did not report demand reduction outside the top 100 hours.					

### 10.2.2 EM&V Sampling Approach

The implementation CSP (Comverge) designed the sample plan to achieve 90% confidence and 20% precision. Comverge developed a sample stratified to include four primary regions in PPL's territory (Lancaster, Lehigh, Harrisburg, and all other). The sample was also stratified by units  $\geq 3$  tons and  $< 3$  tons. The sample points were distributed to reflect the proportion of customers in each region-tonnage stratum. The EM&V CSP and PPL Electric reviewed and approved the sampling plan.

Comverge was responsible for selecting the sample, installing and maintaining metering equipment for a random sample of participants, and installed 104 meters. In addition, the PJM Manual 19 operability study required Comverge to test their devices and cycle about 68<sup>36</sup> units to meet 90/10 criteria (with 0.5 CV). None of the M&V sites with metered units were sites with multiple units.

All metered data collected by Comverge were made available to the EM&V CSP for evaluation. Therefore, the EM&V CSP did not install additional meters.

**Table 10-4: Direct Load Control Metering Sample Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Residential	Residential	43,637	.5	90/10	100	100	Metered data - engineering analysis
Small Commercial	Small Commercial	754			4	4	
<b>Total Metering</b>		<b>44,391</b>	<b>.5</b>	<b>90/10</b>	<b>104</b>	<b>104</b>	
<b>NOTES:</b>							
1. Population size defined as the number of unique customer accounts that enrolled in the program. The PY4 total includes 9,431 participants who enrolled in PY4. The total does not exclude permanent and event opt-outs.							

The EM&V CSP conducted a telephone survey with 95 participants drawn from a random sample of the most recently enrolled participants in PY4 Q1 (N=6,182) and designed to achieve 90% confidence and 10% precision for the program as a whole. The sample was stratified to reach both residential and small commercial accounts as displayed in **Table 10-5**. The survey collected data for the process evaluation.

<sup>36</sup> The implementation CSP grouped 100 metered participants into two groups of 50. For each event, one of these groups had the DLC device activated, and it cycled their A/C compressors. The other group served as a control group. Throughout the DLC season, these groups switched between being cycled and non-cycled.

**Table 10-5: Direct Load Control Survey Sample Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Residential	Residential	6,130	.5	90/10	70	90	Surveys - impact and process evaluations
Small Commercial	Small Commercial	52			25	5	
<b>Total Survey</b>		<b>6,182</b>	<b>.5</b>	<b>90/10</b>	<b>95</b>	<b>95</b>	
<b>NOTES:</b>							
1. Population size is based on active customer accounts that enrolled in PY4Q1.							

### 10.2.3 Ex Ante Adjustment Methodology and Findings

The implementation CSP provided *ex ante* savings and calculations for all demand load control events. The EM&V CSP did not make any TRM *ex ante* adjustments.

### 10.2.4 Ex Post Adjustment Methodology and Findings

The EM&V CSP reviewed all raw meter data for each event and reconciled meters with additional information provided by the implementation CSP. Meters captured data in five-minute intervals. Two meters were removed from the EM&V analysis due to *in situ* failure and one meter because there were no data points recorded during the metering period. Data points three hours prior to each event were examined to ensure that there were sufficient data to calculate the baseline kW for each event.

The EM&V CSP determined the validity of meter data by event using the following steps. Refer to Appendix H: Direct Load Control Program Analysis Examples for more information.

**Step 1: Determine the number of data points that are in the range of three hours prior to the beginning of an event through the end of the event.**

- For example, in an event beginning at 3:00 p.m. and ending at 6:00 p.m., count of five-minute interval data points began at noon (three hours prior to the event start time). If there were no missing values during this interval, data capture would include a total of 72 five-minute data points.

**Step 2: Count the number of non-missing five-minute interval data points for each range.**

**Step 3: Determine the keep/drop status of each meter by event.**

- Interval data were examined to determine whether there were sufficient data points for each event and meter. If a meter was missing all data points for a specific event as well as three hours prior to the event, the meter was removed from the specific event. If a meter was missing data from one event, that meter was removed for that specific event and not subsequent events. (Some meters showed missing values for some but not all events.)

The EM&V CSP verified *ex post* savings for PPL Electric's DLC program using PJM's Symmetric Additive Adjustment (SAA) methodology, based on adding an adjustment factor to the non-curtailed group for each event.

The implementation CSP divided M&V metered end points into two groups: A and B. For a given event, one group was defined as the curtailed group and the other as the non-curtailed group. The implementers alternated the curtailed group so that group A and group B were never curtailed at the same time. The implementer used this curtailment methodology to determine baseline load on event days.

The EM&V CSP calculated the 15-minute average kW for both the A and B groups for each event. The EM&V CSP then subtracted the non-curtailed 15-minute average kW from the curtailed 15-minute average kW. To calculate the SAA, the EM&V CSP took the average kW difference for the four 15-minute intervals leading up to the beginning of the event. Next, the EM&V CSP added the resulting adjustment factor to each 15-minute average kW of the non-curtailed group. The EM&V CSP calculated the final average hourly kW reductions as the average of the non-curtailed kW minus the average curtailed kW for the four 15-minute intervals per event hour.

After calculating the average hourly kW impacts, the EM&V CSP compared these results to the *ex ante* values provided by Comverge.

#### **10.2.5 Savings Realization Rate Methodology**

The EM&V CSP verified that 67 of the program's 88 event hours were within PPL Electric's top 100 system peak hours. Across the 67 hours in the top 100 hours, verified average savings were 0.62 kW per end point (M&V metered end point). Total MW savings over the top 100 hours were 16.83 MW<sup>37</sup>.

The implementation CSP provided *ex ante* savings and calculations for all demand load control events. The EM&V CSP compared these to the verified gross *ex post* results and calculated gross realization rates for demand reduction over the top 100 hours.

#### **10.2.6 Summary of Evaluation Results**

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<sup>37</sup> Value at the customer's meter. It has not yet been grossed-up to reflect T&D losses.

**Table 10-6** shows the reported *ex ante* and *ex post* verified savings for the DLC program. The gross realization rate of *ex ante* to *ex post* savings is 100%. This evaluation of the DLC program targeted 90% confidence at 10% precision. The EM&V CSP estimated a two-tailed 90% confidence interval around the verified 16.83 MW over the top 100 hours with precision of  $\pm 9.27\%$ . The 16.83 MW is within desired precision levels described in the sample plan.

**Table 10-6: PY4 Direct Load Control Summary of Evaluation Results for Demand Reduction (Top 100 Hours)**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Savings <sup>2</sup> (MW)	Demand Reduction Realization Rate	Observed Coefficient of Variation ( $C_v$ ) or Proportion or Error Ratio	Relative Precision	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
Residential	16.43	17.80	100%	--	--	17.80	--
Small Commercial	0.40	0.44	100%	--	--	0.44	--
<b>Program Total</b>	<b>16.83</b>	<b>18.23</b>	<b>100%</b>	<b>0.59</b>	<b>9.27%</b>	<b>18.23</b>	<b>--</b>
<b>NOTES:</b> 4. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 5. TRM adjusted <i>Ex Ante</i> and Verified gross demand reductions include T&D losses.							

## 10.3 Impact Evaluation Net Savings

### 10.3.1 Net-to-Gross Ratio Methodology

In this program, PPL Electric contracts with the implementation CSP to deliver MW reduction. The CSP recruits customers and installs a load curtailment device on the air conditioner. We assume that no customer will install a load control device on their air conditioner in the absence of the program; it requires a signal to control the device. Therefore, there is no freeridership.

### 10.3.2 Net-to-Gross Ratio Findings

The process evaluation survey included questions to assess participant spillover. While 22% of respondents reported installing other energy-efficient products in their homes or offices, only one reported being highly influenced by the program to install additional measures. However, this person reported applying for a rebate. Therefore, no spillover is attributed to the program.

## 10.4 Process Evaluation

The process evaluation methods and findings are described in Appendix K: Process Evaluation.

## 10.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 10-7**.

**Table 10-7: Summary of Direct Load Control Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants <sup>1</sup>	\$0	\$0	\$0
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
Design and Development	\$0	\$0	\$0
Administration <sup>2</sup>	\$0	\$0	\$0
Management <sup>3</sup>	\$24	\$1,690	\$8,831
Marketing <sup>4</sup>	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$24</b>	<b>\$1,690</b>	<b>\$8,831</b>
<b>EDC Evaluation Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>SWE Audit Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total EDC Costs<sup>5</sup></b>	<b>\$24</b>	<b>\$1,690</b>	<b>\$8,831</b>
<b>Participant Costs<sup>6</sup></b>	<b>N/A</b>	<b>\$0</b>	<b>\$0</b>
<b>Total TRC Costs<sup>7,8</sup></b>	<b>N/A</b>	<b>\$1,690</b>	<b>\$7,473</b>
Total Lifetime Energy Benefits <sup>8</sup>	N/A	N/A	N/A
Total Lifetime Capacity Benefits <sup>8</sup>	N/A	\$794	\$630
<b>Total TRC Benefits<sup>9,8</sup></b>	<b>N/A</b>	<b>\$794</b>	<b>\$630</b>
<b>TRC Ratio<sup>10,8</sup></b>	<b>N/A</b>	<b>N/A</b>	<b>0.08</b>

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. PPL pays the CSP to deliver the program. The CSP determines and pays incentives to participants. In accordance with the TRC Order, CSP payments to participants are treated as a program management expense, not an incentive.
2. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.

3. Includes EDC program management, CSP program management, general management oversight, and major accounts.
4. Includes the marketing CSP and marketing costs by program CSPs.
5. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
6. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
7. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.
8. CPITD value is discounted to PY1.
9. 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.
10. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.

## 11 Load Curtailment Program

The Load Curtailment Program reduced peak electricity usage among large commercial and industrial customers.

A program implementation CSP (EnerNOC) operated the turnkey program and contracted with PPL Electric to provide load reduction. The implementation CSP recruited, contracted with, and scheduled the load reductions with participants (PPL Electric customers). Participant customers contracted with the implementation CSP to decrease load during peak-hour periods by shifting or eliminating load, or by using back-up or distributed generation that meets environmental regulations. In exchange for the load curtailment, the implementation CSP paid customers an incentive. PPL Electric and the implementation CSP notified participant customers of peak-hour events during the summer of 2012.

As currently structured in Phase I of Act 129, peak load reduction compliance targets applied only for summer 2012. As such, the DLC program had a measure life of one year.

The primary objective of the Load Curtailment Program was to reduce PPL Electric's demand during the 100 hours of greatest demand between June 1 and September 30, 2012.

Specifically, the program goals were to:

- Reduce peak demand by providing incentives for energy usage reduction during peak hours in the 2012 summer period.
- Provide value to customers with energy management tools and cost savings.
- Obtain firm load reductions of 156 MW (average over the 100 peak summer hours).<sup>38</sup>

### 11.1 Program Updates

The Load Curtailment Program was implemented as designed. The program was enrolled in PY3 but open to participation only in PY4. In summer 2011, the implementation CSP tested systems and processes. Events were called during PY4 Q1 and Q2.

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<sup>38</sup> Given the uncertainty associated with accurately predicting the top 100 peak load hours, PPL Electric designed the Load Curtailment Program for a nominal 50 hours of interruptions with 300 MW of load reduction. The EM&V CSP grossed-up peak load reductions to reflect transmission and distribution losses because PPL Electric established the peak load reduction target at the system level but measured the peak load reductions at the customer level (retail meter).



## 11.2 Impact Evaluation Gross Savings

### 11.2.1 Reported Gross Savings

The implementation CSP executed 298 Load Curtailment Program contracts. **Table 11-1** breaks out the program's PY4 participation, savings, and incentives by quarter. **Table 11-2** shows the cumulative reported results by sector through the end of PY4.

**Table 11-1: Load Curtailment Reported Results**

Reporting Period <sup>1</sup>	Participants <sup>2</sup>	Reported Gross Energy Savings <sup>3</sup> (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction <sup>4</sup> (MW)	Total Reported Gross Demand Reduction <sup>4,5</sup> (MW)	Incentives (\$1,000)
PY4 Q1 + Q2	298	N/A	128.12	128.12	\$0
PY4 Q3	--	N/A	--	--	\$0
PY4 Q4	--	N/A	--	--	\$0
<b>PY4 Total</b>	<b>298</b>	<b>N/A</b>	<b>128.12</b>	<b>128.12</b>	<b>\$0</b>
<b>CPITD Total</b>	<b>298</b>	<b>N/A</b>	<b>128.12</b>	<b>128.12</b>	<b>\$0</b>
<b>NOTES:</b> 1. Events were called during Q1 and Q2, June–September 2012. 2. Participants are defined as distinct enrolled contracts. The PY4 participants total includes 200 participants who enrolled prior to PY4. 3. The Load Curtailment Program did not report energy savings. 4. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 5. The Load Curtailment Program did not report demand reduction outside the top 100 hours.					

**Table 11-2: Load Curtailment Reported Results by Sector**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings <sup>2</sup> (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction <sup>3</sup> (MW)	Total Reported Gross Demand Reduction <sup>3,4</sup> (MW)	Incentives (\$1,000)
Large Commercial and Industrial	144	N/A	120.42	120.42	\$0
Small Commercial	154	N/A	7.70	7.70	\$0
<b>PY4 Total</b>	<b>298</b>	<b>N/A</b>	<b>128.12</b>	<b>128.12</b>	<b>\$0</b>
<b>CPITD Total</b>	<b>298</b>	<b>N/A</b>	<b>128.12</b>	<b>128.12</b>	<b>\$0</b>
<b>NOTES:</b> 1. Participants are defined as distinct enrolled contracts. The PY4 participants total includes 200 participants who enrolled prior to PY4. 2. The Load Curtailment Program did not report energy savings. 3. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 4. The Load Curtailment Program did not report any demand reduction outside the top 100 hours.					

### 11.2.2 EM&V Sampling Approach

The EM&V CSP analyzed 290 electric meters included in contracts negotiated by the Implementation CSP with PPL Electric's customer participants. These 290 meters represented the entire population of meters with data sufficient for analysis and include both PPL's meters that collected data in sufficient detail for this program and special meters installed by the Implementation CSP for this program. Meters installed for participants who opted out of the program were not included in the final analysis.

**Table 11-3: Load Curtailment Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size <sup>1</sup>	Evaluation Activity
All	None	290	NA <sup>2</sup>	NA <sup>2</sup>	Census	290	Meter data analysis and engineering review
Program Total	None	290	NA <sup>2</sup>	NA <sup>2</sup>	Census	290	
<b>NOTES:</b> 1. Population size defined by the numbers of meters. 2. Since this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful.							

### 11.2.3 Ex Ante Adjustment Methodology and Findings

The implementation CSP (EnerNOC) provided *ex ante* savings for all participants and load curtailment events.

### 11.2.4 Ex Post Adjustment Methodology and Findings

The EM&V CSP verified *ex post* savings for PPL Electric's Load Curtailment Program by independently computing demand reduction using one of four methodologies, in compliance with PJM protocols:

- Five-day
- Five-day symmetric additive adjustment (SAA)
- Seven-day
- Seven-day symmetric additive adjustment (SAA) .

PPL Electric believes there are two ways to interpret the 2012 TRM when determining peak load reductions for the Load Curtailment Program and has shown both methods belowSection 4.0 of the 2012 TRM states:

“Hourly peak load reductions from demand response (DR) measures for Direct Load Control (DLC) and Load Curtailment (LC) will be determined in accordance with PJM measurement & verification protocols, related business rules, protocol approval processes and settlement clearing due diligence practices that will be in place during the 2012 summer period (June 1 - September 30, 2012), as verified by the EDC and reviewed by both the EDCs’ independent evaluators and the SWE.”

PPL Electric followed PJM measurement and verification protocols for the Act 129 Load Curtailment Program, but believes it is not possible to follow PJM’s “settlement clearing due diligence practices” for the Act 129 Load Curtailment Program. PPL Electric used PJM measurement and verification protocols (i.e., the difference between the customer’s actual load and baseline load) verbatim to determine the magnitude of the load change during each billing interval. In some of those intervals, the customer’s load increased relative to the baseline, when calculated in accordance with PJM M&V protocols. In accordance with the methodology specified in PPL Electric’s Load Curtailment CSP contract, those billing intervals with a load increase are set to zero (i.e., the Load Curtailment CSP and the customer did not participate in Act 129 Load Curtailment and were not paid for load reductions in that billing interval) for settlement purposes. The PUC/SWE believe that load increases in a billing interval should offset load reductions in other billing intervals during an event day, thereby decreasing Act 129 load peak load reductions.

PPL Electric believes its method (zeroing out load increases during billing intervals) to determine load curtailment savings is the correct approach for the following reasons:

1. PPL Electric’s Act 129 Load Curtailment Program followed the PJM protocols for determining the magnitude of the load change (difference between the customer’s baseline load and actual load).
2. PPL Electric believes it is impossible for the Act 129 Load Curtailment Program to follow all of the PJM settlement protocols and procedures. Therefore, PPL Electric used settlement (payment) procedures described in its PUC-approved EE&C Plan and Load Curtailment CSP contract. Here are some examples of PJM settlement protocols and procedures that PPL Electric believes are impossible to follow for Act 129:
  - i. PJM requires a day-ahead binding DR bid that does not fit PPL Electric’s Act 129 program requirements, does not comply with PPL Electric’s approved EE&C Plan, and does not comply with PPL Electric’s approved CSP contract. If PPL Electric would have required a binding, day-ahead commitment from customers for 50 – 100 hours in its Load Curtailment Program, no CSP would have bid, or the price would have been double or triple, and it is likely that an insufficient number of customers (MWs) would have enrolled.
  - ii. PJM imposes financial penalties if the CSP/customer does not meet its day-ahead DR bid (if there is a load increase in a meter interval). That does not fit the PPL Electric’s Act 129 program requirements, does not comply with PPL Electric’s approved EE&C Plan, and does not comply with PPL Electric’s approved CSP contract. If PPL Electric imposed penalties when the CSP/customer did not meet its binding DR (had a load increase in a

meter interval), no CSP would have bid, or the price would have been double or triple, and it is likely that an insufficient number of customers (MWs) would have enrolled.

- iii. PJM's DR payment is based on PJM's locational marginal price (LMP). PPL Electric's Act 129 DR program is based on a competitively bid firm price.
- iv. If the actual load reduction, compared to the desired load reduction (committed day-ahead), is outside the deviation levels, PJM assesses balancing operating reserve charges. The Act 129 Load Curtailment does not have a similar charge.
- v. PPL Electric's contract with the Load Curtailment CSP clearly states that settlement is based on five-minute meter intervals (hourly if the customer does not have a meter capable of five-minute data) and any load increases (negative reductions) during a billing interval are treated as "non-participation" in that billing interval and are set to zero. In other words, if the customer does not achieve a load reduction in the five-minute settlement period, the customer does not get paid, and PPL Electric claims a zero load reduction. The same rationale would apply if the settlement period were one hour. If a customer achieved a negative reduction (i.e., a load increase) in an hour, the customer did not achieve a reduction, the customer would not get paid, and PPL Electric would claim zero MW for that hour. Therefore, regardless of whether the settlement period is five minutes or one hour, a load increase in that settlement period is treated as zero (i.e., non-participation). Similarly, if PPL Electric calls for a load reduction and the customer chooses not to participate and the customer's load is greater than the customer's baseline, the reduction would be treated as 0 MW.

#### ***11.2.4.1 Five-Day Methodology***

The following steps describe the five-day process for determining potential baseline days, applying the 25% rule (described in Step 3), and calculating hourly-level demand impacts during event time.

##### ***Step 1: Define potential baseline days.***

- PJM protocols define a baseline day as any non-holiday, non-weekend, non-PPL-Electric event, non-PJM event day, which occurs within 45 days of an event.

##### ***Step 2: Choose the closest five potential basis days prior to each event date.***

- For each event, the EM&V CSP selected five baseline (basis) days prior to the event. The method is based on the PJM protocols described in Step 1.

##### ***Step 3: Apply 25% rule to validate five basis days.***

- The EM&V CSP calculated the mean kW for each of the five selected basis days (during hours corresponding to event) and then calculated the mean across all five basis days.

- If the mean kW for any day was less than 25% of the mean across all five days, the EM&V CSP selected the next potential basis day and started the 25% rule process again until the mean of all five basis days was greater than 25% of the mean across all five baseline days.

***Step 4: Select the four highest days based on mean kW.***

- The EM&V CSP calculated the mean kW during corresponding event hours for each of the five selected basis days, and selected the top four days.

***Step 5: Calculate the demand reduction for each event period five-minute interval.***

- The EM&V CSP subtracted the actual event period demand from the customer baseline (CBL)demand (calculated in Step 4) for each five-minute interval.
- If an individual five-minute interval reported negative demand reduction (that is, an increase in demand), then the interval savings were converted to 0<sup>39</sup>.)

***Step 6: Average the five-minute interval savings across each hour to determine hourly-level impacts.***

#### ***11.2.4.2 Five-Day Symmetric Additive Adjustment (SAA) Methodology***

The following steps describe the five-day SAA process for determining potential baseline days, applying the 25% rule, and calculating hourly-level demand impacts during event time.

***Step 1 – Step 4: Same as the five-day methodology.***

***Step 5: Compare the load curve of the average baseline (Step 4) to the actual event period load curve and apply the Symmetric Additive Adjustment (SAA).***

- The EM&V CSP calculated the SAA by individually averaging the five-minute intervals for both the average baseline and the actual event day for the time period that starts four hours before the start of the event and lasts three hours. For example, if the event started at noon, the EM&V CSP averaged the interval data from 8:00 a.m. to 11:00 a.m.
- The EM&V CSP subtracted the event day average from the baseline average to calculate the “additive adjustment.”
- The EM&V CSP added the “additive adjustment” to each baseline interval to create the SAA baseline.

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<sup>39</sup> Converting the interval to zero conforms with PPL Electric’s interpretation of the PJM protocol and method zeroing out load increases during billing intervals. To compute demand reduction according to the SWE’s interpretation of the PJM protocol, load increases would be retained at this step.

***Step 6: Calculate the demand reduction for each event period five-minute interval.***

- The EM&V CSP subtracted the actual event period demand from the SAA baseline demand (calculated in Step 5) for each five-minute interval.
- If an individual five-minute interval reported negative demand reduction, the interval's savings were converted to 0.<sup>40</sup>

***Step 7: Average the five-minute interval savings across each hour to determine hourly-level impacts.***

***11.2.4.3 Seven-Day Methodology and Seven-Day Symmetric Additive Adjustment (SAA) Methodology***

The seven-day methodology follows the same steps as the five-day method with the following exceptions:

- There are no weekend exclusions.
- Basis days are the previous three eligible same days of the week (e.g., if an event was called on a Monday then the basis days consisted of the three previous non-event Mondays).
- There is no high day selection.

For the seven-day SAA, the EM&V CSP performed Steps 5 through 7 described above for the five-day SAA.

Appendix I: Load Curtailment Five-Day Methodology illustrates the methodology described above for both the five-day method and the five-day symmetric additive adjustment (SAA) method. Examples of seven-day methods are not provided because, once baseline event days are obtained, the methods to calculate savings are identical to five-day methods.

**11.2.5 Savings Realization Rate Methodology**

The realization rate is the *ex post* evaluated savings or demand reduction expressed as a percentage of the *ex ante* adjusted savings or demand reduction. The EM&V CSP verified that *ex post* gross savings for the Load Curtailment program are 128.3 MW over the top 100 hours of PPL Electric system demand. The

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<sup>40</sup> See prior footnote.

*ex ante* savings provided by the implementation CSP (EnerNOC) are 128.2 MW, and the realization rate is 100.1%.<sup>41</sup>

### 11.2.6 Summary of Evaluation Results

The Load Curtailment Program targeted demand reduction only. No energy savings were claimed in this program.

There were two sites in which *ex ante* and *ex post* savings differed significantly. In one case, the discrepancy existed on only one event day. For the second, discrepancies occurred in all event day hours.

**Table 11-4: PY4 Load Curtailment Summary of Evaluation Results for Demand (Top 100 Hours) Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate	Observed Coefficient of Variation (C <sub>v</sub> ) or Proportion	Relative Precision	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
Program Total <sup>4</sup>	128.12	133.73	88.4%	NA <sup>3</sup>	NA <sup>3</sup>	118.2	--
Program Total (Alt) <sup>5</sup>	128.12	133.73	100.1%	NA <sup>3</sup>	NA <sup>3</sup>	133.9	--
<b>NOTES:</b> 1. Reported gross demand reductions do not include the gross-up to reflect T&D losses. 2. TRM Adjusted <i>Ex Ante</i> and Verified gross demand reductions include T&D losses. 3. Because this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful. 4. Uses PUC/SWE methodology to determine Verified Gross Demand Reduction. Refer to discussion in section 11.2.4 for more information. 5. Uses PPL's interpretation of the TRM to determine reported gross demand reduction. Refer to discussion in section 11.2.4 for more information.							

### 11.3 Impact Evaluation Net Savings

The Statewide Evaluator conducted an analysis examining net savings and filed a separate report. The SWE developed the survey instrument and analysis methodology. The targeted number of surveys was 19, to meet 80% confidence and 20% precision. A total of 17 surveys were completed. The EM&V CSP conducted the surveys but did not conduct an independent analysis of net savings.

### 11.4 Process Evaluation

Demand reduction targets were required only in PY4. The program was not included in the Phase II portfolio of programs. For these reasons, the EM&V CSP did not conduct a process evaluation for this program.

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<sup>41</sup> These MW values have not yet been grossed-up to reflect T&D losses.

## 11.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs. A breakdown of the program finances is presented in **Table 11-5**.

**Table 11-5: Summary of Load Curtailment Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants <sup>1</sup>	\$0	\$0	\$0
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
Design and Development	\$0	\$0	\$0
Administration <sup>2</sup>	\$0	\$0	\$0
Management <sup>3</sup>	\$1	\$5,980	\$10,076
Marketing <sup>4</sup>	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$1</b>	<b>\$5,980</b>	<b>\$10,076</b>
<b>EDC Evaluation Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>SWE Audit Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total EDC Costs<sup>5</sup></b>	<b>\$1</b>	<b>\$5,980</b>	<b>\$10,076</b>
<b>Participant Costs<sup>6</sup></b>	<b>N/A</b>	<b>\$0</b>	<b>\$0</b>
<b>Total TRC Costs<sup>7,8</sup></b>	<b>N/A</b>	<b>\$5,980</b>	<b>\$8,271</b>
Total Lifetime Energy Benefits <sup>8</sup>	N/A	N/A	N/A
Total Lifetime Capacity Benefits <sup>8</sup>	N/A	\$5,149	\$4,087
<b>Total TRC Benefits<sup>9,8</sup></b>	<b>N/A</b>	<b>\$5,149</b>	<b>\$4,087</b>
<b>TRC Ratio<sup>10,8</sup></b>	<b>N/A</b>	<b>N/A</b>	<b>0.49</b>
<b>Load Curtailment Alternative Methodology<sup>11</sup></b>			
<b>Total TRC Costs<sup>7,8</sup></b>	<b>N/A</b>	<b>\$5,980</b>	<b>\$8,271</b>
Total Lifetime Energy Benefits <sup>8</sup>	N/A	N/A	N/A
Total Lifetime Capacity Benefits <sup>8</sup>	N/A	\$5,831	\$4,628
<b>Total TRC Benefits<sup>9,8</sup></b>	<b>N/A</b>	<b>\$5,831</b>	<b>\$4,628</b>
<b>TRC Ratio<sup>10,8</sup></b>	<b>N/A</b>	<b>N/A</b>	<b>0.56</b>
<b>NOTES</b>			



*Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.*

7. PPL pays the CSP to deliver the program. The CSP determines and pays incentives to participants. In accordance with the TRC Order, CSP payments to participants are treated as a program management expense, not an incentive.
8. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
9. Includes EDC program management, CSP program management, general management oversight, and major accounts.
10. Includes the marketing CSP and marketing costs by program CSPs.
11. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
12. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
13. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.
14. CPITD value is discounted to PY1.
15. 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.
16. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.
17. Uses PPL's interpretation of the TRM to determine reported gross demand reduction. Refer to discussion in section 11.2.4 for more information.

## 12 Renewable Energy Program

The Renewable Energy Program (closed to new applicants in PY3) encouraged PPL Electric customers to install a solar photovoltaic (PV) array or ground-source heat pump (GSHP) at their home or institutional building. This program offered a financial incentive in the form of a rebate that reduced up-front system costs. Customers were also encouraged to reduce their load by installing applicable energy-efficiency measures prior to installing a renewable energy system.

The objectives of the Renewable Energy Program were:

- Encourage customers to install renewable energy equipment.
- Promote other PPL Electric EE&C programs.
- Achieve energy and demand reduction.

### 12.1 Program Updates

In PY4, the Renewable Energy Program provided incentives to nine institutional GSHP projects that reserved incentives before the program closed. The program closed after exhausting funding.

### 12.2 Impact Evaluation Gross Savings

#### 12.2.1 Reported Gross Savings

**Table 12-1** shows the reported results by quarter. The Renewable Energy Program closed to new applications in PY3 and only nine projects were completed and rebated in PY4. These projects joined the wait list before the program's end date and finalized their applications in PY4 once installation was complete. No projects received rebates in PY4 Q4.

**Table 12-1: CPITD Renewable Energy Program Reported Results by Quarter**

Reporting Period	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	23	77.8	0.034	0.034	\$6
PY4 Q2	24	357.5	0.182	0.182	\$183
PY4 Q3	69	424.2	0.016	0.049	\$231
PY4 Q4	0	0	0	0	\$0
<b>PY4 Total</b>	<b>116</b>	<b>859.5</b>	<b>0.232</b>	<b>0.265</b>	<b>\$420</b>
<b>CPITD Total</b>	<b>1,946</b>	<b>14,705</b>	<b>2.53</b>	<b>2.56</b>	<b>\$5,427</b>
<b>NOTES:</b>					
1. Participants refer to unique accounts.					

**Table 12-2** shows reported results by sector. Rebates were provided only to government, non-profit, and institutional (GNI) customers during PY4.

**Table 12-2: Renewable Energy Program Reported Results by Sector**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Government, Non-Profit, Institutional	116	859.5	0.232	0.265	\$420
<b>PY4 Total</b>	<b>116</b>	<b>859.5</b>	<b>0.232</b>	<b>0.265</b>	<b>\$420</b>
<b>CPITD Total</b>	<b>1,946</b>	<b>14,705</b>	<b>2.53</b>	<b>2.56</b>	<b>\$5,427</b>
<b>NOTES:</b>					
1. Participants refer to unique accounts.					

### 12.2.2 EM&V Sampling Approach

**Table 12-3** shows the sampling strategy for PY4. The EM&V CSP designed the sample to meet 85/15 confidence and precision (C/P) at the program level. However, all projects were included in the records reviews because some of the data required for calculating savings were not always available within the records (e.g., sometimes the GSHP manufacturer and model number was incorrect and the system capacity or efficiency could not be verified). Requesting records for all projects ensured that data were available to calculate savings for at least seven projects, necessary to meet the C/P target.

During Q3, the EM&V CSP conducted site visits for five sites to collect information about the size of the circulating pump and to collect any other missing information in the records (e.g., three sites were missing the manufacturer name, which was entered in EEMIS as “N/A”). The EM&V CSP did not conduct surveys for this program in PY4.

**Table 12-3: Renewable Energy Program Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
GSHP	GSHP Projects	9	0.5	85/15	9	8	Records review
					5	5	Site visits
<b>Program Total</b>	<b>GSHP Projects</b>	<b>9</b>	<b>0.5</b>	<b>85/15</b>	<b>9</b>	<b>8</b>	<b>Records review</b>
					<b>5</b>	<b>5</b>	<b>Site visits</b>

Two savings adjustments were necessary to calculate a realization rate. The first results in the TRM-adjusted *ex ante* savings. The second results in the *ex post* verified savings. Both methodologies are explained below.

### **12.2.3 Ex Ante Adjustment Methodology and Findings**

The adjusted *ex ante* savings amended the savings reported in EEMIS (TRM adjusted *ex ante* savings) based on actual customer system characteristics, truing up the *ex ante* using the algorithms in the TRM. This adjustment accounted for differences between deemed planning assumptions used to report savings and installed equipment. It relied solely on information and records in the EEMIS tracking database. These adjustments resulted in the adjusted *ex ante*, bringing the reported savings into alignment with the TRM.

For GSHP, the PY4 EEMIS tracking database reported savings calculated based on capacity and efficiency values found in the customer's application. TRM *ex ante* adjustments were made for location, building type, and energy consumption of the ground loop pump. The EM&V CSP accounted for the location variation of all program participants in the adjusted *ex ante* savings by mapping ZIP codes to the TRM reference tables. The EM&V CSP then looked up the EFLH values corresponding to the building type reported in EEMIS. The EM&V CSP made assumptions about the size of the ground loop pump based on site visit data collected in PY2 through PY4 and took into account the energy consumption of this pump during the *ex ante* savings adjustments. This pump consumption is not taken into account in the reported savings.

### **12.2.4 Ex Post Adjustment Methodology and Findings**

To calculate the realization rate, the EM&V CSP verified installation rates and qualifying equipment using records data and site visits.

During records reviews for GSHPs, the EM&V CSP verified capacities, EER values, and coefficient of performance (COP) values using the AHRI database<sup>42</sup> for systems with valid manufacturer and model numbers. For a sample of five projects, the EM&V CSP conducted site visits to verify that the reported equipment type and quantity were installed, and collected information about the size of the ground loop pump.

### **12.2.5 Savings Realization Rate Methodology**

Adjustments reflect the results of M&V activities and are included in the *ex post* evaluated savings. The realization rate is the ratio of the evaluated *ex post* savings to the adjusted *ex ante* savings.

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<sup>42</sup> <http://www.ahridirectory.org/ahridirectory/pages/wbahp/defaultSearch.aspx>

## 12.2.6 Summary of Evaluation Results

Table 12-4 and Table 12-5 summarize the evaluation results for energy and demand reduction for the Renewable Energy Program.

**Table 12-4: PY4 Renewable Energy Program Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Savings (MWh/yr)	Energy Realization Rate	Error Ratio	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
All	860	798	72%	0.44	9.8%	578	--
<b>Program Total</b>	<b>860</b>	<b>798</b>	<b>72%</b>	<b>0.44</b>	<b>9.8%</b>	<b>578</b>	<b>--</b>
<b>NOTES:</b>							
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.							

**Table 12-5: PY4 Renewable Energy Summary of Evaluation Results for Demand (Top 100 Hours)**  
**Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Error Ratio	Relative Precision	Verified Gross Demand Reduction <sup>2</sup> (MW)	Unverified Gross Demand Reduction (MW)
All	0.232	0.467	78%	0.67	14.9%	0.363	--
<b>Program Total</b>	<b>0.232</b>	<b>0.467</b>	<b>78%</b>	<b>0.67</b>	<b>14.9%</b>	<b>0.363</b>	<b>--</b>
<b>NOTES:</b>							
6. Reported gross demand reductions do not include the gross-up to reflect T&D losses.							
7. <i>Ex Ante</i> and Verified gross demand reductions include T&D losses.							
8. The realization rate is implied from program level analysis. No realization rate was computed for just the top 100 hours.							

For institutional GSHP PY4 projects, the realization rate was 72% ± 9.8% for energy savings and 78% ± 14.9% for peak demand reduction, with 90% confidence.

The EM&V CSP verified the heating capacity, cooling capacity, EER, and COP by looking up the systems in the AHRI database. Often, the capacity and efficiency values reported in EEMIS corresponded to a ground water source heat pump (GWSHP) application of the same system that has a higher capacity and higher efficiency values than the corresponding ground loop heat pump (GLHP) application. The GLHP values were used for calculating the verified savings, as this is the most common system type.

Two projects in particular contributed to the energy and demand realization rates. For the first project, the reported efficiency values were much higher than the verified values. The average reported EER value across all systems installed at the site was 18.7, while the average verified EER value was 14.6. The average reported COP value was 3.7 and the average verified EER value was 3.2. At the other site,

negative energy savings were found after adjusting for the capacity, efficiency, and accounting for the energy consumption of the ground loop pump. This site was not visited, so negative savings could be a result of the EM&V CSP's assumption about the size or efficiency of the ground loop pump. However, this result is partly because one system at the site that had a heating efficiency less than the baseline efficiency from the TRM.

### **12.3 Impact Evaluation Net Savings**

The EM&V CSP did not conduct surveys in PY4 to assess net-to-gross, as the number of participants was small and the program will not be continued in Phase II.

### **12.4 Process Evaluation**

The EM&V CSP did not conduct a process evaluation for the Renewable Energy Program during PY4 because this program has ended and will not be continued under Phase II.

## 12.5 Financial Reporting

All cost data shown below are through August 31, 2013. As described in the note for Table 1-10, PPL Electric expects some additional costs and adjustments subsequent to August 31, 2013. These are expected to have a negligible impact on the accuracy of TRC values for the portfolio and for individual programs.. A breakdown of the program finances is presented in **Table 12-6**.

**Table 12-6: Summary of Renewable Energy Program Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$0	\$420	\$5,427
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$0</b>	<b>\$420</b>	<b>\$5,427</b>
Design and Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2</sup>	\$1	\$1	\$203
Marketing <sup>3</sup>	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>\$1</b>	<b>\$1</b>	<b>\$203</b>
<b>EDC Evaluation Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>SWE Audit Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total EDC Costs<sup>4</sup></b>	<b>\$1</b>	<b>\$421</b>	<b>\$5,630</b>
<b>Participant Costs<sup>5</sup></b>	<b>N/A</b>	<b>\$5,872</b>	<b>\$68,178</b>
<b>Total TRC Costs<sup>6,7</sup></b>	<b>N/A</b>	<b>\$6,293</b>	<b>\$67,264</b>
Total Lifetime Energy Benefits <sup>7</sup>	N/A	\$689	\$19,913
Total Lifetime Capacity Benefits <sup>7</sup>	N/A	\$128	\$1,312
<b>Total TRC Benefits<sup>8,7</sup></b>	<b>N/A</b>	<b>\$816</b>	<b>\$21,225</b>
<b>TRC Ratio<sup>9,7</sup></b>	<b>N/A</b>	<b>0.13</b>	<b>0.32</b>

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Includes the marketing CSP and marketing costs by program CSPs.
4. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
5. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.
6. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.

7. CPITD value is discounted to PY1.
8. 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.
9. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.



## 13 HVAC Tune-Up Program

The HVAC Tune-Up Program is offered to all small commercial and industrial (C&I) customers with an existing split or packaged HVAC rooftop unit (RTU). Owners or tenants occupying existing buildings are the primary recipients of program services.

The HVAC Tune-Up Program is designed to increase the operating performance of small rooftop HVAC and split-system units in light commercial buildings. The efficiency opportunities include three main areas: refrigeration measures; economizer measures; and, thermostat measures.

The program offers financial incentives to contractors to help offset the cost of diagnosing the HVAC system and making energy-saving retrofits. Participating contractors use the Service Assistant™ diagnostic tool to analyze the HVAC system. This tool records and reports diagnostic data that are used to track work completed, and these data are reported by the program implementer. The program implementer also uses these data to estimate the energy savings for each measure reported.

### 13.1 Program Updates

After three years of operation, the HVAC Tune-Up Program is far behind its original planned savings and participation goals.<sup>43</sup> PPL Electric updated its EE&C Plan for PY3 and PY4 (Docket No. M-2009-2093216) and requested a change in the HVAC Tune-Up Program expectations to reflect the low participation.

Because of the low participation, HVAC contractors were eligible for additional incentives after they serviced their first 50 qualifying units. Incentives were capped at a total of \$3,000 per contractor. Incentives offered were: 30 each for 51 through 100 units; \$50 each for 101 through 120 units; and, \$70 each for 121 through 140 units.

In addition to these incentives, an incentive of \$500 was offered for every 12 thermostat replacement measures completed, up to a maximum of \$1,000 per contractor. The program is not promoted directly to end-use customers. These changes were promoted at the end of PY3. No additional changes were made in PY4; the program was open to contractors to continue participation but was not promoted because of continued lack of success from year to year. Measures were reported in Q1 and Q2 of PY4. Although contractors could have continued participation through May of 2013, there were no measures reported in 2013.

### 13.2 Impact Evaluation Gross Savings

#### 13.2.1 Reported Gross Savings

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<sup>43</sup> The original goals planned for 5,770 customers through 2013, with a total reduction of 22,180 MWh and 11 MW.

**Table 13-1** breaks out the program’s participation, savings, and incentives by quarter through the end of PY4. The number of measures listed represents the number of incentives provided. Measures included diagnostic test-in, economizer test and adjustment, refrigerant charge adjustment, and thermostat replacement. The number of participants listed in **Table 13-1** represents the number of measures for which incentives were offered. One HVAC system may receive more than one incentive. A participant is defined as a rebated measure (either refrigerant charge adjustment, economizer repair, thermostat installation).

**Table 13-1: CPITD HVAC Tune-Up Reported Results by Quarter**

Reporting Period	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY4 Q1	142	219.5	.00068	0.01	\$7
PY4 Q2	132	144.5	.002	0.06	\$12
PY4 Q3	0	0	0	0	\$2
PY4 Q4	0	0	0	0	\$0
<b>PY4 Total</b>	<b>274</b>	<b>364</b>	<b>.00268</b>	<b>0.070</b>	<b>\$21</b>
<b>CPITD Total</b>	<b>1707</b>	<b>1649</b>	<b>1.08</b>	<b>1.15</b>	<b>\$69</b>
<b>NOTES:</b>					
1. Participants refer to the number of measures. 106 HVAC units received measures.					

**Table 13-2** shows the number of units receiving various measures. Contractors receive a \$25 rebate for conducting diagnostic test, but if the unit does not require service, no work is performed. There was only one unit where this was the case though. There were four economizer measures that were “test only” and did not receive service.

**Table 13-2: Number of Units Receiving Measures**

Measure Mix	Occurrence	Number of Measures per Unit	Total Number of Measures
Test-in only	1	1	1
Test-in and Economizer	2	2	4
Test-in, T-stat (2 per unit)	3	4	12
Test-in, Refrigerant charge	36	2	72
Test-in, Refrigerant charge, T-stat (2 per unit)	7	4	28
Test-in, Economizer, Refrigerant charge	26	3	78
Test-in, Economizer, Refrigerant charge, T-stat (2 per unit)	12	5	60
Economizer Only	19	1	19
<b>Total</b>	<b>106</b>		<b>274</b>

**Table 13-3** shows the cumulative reported results by sector through the end of PY4. No rebates were provided to GNI customers during PY4.

**Table 13-3: HVAC Tune-Up Reported Results by Sector**

Sector	Participants <sup>1</sup>	Reported Gross Energy Savings (MWh/yr)	Top 100 Hours Reported Gross Demand Reduction (MW)	Total Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Small Commercial and Industrial	239	316	.00268	0.0470	\$9
Large Commercial and Industrial	35	48	0	.023	\$11
<b>PY4 Total</b>	<b>274</b>	<b>364</b>	<b>.00268</b>	<b>0.070</b>	<b>\$21</b>
<b>CPITD Total</b>	<b>1707</b>	<b>1649</b>	<b>1.08</b>	<b>1.15</b>	<b>\$69</b>
<b>NOTES:</b>					
1. Participants refer to the number of measures. 106 HVAC units received measures.					

### 13.2.2 EM&V Sampling Approach

The EM&V CSP determined realization rates for the PY4 HVAC Tune-Up Program through EEMIS records reviews, contractor interviews from PY2 with updated participation data from PY4, and an engineering review of data. The energy and demand reduction resulting from tune-up measures were estimated using contractor-reported measurements, which serve as inputs to the implementation CSP's

proprietary savings estimator. The EM&V CSP reviewed all measurement and savings data reported in PY4 for errors and reasonableness of savings.

The sampling strategy for the HVAC Tune-Up Program records reviews is presented in **Table 13-4**.

**Table 13-4: HVAC Tune-Up Sampling Strategy for PY4**

Stratum	Strata Boundaries	Population Size <sup>1</sup>	Assumed Coefficient of Variation (C <sub>v</sub> ) or Proportion in Sample Design	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
ALL	None	274	N/A <sup>2</sup>	N/A <sup>2</sup>	Census	274	Engineering desk review, data tracking review
<b>Program Total</b>	<b>None</b>	<b>274</b>	<b>N/A<sup>2</sup></b>	<b>N/A<sup>2</sup></b>	<b>Census</b>	<b>274</b>	
<b>NOTES:</b> 1. Population size refers to the number of measures. 2. Since this program's evaluation did not include sampling, C <sub>v</sub> and precision are not meaningful.							

The evaluation included a full database review of all measures (covering a census of PY4 program participants), so the final savings estimate is not subject to sampling error. For this reason, a discussion of the sampling precision of the verified savings total is not warranted.

### 13.2.3 Ex Ante Adjustment Methodology and Findings

The third-party implementation CSP, Field Diagnostic Services, Inc., (FDSI) provided several documents that contained energy-savings calculations and an overview of the proprietary Savings Estimator Program. One of the documents, *Estimating Efficiency and Capacity for Vapor Compression Cycle Equipment Calculation Algorithms*, clarified the methods used to estimate compressor capacity and COP described in U.S. Patent No. 6,701,725. The EM&V CSP used the expected performance and measured performance values to develop an efficiency index and a capacity index.

The EM&V CSP completed a calculation review of these indices to evaluate savings from tune-ups. In PY2, these indices were independently calculated for comparison and to assess the reasonableness of *ex ante* reported savings values. There was no change to the methodology the implementation CSP used to estimate *ex ante* savings in PY4. Because the reported savings were found reasonable and were used for PY2 and PY3, no additional review was completed for the PY4 evaluation. The EM&V CSP accepts the *ex ante* reported savings for refrigerant charge adjustment because savings are calculated from pre- and

post-measurement primary data and algorithms verified in the PY2 evaluation. The algorithms verified use efficiency improvement for each individual tune-up based on detailed diagnostic measurements.<sup>44</sup>

#### **13.2.4 Ex Post Adjustment Methodology and Findings**

The EM&V CSP discovered and resolved deficiencies in records during the first review of all PY4 reported data.

#### **13.2.5 Savings Realization Rate Methodology**

The PY2 evaluation revealed that FDSI's energy-savings calculation methodology is sound and rigorous. The same methodology was used in PY4. The EM&V CSP conducted an engineering review of all reported measures to verify savings claimed in PY4. This included reviewing contractor-recorded measurements and setpoints. The realization rate was calculated as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

#### **13.2.6 Summary of Evaluation Results**

In PY4, the HVAC Tune-Up Program realized 100% of the *ex ante* adjusted energy savings, as shown in **Table 13-5**. The majority of energy and demand reduction are attributable to the small C&I sector.

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<sup>44</sup> The 2012 TRM provides a savings algorithm for refrigerant charge adjustment based on a 2003 California RTU survey. This is one of three measures offered through the program and cannot be used to estimate savings for this program. In addition, the TRM algorithm for refrigerant charge adjustment correlates savings to percent change in mass of refrigerant, a metric that is not tracked by the program. There are no commercial economizer or programmable thermostat measures in the 2012 TRM. A program refrigeration measure often includes more than just refrigerant charge adjustment. It can include coil cleaning, air filter changes, airflow adjustment –all measures which improve efficiency. Therefore the EM&V CSP uses the implementation CSP's estimated savings, based on actual test data.

**Table 13-5: PY4 HVAC Tune-Up Summary of Evaluation Results for Energy<sup>1</sup>**

Stratum	Reported Gross Energy Savings (MWh/yr)	TRM Adjusted <i>Ex Ante</i> Energy Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation ( $C_v$ ) or Proportion	Relative Precision	Verified Gross Energy Savings (MWh/yr)	Unverified Gross Energy Savings (MWh/yr)
All	364	364	100%	N/A <sup>2</sup>	N/A <sup>2</sup>	364	--
Program Total	364	364	100%	N/A <sup>2</sup>	N/A <sup>2</sup>	364	--

**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. Because this program's evaluation did not include sampling,  $C_v$  and precision are not meaningful.

**Table 13-6: PY4 HVAC Tune-Up Summary of Evaluation Results for Demand (Top 100 Hours) Stratum**

Stratum	Reported Gross Demand Reduction <sup>1</sup> (MW)	TRM Adjusted <i>Ex Ante</i> Demand Reduction <sup>2</sup> (MW)	Demand Reduction Realization Rate <sup>3</sup>	Observed Coefficient of Variation ( $C_v$ ) or Proportion	Relative Precision	Verified Gross Demand Reduction (MW)	Unverified Gross Energy Savings (MW)
All	.00268	.00268	100%	N/A <sup>4</sup>	N/A <sup>4</sup>	.00268	--
Program Total	.00268	.00268	100%	N/A <sup>4</sup>	N/A <sup>4</sup>	.00268	--

**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. The realization rate is implied from program level analysis.
4. Because this program's evaluation did not include sampling,  $C_v$  and precision are not meaningful.

### **13.3 Impact Evaluation Net Savings**

#### **13.3.1 Net-to-Gross Ratio Methodology**

No participant contractor surveys were conducted in PY4. The NTG ratio in PY4 was calculated using PY2 research which assessed freeridership by identifying contractors who were already using a diagnostic tool like the tool required by the program. These contractor interviews in PY2 assessed each individual contractor's level of free-ridership.

#### **13.3.2 Net-to-Gross Ratio Findings**

Only one contractor was considered a freerider in PY2, and that contractor did not participate in PY4. No additional freeridership assessment was conducted in PY4. Results from PY2 were used to estimate the NTG ratio, which is 1.0.

### **13.4 Process Evaluation**

This program did not achieve participation or savings after Q2, and contributed very little to the Phase I portfolio. The program is not included in the Phase II portfolio. For these reasons, no process evaluation was conducted in PY4.

## 13.5 Financial Reporting

All cost data shown below are through August 31, 2013.. According to PPL Electric's tune-up program manager, the implementation contractor was not charging administration costs in PY4 because participation did not meet contractual obligations. A breakdown of the program finances is presented in **Table 13-7**.

**Table 13-7: Summary of HVAC Tune-Up Program Finances**

	<b>IQ (\$1,000)</b>	<b>PYTD (\$1,000)</b>	<b>CPITD (\$1,000)</b>
EDC Incentives to Participants	\$0	\$21	\$69
EDC Incentives to Trade Allies	\$0	\$0	\$0
<b>Subtotal EDC Incentive Costs</b>	<b>\$0</b>	<b>\$21</b>	<b>\$69</b>
Design and Development	\$0	\$0	\$0
Administration <sup>1</sup>	\$0	\$0	\$0
Management <sup>2,3</sup>	-\$56	-\$52	\$675
Marketing <sup>4</sup>	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
<b>Subtotal EDC Implementation Costs</b>	<b>-\$56</b>	<b>-\$52</b>	<b>\$693</b>
<b>EDC Evaluation Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>SWE Audit Costs</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total EDC Costs<sup>5</sup></b>	<b>-\$56</b>	<b>-\$31</b>	<b>\$762</b>
<b>Participant Costs<sup>6</sup></b>	<b>N/A</b>	<b>\$1</b>	<b>\$18</b>
<b>Total TRC Costs<sup>7,3,8</sup></b>	<b>N/A</b>	<b>-\$27</b>	<b>\$721</b>
Total Lifetime Energy Benefits <sup>8</sup>	N/A	\$113	\$481
Total Lifetime Capacity Benefits <sup>8</sup>	N/A	\$13	\$143
<b>Total TRC Benefits<sup>9,8</sup></b>	<b>N/A</b>	<b>\$126</b>	<b>\$624</b>
<b>TRC Ratio<sup>10,8</sup></b>	<b>N/A</b>	<b>N/A<sup>11</sup></b>	<b>0.87</b>

### NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cost Test Order approved July 28, 2011. Please see the "Report Definitions" section of this report for more details.

1. Includes the administrative CSP (rebate processing), tracking system, and general administration and clerical cost.
2. Includes EDC program management, CSP program management, general management oversight, and major accounts.
3. Negative IQ and PYTD costs due to PPL internal cost adjustment.
4. Includes the marketing CSP and marketing costs by program CSPs.
5. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
6. Per the 2011 Total Resource Cost Test Order, the net Participant Costs are the costs for the end-use customer.



7. Total TRC Costs includes EDC Evaluation Costs, Total EDC Costs and Participant Costs.
8. CPITD value is discounted to PY1.
9. 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.
10. TRC Ratio equals Total TRC Benefits divided by Total TRC Costs.
11. N/A due to negative Total TRC Cost.

## Appendix A: PY4 Verification Sampling

This appendix describes the PY4 verification sampling plan the EM&V CSP (Cadmus) developed early in PY4. The sampling plan was based on PY3 participation rates and verification results, realization rates, and coefficient of variation and/or sampling error. The actual application of the sampling plan for each program in PPL Electric's portfolio is described in the body of this annual report.

### Sampling Guidelines

In November 2010, the SWE provided *Sampling Resolutions*, a set of guidelines that established revised and refined sampling protocols for ACT 129 programs. Guidelines were refined by SWE in February, 2011. The EM&V CSP sampling plans align with and exceed the SWE directives.

SWE's sampling guidelines require confidence and precision targets in five areas:

1. 90/10 for Residential Portfolio
2. 90/10 for Non-Residential Portfolio
3. 85/15 for each Program within each Portfolio
4. Government/Non Profit and Low Income sector populations should be treated as independent program populations (and sampled at 85/15) if their contribution to the respective sector level portfolios is >20%
5. All C/P levels are minimum levels. EDC evaluators are encouraged to exceed minimum requirements

### PPL Electric Programs

There are 12 programs in PPL Electric's portfolio approved in the EE&C Plan that claimed savings in PY4. The programs included two expressly targeting demand reduction. The portfolio includes a number of programs that serve multiple sectors.

### Participant Definitions

Participants are defined differently by program, as shown in **Table A-1**. For some, there is one job identification number (CSP Job Number) per customer, defined by their billing account number. These include, for example, Consumer Behavior and Education, WRAP, and E-PowerWise. For other programs, e.g., Efficient Equipment, each rebate form processed receives a CSP Job Number. Households can submit more than one rebate form. Each rebate form can include one measure or multiple measures. In addition, each rebate form and CSP Job Number could report one or more than one installation of the same measure. The participant definitions are summarized by program in **Table A-1**.

**Table A-1: PY4 Participant Definition by Program**

Program	Participant Definition	Can there be more than one measure per CSP Job Number?	Sample Defined By:
Appliance Recycling	CSP job number (unique rebates).	Yes	CSP job number
CFL Lighting Campaign	Number of CFLs discounted by the program, divided by average number of bulbs per purchase at the store, determined through surveys.	NA; upstream discount	Survey responses
Consumer Behavior & Education	Household (unique account number).	No	Account number
Efficient Equipment	CSP job number (unique rebate application).	Yes	CSP job number, account number
Efficient Equipment lighting	Project (unique account number; multiple measures per project submitted on the same rebate form/Appendix C).	Yes	Project – determined by CSP job number, account number
Efficient Equipment—Direct Discount	Project (unique account number; multiple measures per project submitted on the same rebate form/Appendix C).	Yes	Project – determined by CSP job number, account number
Energy Assessment and Weatherization	CSP job number (unique rebate application) by type of energy assessment (survey, audit all electric, audit CAC only). Multiple measures can be recommended and/or claimed per assessment.	Yes	CSP job number, account number
Renewable Energy	Bill Account number (one location per bill account number) Program closing PY4	Yes	account number
Act 129 WRAP	Household (unique account number): 1 CSP job number. Savings were deemed by job type regardless of the number of measures installed.	No	Account number, job number
E-Power Wise	Household (unique account number): 1 energy kit per CSP job number. The energy kit includes multiple measures, but there is one kit per household.	No	Account number, CSP job number
HVAC Tune-Up	Individual roof top units (RTU) that received some type of incentive. This includes only diagnostic test-in in some cases (determined using account number, site ID, unit ID). Multiple RTU per account number/address. Not all units received the same services/measures.	No, but multiple Job Numbers per RTU	Account number, Site ID, Unit ID CSP job number,
Custom Incentive Program	Project level identifier; can include multiple measures	Yes	Project - Job number
Direct Load Control	Unique account number (household or business).	No	Account number, CSP job number
Load Curtailment	Unique business (project contract).	No	Project - Job number

## **PY4 Evaluation Activities**

Evaluation activities and measure verification include records review (desk audits), participant surveys, site visits to a sample of nonresidential participants, and metering where appropriate. The records reviews also play a primary role in QA/QC. Where metering was conducted, the sample was nested within site visits. Site visits, by their nature, include records review. **Table A-2** shows the evaluation activities for each of the programs that claimed savings in PY4. Nonparticipant surveys were conducted for select programs to collect information for the net savings adjustments.

**Table A-2: PY4 Evaluation Activities**

Programs	Sectors	Records Review	Participant Surveys	Non-participant Surveys	Site Visits	Metering
Appliance Recycling	Residential	Census -- Quarterly	Q3	NA	NA	NA
Residential Lighting (CFL)	Residential	Census -- Quarterly	Q3		NA	NA
Consumer Behavior & Education	Residential	Census -- Quarterly	Q3	Q3	NA	NA
Efficient Equipment	Residential	Quarterly	Q3	NA	NA	NA
Energy Assessment and Weatherization	Residential	Quarterly	Q3	NA	NA	NA
Low Income WRAP	Residential low income	Census to identify duplicates Quarterly, prorated by job type	NA	NA	NA	NA
E-Power Wise	Residential low income	Census database, Quarterly	NA	NA	NA	NA
Renewable Energy	Government/Non-profit	Program closed; census of remaining GSHP projects	NA	NA	NA	NA
Efficient Equipment non-lighting	Non-residential	Batched	Q3	NA	Batched	NA
Efficient Equipment lighting	Non-residential	Quarterly	Q3	NA	Quarterly	As needed
Efficient Equipment Direct Discount	Small commercial	Quarterly	Q3	NA	Quarterly	NA
HVAC Tune-Up	Small commercial	Census at program end	NA	NA	NA	NA
Custom Incentive Program	Commercial & Industrial	Census large stratum projects Sample small stratum projects	Q3, Q4	NA	As needed	As needed
Direct Load Control	Residential, Commercial	Census of metered units included in the analysis	Q3	NA	NA	By CSP
Load Curtailment	Commercial & Industrial	Census of data included in the analysis	Q3	NA	NA	By CSP

## Sample Size Specifications

The PY4 sample targets shown in **Table A-3** are designed to meet 90% confidence and 10% precision by portfolio sector (residential and non-residential). Sampling targets were designed in accordance to the SWE Guidance Memo 0003, *Sampling Resolutions*, issued in November 2010 and revised in February 2011.

For purposes of defining sample sizes according to the SWE Guidance Memo, each sector was considered first, and each program within the sector considered second.

Verification samples met or exceeded required rigor levels of 90/10 for the residential, non-residential, and low income segments. Generally, sample sizes meeting 90/10 were maximized at 68-70 sample points (using 0.5 CV).

Sample sizes by program met or exceeded rigor levels designed to meet 85% confidence and 15% precision (85/15). Generally, sample sizes meeting 85/15 are maximized at 20-25 sample points (using 0.5 CV). Samples in the following tables either met or were rounded up to meet or exceed this target. The government/non-profit sector meets or exceeds 85/15.

PY4 initial sample sizes were derived considering PY3 participation and verification realization rates and Cv. Samples will be reviewed each quarter to adjust the measure mix or prorate by measure or sector, as appropriate for the program and sector. Final verification samples were revised (were needed) in PY4 Q4, considering participation in all measure groups.

**Table A-3: PY4 Annual Sampling Strategy by Program**

Programs	PY3 CoV or Error Ratio	PY3 Participation Population Used to determine PY3 sample	PY4 Planned Confidence & Precision	PY4 Records Review	PY4 Participant Surveys	PY4 Site Visits	Notes
Appliance Recycling	21%	12,948 (unique CSP job numbers)	85/15	Census (Quarterly Review)	70 participants (Planned Q3) Sample points allocated to 3 groups	NA	Designed to meet minimum for 90/10 (68), prorated by appliance type. Allocate survey sample points (in proportion to reported savings) among the 3 groups defined in EEMIS data: (1) units not replaced; (2) units replaced with EnergyStar; (3) units replaced with standard units.
Residential Efficient Lighting (CFL Lighting Campaign)	NA (census)	441,738 bulbs	90/10	Census (Quarterly Review)	300 (Planned Q3)	NA	Upstream program; participants unknown. Sample size 300, for a 90/10 precision target, including NTG adjustment. The PY3 database included 60,078 records representing unique SKU purchased on a specific date, at a specific retail store.
Consumer Behavior & Education	NA (census)	101,468 (50,000 legacy 50,000 expansion)	90/5	Census (Planned Q4)	150 participants 40 drop-outs 150 nonparticipants (Planned Q3)	NA	Billing analysis includes census of participants Surveys examine program processes and measure adoption.
Efficient Equipment – residential	17%	37,613	90/10	70 stratified (Planned Q3) Allocated to 3 groups	70 stratified (Planned Q3) Allocated to 3 groups	NA	Samples by stratum defined by technology (based on large and small savers, plus a stratum for refrigerators (large participation in PY3). 50 sample points will be allocated to the large strata (HVAC measures), 10 points to refrigerators, 10 sample points randomly distributed across all other measures. Record reviews and surveys are independent samples. See Table 8.
Efficient Equipment - Non- residential non-lighting	167%	9,570	85/15 at program	20 (Same sample	70	20 (Planned	Samples by two strata (20 each) defined by measure groups. Site visits: ASD/VSD, refrigeration and motors are one stratum, with

Programs	PY3 CoV or Error Ratio	PY3 Participation Population Used to determine PY3 sample	PY4 Planned Confidence & Precision	PY4 Records Review	PY4 Participant Surveys	PY4 Site Visits	Notes
(medium & small stratum)		(36 ASD/VSD)	level; 90/10 at sector level  2 non- residential non-lighting strata	as site visit sample)	(Planned Q3) 35 medium strata 35 small strata	Q3)	about 50% of savings in PY3; allocate 20 site visits to this group. For the small strata site visit, measures will be nested within the ASD/VSD sample if at all possible. Inspect everything reasonable at the site.  Surveys are independent of the site visit samples, and are randomly selected samples. See Table 6.
Efficient Equipment - Non-residential Direct Discount	40%	3,398 including Direct Discount	90/10	Total 50 records reviews; same sample as site visits.	70 (Planned Q3)	Total 50 site visits.	Direct Discount represented 46% non-residential lighting savings in PY3. Measures primarily direct install lighting, some refrigeration. Customers will be interviewed to verify measure installation, NTG, and for process questions. Site visit and survey samples are independent. Site visit sample points assigned through Efficient Equipment Lighting sample.
Efficient Equipment - Non-residential lighting (large stratum)	40%				70 (Planned Q3)		(Direct Discount achieved 46% of all non-residential lighting savings in PY4Q1. Due to program ramp-up, expect PY4Q1 to better represent this program than PY3.) Four Strata within Efficient Equipment Lighting (Large, medium, small savings; Direct Discount). Sample points assigned proportionate to participation. GNI allocated 15 sample points proportionately across all strata. Large stratum included majority of ex ante savings. Sample must approach 90/10; CV = .04 (planned 50 site visits and records review for PY4). Sample size will meet GNI sector precision targets by allocating 15 of the 50 points to GNI.



Programs	PY3 CoV or Error Ratio	PY3 Participation Population Used to determine PY3 sample	PY4 Planned Confidence & Precision	PY4 Records Review	PY4 Participant Surveys	PY4 Site Visits	Notes
							Metering as needed. Phone surveys focus primarily on process related issues, with some questions to verify or clarify measure installation. Satisfaction/process related surveys are not conducted during site visits.
Energy Assessment and Weatherization	NA for weatherization rebates 14.5% for Home Energy Assessment participants	1,772	85/15	Census of records out of range (anticipate about 30, e.g. screen for excessive R-value)	140 (Two samples; Planned for Q3)	NA	70 Surveys designed to meet minimum for 90/10 (68), sample points will be proportionately allocated by audit type (two program tracks). 70 surveys conducted with participants installing major weatherization measures. Records review focus on QAQC for entries out of range. All records included in QAQC review are eligible for phone survey.
Renewable Energy, GNI	Calculated 45% for GSHP	GNI	85/15	~5 GNI (Planned Q4)	NA	NA	Program closing; about 5 GSHP remain. No site visits. Desk reviews only.
Act 129 WRAP	NA	4,545	Designated low income programs meet 90/10 as a sector.	24 annually	NA	NA	6 quarterly records reviews, prorated by job type.
E-Power Wise	22%	2,693 total		Census EEMIS to identify duplicates	Census of written surveys included in kits	NA	Phone survey not conducted in PY4. Review of a sample of the enrollment records will be minimal since no major errors were identified in PY1 through PY3.
HVAC Tune-Up	NA	Census serviced units	85/15	Census	NA	NA	Midstream program.
Custom Incentive Program	76% Cv for small stratum; census planned for large	132  (69 small projects 29 large	90/10	All large Sample small  (Same sample	70	All large Sample small	Anticipate 25 large projects and 27 small projects in PY4 Metering and spot measurements as needed. Number of customer surveys proportionate with large and small projects (census of large if not many); allocate by sector proportionately.

Programs	PY3 CoV or Error Ratio	PY3 Participation Population Used to determine PY3 sample	PY4 Planned Confidence & Precision	PY4 Records Review	PY4 Participant Surveys	PY4 Site Visits	Notes
	stratum)	projects)		as site visits)			Number of surveys depends on number of completed, paid, and verified projects each quarter. Surveys focus on customer satisfaction and the program processes.
Direct Load Control	--	New PY3	85/15	Census metered units (about 100 units) (25 in sample to test analysis) (Q2)	95 (25 small business; 70 residential) (Q2)	NA	Test events were called in PY 3 (summer 2011). Demand reduction from events called in PY 4 (summer 2012) will be claimed. Surveys conducted in Q2 with samples for residential and small commercial samples.
Load Curtailment	--	New PY3	85/15	Census (Planned Q3)	20 (SWE survey Planned Q2)	NA	Review Forecasting methods & model performance. Demand reduction from events called in PY 4 (summer 2012) will be claimed. Surveys developed by SWE will be conducted in PY4.

The PY4 sampling strategy for each program that will claim savings is discussed below.

### ***Efficient Equipment Program***

The Efficient Equipment Program is open to all sectors. For sampling, two sectors were identified: residential and non-residential. Participation in the Government and Non-Profit participants will be monitored to determine whether it meets 20% of the program's total program savings. However, the EM&V CSP will allocate sample points to the GNI sector.

In PY3, over 13,000 participants in the non-residential sector received rebates for measures installed through the Efficient Equipment program. Because of the large variation in ex ante savings across measures, measure groups were defined and stratified by large, medium and small ex ante savings. The PY4 sampling plan is based on the participation in PY3, anticipating similar participation.

### **Non-residential Sector**

The measure groups planned for the PY4 Efficient Equipment Program's non-residential participants are shown in **Table A-4**. The strata were determined from cumulative PY3 participation, examining the verified savings and number of participants. Lighting measures clearly comprise the largest measure group and are treated as the large stratum. The PY4 medium stratum includes the ASD and VSD measure groups. The PY4 non-residential small stratum includes HVAC measures, residential appliances, office equipment and miscellaneous measures.

The EM&V CSP reviewed the measures rebated during PY4 from Q1 through Q3 to determine whether any adjustments were needed to the strata. That is, the EM&V CSP separated the program rebates by sector, residential and non-residential, and checked the quantities of measures rebated and the associated contribution of reported savings (kWh) to the total sector's savings. Through this analysis, the EM&V CSP determined there was no need to change the strata or targeted number of measures or projects in each sample.

**Table A-4: PY4 Efficient Equipment Program Non-residential Strata**

PY4 Efficient Equipment Non-residential Strata				
Stratum	Stratum Definition	PY3 Percent of Efficient Equipment verified savings	Measure Groups Included in Stratum	PY4 Sampling Rigor & CoV
Large	Top measure	92%	Lighting	90/10, CoV = .4
Medium	Next 10%	3%	VSD and ASD and refrigeration	NA
Small	Last 10%	1%	All others: HVAC, appliances, office equip, other	NA

### **Lighting Measures**

Since lighting measures included in the large stratum exhibited a large variability in the range of *ex ante* reported and verified savings in PY3, this stratum is again separated into large, medium, and small stratum. A fourth stratum within lighting includes the Direct Discount participants. In PY4 Q1, these participants contributed 46% of all lighting related savings to the program. the EM&V CSP expects this level of participation to continue through PY4, and that it is a better indicator of performance than the total PY3 participation. This is because the program was ramping up in PY3, and PPL has offered a number of special offers and incentives to encourage participation in the small commercial sector.

A total of 15 sample points will be assigned to GNI sector participants across all four strata.

Each quarter the non-residential non-lighting sample will be reexamined and the samples drawn according to the strategy shown in **Table A-5**. That is, Direct Discount projects receive 46% of the sample points; the large stratum consists of the projects with the top 50% of reported *ex ante* savings, the medium stratum includes projects with the next 30% of savings, and the small stratum includes projects with the last 20% of savings. Therefore, the range of kWh savings in each stratum could change each quarter, depending on the projects that are processed and recorded in EEMIS (PPL EU's data tracking system) each quarter.

The PY4 sampling plan for verification activity for the non-residential lighting participants is shown in **Table A-5**. Site visits, by their nature, include records review and verification. the EM&V CSP plans to conduct about 50 site visits in PY4, (based on CV = .4 in PY3), drawing 13 sample points from each quarter's participants (using projects recorded and savings claimed in EEMIS).

**Table A-5: PY4 Efficient Equipment Non-residential Large Stratum: Lighting**

PY4 Lighting Large Strata			
Stratum	Percent of <i>ex ante</i> savings	PY4 Site Visit and Records Review Sample	PY4 Survey Sample
Direct Discount	46% in PY4 Q1	24 (46% of sample)	70
Large lighting projects	Standard, large (top 50% of kWh)	12 (27% of sample)	70
Medium lighting projects	Standard, medium (30% of kWh)	8 (16% of sample)	
Small lighting projects	Standard, small (20% of kWh)	8 (11% of sample)	
	Total	52	140

**Table A-6** shows the PY4 sampling plan by quarter.

**Table A-6: PY4 Quarterly Efficient Equipment Non-residential Lighting Sampling Plan**

Sample Count Allocation	Q1	Q2	Q3	Q4	Total
Direct Discount	6	6	6	6	24
Standard, large (50%)	3	3	3	3	12
Standard, medium (30%)	2	2	2	2	8
Standard, small (20%)	2	2	2	2	8
Total	13	13	13	13	52

### Non-lighting measures

The PY3 non-lighting measures' contributions to savings were ranked. the EM&V CSP based the PY4 sample size on these measures' contribution of savings to the program and sector, on the PY3 realization rates, and PY3 Cv. The resulting PY4 non-lighting strata are shown in **Table A-7**, which summarizes the sample size for the independent verification activities, including records review, site visits, and surveys. ASD/VSD measures constituted 50% of all non-lighting measure savings in the non-residential sector.

The sample for the small strata is nested within the medium strata. Site visits will be conducted for a sample of 20 projects. Other measures installed at that site will be inspected and verified as well. The EM&V CSP will verify the census if the quantity is less than 20, and a sample if the quantity is larger than 20. The EM&V CSP will verify all small strata measures at the same sites, targeting 20.

If the medium strata sites do not yield 20 small strata measures, the EM&V CSP will not conduct site visits specifically for small strata measures. Instead, the EM&V CSP will conduct a records review for 20 projects installing measures in the small strata.

Each quarter, the EM&V CSP reviews the measures rebated to determine whether any adjustments were needed to the strata. That is, the EM&V CSP checked the quantities of measures rebated and the associated contribution of reported savings (kWh) to the total non-residential sector's savings. Through this analysis, the EM&V CSP determined there was no need to change the strata or targeted number of measures or projects in each sample.

**Table A-7: PY4 Efficient Equipment Non-residential Medium and Small Strata**

PY4 Efficient Equipment Non-residential Medium and Small Strata				
Stratum	Measure Groups Included	PY4 Sampling Rigor	Annual PY4 Records Review Sample	PY4 Survey Sample
Medium	ASD/VSD, refrigeration measures	85/15 for both strata, CV = .5	20 records reviews conducted with site visits	35: random sample, independent of site visits
Small	HVAC, motors, appliances, office equip, other		20 records reviews with site visits; site visits nested within medium stratum	35: random sample, independent of site visits

## Non-residential Surveys

Participant surveys will be fielded once to collect input to determine the net-to-gross ratio and to assess process related issues including program satisfaction. The EM&V CSP will include a sample of 70 lighting participants in the telephone surveys. Since the Direct Discount delivery channel was launched in PY3, the EM&V CSP will continue to administer a separate survey for this group of participants, selecting a random sample of 70 participants. A third sample of 70 surveys will be selected for the medium and small strata, with the sample split evenly across the two strata.

## Residential Sector

The EM&V CSP based the PY4 sampling for residential sector participants in the Efficient Equipment program on the final PY3 participation, realization rates, Cv and the overall contribution of savings to the program and sector. The residential sector was divided into three strata. In PY3, the HVAC measures constituted 139% of savings in the residential sector. Refrigerators comprised the largest group (14,840 units) and 16% of the savings. All other measures were grouped into a stratum; these measures include clothes washers, air conditioners, and home office equipment.

In PY4, 50 sample points will be allocated to the large residential strata, 10 sample points will be allocated to refrigerators, and 10 will be allocated to the small strata with all other measures.

**Table A-8** shows the measures included in each Efficient Equipment residential stratum in PY4. Because the cumulative realization rates and precision were very high for the small and medium strata in PY3, the majority of sample points in PY4 will be assigned to the large stratum. Rigor levels for the residential section in this program should approach 90/10 since the majority of residential sector savings across all programs occur in this program. Therefore, 70 sample points are distributed across these strata. Verification activities include independent samples for records reviews and surveys. No site visits are conducted for the residential sector.

The EM&V CSP reviewed the measures rebated during PY4 from Q1 through Q3 to determine whether any adjustments were needed to the strata. That is, the EM&V CSP checked the quantities of measures rebated and the associated contribution of reported savings (kWh) to the total residential sector's savings. Through this analysis, the EM&V CSP determined there was no need to change the strata or targeted number of measures or projects in each sample.

**Table A-8: PY4 Efficient Equipment Program Residential Strata**

Stratum	Stratum Definition	PY4 Measure Groups	PY4 Sample Size
Large	Top 50%	HVAC measures (ASHP, room AC, ductless mini-split, HPWH, RTS, commercial reach in refrigeration)	50 sample points
Medium	Next largest group	Energy Star Refrigerators	10 sample points
Small	All other measures	White goods, office equipment, air conditioners, other	10 sample points

### ***Renewables Program***

The Renewables Program offered two technologies during PY3, PV systems and Ground Source Heat Pumps. The program closed to the residential sector in PY3. The program is open to only the government, non-profit sector in PY4 for a few remaining projects in progress. Installations will be verified through records reviews and engineering analyses. The PY4 verification will occur in Q3 and Q4, to include all GSHP in the final analysis. No site visits or surveys are planned.

### ***HVAC Tune-Up***

The sampling unit for the HVAC Tune-up program is the individual serviced unit, including all measures that apply to the serviced unit. Servicing can include multiple measures, depending on the outcome of the diagnostic test results. The unit of sample is not a 'project' which could include multiple roof top units (RTU) at one location.

In PY3, all units were included in the desk review and analysis. The same approach will be taken in PY4. No site visits or metering will be conducted. No phone surveys of participant end users or contractors will be conducted.

### ***Custom Incentive Program***

Each custom project was defined as large or small for verification purposes. Large projects are identified in real time and all are included in the impact evaluation sample. These projects generally have a large amount of savings (currently defined as reserved (*ex ante*) savings greater than 500,000 kWh/yr.).

A sample of small projects will be selected from all projects completed and paid during PY4. Savings for this sample will be verified and a realization rate determined based on this sample. The realization rate will be applied to the population of the projects in the small project stratum.

The telephone survey sampling plan will meet or exceed 90/10 at the program level. The EM&V CSP will select a random sample of 35 participants from the large stratum and 35 participants from the small stratum. The EM&V CSP will select a sample from the PY3 participants and the PY4 participants for a total of 140 surveys. Surveys will be further stratified to represent completed projects with and without a Technical Assessment, and a sample that dropped out of the program. The primary purpose of this telephone survey is to collect data used as inputs for the Net-to-Gross ratio, including freeridership and participant spillover.

## ***Appliance Recycling***

Sample sizes meet or exceed the SWE's requirements for sampling to meet 85/15 by program.

The records review includes a census of participants in the EEMIS database, verified by unique CSP job numbers (i.e., unique rebates). The CSP job number is tied to the rebate applications; a rebate can include more than one appliance.

Participant telephone surveys will be fielded once, with a target sample of 70 respondents, meeting 90/10 criteria for confidence and precision. Sample points will be allocated across three strata defined by EEMIS data: (1) units not replaced; (2) units replaced with EnergyStar; (3) units replaced with standard units. The sample will be prorated based on data recorded in EEMIS for these three categories. The surveys will confirm that participants replaced units as recorded.

PY1 and PY2 nonparticipant survey data will be used in PY4; no new ARP nonparticipant surveys will be conducted in PY4. Non-participant survey data are used to determine the net savings and part use factor.

## ***Residential Lighting***

This upstream program offers discounts for CFL and LED to the manufacturer and retailers. Actual purchasers of the discounted bulbs are not known. The telephone survey sample frame will be developed from PPL Electric's customer database. To ensure that the telephone survey provides useful results for both participants and non-participants while staying within a reasonable budget, the survey will be conducted using the maximum and minimum target numbers for completed interviews. For PY4, 300 customer surveys are targeted. The PY4 survey efforts are designed to target 90% confidence with 10% precision.

The records review includes a census of job numbers (by SKU) in the EEMIS database. The EM&V CSP will examine all new SKU as they are added by the program CSP and PPL. This examination confirms data are entered correctly into EEMIS and the savings are correct.

Sample sizes meet or exceed the SWE's requirements for sampling to meet 85/15 by program and 90/10 by sector.

## ***Consumer Behavior & Education***

In PY4, PPL Electric anticipates 100,000 customers will receive Home Energy Reports. As in prior program years, a regression analysis will be conducted using customers' consumption data, and include the census of participants and non-participants. The net results will be used to verify program level savings.

A survey of customers receiving Home Energy Reports will be conducted annually. The EM&V CSP will survey 150 customers receiving Home Energy Reports during the program year, and 150 customers who do not receive the report. This non-participant sample will be drawn from the population that the



program CSP uses as the non-participant sample. The sample strata will be sufficiently large to estimate the program effect i.e., the difference between the two groups. the EM&V CSP will also survey 40 customers who drop out of the program.

### ***Energy Assessment and Weatherization***

The audit records review of PY3 Q3 and Q4 found data were 100% error-free. The records review of the weatherization data was also error free for the data that matters when using the TRM in effect. Therefore, the number of records included in a desk review will be limited in PY4. The sample for desk review of the home audit records will be limited to 15. For participants who installed weatherization measures, the sample will focus on records that are out-of-range from expected values. The EM&V CSP will set data screens and review the census of out-of-range records, anticipating about 30 in PY4.

Two telephone surveys will be conducted to meet sampling rigor of 90/10.

- One survey will be conducted with 70 randomly selected customers participating in PY4. The sample will be allocated equally between participation in the walk-through surveys and the comprehensive audit.
- A second survey will be conducted with 70 randomly selected program participants who installed any of the major measures. These customers may not have received an audit.

### ***Low Income WRAP***

The sample size for the two designated low income programs will meet sampling rigor of 90/10.

Prior verification found few errors in data entry and classification of projects in one of the strata. In PY4, 24 records will be reviewed and verified. Records will be stratified by job type (i.e., baseload, low-cost, and full-cost) and by whether the site received a field inspection. Six sample points per quarter will be randomly selected from sites where a field inspection was conducted.

### ***Low Income E-PowerWise***

Together with low income WRAP, the sampling is designed to meet 90/10 requirements in the low income sector.

The EM&V CSP will review all of the PPL Electric EEMIS database records to verify that the program counts only one kit per household, and to capture duplications across program quarters. This review will also ensure that records contained in the PPL Electric EEMIS database are traceable to the implementation contractor's database.

In PY1 through PY3, the EM&V CSP conducted a QA/QC review of a random sample of 70 participant enrollment forms. The EM&V CSP found no major errors. Therefore, the EM&V CSP will conduct these QA/QC reviews of the enrollment forms in PY4 only if issues or errors are identified. Once resolved, the EM&V CSP will not sample further.

No telephone surveys are planned for PY4. The EM&V CSP will analyze the census of surveys included in the kits returned by mail.

### ***Direct Load Control***

The Direct Load Control program includes residential and small commercial customers. The sample plan was designed to meet 90% confidence and 10% precision in each of the two sectors. The target for residential sector is 70 completed surveys. Because there are fewer small commercial customers, the EM&V CSP is targeting 25 completed surveys.

The engineering analysis will include the census of all metered units with valid data recorded. The implementation CSP meters a sample of participants and will provide data for analysis. The EM&V CSP selected a sample of records from metered units to test the analytic process and data inputs. The engineering analysis will compute demand reduction over the top 100 system peak hours identified by PPL.

### ***Load Curtailment***

The census of participants will be included in the engineering analysis to compute demand reduction over the top 100 system peak hours identified by PPL.

The SWE designed a participant survey, provided this to PPL and the EDC Evaluation teams, and selected the sample. The SWE targeted 20 completed surveys, stratified by customer segment. The EM&V CSP will conduct the surveys in Q2.

### **Telephone Survey Sampling Procedures**

The EM&V CSP will conduct telephone surveys in PY4 with the sample selected from Q1 and Q2 participants who represent the full program population.

The EM&V CSP developed two types of telephone survey sampling procedures for PPL Electric Utilities Act 129 programs. This section discusses each of these survey sampling procedures in detail.

The first process is used for programs that use PPL's EEMIS tracking system. The second process was developed for programs that do not utilize EEMIS and for non-participant surveys. These programs include the population surveyed for the upstream CFL program, and the Behavior and Education non-participant sample.

For participant surveys, a program participant is defined as a unique billing account number that installs an energy efficiency measure under that program. Accounts that install multiple measures are counted only once. For example, if a single billing account installs both a central air conditioner and a dishwasher under the Efficient Equipment program, that account is treated as a single participant.

### *EEMIS-Sourced Sampling*

Survey results will inform various process evaluation metrics, verify measure installation, and collect data for the net-to-gross analysis. During PY4, this methodology will be used to select samples for telephone surveys. No telephone surveys are planned for Renewables and E-PowerWise.

- Appliance Recycling
- Efficient Equipment (Residential, Non-residential, Direct Discount)
- Energy Assessment and Weatherization
- Direct Load Control

The sample for these surveys will be selected using the same process used in PY2 and PY3:

1. Determine targeted number of completed surveys per program, sufficient to meet confidence and precision requirements.
2. Aggregate EEMIS participant records across selected programs.
3. Summarize EEMIS data by billing account and measure code.
4. Remove any account contacted for a phone survey within the past twelve months, either by the EM&V CSP or by Bellomy Research (PPL Electric's survey vendor).
5. Remove any account with an invalid phone number (e.g., less than 10 digits, invalid area code, etc.).
6. Apply any additional exclusion to the pool of stratified accounts; this may include items like site visits or other phone verification activity.
7. Randomly select a set of accounts of sufficient size within each stratum, such that calling all names in that set will yield enough completed surveys to meet the designated sample size requirements. Typically, the sample is six times the sample size targets.
8. For all selected names, append contact information and any program participation data needed to inform the read-ins for all survey questions.
9. Deliver the selected names to subcontractor conducting telephone surveys, along with any special instructions for calling.

### *Non-EEMIS Sourced Sampling*

Non-participant and other participant surveys are conducted each year. In PY4 the EM&V CSP will use the same methodology used in PY2 and PY3 to develop calling samples for three surveys.

- Residential Lighting
- Behavior and Education Program participants

The sample for these surveys will be drawn from PPL's customer information database or from the Behavior and Education Program participant database, as appropriate. The process is as follows:

1. Select a large sample of accounts (typically 5,000 to 10,000) from PPL's customer database or alternative data source.

2. Remove any account that has been contacted for a phone survey within the past twelve months, either by the EM&V CSP or by Bellomy Research (PPL Electric's survey vendor).
3. Remove any account with an invalid phone number (for example, less than 10 digits, invalid area code, etc.).
4. For all selected names, append contact information and any additional data needed to inform the read-ins for all survey questions.
5. Deliver the selected names to subcontractor conducting telephone surveys, along with any special instructions for calling.

## Appendix B: Fuel Switching

On October 26, 2009, the PA PUC entered an opinion and order approving PPL Electric's Act 129 plan. In the order, the PA PUC required PPL Electric to track and report the frequency of customers switching to electric appliances from gas appliances. In addition to reporting the frequency of these occurrences, PPL Electric is required to report replacement appliance and system information. This appendix summarizes information collected by PPL Electric through rebate forms and includes a summary of additional research undertaken by the EM&V CSP regarding fuel switching. The independent evaluation concludes that while 0.79% of rebated appliances in the Efficient Equipment Incentive Program indicated fuel switching, the actual occurrence reflected by the phone surveys is much lower. Participants reported switching from gas to electric on their rebate forms for 163 appliances. However, phone survey results indicate that only about 40% of these 163 appliances are true instance of fuel switching, meaning less than 0.5% of customers in the Efficient Equipment Program switched from a gas appliance to an electric appliance in PY4.

### Efficient Equipment Incentive Program

In PY4, PPL Electric issued over 20,600 rebates to residential customers. Of those, only 163 (0.79%) were reported by customers as replacing gas equipment. Surveys fielded to a sample of fuel switching customers indicate that only a small proportion of these projects are true instances of fuel switching, and there is no indication that the fuel switching is highly motivated by the program rebates.

**Table B-1** summarizes data collected from customer rebate forms, summarizing the measures that, according the customer rebate forms, replaced gas equipment. The table summarizes the number of customer-indicated gas replacement measures, total rebates issued for the measure, and the percentage of total rebates that were reported as gas replacement. Of the rebated measures, most customers indicated that they replaced a gas device with a central air conditioner (CAC), followed by heat pump hot water heater replacement. Comparable gas equipment does not exist for some of the rebated measures. For instance, refrigerators, room air conditioners, and clothes washers do not have gas equivalents, which mean some customers may have been confused about the question on the rebate form. CAC systems do not have a gas equivalent; however, these customers most likely upgraded both their heating and cooling systems and replaced a gas heating system. The surveys indicate that, in general, customers replaced old gas heating systems with new gas heating systems.

For reporting consistency between PY1 through PY3, and to compare results across years, **Table B-1** includes all measures rebated, including those that do not report fuel switching. The percentage of rebate forms indicating fuel switching compared to the total number of rebates issued is used to determine an initial rate of fuel switching.

**Table B-1: Summary of PY4 Rebate Forms**

Measure Name <sup>1</sup>	Rebate Forms Indicating Measure Replaced Gas Device	Total Rebates Issued	Percent of Total
CAC - SEER 16 <sup>2</sup>	68	706	9.6%
Heat Pump Hot Water Heater	50	1,070	4.7%
Ductless Heat Pump	19	1,446	1.3%
ASHP - SEER 16	17	1,229	1.4%
ASHP - SEER 15	8	730	1.1%
Energy Star Refrigerator <sup>2</sup>	1	11,295	0.0%
Room AC (1st Unit) <sup>2</sup>	0	4,178	0.0%
Clothes Washer (Tier 2 MEF) <sup>2</sup>	0	1	0.0%
Programmable Thermostat	0	1	0.0%
High-efficiency Gas Furnace (RTS fuel switching)	0	12	0.0%
Solar Hot Water Heater	0	2	0.0%
<b>TOTAL</b>	<b>163</b>	<b>20,670</b>	<b>0.79%</b>
<b>TOTAL for measures with a gas equivalent</b>	<b>94</b>	<b>4,490</b>	<b>2%</b>
<b>NOTES:</b>  1. Customer reported they switched from gas equipment to electric equipment 2. Measures do not have a gas equivalent			

In PY4, the EM&V CSP fielded a survey of residential Efficient Equipment Incentive Program participants that included questions related to fuel switching. The surveys were conducted during PY4 Quarter 3 and the survey sample frame included all 65 customers who reported replacing a gas device on their applications submitted during Quarter 1 or Quarter 2. The target was to complete 34 surveys, however a total of 18 surveys were completed. An attrition table showing the final survey disposition is shown in **Table B-2**.

The fuel-switching questions were designed to determine whether gas devices were actually replaced as indicated on rebate forms, and, if so, whether they were replaced with electric equipment. The survey also asked if participants had received incentives from PPL Electric through the Efficient Equipment Incentive Program for those replacements. Responses from customers were reviewed against issued rebates to determine if the customer did receive a rebate for the fuel-switching equipment. Partially completed surveys are not included in the analysis.

**Table B-2: Fuel Switching Customer Survey Summary**

Disposition	Frequency
Completed	18
Refused	16
No answer/answering machine	23
Invalid number/number not in service	3
Employed/affiliated by PPL Electric or employed in Market Research	0
Partial complete	5
<b>Total</b>	<b>65</b>

Of the 18 respondents, 17 households (94%) confirmed that they had replaced a gas device and only one household did not replace a gas device. Respondents reported a total of 20 replaced devices; three respondents reported replacing two devices. See **Table B-3** below for the summary of replaced gas devices.

**Table B-3: Summary of Replaced Gas Devices**

Gas Device	Number Replaced
Gas water heater	10
Gas furnace - space heating	8
Gas Boiler- space heating	1
Clothes dryer <sup>1</sup>	1
<b>Total</b>	<b>20</b>
<b>NOTES:</b>  1. PPL Electric does not offer rebates for electric clothes dryers and clothes dryers do have a gas equivalent. The surveyed customer was most likely confused about equipment type replaced.	

The majority of respondents cited broken and old devices as the reason why gas equipment was replaced (16 of 20 replaced devices). See **Table B-4** below.

**Table B-4: Summary of Reasons for Replacing Gas Devices**

Reason	Count
Didn't work right or old, and in need of replacement	8
Broken and/or failed	8
Other <sup>1</sup>	9
<b>Total<sup>2</sup></b>	<b>25</b>
<b>NOTES:</b>  1. Other reasons consisted of “wanting more efficient equipment; (n=2)” “rising cost of fossil fuels;” “cost and it was leaking;” “chose to replace both when getting the central air” (n=2); “using too much gas;” “replace AC and furnace at the same time;” “GE Advertising” 2. Five customers listed two reasons as to why one device was replaced.	

**Figure B-1** and **Figure B-2** show the response patterns for customers who replaced gas heating and water heating equipment, respectively.

### Gas Heating Equipment

In **Figure B-1**, for gas heating equipment, the initial column of responses (“Reason for Replacement”) shows the customer’s reason for replacing a gas heating system. Of the 10 units<sup>45,46</sup> replaced, seven were replaced because of equipment issues.

The “Other” category includes one customer citing “using too much gas,” two choosing to replace both A/C and furnace at the same time, and one customer wanting more efficient equipment.

The second column of responses (“Reported New Equipment (from survey)”) in **Figure B-1**) demonstrates that the majority of respondents installed gas furnaces to replace their previous gas heating equipment. In only one instance did a respondent report that electric equipment (Central Air Conditioning-CAC) directly replaced a gas device, and as you cannot heat a home with CAC it is likely that this respondent

<sup>45</sup> The units include “Gas furnace-heating space,” “Gas Boiler-Space Heating,” and “Gas Clothes Dryer” categories

<sup>46</sup> One customer response is repeated twice in Figure E-1 as this customer cited two reasons why one device was replaced



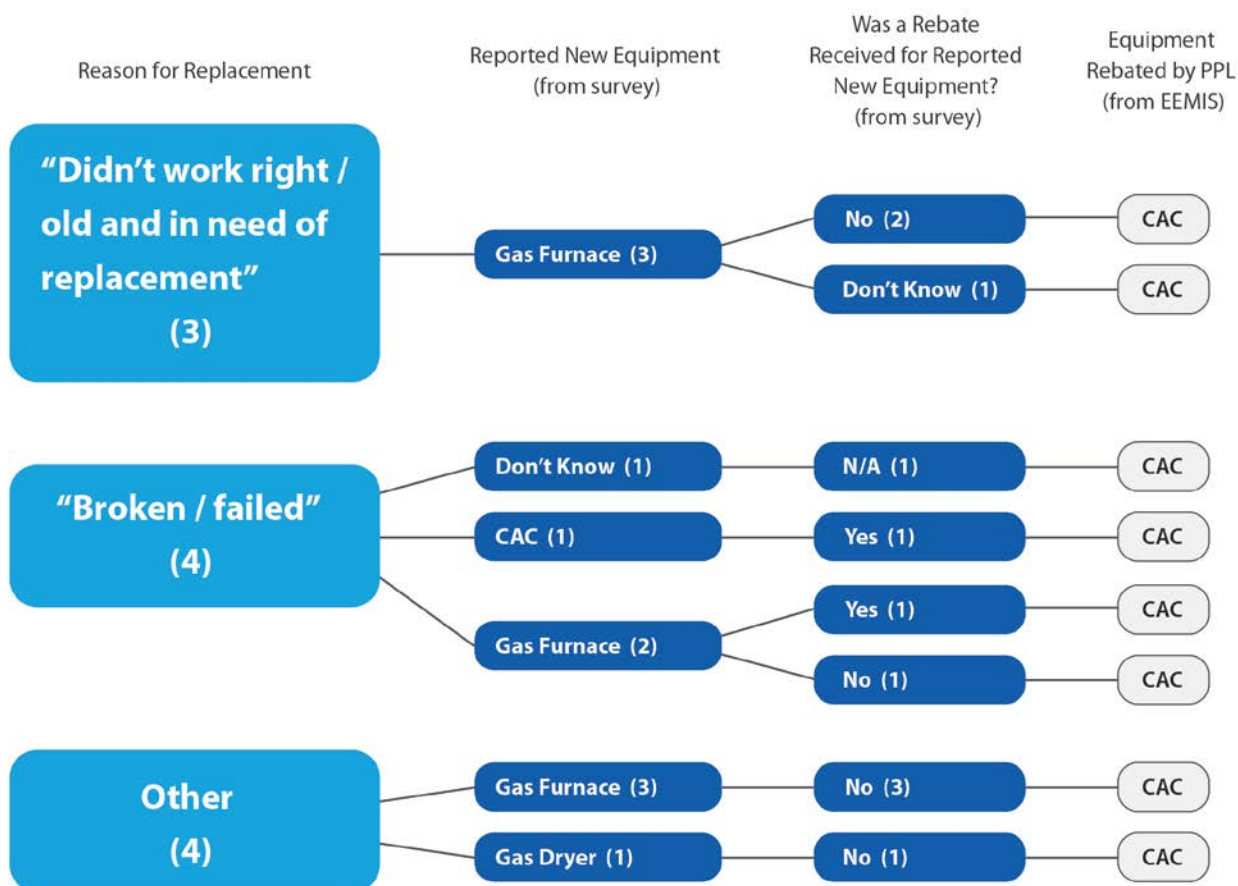
was confused by the question. Another respondent reported replacing their gas heating equipment with a gas dryer, and was also likely confused by the question during the survey.

The third column (“Was a Rebate Received for Reported New Equipment? (from survey)” in **Figure B-1**) shows that only two surveyed customers confirmed receiving a rebate for the equipment they reported that replaced their previous gas heating device.

As summarized in the last column, “Equipment Rebated by PPL (from EEMIS),” all customers who confirmed replacing a gas heating device in the survey received a rebate for a CAC system. These customers reported on their rebate application form that their CAC system replaced a gas device.

A comparison of the reported new equipment (from survey) with the equipment rebated by PPL (from EEMIS) indicate that there were no true instances of fuel switching from gas space heating equipment.

**Figure B-1: Respondents Replacing Gas Heating Equipment and Other Gas Equipment**



Additionally, in terms of air conditioning replacement, of the eight households that confirmed they had replaced a gas furnace or boiler, all eight had air conditioning before the replacement. See **Table B-5**. However, as shown in Figure E-1, eight of ten respondents replaced a gas heating device with another gas heating device. One respondent reported replacing their gas heating device with a gas dryer, one reported replacing it with a CAC, and the last respondent did not know. Since you cannot heat your home with a gas dryer or a CAC, these results indicate customers most likely upgraded both their heating and cooling systems at the same time and replaced an old gas furnace with a new gas furnace and replaced an old CAC with a new energy efficient CAC that received a rebate from PPL Electric.

**Table B-5: Households with air conditioning before replacing a gas device**

Air Conditioning	Count
Yes	8
No	0
<b>TOTAL</b>	<b>8</b>

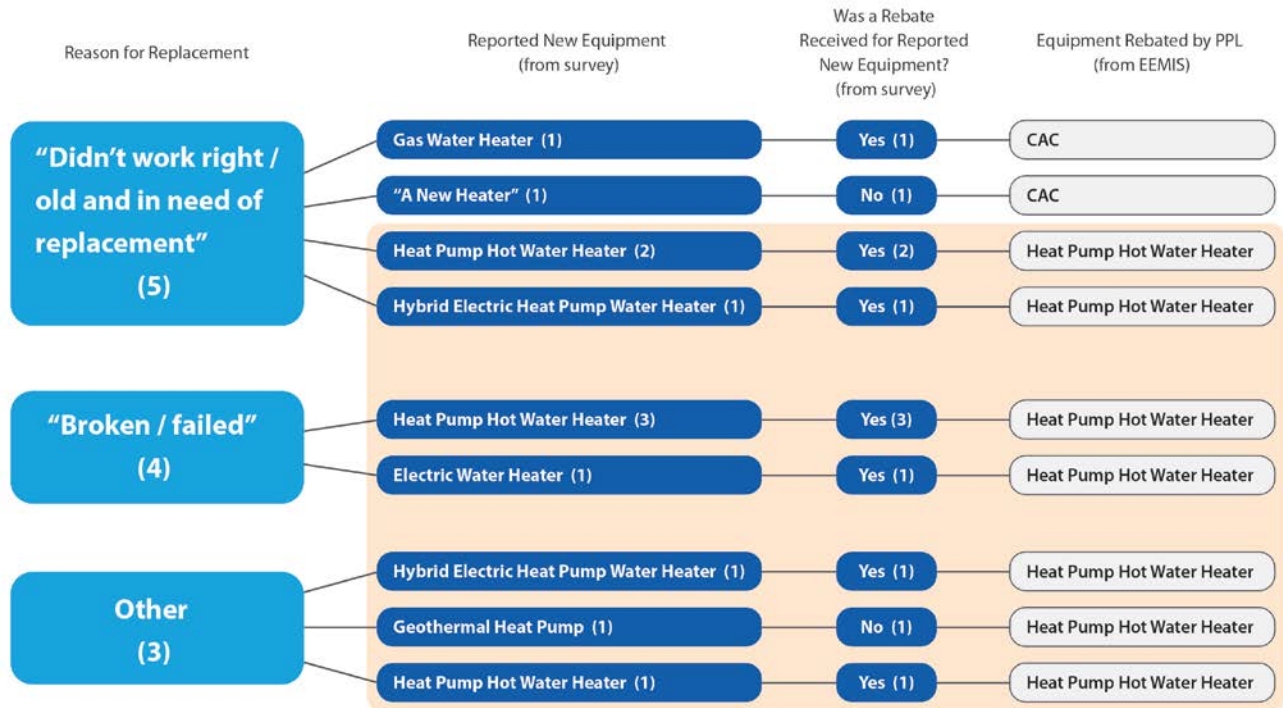
### Gas Water Heating Equipment

**Figure B-2**<sup>47</sup> illustrates that most respondents replaced their gas water heater because it was broken or operating poorly. The “Other” category includes three customers citing efficiency, “rising cost of fossil fuels,” and “cost... [and leaking equipment]” as reasons for replacement.

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<sup>47</sup> Two customer responses are repeated twice in Figure E-2 as these customers cited two reasons why one device was replaced

**Figure B-2: Respondents Replacing Gas Water Heating Equipment**



The incidence of a direct, rebated switch from a gas device to an electric device is much higher with gas water heating equipment than with gas heating equipment. Seven customers installed replacement electric water heating devices (all heat pump hot water heaters). One additional customer reported replacing a gas water heating device with a geothermal heat pump, and received a rebate from PPL Electric for a heat pump water heater.<sup>48</sup> These eight customer responses are highlighted in light orange above.

<sup>48</sup> Cadmus found that some residential heat pump water heater records in EEMIS during PY4 were actually geothermal heat pumps and not heat pump water heaters. However, geothermal heat pumps can provide both home heating and cooling and water heating, so this is a valid survey response and indicates an instance of fuel switching.

## Respondents Receiving Rebates

Ten<sup>49</sup> of the 17 respondents who confirmed replacing a gas device reported receiving a rebate for new equipment. As shown in **Table B-6** below, five of the ten respondents indicated that receiving a rebate was a high motivational factor for either getting more energy efficient equipment, or replacing a broken or poorly operating unit.

Three of the eight respondents who replaced gas water heaters viewed receiving a rebate as high importance, and both respondents who replaced gas space heating devices viewed receiving a rebate as high importance.

**Table B-6: Importance of Receiving a Rebate from PPL Electric**<sup>50</sup>

Rebate Importance	Gas Space Heaters Replaced	Gas Water Heaters Replaced
Low importance (1-4)	0	0
Medium importance (5-7)	0	4
High importance (8-10)	2	3
No response	0	1

In general, while 0.79% of customers reported fuel switching on their rebate form for equipment rebated through the Efficient Equipment Incentive Program, survey data indicates that the actual incidence of fuel switching is lower than reported: only eight out of 17 respondents (equivalent to eight out of 20 replaced devices, or 40%) who confirmed replacing a gas device actually directly replaced gas equipment with electric equipment and received a rebate for the new electric device.

Extrapolating these results, we can assume about 65 of the total 163 (40%) rebate forms indicating measure replaced gas device in **Table B-1** are true instances of rebated fuel switching. However, given that less than 1% reported fuel switching altogether, this results in less than 0.5% of customers who may switch fuels. These primarily install heat pump water heaters.

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<sup>49</sup> One respondent did receive a rebate, but did not respond to the question asking, "How important was the rebate when deciding to install the replacement device?"

<sup>50</sup> One respondent answered "Don't Know" when asked the importance of the rebate in decision to replace a gas device

## Appendix C: Residential Lighting Program Net to Gross Analysis

### Freeridership , Spillover, and NTG Methodologies

The EM&V CSP conducted a telephone survey with a random sample of residential PPL Electric customers as the primary means of assessing the Residential Lighting's PY4 freeridership, spillover, and the NTG ratio. The survey began with a battery of questions to identify respondents who were aware of CFLs prior to the survey. Responses from 154 customers who had purchased one or more CFLs in the past three months were used in the NTG analysis (out of 301 total respondents who completed the telephone survey).

Freeridership was analyzed on a per-CFL basis, rather than per-customer. The 154 respondents reported that they had collectively purchased 1,201 CFLs over the past three months.

Through their answers to the customer survey, the respondents were grouped into four categories:

1. Recent CFL purchasers who bought a CFL within the past three months and were aware<sup>51</sup> of PPL Electric's CFL Campaign before they participated in the survey. Only respondents who had recently purchased a CFL were included in the NTG analysis. (Respondents who had recently received a free CFL but had not purchased any were excluded.)
2. Recent CFL purchasers who were unaware of PPL Electric's CFL Campaign.
3. Respondents who were aware of CFLs but had not recently purchased any.
4. Respondents who were unaware of CFLs prior to answering the survey questions.

The NTG analysis incorporated respondents from the first two categories above; that is, respondents who had purchased one or more CFLs in the past three months, including those who were aware of the Residential Lighting Program and those who were not. Respondents in categories 3 and 4 were not included in the NTG analysis.

### Freeridership, Spillover, and NTG Findings

The 85 PY4 survey respondents who were aware of the program reported purchasing a total of 743 CFLs in the past three months. Based on their responses to a battery of freeridership questions, the weighted mean freeridership rate for CFLs purchased by category 1 respondents (aware of the program) was 39%, with an upper bound of 47% and a lower bound of 31%.

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<sup>51</sup> Respondents were considered to be aware of PPL's program if they responded affirmatively to either or both of two questions, one asking if they knew PPL provided funding to discount CFLs, and, one asking if they had seen educational or promotional materials from PPL.

The freeridership questions were designed to measure the influence of the program's discount on purchase behavior, with respect to both the quantity of bulbs purchased and timing of purchases. Respondents were asked whether they would have purchased the same number of bulbs, and whether they would have purchased those bulbs during the same period or at a later date, if they had cost \$1.10 more per bulb. The combination of a respondent's answers to these questions determined the respondent's freeridership score.

The model used to compute this range uses the sample size and a two-tailed test targeted at the 90% confidence interval to determine the average score's absolute precision. The "upper bound" reflects adding the weighted mean freeridership score together with the absolute precision estimate, while the "lower bound" equals the weighted mean score after subtracting the absolute precision estimate. Absolute precision values have the same units as the quantities being measured. Relative precision values are ratios and have no units; they are commonly expressed as a percent.

The 69 respondents in category 2 (unaware of the program) reported they had collectively purchased 458 CFLs in the past three months. The EM&V CSP observed that, due to the upstream nature of the program, some of these respondents were likely influenced by the program's reduction of CFL prices, even though they were not aware of it.

- Category 2 respondents who bought CFLs and were unknowingly influenced by the program are considered spillover.
- Category 2 respondents who bought CFLs but were not influenced by the program are freeriders.

The EM&V CSP reasoned that, at most, freeridership among recent purchasers who were unaware of the program was 39% (the average of those who were aware of the program). In other words, purchasers who were unaware of the program would not be more likely to be freeriders than purchasers who were aware of program. (If anything, they would be less likely to be freeriders.) At the low end, freeridership for recent purchasers who were unaware of the program was assumed to be 31% (the same lower bound as for recent purchasers who were aware of the program), resulting in a low-end estimate of 69% for spillover.

The EM&V CSP computed the Residential Lighting NTG ratio using the following equations. The calculation is also shown graphically in **Figure C-1**.

$$(1) \text{ Net FR} = \frac{((\text{CFL}_{\text{Aware}} * \text{FR}_{\text{Aware}}) + (\text{CFL}_{\text{Unaware}} * \text{Not-Influenced}_{\text{Unaware}}) - (\text{CFL}_{\text{Unaware}} * \text{Influenced}_{\text{Unaware}}))}{\text{CFL}_{\text{Total}}}$$

$$(2) \text{ NTG} = 1 - \text{Net FR}$$

Where:

Net FR = Net freeridership, defined as freeridership minus spillover.

$CFL_{\text{Aware}}$  = Number of CFLs recently purchased by respondents who were aware of the program.

$FR_{\text{Aware}}$  = Freeridership rate for respondents who were aware of the program (derived from the battery of freeridership questions on the customer survey).

$CFL_{\text{Unaware}}$  = Number of CFLs recently purchased by respondents who were *not* aware of the program.

$\text{Not-Influenced}_{\text{Unaware}}$  = Percent of CFLs purchased by respondents who were not aware of the program and were not influenced by it (considered freeriders).

$\text{Influenced}_{\text{Unaware}} = 1 - \text{Not-Influenced}_{\text{Unaware}}$  = Percent of CFLs purchased by respondents who were not aware of the program but were influenced by it (considered spillover).

$CFL_{\text{Total}}$  = Total number of CFLs recently purchased by respondents.

For the mid-range freeridership case:

(1)  $\text{Net FR} = ((743 * 39\%) + (458 * 39\%) - (458 * 61\%)) / 1201 = 16\%$

(2)  $\text{NTG} = 1 - 16\% = 84\%$

For the high-range freeridership case:

(1)  $\text{Net FR} = ((743 * 47\%) + (458 * 39\%) - (458 * 61\%)) / 1201 = 21\%$

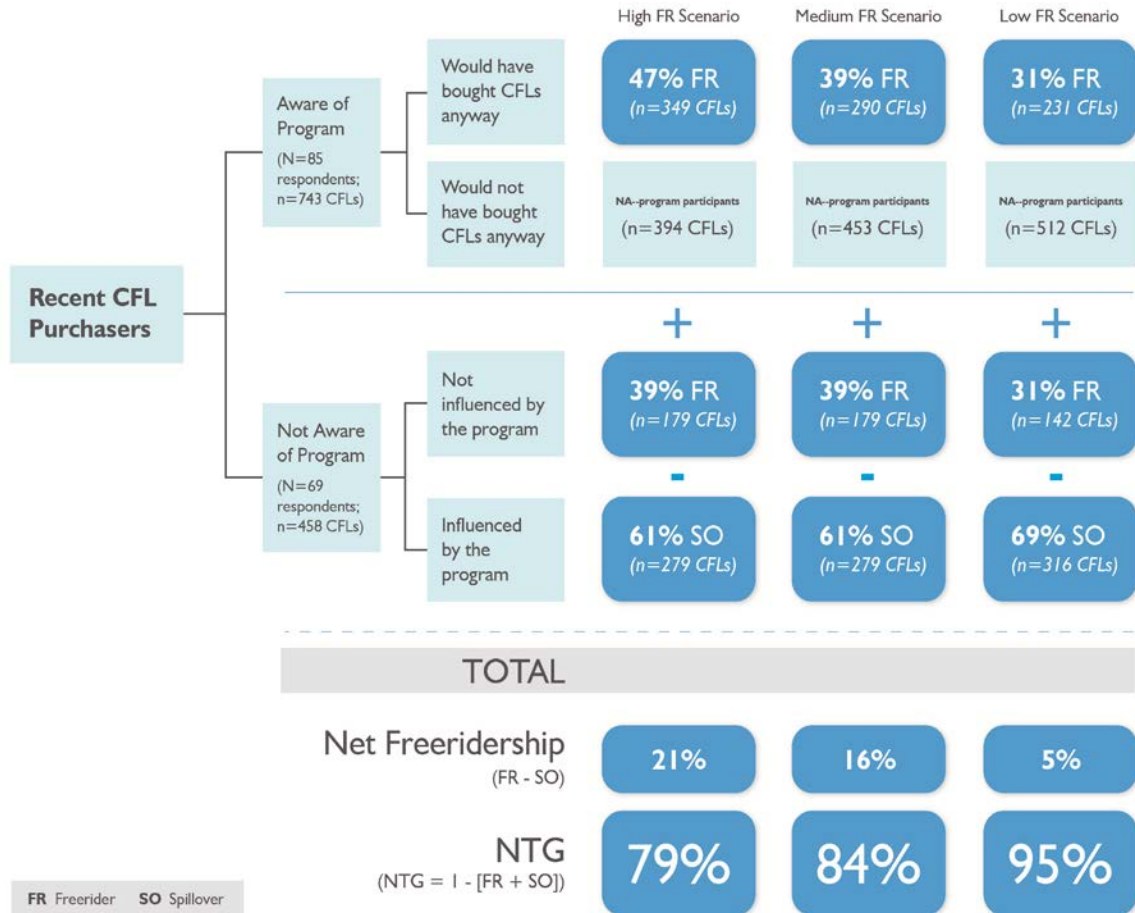
(2)  $\text{NTG} = 1 - 21\% = 79\%$

And for the low-range freeridership case:

(1)  $\text{Net FR} = ((743 * 31\%) + (458 * 31\%) - (458 * 69\%)) / 1201 = 5\%$

(2)  $\text{NTG} = 1 - 5\% = 95\%$

**Figure C-1. Residential Lighting Net-to-Gross Calculation**





## Appendix D: Cross-Sector Sales Analysis

### Methodology

The method for estimating cross-sector CFL sales involved three steps:

1. Determine the total number of screw-type CFLs purchased by small C&I customers, by business type, in PPL service area
2. Estimate the proportion of all sales that were program-discounted
3. Estimate the proportion of program-discounted bulbs sold to small C&I customers, by business type

The next sections discuss each of the three steps the EM&V CSP took to estimate program-discounted sales to the small C&I customer segment (GS1 rate class).

#### 1. Determine the number of Screw-type CFLs purchased by small C&I customers in PPL service area

The EM&V CSP surveyed 1,209 small C&I customers (GS1 rate class) and asked each respondent whether they purchased any CFLs in the previous six months. The survey continued for the 301 respondents who reported they purchased CFLs in the past six months. These 301 respondents were asked questions to determine how many bulbs they purchased, and whether the bulbs were purchased at a participating retailer. **Table D-1** shows the number of respondents who were screened out of the survey because they did not know if their business purchased CFLs, who reported they were not recent purchasers, and who reported they were recent purchasers.

**Table D-1. Key Findings from Small C&I CFL Survey**

Respondent Category	N
Recent purchasers who completed survey	301
Did not complete survey	127
Not recent purchasers (survey ended)	619
Did not know/refused to answer	37
Survey terminated via other screening questions	125
<b>Total Surveyed</b>	<b>1209</b>

Respondents were asked where they installed the purchased bulbs, and stated bulbs were installed in their businesses, in their homes, or both. Those who installed all bulbs in residences were excluded from the analysis. Where respondents (n=37) stated some bulbs were installed in homes and some in businesses, The EM&V CSP counted 76% of bulbs toward the business. This percentage was determined

using the ratio of the number of purchased bulbs determined through residential surveys (8.04) to the average number of purchased bulbs determined through the small C&I surveys (24.89).<sup>52</sup>

The EM&V CSP also adjusted the average number of bulbs purchased by C&I customers (24.89) to subtract the bulbs installed in residences. This adjustment resulted in an average of 24.04 bulbs purchased for commercial installations.

High-level findings are shown in **Table D-2**.

**Table D-2. Key Findings from Small C&I CFL Survey**

Percent of Respondents Who Purchased CFLs <sup>1</sup>	Percent of Respondents Who Purchased CFLs from Participating Retailer	Average Bulbs per Respondent
32% <sup>2</sup>	20% <sup>3</sup>	24.04
<b>NOTES:</b> 1. Respondents who said they did not know or who did not answer the question about bulb purchases were excluded from the survey results. Respondents unaware of CFLs were screened out of the survey. 2. 619 reported they did not purchase bulbs. 301 respondents reported they did purchase bulbs. Of these, 9 installed them in homes and were excluded. 37 installed bulbs in both home and business; the bulb count for these respondents was prorated, counting 76% toward businesses. 3. 292 respondents (32%) purchased bulbs. 236 of these 292 (81%) purchasing bulbs for businesses purchased them from retailers. 184 of the 236 (78%) purchased their bulbs from participating retailers. $32\% * 81\% * 78\% = 20\%$ purchased from participating retailers. Participating retailers are those who offered discounted CFLs through PPL EU's upstream lighting program.		

## 2. Estimate the proportion of all CFL sales that were program-discounted bulbs

Using survey data, The EM&V CSP calculated total program bulbs purchased by the small C&I customer segment. That is, 20% of small C&I customers purchased CFLs from participating retailers. Survey results indicate that on average, small commercial customers purchased about 24.04 bulbs. However, not all CFLs sold at participating retailers are actually discounted by the PPL program. Therefore, The EM&V CSP estimated the proportion of all CFLs sold (to both residential and nonresidential customers) that were discounted by the program. We applied this adjustment to the bulbs purchased by the small C&I customers.<sup>53</sup>

<sup>52</sup> When respondents said bulbs were installed in a residence and business, the survey did not ask for counts by location. We used the proportion of bulbs reported in the residential survey to adjust the number purchased so that not all bulbs were counted toward the business. Data were cleaned for potential outliers. For example, one respondent (a builder) reported purchasing 3000 CFL for new homes being constructed. These data were excluded.

<sup>53</sup> Although we asked respondents to consider purchases in the past six months, when annualizing the data it became clear that the result was unreasonable. We looked into several factors and concluded there may be recall bias. For that reason we used the reported average bulbs/per respondent as a proxy for the full year.

**Table D-3** shows the percentage of CFLs purchased by respondents of the residential and small commercial surveys. We multiplied this percentage times the PPL customer counts in each segment to derive the number of PPL’s residential and commercial customers purchasing bulbs.

**Table D-3. Derived Numbers of Customers Purchasing Bulbs from Participating Retailers**

Respondent Group	Percentage of Respondents Who Purchased CFLs from a Participating Retailer	Customers in PPL Territory <sup>1</sup>	Number of PPL Customers Purchasing CFL bulbs from Participating Retailers
Residential	33%	1,226,562	407,117
Small C&I <sup>54</sup>	20%	140,413	28,083
<b>NOTES:</b>			
1. Customer counts based on residential and GS1 small commercial account numbers			

**Table D-4** illustrates PPL’s total CFL sales using the average bulbs per respondent as an annual estimate. We estimated total CFL sales from participating retailers per year (3,948,461) using the average number of bulbs residential and small commercial customers reported they purchased. That is, the number of customers was multiplied by the average number of bulbs purchased.

**Table D-4. Total CFL Sales from Participating Retailers per Year**

Respondent Group	Number of PPL Customers Purchasing CFL bulbs from Participating Retailers	Average Bulbs per Respondent	Total CFL Sales from Part. Retailers Per Year
Residential	407,117	8.04 bulbs	3,273,219
Small C&I	28,083	24.04 bulbs	675,242
<b>Total</b>	-	-	<b>3,948,461</b>

We then estimated the percentage of total bulb sales that were discounted. Using Ecova’s PY4 sales data (2,503,377), we calculated that 63% of all CFL sales from participating retailers were discounted by the program ( $2,503,377 / 3,948,461 = 63\%$ ).

This figure is generally supported by other research, including:

- In the Northwest, the percentage of discounted bulb sales is 52%.<sup>55</sup> CFL purchases per capita in the Northwest are, on average, 1.2 bulbs per person per year.<sup>56</sup>

<sup>54</sup> Cadmus used a subset of the small C&I customers, using the GS1 rate code from PPL’s most recent quarterly customer extract, as the base count for small C&I customers for this analysis. Approximately 31,000 “larger” small C&I customers in the GS3 rate code are not included in this count even though some of the GS3 customers may use CFLs. That is expected to offset a similar number of GS1 accounts where CFLs may not be suitable (e.g., cable TV amplifiers, telecom devices, railroad and pedestrian crossing signals, billboard lights, etc.).

<sup>55</sup> Study included sales from participating and non-participating retailers. DNV KEMA. July 2013. “2012-2013 Northwest Residential Lighting Market Tracking Study.” Prepared for the Northwest Energy Efficiency Alliance (NEEA).

- A California shelf-stocking study found bulbs on the shelf with a utility discount represented 37% of all bulbs.<sup>57</sup>
- A Maryland shelf-stocking study found 52% of bulbs on the shelf were discounted.<sup>58</sup>

These studies found a slightly lower percentage of discounted bulb sales than PPL's because they were measuring slightly different parameters. For example, both the Northwest study and the California study included bulb sales (in the Northwest) or shelf-stocking data (in California) from all CFL channels, not just the retailers participating in the program. This is likely to drive down the percentage of total bulbs that are program bulbs.

In both the California and the Maryland study, the percentage of program bulbs pertains to bulbs stocked, not sales. Due to the price elasticity of CFLs, it is reasonable to assume that the proportion of program-discounted bulbs sales is likely to be higher than the proportion of program bulbs on the shelf.

### 3. Estimate the proportion of bulbs sold to small C&I customers

The EM&V CSP calculated the total number of program-discounted bulbs purchased by small C&I customers using the percentage of customers who reported purchasing bulbs from a participating retailer, the number of bulbs per respondent, and the 63% adjustment factor (the proportion of discounted program bulbs). See **Table D-5**.

To calculate the percentage of program bulbs sold to the small C&I segment, we divided total program purchases per year (428,112) by the PY4 annual program bulb sales (2,503,377 reported by Ecova), resulting in 17%.

**Table D-5. Program Bulbs Purchased by Small C&I Customers**

Percentage of Small C&I Respondents Who Purchased CFL from Participating Retailer	PPL Small C&I Customer Population	Number of Small C&I Customers who Purchased Bulbs	Bulbs Purchased Per Respondent per Year	Total CFLs Purchased Per year	Total Program-Discounted CFLs Purchased per Year
20% <sup>1</sup>	140,413 <sup>2</sup>	28,083	24.04	675,242 <sup>3</sup>	428,112 <sup>4</sup>
<b>NOTES:</b> <ol style="list-style-type: none"> <li>1. 32% respondents purchased CFL; 81% from retailer; 78% from participating retailer (Table 1)</li> <li>2. Excludes GS3 customers; population provided by PPL</li> <li>3. 20% * 140,413 * 24.04</li> <li>4. 675,242 * 63% (rounded)</li> </ol>					

<sup>56</sup> Average across WA, OR, ID, and MT. DNV KEMA, 2013, Op cit.

<sup>57</sup> Study includes bulbs on the shelf for participating and non-participating retailers. 2012 Data from DNV KEMA's California Retail Lighting Shelf Survey (CRLSS) online tool, available at: <http://websafe.kemainc.com/projects62/crlss/Home.aspx>

<sup>58</sup> Study included only participating retailers. Cadmus, 2013, report not yet publically available.

## Benchmarking

This analysis shows that 17% of all program-discounted CFLs were purchased by small commercial customers. At 90% confidence (and 301 complete surveys with recent purchasers) the interval is +/- 4.74%. This results in a range of 12.4% up to 21.8%.

These findings suggest a cross-sector sales ratio that is slightly higher than what other studies have reported. Other studies (using other methods) have found that small commercial customers purchase or install a range of 3% to 11% of program-discounted bulbs. **Table D-6** summarizes the approaches and the results of other studies that have measured cross-sector sales of discounted bulbs.

**Table D-6. Findings from Cross-Sector Sales Studies**

Utility	State	Study Method	Sample		Findings				Evaluation Time Period
			# of Stores	Completes	Upstream Bulb Purchases	% of Sales	Business Purchasers	Bulbs/ Customer	
PPL	PA	Phone (Small Business)	n/a	920	428,112	17%	292	24.04	2013
PG&E <sup>59</sup>	CA	Phone + Site Visits (Small Business)	n/a	2,434	2,446,567 <sup>3</sup>	6%	586	-	2006-2008
SCE <sup>60</sup>	CA	Phone + Site Visits (Small Business)	n/a	2,533	1,396,420 <sup>3</sup>	6%	426	-	2006-2008
SDG&E <sup>61</sup>	CA	Phone + Site Visits (Small Business)	n/a	3,395	408,830 <sup>3</sup>	5%	521	-	2006-2008
PECO <sup>62</sup>	PA	Intercept	-	144	-	7.7% <sup>1</sup>	9	~10	2010
Midwestern Utility <sup>2</sup>		Intercept	24	611	46,272	3%	-	-	2010
Mid-Atlantic Utility <sup>2</sup>		Intercept	16	445	-	5%	-	-	2010
Midwestern <sup>2</sup>		Phone (Residential Gen. Pop.)	n/a	300	n/a	11%	-	-	2011
<b>NOTES:</b> 1. PECO's initial study determined that 12.2% of bulbs were purchased by and installed in commercial facilities with a confidence interval of +/- 4.5%. Because the SWE considered this estimate high, Navigant revised the estimate downward to 7.7%. 2. Research conducted by Cadmus; reports not publically available. 3. Estimates of sales for the "under 150kW nonresidential population" of upstream CFLs purchased, in place, operable, in storage									

There are several reasons methods used in other studies could lead to different results than those determined through the EM&V CSP's study method (phone survey with commercial businesses). Many of the studies described in **Table D-6** involved either a store intercept or a phone survey conducted with residential customers. Regional differences will also impact results. Possible reasons for differences are summarized next.

<sup>59</sup> KEMA, Feb. 2010. *Final Evaluation Report: Upstream Lighting Program, Volumes 1 and 2*, prepared for the California Public Utilities Commission. [www.energydataweb.com/cpucFiles/18/FinalUpstreamLightingEvaluationReport\\_2.pdf](http://www.energydataweb.com/cpucFiles/18/FinalUpstreamLightingEvaluationReport_2.pdf) See also: Itron, Inc. Feb. 2010. *Small Commercial Contract Group Direct Impact Evaluation Report*, Appendix I, "Nonresidential Upstream CFL Purchase Quantities and Installation and Storage Rates." Available for download at: [www.calmac.org/AllPubs.asp](http://www.calmac.org/AllPubs.asp)

<sup>60</sup> Ibid.

<sup>61</sup> Ibid.

<sup>62</sup> Navigant, Quarterly Report to the PA Public Utility Commission (PY4 Q4), prepared for PECO. July 2013. Appendix B. Navigant notes "that this 12.2 percent represents the mean estimate of C&I installations using a weighted average of number of bulbs installed in commercial applications and not the percentage of customers purchasing bulbs. This proportion was relatively consistent across standard compact fluorescent lamp (CFL) and specialty CFL installations." "For the commercial customers purchasing more than twice the average number of CFLs purchased by residential only customers (5.14 CFLs), calculations assume that only 5.14 CFLs would be installed in their residence, and the rest would be installed in the commercial facility. Findings yield an estimated mean installation rate in C&I applications of 12.2 percent."

**Regional Differences:** While the California study was most similar to the EM&V CSP's method (which included phone surveys with small business customers), the market characteristics of PPL's utility territory differ significantly from those in California and therefore The EM&V CSP does consider the results of the California study transferrable to PA. This is generally consistent with the SWE's recent position not to apply forecasted hours of use (HOU) from a California metering study to Pennsylvania. It also follows the guidance from the Uniform Methods Project Residential Lighting Protocols that data from one region of the country should not be extrapolated to another region.<sup>63</sup> The HOU assumption used in the calculation of savings for PPL's small commercial customers was derived by mapping the SIC codes for the customers included in the assumed customer base (140,413 customers) to building types in the TRM. As shown in Appendix A, this result was compared to results using the SIC codes from survey respondents, as well as various sub-categories of survey respondents, to ensure representativeness of the data.

**Residential Phone Surveys:** Using a residential general population telephone survey to determine the number of CFLs purchased by commercial customers is likely to underreport cross-sector sales. This method relies on the chance that some residential respondents will also own or manage a business, and, be responsible for the business' lighting purchases. It also assumes these respondents will be able to answer questions about bulb purchases for their business.

**Intercept Studies:** An intercept study is useful for gathering accurate data on the type of bulb purchased from the store, and offers the opportunity to determine if the purchased bulb was a program-discounted bulb. However, estimating CFLs purchased by commercial customers may be difficult.

- Intercept studies are highly dependent on securing retailer store permission – a logistical challenge prevalent in nearly all intercept studies.<sup>64</sup> Some stores may not grant permission to have interviewers at their stores, or might only allow them for limited times of the day.
- The participants in the intercept study are the shoppers in the store during the specific times and dates the study is conducted. These may not be the times commercial businesses shop. This could affect the ratio of residential to non-residential purchases because business customer purchase behavior patterns likely differ from residential patterns.

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<sup>63</sup> National Renewal Energy Laboratory. (April, 2013) *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures; Chapter 6: Residential Lighting Evaluation Protocol*. Prepared for U.S. Department of Energy.

<sup>64</sup> Cadmus has conducted multiple intercept studies for clients across the country and has continued to find working with stores to secure permission to be a major challenge in sample design. The following paper details these obstacles and the implications: Swayne, Kate and Shepard, Brian (Cadmus). "Intercepts: 'How-to,' Lessons Learned, and Potential Application in a Post-CFL World." International Energy Program Evaluation Conference, 2011.

- Intercept studies are not typically effective in targeting a specific number of interviews with small business customers in the same way a phone survey is. This generally leads to a smaller sample of business customers included in the study.

**PECO's Results:** PECO conducted a store intercept study in PY2, determining that 12.2% of bulbs (+/- 4.5%) were purchased by and installed in commercial customers' facilities.<sup>65</sup> The PECO intercept study interviewed 144 customers. Of 144 intercepts, 9 purchasers reported they would install at least some of the bulbs in a commercial location. The study reports that commercial customers purchased and installed roughly 10 CFLs (or about double the number that residential customers purchased; see footnote 9). This is one of the differences between PECO and PPL. PPL's small commercial customers purchased an average of 25 bulbs, more than 2.5 times the number PECO reported, which helps to explain the higher percentage of sales in PPL's territory.

PECO's report indicates their estimates accounted for installation rates (see footnote 9). The estimates for PPL were not adjusted by installation rates. PPL's small commercial customer survey data shows that about 79% of purchased bulbs were installed (close to the deemed residential ISR of 84%). Our calculations proportioning the sales to residential and commercial customers do not consider installation rates. The ISR is taken into account in the savings estimates for both residential and commercial customers.

## Decision

Given the unique characteristics of various areas where these studies were conducted, and the differences in study methods, results may not be transferable to PPL Electric's service area. Some may argue that PPL's estimates of commercial sales are high, ranging from 12.4% to 21.8% (17% +/- 4.74%). However, the low end of PPL's estimate (12.4%) still falls within PECO's estimate of 7.7% to 16.7% (12.2% +/- 4.5%).

Since there is uncertainty in the total number of sector-specific sales and in the absence of more reliable sources for total CFL sales, PPL adopted the conservative estimate of 12.4%, which is the low end of the range determined using survey data (PPL submitted a summary Cross Sector Sales Memo to the SWE, responded to SWE's comments, and finalized the memo on 10/8/2013)

## Savings Adjustments

The adjustments to energy and demand savings are based on different assumptions regarding hours of use (HOU), coincidence factor (CF), and installation rate (ISR). Residential bulb savings are based on assumptions defined in the TRM. The TRM also defines assumptions for commercial bulbs, but these are

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<sup>65</sup> Navigant, Quarterly Report to the PA Public Utility Commission (PY4 Q4), prepared for PECO. July 2013. Appendix B.



based on building type. To determine the appropriate assumptions to use for bulbs sold through the upstream program, the EM&V CSP used data from PPL's customer database, specifically, those records used to define PPL's Small Commercial customer population. The EM&V CSP used a combination of the more detailed description of each customer's sector and their SIC code to map each record to a building type associated with assumptions in the 2013 TRM Table 3-4. The EM&V CSP used the percentage of PPL's customer based for each building type to produce weighted averages of the TRM assumptions for HOU and CF. The ISR assumption was based on the results of the small-commercial customer survey.

As seen in the 2013 TRM algorithms in section 2.30.1, below, savings adjustments from the residential to small commercial sector are based on multipliers comprised of the proportional differences between the assumptions shown in **Table D-7**.

$$\Delta kWh = (Watts_{base} - Watts_{CFL}) \times CFL_{hours} \times 365 / 1000 \times ISR_{CFL}$$

$$\Delta kW_{peak} = (Watts_{base} - Watts_{CFL}) / 1000 \times CF \times ISR_{CFL}$$

**Table D-7: Residential vs. Commercial Assumptions**

	HOU	CF	ISR
Residential Assumption	3,291	0.82	84%
Small Commercial Customer Base	1,095	0.05	79%

The savings adjustment is shown in **Table D-8**.

**Table D-8: Saving-adjustment Multipliers**

KWh	KW
282%	1536%

Removing 12.4 percent of savings from the residential sector, applying the gross ups, and moving savings to the small commercial sector results in the adjustments shown in **Table D-9**.

**Table D-9: Savings Adjustments**

<b>Verified Savings</b>	<b>MWh</b>	<b>MW<sup>1</sup> (without T&amp;D losses)</b>
CPITD PY4	451,544	22.66
New CPITD	608,911	65.68
Additional Savings	157,367	43.02
Residential Adjustment	(55,817)	(2.80)
Small C&I Addition	213,184	45.82
New Residential	395,727	19.86
<b>Adjusted Savings</b>	<b>608,911</b>	<b>65.68</b>
<b>NOTES:</b>		
1. Total verified demand reduction. The additional savings applied to the Top 100 Hours demand reduction is 34.72 MW (excluding T&D losses).		

## Appendix E: Additional Energy-Efficiency Behavior & Education Program Impact Analysis

### Data Development

The EM&V CSP cleaned and prepared the data (consumption histories) for analysis. First, the EM&V CSP dropped homes whose accounts became inactive, who were flagged, or who did not have a complete PY4 billing history. A home could be flagged either because a Home Energy Report could not be generated or delivered to the home or the home was occupied by a PPL Electric employee. **Table E-1** shows the details on the data organization.

**Table E-1: Data Preparation Summary**

	Number of observations from billing data	
	Legacy	Expansion
Original billing data	4,815,324	2,889,810
Bills used in estimation	4,653,111	2,661,563
	Number of Customer Accounts	
Customer accounts in estimation <sup>66</sup>	83,729	69,737
Treatment group	41,896	48,026
Control group	41,833	21,711

The cleaning resulted in a balanced panel of 41,896 homes in the legacy treatment group and 41,833 homes in the legacy control group. In the expansion group estimation sample, there were 48,026 treatment group homes and 21,711 control group homes.

The EM&V CSP calculated the heating degree days and cooling degree days (with a base of 65 degrees) for each customer bill and merged them with the billing data.

For the demand reduction analysis, the EM&V CSP collected hourly energy use data for legacy and expansion group homes. The hourly energy use data came from AMI meters installed on residential customer premises. The data for this study covered 2232 summer hours between June 15 and September 15 for 5,000 treatment group homes and 5,000 control group homes in each of the legacy and expansion groups. Altogether, the energy use data included approximately 44 million hourly records.

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<sup>66</sup> Accounts included were not flagged, had first report dates, was active after June 2012 (PY3) and active during PY4 treatment period.

All of the homes were sampled randomly from the legacy and expansion group populations.<sup>67</sup> Sampling had the potential to introduce error in the demand reduction estimates. To minimize this potential, the EM&V CSP used data on monthly energy use in the year before the program to verify that the energy use of sampled and non-sampled homes (as well as of sampled treatment and control group homes) was balanced.

**Table E-2: Demand Reduction Estimation Sample**

	Treatment Homes (N)	Control Homes (N)
Legacy	5,000	5,000
Expansion	5,000	5,000

### Energy Savings Model Specification

To estimate the program energy savings, the EM&V CSP employed a non-parametric, difference-in-differences regression model of monthly energy consumption with customer fixed effects. The average daily electricity (kWh) consumption (ADC) of home 'i' in month 't' is given by:

$$ADC_{it} = \alpha_i + \beta_1 POST_{it} + \beta_2 PROGRAM_{it} \times POST_{it} + \mu_{my} + \varepsilon_{it}$$

**Equation E-1**

where:

- $\alpha_i$  = Home intercept corresponding to non-weather sensitive average daily consumption.
- POST = Indicator variable for whether the period is pre- or post-treatment (this variable is defined with a one month lag to allow time for the home to implement energy savings measures. A lag that was not accounted for would depress the coefficient on  $\beta_2$ ).
- PROGRAM = An indicator variable for program participation (= 1 if the home was in the treatment group; = 0 otherwise).
- $\mu_{my}$  = Month-by-year fixed effects intended to capture weather and other effects on consumption specific to the month. This specification assumes that all control and treatment group homes were sampled

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<sup>67</sup> Instead of analyzing energy use of all program homes before and after the start of the program, the EM&V CSP sampled from the program population and collected data for summer months during the program. It was felt this would minimize the burden on the utility of pulling a large amount of energy use data.

from the same area and experienced the same weather. The EM&V contractor also estimated models that substituted location-specific monthly weather variables for the month-by-year fixed effects.

- $\varepsilon_{it}$  = Error term for home 'i' in month 't.'
- $\beta_1$  = Coefficient representing the impact of factors affecting the consumption of all homes between the pre-treatment and treatment periods.
- $\beta_2$  = Coefficient representing the conditional average treatment effect of the program (the kWh savings impact), controlling for changes in participant usage unrelated to the program.

Identification of the program savings is based on the assumption that a customer's membership in either the treatment group or the control group was unrelated to his or her energy use after conditioning on month-by-year (weather) and individual fixed effects. The experimental design of the program ensures that this assumption was satisfied. The EM&V CSP also tested the statistical equivalence of the treatment and control groups and reported results of those tests in the PY2 and PY3 evaluations. The EM&V CSP did not find any statistically significant differences between treatment and control groups.

In this framework, it is possible to measure monthly treatment effects by including interaction terms between POST x PROGRAM and observable home characteristics. For example, the following specification was used to estimate the figures that show how monthly savings evolve over the entire period and the persistence of savings in homes in the second year of the program:

$$ADC_{it} = \alpha_i + \sum_{p=1}^P \beta_p \text{MONTH}_{ipt} + \sum_{p=1}^P \beta_p \text{PROGRAM}_{it} \times \text{MONTH}_{ipt} + \varepsilon_{ipt}$$

**Equation E-2**

where:

- $p$  = Indexes the month number in the estimation period ( $p = 1, 2, \dots$ ).

In this framework, the average daily savings of the program on homes in month ‘p’ equals:

$$\text{Average savings in month } p = \beta_p, \text{ for } p = 1 \text{ to } P.^{68}$$

### Demand Reduction Model Specification

To estimate the program demand reduction, the EM&V CSP also employed non-parametric regression. For each of the homes in the legacy group and expansion group, the EM&V CSP estimated the following regression model of hourly energy use (kWh):

$$\text{kWh}_{it} = \beta_1 \text{Top100}(1)_{it} * \text{Treat}(1)_{it} + \beta_2 (1 - \text{Top100}(1)_{it}) * \text{Treat}(1)_{it} + \tau_t + \varepsilon_{it}$$

**Equation E-3**

where:

$\text{Top100}(1)_{it}$  = one if hour  $t$  was a PPL Electric system peak hour and equals zero, otherwise.

$\text{Treat}(1)_{it}$  = one if the home was in the program treatment group and equals zero, otherwise.

$\tau_t$  = average home energy use in hour  $t$ . The regression includes hour fixed effects to control for differences between hours in average energy use.

$\varepsilon_{it}$  = Model error term.

The coefficient  $\beta_1$  represents the average treatment effect of the behavior program on demand during utility system peak hours, and  $\beta_2$  represents the treatment effect in all other hours. Note that because of the experimental program design, the treatment effects are net of other demand-side management that may have reduced peak demand, such as participation in the utility’s demand response programs.

We estimated the model by OLS and Huber-White standard errors clustered on homes to account for correlation in each home’s energy use across hours.

### PY4 Behavior and Education Energy Savings Estimates

**Table E-3** shows estimates of the PY4 impacts for the legacy group from several specifications of **Equation E-1**. All of the models were estimated by ordinary least squares (OLS), and the standard errors

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<sup>68</sup> Note that the savings estimate for each month captures some savings from the preceding month. The first bill in each calendar year was issued in January, the second bill was issued in February, etc. Unless the billing cycle exactly coincided with a calendar month, a bill included consumption from some days in the preceding month. This means, for example, that consumption for an April bill had the highest probability of occurring around April 1 of that month. If billing cycles are uniformly distributed over days of the month, April 1 is included in the largest number of bills, March 31 and April 2 are included in the second largest number of bills, and March 30 and April 3 are included in the third largest number of bills, and so on.

were adjusted for correlation over time in a customer's consumption using Huber-White robust standard errors.<sup>69</sup>

**Table E-3: Conditional Average Program Treatment Effects for Legacy Group PY4**

	Model 1	Model 2	Model 3	Model 4
Post PY 2	1.971	11.569	-2.682	11.024
	(0.03)	(1.88)	(0.04)	(1.98)
Post PY 3	-1.963	9.112	-3.425	9.203
	(0.05)	(6.23)	(0.05)	(7.00)
Post PY 4	-0.206	15.119	-3.637	16.931
	(0.05)	(2.88)	(0.05)	(2.91)
Participant x Post PY 2	-0.635	-0.634	-0.627	-0.629
	(0.05)	(0.05)	(0.05)	(0.05)
Participant x Post PY 3	-0.913	-0.911	-0.902	-0.903
	(0.07)	(0.07)	(0.07)	(0.07)
Participant x Post PY 4	-0.987	-0.992	-0.990	-0.990
	(0.07)	(0.07)	(0.07)	(0.07)
Customer Fixed Effects	Yes	Yes	Yes	Yes
Month-by-Year Fixed Effects	No	Yes	No	Yes
Weather Polynomials	No	No	Yes	Yes
R2	0.005	0.202	0.202	0.221

Across the model specifications, the Behavior and Education Program effect on average daily consumption is precisely estimated and consistent. According to Model 2, which includes customer and month-by-year fixed effects, the PY2 program impact, shown by the coefficient on Participant x Post PY 2, was to reduce average daily consumption by approximately -0.63 kWh per home. The PY3 impact was to reduce average daily consumption by -0.91 kWh per home. The PY4 impact was to reduce average daily consumption by -0.99 kWh per home. Thus, the consumption impact increased by 8.2 % between PY3 and PY4 and 55% between PY2 and PY4.

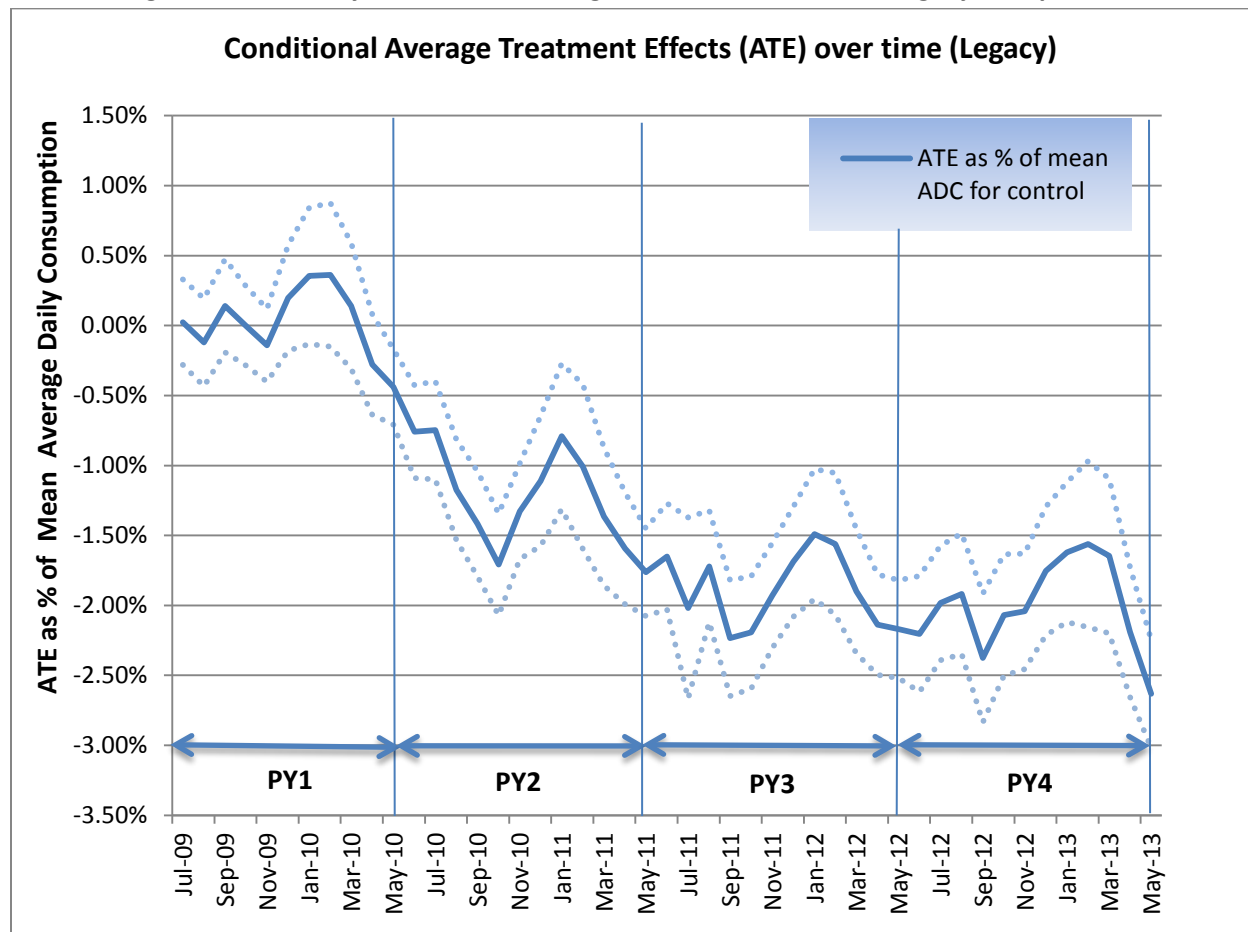
**Figure E-1** shows the percent average daily savings with 95% confidence intervals in each month between June 2009 and May 2012 for the legacy group.<sup>70</sup> The monthly average treatment effects are

<sup>69</sup> Bertrand, Marianne, E. Duflo, and S. Mullainathan. *How Much Should We Trust Difference-in-Differences Estimates*. Quarterly Journal of Economics, 119 (1), pp. 249-275. 2004.

<sup>70</sup> The savings in this figure were derived from a regression of average daily consumption in a month on home fixed effects, month-by-year fixed effects, and month-by-year fixed effects interacted with an indicator variable for receiving the treatment.

shown as a percentage of the mean of the average daily consumption of the control group. As the program did not start until May 2010, there were no program savings before June 2010 and, as expected, the 95% confidence interval includes zero percent savings in this period.

**Figure E-1: Monthly Conditional Average Treatment Effects for Legacy Group Homes**



In the first year of the program, the percent savings (the percent reduction in average daily consumption) trend upward and reach a steady state of approximately 1.7% to 1.8% by the beginning of PY3. The percent savings then fluctuate between 1.5% and 2% in PY3. In PY4, the percent savings increase slightly to just above 2%. The absolute kWh impacts (not depicted) are higher in the winter and summer months when demand for heating and cooling is higher.

**Table E-4** reports regression-based estimates of the expansion group PY4 savings. The only difference between the legacy and expansion regression models is that the treatment period for the legacy group covers two years instead of three. The coefficient on *Participant x Post PY 4* in **Table E-4** is an estimate of the average daily savings in PY4. According to Model 2, the program's effect on a home's consumption was estimated to be -1.03 kWh/day in PY1 and -1.36/day in PY2.

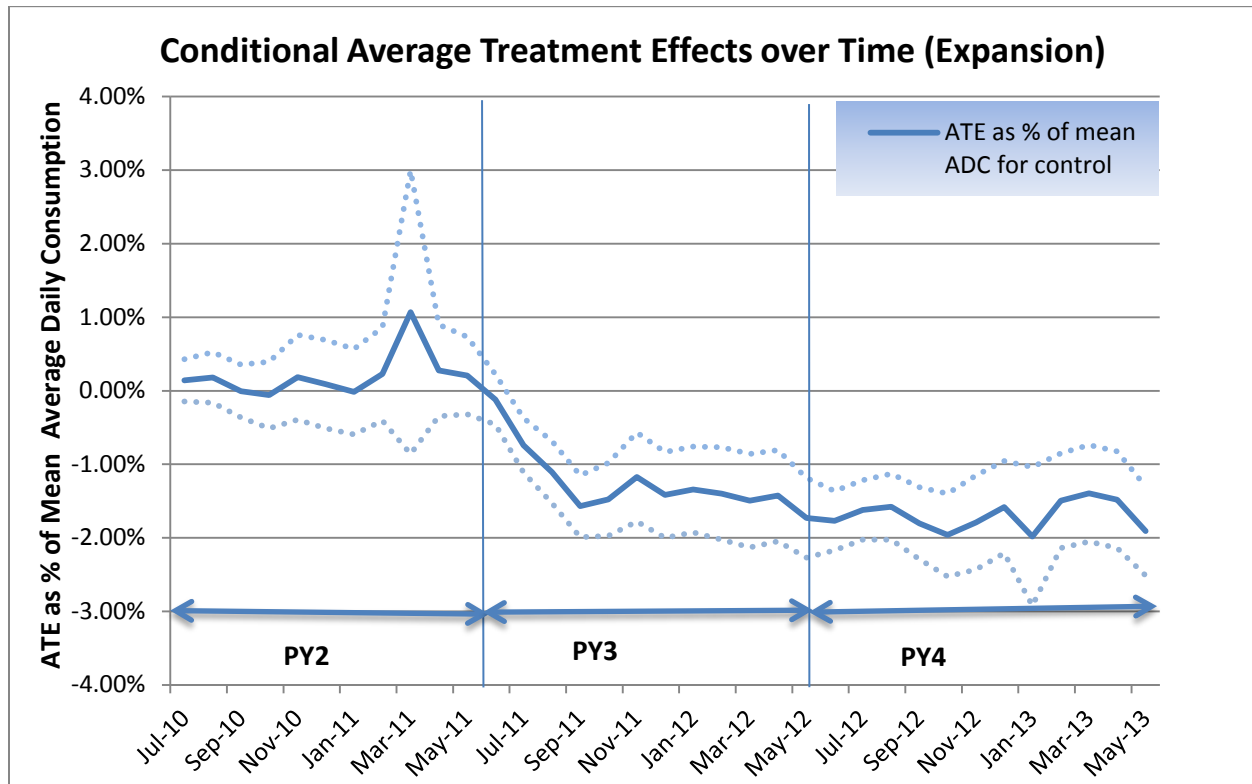


**Table E-4: Conditional Average Program Treatment Effects for Expansion PY4**

	Model 1	Model 2	Model 3	Model 4
Post PY 3	-7.563	4.826	-0.671	0.101
	(0.070)	(0.235)	(0.516)	(1.075)
Post PY 4	-3.540	1.503	-1.687	-4.935
	(0.097)	(2.515)	(0.223)	(11.634)
Participant x Post PY 3	-1.031	-1.026	-1.023	-1.022
	(0.121)	(0.121)	(0.117)	(0.115)
Participant x Post PY 4	-1.356	-1.357	-1.352	-1.355
	(0.144)	(0.144)	(0.142)	(0.142)
Customer Fixed Effects	Yes	Yes	Yes	Yes
Month-by-Year Fixed Effects	No	Yes	No	Yes
Weather Polynomials	No	No	Yes	Yes
R2	0.005	0.183	0.2584	0.2625

**Figure E-2** shows the percent average daily savings (reduction in average daily consumption) for expansion group homes in each month between June 2010 and May 2012. In the first program year (PY3), the savings trended rapidly upward (consumption trends downward in the figure) after the program start and reached a steady state of about 1.5% within six months. In PY4, savings trended upward to about 2%.

Figure E-2: Monthly Conditional Average Treatment Effects for Legacy Group Homes



### Annual Net Program Energy Savings

PY4 ran from June 1, 2012 to May 30, 2013. The EM&V CSP used estimates of the monthly kWh program effects to estimate the PY4 net savings. Specifically, the program savings were estimated as the weighted sum of the conditional average monthly treatment effects:

$$\text{PY3 Savings} = \sum_{p'=1}^{12} \beta_{2p'} * \text{Days}_{p'} * \text{TreatedHomes}_{p'}$$

Where:

$p'$  = Indexes the months of PY4

$\beta_{2p'}$  = The conditional average daily kWh savings in month  $p'$  from Equation H2. The coefficient was obtained from the regression analysis.

$\text{Days}_{p'}$  = The number of days in month  $p'$

$\text{TreatedHomes}_{p'}$  = The number of homes receiving the treatment in that month or in a previous month and whose account was still active.

The PY4 annual savings for the typical program home was estimated as follows:

$$\text{PY4 Savings} = \sum_{p'=1}^{12} -\beta_{2p'} * \text{Days}_{p'}$$

**Table E-5** shows the estimate of PY4 program and typical home savings and associated 95% confidence intervals.

**Table E-5: PY4 Energy Efficiency Behavior & Education Program Energy Savings Estimates**

Program Net Savings			
	Point Estimate (MWh)	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Legacy	15,072	12,513	17,630
Expansion	21,399	14,469	28,328
<b>Total Program</b>	<b>36,470</b>	<b>26,983</b>	<b>45,958</b>
Average Home Net Savings			
	Point Estimate (kWh)	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Legacy	360	308	413
Expansion	495	392	598

The Behavior & Education Program savings for the legacy group were estimated to be 15,072 MWh/yr, with a 95% confidence interval of 12,513 MWh to 17,630 MWh. The program savings in the expansion group were estimated to be 21,399 MWh/yr, with a 95% confidence interval of 14,469 to 28,328 MWh. The total PY4 program savings were estimated to be 36,470 MWh. The adjusted *ex ante* gross energy savings of 35,138 MWh/yr are within 4% of the verified net energy savings and within the 95% confidence interval for verified net savings.

For the average treatment group home, annual savings were 360 kWh/yr or 2%, using legacy control group post-treatment annual consumption as a baseline. For the average expansion group home, annual savings were 495 kWh/yr or 1.7%.

### Test of Statistical Equivalence of the Treatment and Control Groups

A key assumption of the analysis was that the program's CSP randomly assigned homes to treatment and control groups. In the PY2 evaluation, the EM&V CSP checked this assumption for the legacy group by testing for differences in annual energy use in the 12 months before the program started between treatment and control group homes. The EM&V CSP could not reject the hypothesis. In PY3, the EM&V CSP also could not reject the hypothesis of equality of average annual consumption between expansion treatment and control group homes.

### PY4 Behavior and Education Demand Reduction Estimates

**Table E-6** shows the hourly energy use regression results for legacy and expansion group homes.

**Table E-6: Conditional Average Demand Reduction Treatment Effects for PY4**

	Legacy	Expansion
Top100(1)*Treat(1)	-0.0798 <sup>1</sup> (0.0289)	-0.0609 <sup>2</sup> (0.0366)
(1-Top100(1))*Treat(1)	-0.0512 <sup>1</sup> (0.0169)	-0.0397 <sup>2</sup> (0.0226)
Hour fixed effects	Yes	Yes
R <sup>2</sup>	0.208	0.145
N homes	9,994	9,996
N observations	22,255,467	22,239,390
<b>NOTES:</b> 1. Indicates estimate is statistically significant at the 1% level 2. Indicates significance at the 10% level. Dependent variable was energy use per hour. Models estimated by OLS. Standard errors are Huber-White clustered on homes.		

In both models, the interaction variables between the indicator for receiving the treatment and the indicators for peak and non-peak hours were statistically significant at the 10% level. The average demand reduction in the top 100 hours were about 0.08 kW/legacy group home and 0.06 kW/expansion group home or 2.2% and 1.7%, respectively, using the average peak hour demand of control homes as a baseline.

**Table E-7** shows the average demand reduction for the program in the top 100 hours of system peak demand in PY4. The program kW savings were estimated by multiplying the demand reduction per home by the total number of homes that received a home energy report whose billing account was still active in summer 2012.<sup>71</sup>

**Table E-7: PY4 Energy Efficiency Behavior & Education Program Demand Reduction Estimates**

	Program Average Demand Reduction (MW)	90% Confidence Interval Lower Bound	90% Confidence Interval Upper Bound
Legacy	3.447	1.392	5.502
Expansion	3.018	0.036	5.999
Total	6.465	2.844	10.086

<sup>71</sup> The number of treatment group homes with an active billing account during the top 100 hours averaged 43,208 for the legacy group and 49,510 for the expansion group.

The program average peak demand reduction over the top 100 hours was 3.5 MW for legacy group homes and 3.0 MW for expansion group homes. The average peak demand reduction for the whole program was 6.5 MW, enough electricity to meet the demand of approximately 1,800 control group customers during peak hours. The 90% confidence interval for program savings was [2.85 MW, 10.09 MW].

## Appendix F: Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs

The Energy Efficiency Behavior & Education Program savings reflect both behavioral changes, such as turning off lights in unoccupied rooms and adjusting thermostat settings, and investments in energy-saving equipment, such as in high-efficiency furnaces and CFLs. Savings from measures that were rebated through PPL Electric's energy efficiency programs will be counted by the Energy Efficiency Behavior & Education Program and the rebate programs and thus be double counted. This section discusses the estimation of the amount of Energy Efficiency Behavior & Education Program energy savings and demand reduction that were counted in other PPL Electric rebate programs. The total double-counting adjustment to CPITD verified energy was 460 MWh/yr. The adjustment to CPITD verified demand reduction was .02 MW. The double-counting reductions were applied at the portfolio level and not to the Behavior and Education Program.

The amount of savings overlap is relatively straightforward to calculate because of the experimental design of the Energy Efficiency Behavior & Education Program. To illustrate, suppose that there are an equal number of customers in the treatment and control groups and that information exists about the installation of Measure A, which is promoted by the utility, for both groups. Customers in the treatment and control groups are assumed to receive the same treatment from the utility for the program promoting Measure A (i.e., they face the same marketing and incentives). Because customers were randomly assigned to the treatment and control groups, any difference between the groups in the installation of Measure A can be attributed to the behavioral program. If the difference is  $\Delta n_A$  and the per-unit deemed savings are  $s_A$ , then the amount of savings counted by the Energy Efficiency Behavior & Education Program and the other utility program would be  $\Delta n_A * s_A$ .

### Downstream Rebate Programs

For measures promoted by utility programs and tracked at the customer level, the amount of savings overlap was estimated by matching Energy Efficiency Behavior & Education Program treatment and control group customers in the estimation sample (described above) to the PY4 energy efficiency program participation data in EEMIS.<sup>72</sup> Next, the difference between treatment and control groups in PY4 rebated savings per home was calculated and the difference was multiplied by the number of treated homes in the estimation sample whose account was still active in PY4. The result was an

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<sup>72</sup> Each PY4 measure in EEMIS includes an estimate of the annual savings and records the date that the measure was installed. For the double-counting analysis, the annual savings were prorated using a simple formula to account for the fact that rebated measures were installed throughout PY4. The formula multiplied the annual savings by the percentage of PY4 that the measure was installed. The prorated savings may overstate savings for some weather-sensitive measures while understating them for other measures; however, it is expected that the prorated savings will be correct on average.

estimate of Energy Efficiency Behavior & Education Program participant savings that were counted in other PPL Electric programs. For the analysis of double-counted demand reduction, attention was confined to efficiency measures installed between June 1, 2012 and the last date on which a system peak hour occurred.

Homes in the behavior program treatment and control groups participated in five downstream rebate programs in PY4. The Appliance Recycling, Efficient Equipment, and Home Assessment & Weatherization programs accounted for most of the participation.

**Table F-1** and **Table F-2** show the following for, respectively, the behavior program legacy and expansion groups:

- Net energy savings counted in each PPL Electric residential rebate program per home and in total (columns 7 and 8)
- Net energy savings counted in all PPL Electric residential rebate programs per home and in total (columns 7 and 8 of the last row)
- Program uplift, that is, the effect of the behavior program on the participation rate in other programs (column 9).

**Table F-1: Behavioral and Education Program Savings for  
Legacy Group Counted in Downstream Rebate Programs<sup>1</sup>**

Program	Treatment Group		Control Group		Difference (Treatment - Control)				
	(1) Per Home <i>Ex post</i> Verified Savings (kWh/yr)	(2) Participation Rate	(3) Per Home <i>Ex post</i> Verified Savings (kWh/yr)	(4) Participation Rate	(5) Verified <i>Ex post</i> savings per home (kWh/yr)	(6) Program <i>Ex post</i> Verified Savings (MWh/yr)	(7) Net <i>Ex post</i> Verified Savings per home (kWh/yr)	(8) Program Net <i>Ex post</i> Verified Savings (MWh/yr)	(9) Program Uplift
Appliance Recycling	15.50	2.11%	14.25	2.02%	1.25	52.36	0.85	35.59	0.09%
E-Power Wise Program	0.19	0.65%	0.19	0.63%	0.00	-0.15	0.00	-0.15	0.02%
Efficient Equipment Incentive Program - Residential	9.75	2.83%	8.86	2.65%	0.89	37.40	0.64	26.93	0.18%
Low Income WRAP	2.49	0.20%	2.42	0.19%	0.07	2.85	0.07	2.85	0.01%
Residential Energy Assessment & Weatherization	6.09	0.84%	3.97	0.50%	2.12	88.74	1.58	66.29	0.34%
<b>Total</b>	<b>34.01</b>	<b>6.05%</b>	<b>29.69</b>	<b>5.75%</b>	<b>4.33</b>	<b>181.21</b>	<b>3.14</b>	<b>131.52</b>	<b>0.31%</b>
<b>NOTES:</b> 1. <i>Ex post</i> savings are PY4 verified gross savings in treatment and control group homes. Net savings are <i>ex post</i> savings multiplied by program NTG. PY4 net savings overlap was obtained by multiplying the difference in per-home net kWh savings by the number of PPL Electric customers who received Home Energy Reports in PY2 and dividing by 1000.									



**Table F-2: Behavioral and Education Program Savings for  
Expansion Group Counted in Downstream Rebate Programs<sup>1</sup>**

Program	Treatment Group		Control Group		Difference (Treatment – Control)				
	(1) Per Home <i>Ex post</i> Verified Savings (kWh/yr)	(2) Participation Rate	(3) Per Home <i>Ex post</i> Verified Savings (kWh/yr)	(4) Participation Rate	(5) Verified <i>Ex post</i> savings per home (kWh/yr)	(6) Program <i>Ex post</i> Verified Savings (MWh/yr)	(7) Net <i>Ex post</i> Verified Savings per home (kWh/yr)	(8) Program Net <i>Ex post</i> Verified Savings (MWh/yr)	(9) Program Uplift
Appliance Recycling	19.28	2.50%	15.81	2.17%	3.47	166.69	2.36	113.31	0.32%
E-Power Wise Program	0.24	0.80%	0.24	0.81%	0.00	0.00	0.00	0.00	-0.01%
Efficient Equipment Incentive Program - Residential	13.82	3.29%	13.78	3.09%	0.04	1.77	0.03	1.27	0.20%
Low Income WRAP	6.66	0.46%	5.83	0.36%	0.83	39.72	0.83	39.72	0.09%
Residential Energy Assessment & Weatherization	9.77	1.46%	4.91	0.75%	4.86	233.60	3.63	174.50	0.70%
<b>Total</b>	<b>49.76</b>	<b>8.50%</b>	<b>40.56</b>	<b>7.19%</b>	<b>9.20</b>	<b>385.38</b>	<b>6.85</b>	<b>328.80</b>	<b>1.32%</b>
<b>NOTES:</b> 1. <i>Ex post</i> savings are PY4 verified gross savings in treatment and control group homes. Net savings are <i>ex post</i> savings multiplied by program NTG. PY4 net savings overlap was obtained by multiplying the difference in per-home net kWh savings by the number of PPL Electric customers who received Home Energy Reports in PY3 and dividing by 1000.									

The legacy group program energy savings counted in other PPL Electric downstream rebate programs was 131 MWh/yr. or 0.9% of legacy group program savings. The expansion group program energy savings counted in other PPL Electric downstream rebate programs was 329 MWh/yr. or 1.54% of expansion group program savings. The total program energy savings counted in other downstream rebate programs was 460 MWh/yr. or 1.26% of PY4 savings. Refer to **Table F-5** for total double counted energy savings.

**Table F-3** and **Table F-4** show the following for, respectively, legacy and expansion group customers:

- Net demand reduction counted in each PPL Electric residential rebate program per home and in total (columns 5 and 6)

- Net demand reduction counted in all PPL Electric residential rebate programs per home and in total (columns 5 and 6 of the last row)

**Table F-3: Behavioral and Education Program Demand Reduction for Legacy Group Counted in Downstream Rebate Programs<sup>1</sup>**

Program	Treatment Group	Control Group	Difference (Treatment - Control)			
	(1) Per Home Ex post Verified Savings (kW)	(2) Per Home Ex post Verified Savings (kW)	(3) Verified Ex post savings per home (kW)	(4) Program Ex post Verified Savings (kW)	(5) Net Ex post Verified Savings per home (kW)	(6) Program Net Ex post Verified Savings (kW)
Appliance Recycling	0.00081	0.00089	-0.00008	-3.16	-0.00005	-2.15
E-Power Wise Program	0.00000	0.00000	0.00000	-0.04	0.00000	-0.04
Efficient Equipment Incentive Program - Residential	0.00060	0.00057	0.00002	0.94	0.00001	0.63
Low Income WRAP	0.00017	0.00018	-0.00001	-0.35	-0.00001	-0.35
Residential Energy Assessment & Weatherization	0.00030	0.00015	0.00015	6.30	0.00011	4.71
<b>Total</b>	<b>0.00188</b>	<b>0.00179</b>	<b>0.00009</b>	<b>3.69</b>	<b>0.0001</b>	<b>2.79</b>
<b>NOTES:</b> 1. <i>Ex post</i> savings are PY4 verified gross savings in treatment and control group homes. Net savings are <i>ex post</i> savings multiplied by program NTG. PY4 net savings overlap was obtained by multiplying the difference in per-home net kWh savings by the number of PPL Electric customers who received Home Energy Reports in PY2 and dividing by 1000.						

**Table F-4: Behavioral and Education Program Demand Reduction for  
Expansion Group Counted in Downstream Rebate Programs<sup>1</sup>**

Program	Treatment Group	Control Group	Difference (Treatment - Control)			
	(1) Per Home Ex post Verified Savings (kW)	(2) Per Home Ex post Verified Savings (kW)	(3) Verified Ex post savings per home (kW)	(4) Program Ex post Verified Savings (kW)	(5) Net Ex post Verified Savings per home (kW)	(6) Program Net Ex post Verified Savings (kW)
Appliance Recycling	0.00127	0.00080	0.00047	22.47	0.000318	15.28
E-Power Wise Program	0.00001	0.00000	0.00000	0.10	0.000002	0.10
Efficient Equipment Incentive Program - Residential	0.00072	0.00088	-0.00016	-7.49	-0.000103	-4.96
Low Income WRAP	0.00049	0.00048	0.00001	0.63	0.000013	0.63
Residential Energy Assessment & Weatherization	0.00035	0.00007	0.00028	13.33	0.000207	9.96
<b>Total</b>	<b>0.00284</b>	<b>0.00223</b>	<b>0.00061</b>	<b>29.06</b>	<b>0.0004</b>	<b>21.01</b>
<b>NOTES:</b> 1. <i>Ex post</i> savings are PY4 verified gross savings in treatment and control group homes. Net savings are <i>ex post</i> savings multiplied by program NTG. PY4 net savings overlap was obtained by multiplying the difference in per-home net kWh savings by the number of PPL Electric customers who received Home Energy Reports in PY3 and dividing by 1000.						

The legacy group program demand reduction counted in other PPL Electric downstream rebate programs was 2.8 kW or 0.08% of legacy group program demand reduction. The expansion group program energy savings counted in other PPL Electric downstream rebate programs was 21 kW. or 0.70% of expansion group program demand reduction. The total program demand reduction counted in other downstream rebate programs was 24 kW or 0.37% of PY4 savings. The double-counted demand reduction were small because only savings from PY4 measures installed between June 1, 2012 and the last day on which a system peak hour occurred were at risk of being double counted.

**Table F-5: Summary Table for Double Counted Energy and Demand Reduction**

<b>Program</b>	<b>Double Counted Energy Savings (MWh/yr)</b>	<b>Double Counted Savings as Percentage of Behavior and Education Program Savings in PY4</b>	<b>Double Counted Demand Reduction(kW)</b>	<b>Double Counted Demand Reduction as percentage of Behavior and Education Program Reduction in PY4</b>
Legacy	131	0.90%	3	0.08%
Expansion	329	1.54%	21	0.70%
<b>Total</b>	<b>460</b>	<b>1.26%</b>	<b>24</b>	<b>0.37%</b>

### **Upstream Rebate Programs (CFLs)**

The overlap of Energy Efficiency Behavior & Education Program savings and the Residential Lighting savings was not estimated because the Residential Lighting program (formerly CFL Campaign) does not track participation at the customer level.

## Appendix G: E-Power Wise Program Savings Calculations

This appendix provides the inputs and calculations used to determine energy savings for the E-Power Wise Program measures.

### Low-Flow Faucet Aerator Energy Savings, Kitchen and Bath

The energy savings for the kitchen and bath aerators distributed in the participant kits is calculated by the installation rate determined from the participant kit surveys, and used in the “Low Flow Faucet Aerator” algorithm provided in the TRM, as follows:

$$\Delta kWh = ISR \times ESat \times [(F_B - F_P) \times T_{Person-Day} \times N_{Persons} \times 365 \times \Delta T_L \times U_H \times U_E \times Eff^1] / (F/home)$$

Demand reduction is calculated as follows:

$$\Delta kW_{peak} = \Delta kWh \times FED$$

The assumptions for variables used in these equations are provided in **Table G-1**.

**Table G-1: Low-Flow Faucet Aerator Calculation Assumptions**

Parameter	Description	Type	Value	Source
$F_B$	Average Baseline Flow Rate of Aerator (GPM)	Fixed	2.2	2012 TRM
$F_P$	Average Post-Measure Flow Rate of Sprayer (GPM)	Fixed	1.5	2012 TRM
$T_{Person-Day}$	Average Time of Hot Water Usage per Person per Day (minutes)	Fixed	4.95	2012 TRM
$N_{Per}$	Average Number of People per Household	Fixed	2.48	2012 TRM
$\Delta T$	Average Temperature Differential Between Hot and Cold Water (°F)	Fixed	25	2012 TRM
$U_H$	Unit Conversion: 8.33 BTU/Gallons, °F	Fixed	8.33	2012 TRM
$U_E$	Unit Conversion: 1 kWh/3,413 BTU	Fixed	1/3413	2012 TRM
Eff	Efficiency of Electric Water Heater	Fixed	0.90	2012 TRM
F/home	Average Number of Faucets per Household	Fixed	3.5	2012 TRM
FED	Energy to Demand Factor	Fixed	0.00009172	2012 TRM
ESat	Saturation of Electric Water Heaters	Variable	Variable	Participant Kit Surveys
ISR <sup>1</sup>	In-Service Rate	Variable	Variable	Participant Kit Surveys
<b>NOTES:</b>				
1. Used interchangeably with installation rate.				

### Low-Flow Showerhead Savings

The energy savings for the low-flow showerheads distributed in the participant kits is calculated by inputting the installation rate determined by the participant kit surveys into the “Low-Flow Showerhead” algorithm provided in the TRM, as follows:

$$\Delta kWh = ISR * ESat * (((GPM_{base} - GPM_{low}) / GPM_{base}) * people * gals/day * days/year) / showers) * lbs/gal * (TEMP_{ft} - TEMP_{in}) / 1,000,000 / EF / 0.003412$$

Demand reduction is calculated as follows:

$$\Delta kW_{peak} = \Delta kWh * EnergyToDemandFactor$$

An ISR was included in the first calculation above in order to account for the fact that survey data indicated less than a 100% installation rate for this measure. The assumptions for variables used in these equations are provided in **Table G-2**.

**Table G-2: Low-Flow Showerhead Calculation Assumptions**

Parameter	Description	Type	Value	Source
GPM <sub>base</sub>	Baseline Showerhead GPM	Fixed	2.5	2012 TRM
GPM <sub>low</sub>	Low-Flow Showerhead GPM	Variable	2	Participant Kit Surveys
people	Average Number of People per Household	Fixed	2.48	2012 TRM
gals/day	Average Gallons of Hot Water Used by Shower per Day	Fixed	11.6	2012 TRM
days/year	Number of Days per Year	Fixed	365	2012 TRM
showers	Average Number of Showers in Household	Fixed	1.6	2012 TRM
lbs/gal	Pounds per Gallon	Fixed	8.3	2012 TRM
Temp <sub>ft</sub>	Assumed Temperature of Water Used by Faucet	Fixed	120	2012 TRM
Temp <sub>in</sub>	Assumed Temperature of Water Entering House	Fixed	55	2012 TRM
EF	Recovery Efficiency of Electric Hot Water Heater	Fixed	0.9	2012 TRM
EnergyToDem andFactor	Energy to Demand Factor	Fixed	0.00009172	2012 TRM
ESat	Saturation of Electric Water Heaters	Variable	Variable	Participant Kit Surveys
conversion	Constant to Convert MMBtu to kWh	Fixed	0.003412	Participant Kit Surveys
ISR <sup>1</sup>	In-Service Rate	Variable	Variable	Participant Kit Surveys
<b>NOTES:</b>				
1. Used interchangeably with installation rate.				

## CFL Savings

The energy savings for the 15 Watt CFL and 20 Watt CFL distributed in the participant kits are calculated by inputting the installation rates determined by the participant kit surveys into the “ENERGY STAR CFL Bulbs (screw-in)” algorithm provided in the TRM, as follows:

$$\Delta kWh = (Watts_{base} - Watts_{CFL}) \times CFL_{hours} \times 365 / 1000 \times ISR_{CFL}$$

Demand reduction is calculated as follows:

$$\Delta kW_{peak} = (Watts_{base} - Watts_{CFL}) / 1000 \times CF \times ISR_{CFL}$$

The assumptions for variables used in these equations are provided in **Table G-3**.

**Table G-3: CFL Savings Calculation Assumptions**

Parameter	Description	Type	Value	Source
Watts <sub>base</sub>	Wattage of baseline case for CFL.	Fixed	60/75 <sup>1</sup>	2012 TRM
Watts <sub>CFL</sub>	Wattage of CFL	Fixed	15/20	Participant Kit
CFL <sub>hours</sub>	Average hours of use per day per CFL	Fixed	3	2012 TRM
ISR <sub>cfl</sub>	In-Service Rate per CFL	Variable	Variable	Participant Kit Surveys
CF	Demand Coincidence Factor	Fixed	5%	2012 TRM
<b>NOTES:</b>				
1. 60W base for 15W CFL; 75W base for 20W CFL.				

### Electroluminescent Nightlight Savings

The energy savings for the electroluminescent nightlight distributed in the participant kits is calculated by inputting the installation rate determined by the participant kit surveys into the “Electroluminescent Nightlight” algorithm provided in the TRM, as follows:

$$\Delta kWh = ((W_{inc} * h_{inc}) - (W_{NL} * h_{NL})) * 365 / 1000 * ISR_{NL}$$

Demand reduction is calculated as follows:

$$\Delta kW_{peak} = 0 \text{ (assumed)}$$

The assumptions for variables used in this equation are provided in **Table G-4**.

**Table G-4: Electroluminescent Nightlight Savings Calculation Assumptions**

Parameter	Description	Type	Value	Source
W <sub>NL</sub>	Watts per Electroluminescent Nightlight	Fixed	0.03	2012 TRM
W <sub>inc</sub>	Watts per Incandescent Nightlight	Fixed	7	2012 TRM
h <sub>NL</sub>	Average Hours-of-Use per Day per Electroluminescent Nightlight	Fixed	24	2012 TRM
h <sub>inc</sub>	Average Hours-of-Use per Day per Incandescent Nightlight	Fixed	12	2012 TRM
ISR <sub>NL</sub>	In-Service Rate per Electroluminescent Nightlight, to be Revised Through Surveys	Variable	Variable	Participant Kit Surveys

## Appendix H: Direct Load Control Program Analysis Examples

### Determine Number of Data Points

**Table H-1** presents an example of meter data review. kW data are in five-minute intervals or 12 data points per hour. For a given event lasting three hours, the meter recorded 36 data points for the event period. Factoring in the three-hour period preceding this event, the meter recorded 36 additional data points for a total of 72 data points. As described, if a meter missed all event data points as well as data points three hours prior to the beginning of the event, then the meter was removed from that event's analysis. As previously stated, meters were dropped only from specific events; not from the entire set of events unless warranted.

From **Table H-1**, Event 1 contained 60 data points (two-hour event plus three hours prior to the event). In the case of meter 5106, for example, the EM&V CSP dropped the meter from the analysis for Event 1 because it did not record any data. However, the EM&V CSP retained meter 5106 for the Event 2 analysis because the meter recorded sufficient data points for that event.

**Table H-1: Example of Meter Data Review Process**

Meter ID	Event 1 - Count of Data Points (two-hour event plus three hours prior)	Event 1 Decision	Event 2 - Count of Data Points (three-hour event plus three hours prior)	Event 2 Decision
5105	60	Keep	72	Keep
5106	0	Drop	72	Keep
5107	60	Keep	0	Drop
5108	60	Keep	0	Drop

### Meter removal

The EM&V CSP removed between three and eight meters within each event due to missing kW data. **Table H-2** shows the EM&V CSP's meter removal summary.



**Table H-2: Meters Removed From Analysis for Direct Load Control Program**

MW Savings Over Top 100 Hours	Meters Installed	Meters Removed	Meters Removed as Percent of Meters Installed
6/20/2012	104	8	7.7%
6/21/2012	104	8	7.7%
6/29/2012	104	7	6.7%
7/3/2012	104	6	5.8%
7/5/2012	104	6	5.8%
7/6/2012	104	6	5.8%
7/16/2012	104	6	5.8%
7/17/2012	104	6	5.8%
7/18/2012	104	6	5.8%
7/23/2012	104	7	6.7%
7/24/2012	104	7	6.7%
7/26/2012	104	4	3.8%
8/1/2012	104	3	2.9%
8/2/2012	104	3	2.9%
8/3/2012	104	3	2.9%
8/8/2012	104	3	2.9%
8/9/2012	104	3	2.9%

## Verification Example

The following discussion illustrates the methodology used to verify data. This example uses the event called on June 29, beginning at 1:00 p.m. and ending at 5:00 p.m.

For the curtailed and non-curtailed groups, the EM&V CSP first calculated the average kW for each 15-minute interval beginning one hour prior to the start of the event and ending at the final 15-minute interval preceding the end of the event period. For each 15-minute interval, the average kW of the non-curtailed group was subtracted from that of the curtailed group. **Table H-3** shows these calculations.

**Table H-3. Verification Example: 15-Minute Average kW for Curtailed and Non-Curtailed Groups**

15-Minute Interval	Non-Curtailed Average kW	Curtailed Average kW	Curtailed kW - Non-Curtailed kW
11:00 a.m.	1.0048	1.0609	0.0561
11:15 a.m.	1.1282	1.3058	0.1775
11:30 a.m.	1.1258	1.1380	0.0122
11:45 a.m.	1.2439	1.3119	0.0680
noon	1.2993	1.4200	0.1207
12:15 p.m.	1.2866	1.5373	0.2506
12:30 p.m.	1.3384	1.4878	0.1493

15-Minute Interval	Non-Curtailed Average kW	Curtailed Average kW	Curtailed kW - Non-Curtailed kW
12:45 p.m.	1.2730	1.5033	0.2303
1:00 p.m.	1.3943	1.4233	0.0290
1:15 p.m.	1.2776	1.0747	-0.2030
1:30 p.m.	1.3995	0.9782	-0.4213
1:45 p.m.	1.3185	1.2355	-0.0830
2:00 p.m.	1.3977	1.0746	-0.3231
2:15 p.m.	1.3341	1.3125	-0.0216
2:30 p.m.	1.4521	1.2284	-0.2237
2:45 p.m.	1.4870	1.3768	-0.1102
3:00 p.m.	1.5334	1.3548	-0.1785
3:15 p.m.	1.4194	1.4676	0.0481
3:30 p.m.	1.5381	1.3642	-0.1739
3:45 p.m.	1.4919	1.4119	-0.0800
4:00 p.m.	1.6525	1.3366	-0.3159
4:15 p.m.	1.6110	1.5189	-0.0920
4:30 p.m.	1.6789	1.2966	-0.3823
4:45 p.m.	1.6542	1.9939	0.3398

The next step calculates the SAA: the average difference in kW for the four 15-minute intervals directly preceding the start of the event. This example shows the calculated average of the kW differences corresponding to the following 15-minute intervals: noon, 12:15 p.m., 12:30 p.m., and 12:45 p.m. (see **Table H-3**). This calculation results in an SAA of 0.1877 kW. This calculation is shown in **Table H-4**.

**Table H-4. Verification Example: Symmetric Additive Adjustment Calculation**

15-Minute Interval	Curtailed kW - Non-Curtailed kW	Symmetric Additive Adjustment (SAA)
noon	0.1207	0.1877
12:15 p.m.	0.2506	
12:30 p.m.	0.1493	
12:45 p.m.	0.2303	

The EM&V CSP determined the SAA-adjusted kW for the non-curtailed group by adding the SAA to the average kW for each 15-minute interval of the non-curtailed group. Next, the average curtailed kW was subtracted from the SAA-adjusted non-curtailed average kW for each 15-minute interval within the event period. Finally, to calculate the average kW reduction for each hour of the event, the EM&V CSP took the average of these differences for each 15-minute interval for each event hour. As shown in **Table H-5**, average kW reduction was 0.36 kW for the hours ending at 2:00 p.m. and 3:00 p.m., 0.28 kW for the hour ending at 4:00 p.m., and 0.30 kW for the hour ending at 5:00 p.m.

**Table H-5: Verification Example: Average Hourly kW Reduction**

15-Minute Interval	SAA-Adjusted Non-Curtailed Average kW	Curtailed Average kW	SAA-Adjusted Non-Curtailed kW - Curtailed kW	Average Hourly kW Reduction
1:00 p.m.	1.58	1.42	0.16	0.36
1:15 p.m.	1.47	1.07	0.39	
1:30 p.m.	1.59	0.98	0.61	
1:45 p.m.	1.51	1.24	0.27	
2:00 p.m.	1.59	1.07	0.51	0.36
2:15 p.m.	1.52	1.31	0.21	
2:30 p.m.	1.64	1.23	0.41	
2:45 p.m.	1.67	1.38	0.30	
3:00 p.m.	1.72	1.35	0.37	0.28
3:15 p.m.	1.61	1.47	0.14	
3:30 p.m.	1.73	1.36	0.36	
3:45 p.m.	1.68	1.41	0.27	
4:00 p.m.	1.84	1.34	0.50	0.30
4:15 p.m.	1.80	1.52	0.28	
4:30 p.m.	1.87	1.30	0.57	
4:45 p.m.	1.84	1.99	-0.15	

The EM&V CSP used these verification procedures for each event that was called during the summer of 2012.

## Appendix I: Load Curtailment Five-Day Methodology

### Standard Five-Day Method Example

The EM&V CSP selected an actual example event hour from 6/20/2012 for the hour ending 17 (i.e., 16:00-16:59) for the standard three-day method.

**Table I-1** shows the demand for the event period and the five baseline days (6/13/2012, 6/14/2012, 6/15/2012, 6/18/2012, and 6/19/2012). The table shows the lowest usage baseline day (6/14/2012) in italics.

**Table I-1: Five-Minute Average kW for Five-Day Event and Baseline Days for Hour Ending 17**

Five-Minute Interval (period ending)	6/13/2012	6/14/2012	6/15/2012	6/18/2012	6/19/2012	6/20/2012 (event)
16:05	10994	<i>10445</i>	10479	11437	13686	11635
16:10	10994	<i>10445</i>	10479	11437	13686	11635
16:15	10994	<i>10445</i>	10479	11437	13686	11635
16:20	11073	<i>10610</i>	10462	11368	13803	11787
16:25	11073	<i>10610</i>	10462	11368	13803	11787
16:30	11073	<i>10610</i>	10462	11368	13803	11787
16:35	10977	<i>10476</i>	11096	11313	13907	11574
16:40	10977	<i>10476</i>	11096	11313	13907	11574
16:45	10977	<i>10476</i>	11096	11313	13907	11574
16:50	10942	<i>10692</i>	10717	11599	13889	11973
16:55	10942	<i>10692</i>	10717	11599	13889	11973
17:00	10942	<i>10692</i>	10717	11599	13889	11973
<b>Average Hour 17</b>	<b>10996</b>	<b><i>10556</i></b>	<b>10689</b>	<b>11429</b>	<b>13821</b>	<b>11742</b>

In this method, the lowest average demand day—6/14/2012—is removed. The remaining four baseline days were 6/13/2012, 6/15/2012, 6/18/2012, and 6/19/2012.

**Table I-2** shows the demand for the four selected baseline days and the event day. From these days, the EM&V CSP obtained the average demand usage for each five-minute interval for both the average baseline days and the event day. The EM&V CSP calculated the difference of the average baseline demand and the event demand, truncating any negative savings to 0.

The final savings for 6/20/2012 at hour ending 17 is then 65.76 kW and therefore identical to the savings estimated by EnerNOC for that hour.

**Table I-2: Average Demand for Selected Days and Final Five-Day Savings Calculations**

Five-Minute Interval (period ending)	6/13/2012	6/15/2012	6/18/2012	6/19/2012	6/20/2012 (event)	Average Baseline	Average Event	Difference	Final Savings (negative savings truncated to 0)
16:05	10994	10479	11437	13686	11635	11649.12	11635.20	13.92	13.92
16:10	10994	10479	11437	13686	11635	11649.12	11635.20	13.92	13.92
16:15	10994	10479	11437	13686	11635	11649.12	11635.20	13.92	13.92
16:20	11073	10462	11368	13803	11787	11676.48	11786.88	-110.40	0
16:25	11073	10462	11368	13803	11787	11676.48	11786.88	-110.40	0
16:30	11073	10462	11368	13803	11787	11676.48	11786.88	-110.40	0
16:35	10977	11096	11313	13907	11574	11822.88	11573.76	249.12	249.12
16:40	10977	11096	11313	13907	11574	11822.88	11573.76	249.12	249.12
16:45	10977	11096	11313	13907	11574	11822.88	11573.76	249.12	249.12
16:50	10942	10717	11599	13889	11973	11786.88	11973.12	-186.24	0
16:55	10942	10717	11599	13889	11973	11786.88	11973.12	-186.24	0
17:00	10942	10717	11599	13889	11973	11786.88	11973.12	-186.24	0
Average Savings Hour 17 (across five-minute periods)									65.76

### Five-Day SAA Method Example

The first four steps that obtain the five baseline days, and then the final four baseline days, are identical for the SAA method.

The EM&V CSP selected an actual example event hour from 8/3/2012 for hour ending 13 (i.e., 12:00-12:59) for the five-day symmetric additive adjustment method. **Table I-3** shows the demand for the event period and the five baseline days (namely 7/27/2012, 7/30/2012, 7/31/2012, 8/1/2012, and 8/2/2012). The table shows the lowest usage baseline day (8/2/2012) in italics.

**Table I-3: Five-Minute Average kW for Five-Day SAA Event and Baseline Days for Hour Ending 13**

Five-Minute Interval (period ending)	7/27/2012	7/30/2012	7/31/2012	8/1/2012	8/2/2012	8/3/2012 (event)
12:05	20736	18662	21254	17107	<i>15034</i>	21773
12:10	20736	19181	21254	17107	<i>15552</i>	20736
12:15	21773	18662	21254	17107	<i>16070</i>	18144
12:20	22291	19181	21254	17107	<i>15552</i>	12960
12:25	22810	18662	21254	17626	<i>16070</i>	12960
12:30	22291	19181	20736	17107	<i>16070</i>	12960
12:35	22810	18144	20736	17626	<i>16070</i>	12960
12:40	22291	18144	21254	17626	<i>15552</i>	12960

Five-Minute Interval (period ending)	7/27/2012	7/30/2012	7/31/2012	8/1/2012	8/2/2012	8/3/2012 (event)
12:45	22810	17626	20736	18144	16070	13478
12:50	22810	18662	20736	18144	16070	13478
12:55	22810	18144	21254	18662	16070	13478
13:00	22810	18144	20736	18662	16070	13997
<b>Average Hour 13</b>	<b>22248</b>	<b>18533</b>	<b>21038</b>	<b>17669</b>	<b>15854</b>	<b>14990</b>

As part of the method, the EM&V CSP removed the lowest average demand day, 8/2/2012. The remaining four baseline days are 7/27/2012, 7/30/2012, 7/31/2012, and 8/1/2012.

Up to this point, the steps are identical to the standard five-day approach. The EM&V CSP then applied the symmetric additive adjustment (SAA). To calculate the SAA, the EM&V CSP individually averaged the five-minute intervals for both the average baseline and the actual event day for the time period that started four hours before the start of the event and lasted for three hours.

**Table I-4** shows how to calculate the symmetric adjustment. In this example, the hour began at (12:00), and ended at (12:59). The symmetric adjustment period began at (08:00) and ended at (10:59). These corresponded to the three hours ending 9, 10, and 11. The average baseline demand for the three symmetric adjustment hours is 19508.4 kW and the average event demand is 18676.8 kW. The difference of these numbers (-831.6 kW) is the “additive adjustment.”

**Table I-4: Five-Minute Average kW for Five-Day SAA Event and Baseline Days for Symmetric Adjustment**

Five-Minute Interval (period ending)	7/27/2012	7/30/2012	7/31/2012	8/1/2012	8/3/2012 (event)
08:05	20736	18662	21254	17107	21773
08:10	20736	19181	21254	17107	20736
08:15	21773	18662	21254	17107	18144
08:20	22291	19181	21254	17107	12960
08:25	22810	18662	21254	17626	12960
08:30	22291	19181	20736	17107	12960
08:35	22810	18144	20736	17626	12960
08:40	22291	18144	21254	17626	12960
08:45	22810	17626	20736	18144	13478
08:50	22810	18662	20736	18144	13478
08:55	22810	18144	21254	18662	13478
09:00	22810	18144	20736	18662	13997
09:05	20736	18662	21254	17107	21773
09:10	20736	19181	21254	17107	20736
09:15	21773	18662	21254	17107	18144

Five-Minute Interval (period ending)	7/27/2012	7/30/2012	7/31/2012	8/1/2012	8/3/2012 (event)
09:20	22291	19181	21254	17107	12960
09:25	22810	18662	21254	17626	12960
09:30	22291	19181	20736	17107	12960
09:35	22810	18144	20736	17626	12960
09:40	22291	18144	21254	17626	12960
09:45	22810	17626	20736	18144	13478
09:50	22810	18662	20736	18144	13478
09:55	22810	18144	21254	18662	13478
10:00	22810	18144	20736	18662	13997
10:05	20736	18662	21254	17107	21773
10:10	20736	19181	21254	17107	20736
10:15	21773	18662	21254	17107	18144
10:20	22291	19181	21254	17107	12960
10:25	22810	18662	21254	17626	12960
10:30	22291	19181	20736	17107	12960
10:35	22810	18144	20736	17626	12960
10:40	22291	18144	21254	17626	12960
10:45	22810	17626	20736	18144	13478
10:50	22810	18662	20736	18144	13478
10:55	22810	18144	21254	18662	13478
11:00	22810	18144	20736	18662	13997
<b>Average Demand Symmetric Adjustment Period</b>	<b>19508.4</b>				<b>18676.8</b>
<b>Additive Adjustment (baseline kW – event kW)</b>	<b>-831.6</b>				

**Table I-5** shows the SAA adjustment. Calculating the unadjusted average baseline demand is identical to the standard five-day method. The EM&V CSP added the -831.6 kW adjustment to the unadjusted baseline demand. This results in the SAA adjusted demand.

The EM&V CSP calculated the difference of the average SAA-adjusted baseline demand and the event demand as in the standard five-day method, truncating any negative savings to 0.

The final savings for 8/3/2012 at hour ending 13 is 4480.2 kW. This is identical to the *ex ante* savings estimated for that hour.

**Table I-5: Average Demand for Selected Days and Final Five-Day SAA Savings Calculations**

Five-Minute Interval (period ending)	7/27/2012	7/30/2012	7/31/2012	8/1/2012	8/3/2012 (event)	Unadjusted Average Baseline	Additive Adjustment	Average SAA Adjusted Baseline	Average Event	Difference	Final Savings (negative savings truncated to 0)
12:05	20736	18662	21254	17107	21773	19440.0	-831.6	18608.4	21772.8	-3164.4	0
12:10	20736	19181	21254	17107	20736	19569.6	-831.6	18738.0	20736.0	-1998.0	0
12:15	21773	18662	21254	17107	18144	19699.2	-831.6	18867.6	18144.0	723.6	723.6
12:20	22291	19181	21254	17107	12960	19958.4	-831.6	19126.8	12960.0	6166.8	6166.8
12:25	22810	18662	21254	17626	12960	20088.0	-831.6	19256.4	12960.0	6296.4	6296.4
12:30	22291	19181	20736	17107	12960	19828.8	-831.6	18997.2	12960.0	6037.2	6037.2
12:35	22810	18144	20736	17626	12960	19828.8	-831.6	18997.2	12960.0	6037.2	6037.2
12:40	22291	18144	21254	17626	12960	19828.8	-831.6	18997.2	12960.0	6037.2	6037.2
12:45	22810	17626	20736	18144	13478	19828.8	-831.6	18997.2	13478.4	5518.8	5518.8
12:50	22810	18662	20736	18144	13478	20088.0	-831.6	19256.4	13478.4	5778.0	5778
12:55	22810	18144	21254	18662	13478	20217.6	-831.6	19386.0	13478.4	5907.6	5907.6
13:00	22810	18144	20736	18662	13997	20088.0	-831.6	19256.4	13996.8	5259.6	5259.6
Average Savings Hour 13 (across five-minute periods)											<b>4480.2</b>



## Appendix J: Low-Income Participation in Non-Low-Income Programs

PPL Electric tracked the number of low-income households participating in programs open to all residential customers. In other words, it tracked low-income participation in non-low income programs. This population was determined according to the methodology approved by the Commission and outlined in the PPL Electric memo, *Method to Estimate Low-Income Savings in Non Low-Income Programs*, dated June 1, 2011.

In PY4, participants below 150% of the Federal Poverty Level (FPL) were associated with verified gross savings of 15,800 MWh/year (see **Table J-9**) in non-low income programs. The cumulative savings at the end of Phase I associated with low-income participation in non-low income programs was 65,376 MWh/year (excludes prior year savings from the Customer Behavior and Education program).

This analysis only includes respondents who answered survey questions regarding number of individuals in their household, estimated annual household income, and who completed the entire survey. See **Table J-11** for the percentage of respondents who answered these questions. The upstream residential lighting program includes only recent purchasers of CFLs.

**Table J-6: PY1 Verified Gross Savings Attributable to Low Income Participation in Non-Low Income Programs Below 150% of the Federal Poverty Level**

Program	Total Survey Respondents	Number Meeting FPL Guidelines	Percent	PYTD Verified Gross Impact (MWh/yr)	Savings Associated with 150% FPL Population
Appliance Recycling	61	3	5%	9,237	454
Home Energy Assessment & Weatherization	0	0	0%	0	0
Energy Efficiency Behavior & Education	0	0	0%	0	0
Renewable Energy	49	0	0%	2,791	0
Efficient Equipment Incentive (Residential sector only)	57	4	7%	9,573	672
Residential Lighting	52	7	13%	61,838	8,324
<b>Overall Totals</b>	<b>219</b>	<b>14</b>	<b>N/A</b>	<b>83,439</b>	<b>9,450</b>

**Table J-7: PY2 Verified Gross Savings Attributable to Low Income Participation in Non-Low Income Programs Below 150% of the Federal Poverty Level**

Program	Total Survey Respondents	Number Meeting FPL Guidelines	Percent	PYTD Verified Gross Impact (MWh/yr)	Savings Associated with 150% FPL Population
Appliance Recycling	102	6	6%	24,934	1,467
Home Energy Assessment & Weatherization	50	2	4%	693	28
Energy Efficiency Behavior & Education	224	35	16%	13,286	2,076
Renewable Energy	77	0	0%	11,788	0
Efficient Equipment Incentive (Residential sector only)	158	2	1%	48,294	611
Residential Lighting	220	29	13%	146,000	13,754
<b>Overall Totals</b>	<b>831</b>	<b>74</b>	<b>N/A</b>	<b>244,995</b>	<b>17,935</b>

**Table J-8: PY3 Verified Gross Savings Attributable to Low Income Participation in Non-Low Income Programs Below 150% of the Federal Poverty Level**

Program	Total Survey Respondents	Number Meeting FPL Guidelines	Percent	PYTD Verified Gross Impact (MWh/yr)	Savings Associated with 150% FPL Population
Appliance Recycling	52	4	8%	18,893	1,453
Home Energy Assessment & Weatherization	76	19	25%	2,144	536
Energy Efficiency Behavior & Education	252	26	10%	29,369	3,030
Renewable Energy	0	0	0%	2,381	0
Efficient Equipment Incentive (Residential sector only)	67	5	7%	15,240	1,137
Residential Lighting	133	22	17%	127,802	21,140
<b>Overall Totals</b>	<b>580</b>	<b>66</b>	<b>N/A</b>	<b>193,449</b>	<b>27,297</b>

**Table J-9: PY4 Verified Gross Savings Attributable to Low Income Participation in Non-Low Income Programs Below 150% of the Federal Poverty Level**

Program	Total Survey Respondents	Number Meeting FPL Guidelines	Percent	PYTD Verified Gross Impact (MWh/yr)	Savings Associated with 150% FPL Population
Appliance Recycling	92	13	14%	22,308	3,152
Home Energy Assessment & Weatherization	97	5	5%	5,188	267
Energy Efficiency Behavior & Education	226	13	6%	36,470	2,098
Renewable Energy	0	0	0%	578	0
Efficient Equipment Incentive (Residential sector only)	50	4	8%	10,498	840
Residential Lighting	140	22	16%	60,087	9,442
<b>Overall Totals</b>	<b>605</b>	<b>57</b>	<b>N/A</b>	<b>134,551</b>	<b>15,800</b>

**Table J-10: CPITD Verified Gross Savings Attributable to Low Income Participation in Non-Low Income Programs Below 150% of the Federal Poverty Level**

Program	Savings Associated with 150% FPL Population
Appliance Recycling	6,527
Home Energy Assessment & Weatherization	977
Energy Efficiency Behavior & Education <sup>1</sup>	2,098
Renewable Energy	-
Efficient Equipment Incentive (Residential sector only)	3,260
Residential Lighting	52,660
<b>Overall Totals</b>	<b>65,522</b>
<b>NOTES:</b> 1. Savings for education measures do not accumulate across program years.	

**Table J-11: Percentage of Respondents Answering Income and Household Questions**

Program	Total PY4 Completed Survey	Total Responding to Income/Household Questions <sup>1</sup>	Percent Responding to Income/Household Questions and Completing Full Survey	Percent of Respondents Refusing to Answer Income/Household Questions or Not Completing Full Survey
Appliance Recycling	142	92	65%	35%
Home Energy Assessment & Weatherization	121	97	80%	20%
Energy-Efficiency Behavior & Education	327	226	69%	31%
Residential Efficient Equipment	76	50	66%	34%
Residential Lighting	175 <sup>2</sup>	140 <sup>2</sup>	80%	20%
<b>Overall Totals</b>	<b>841</b>	<b>605</b>	<b>72%</b>	<b>28%</b>
<b>NOTES:</b> 1. Counts only include respondents who had information regarding number of individuals in their household, estimated annual household income, and who completed the entire survey. If the respondent does not answer either of the income or family size questions, then they are not counted in this analysis. 2. This number only includes respondents who were recent CFL purchasers.				

### PY4 Survey Questions for Federal Poverty Level Guidelines

These questions were used to collect household income and number of people in the house hold. These data were used to determine low income participation in non-low-income programs.

**HC1. 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)

**D3. In 2012, was your annual household income before taxes above or below \$50,000?**

- 1. (Below \$50,000)
- 2. (Above \$50,000) [SKIP TO D7]
- 3. (Exactly \$50,000) [SKIP TO CLOSING]
- 98. (Don't Know) [SKIP TO CLOSING]
- 99. (Refused) [SKIP TO CLOSING]

[ASK IF D3=1]

**D4. In 2012, was your annual household income before taxes above or below \$25,000?**

- 1. (Below \$25,000)
- 2. (Above \$25,000) [SKIP TO D6]
- 3. (Exactly \$25,000) [SKIP TO CLOSING]

[ASK IF D3=1]

**D5. Which of the following categories best represents your annual household income before taxes in 2012? Please stop me when I read your category:**

- 1. Under \$10,000
- 2. \$10,000 to under \$15,000
- 3. \$15,000 to under \$20,000
- 4. \$20,000 to under \$25,000
- 98. (Don't Know)
- 99. (Refused)

[ASK IF D4=2]

**D6. Which of the following categories best represents your annual household income before taxes in 2012? Please stop me when I read your category:**

- 1. \$25,000 to under \$30,000
- 2. \$30,000 to under \$35,000
- 3. \$35,000 to under \$40,000
- 4. \$40,000 to under \$45,000
- 5. \$45,000 to under \$50,000
- 98. (Don't Know)
- 99. (Refused)

[ASK IF D3=2]

**D7. Which of the following categories best represents your annual household income before taxes in 2012? Please stop me when I read your category:**

- 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)

**Table J-12: Federal Poverty Guidelines**

	PY1	PY2	PY3	PY4
Persons in family	2010 Continental US <sup>1</sup>	2011 Continental US <sup>2</sup>	2012 Continental US <sup>3</sup>	2013 Continental US <sup>4</sup>
1	\$ 10,830	\$ 10,890	\$ 11,170	\$ 11,490
2	\$ 14,570	\$ 14,710	\$ 15,130	\$ 15,510
3	\$ 18,310	\$ 18,530	\$ 19,090	\$ 19,530
4	\$ 22,050	\$ 22,350	\$ 23,050	\$ 23,550
5	\$ 25,790	\$ 26,170	\$ 27,010	\$ 27,570
6	\$ 29,530	\$ 29,990	\$ 30,970	\$ 31,590
7	\$ 33,270	\$ 33,810	\$ 34,930	\$ 35,610
8	\$ 37,010	\$ 37,630	\$ 38,890	\$ 39,630
For each additional person add	\$ 3,740	\$ 3,820	\$ 3,960	4,020
<b>NOTES:</b> 1. <a href="http://aspe.hhs.gov/poverty/10poverty.shtml">http://aspe.hhs.gov/poverty/10poverty.shtml</a> 2. <a href="http://aspe.hhs.gov/poverty/11poverty.shtml">http://aspe.hhs.gov/poverty/11poverty.shtml</a> 3. <a href="http://aspe.hhs.gov/poverty/12poverty.shtml">http://aspe.hhs.gov/poverty/12poverty.shtml</a> 4. <a href="http://aspe.hhs.gov/poverty/13poverty.shtml">http://aspe.hhs.gov/poverty/13poverty.shtml</a>				

## **Appendix K: Process Evaluation**

The Process Evaluation will be submitted as a standalone document.