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November 15, 2012

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

Final Annual Report for Year 3 of PPL Electric Utilities Corporation's Act 129 Plan RE: Docket No. M-2009-2093216

Dear Secretary Chiavetta:

Enclosed is PPL Electric Utilities Corporation's ("PPL Electric") Final Annual Report for Year 3 of PPL Electric's Act 129 Plan. Pursuant to the Pennsylvania Public Utility Commission's May 25, 2011 Secretarial Letter issued at Docket No. M-2008-2069887, PPL Electric hereby files its Final Annual Report with the Secretary of the Commission and the Act 129 Statewide Evaluator. In addition, PPL Electric will post its Final Annual Report on its ePower website.

If you have any questions concerning this matter, please contact me at the address or telephone numbers provided above.

Respectfully Submitte

ndrew S. Tubbs

AST/jl Enclosures cc: Richard F. Spellman, GDS Associates Inc., Act 129 Statewide Evaluator



Final Annual Report to the Pennsylvania Public Utility Commission

For the Period June 2011 through May 2012 Program Year 3

For Pennsylvania Act 129 of 2008 Energy Efficiency and Conservation Plan

Prepared by The Cadmus Group, Inc.

For

PPL Electric

November 15, 2012



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Table of Contents

A	ACRONYMS1					
R	EPORT [DEFINITIONS	3			
1	OVE	ERVIEW OF PORTFOLIO	5			
	1.1	SUMMARY OF PROGRESS TOWARD COMPLIANCE TARGETS	6			
	1.2	SUMMARY OF ENERGY IMPACTS	12			
	1.3	SUMMARY OF FUEL SWITCHING IMPACTS	15			
	1.4	SUMMARY OF DEMAND IMPACTS	17			
	1.5	SUMMARY OF PY3 NET-TO-GROSS RATIOS	20			
	1.6	SUMMARY OF PORTFOLIO FINANCES AND COST-EFFECTIVENESS	24			
	1.7	SUMMARY OF COST-EFFECTIVENESS BY PROGRAM	26			
2	APP	LIANCE RECYCLING PROGRAM	28			
	2.1	PROGRAM UPDATES	28			
	2.2	IMPACT EVALUATION GROSS SAVINGS	29			
	2.3	IMPACT EVALUATION NET SAVINGS				
	2.4	PROCESS EVALUATION	34			
	2.5	FINANCIAL REPORTING				
3	RESI	DENTIAL LIGHTING PROGRAM				
	3.1	PROGRAM UPDATES	37			
	3.2	IMPACT EVALUATION GROSS SAVINGS	37			
	3.3	IMPACT EVALUATION NET SAVINGS	41			
	3.4	PROCESS EVALUATION	44			
	3.5	Financial Reporting	44			
4	CUST	TOM INCENTIVE PROGRAM				
	4.1	PROGRAM UPDATES	46			

	4.2	IMPACT EVALUATION GROSS SAVINGS	47
	4.3	IMPACT EVALUATION NET SAVINGS	51
	4.4	PROCESS EVALUATION	51
	4.5	FINANCIAL REPORTING	51
5	ENE	RGY EFFICIENCY BEHAVIOR & EDUCATION PROGRAM	53
	5.1	PROGRAM UPDATES	53
	5.2	Impact Evaluation Gross Savings	53
	5.3	Impact Evaluation Net Savings	57
	5.4	PROCESS EVALUATION	57
	5.5	FINANCIAL REPORTING	57
6	EFFI	CIENT EQUIPMENT INCENTIVE PROGRAM	59
	6.1	PROGRAM UPDATES	59
	6.2	Impact Evaluation Gross Savings	60
	6.3	Impact Evaluation Net Savings	74
	6.4	PROCESS EVALUATION	76
	6.5	FINANCIAL REPORTING	76
7	E-PC	WER WISE PROGRAM	78
	7.1	PROGRAM UPDATES	78
	7.2	Impact Evaluation Gross Savings	78
	7.3	Impact Evaluation Net Savings	88
	7.4	PROCESS EVALUATION	88
	7.5	FINANCIAL REPORTING	88
8	WIN	TER RELIEF ASSISTANCE PROGRAM (WRAP)	90
	8.1	PROGRAM UPDATES	90
	8.2	IMPACT EVALUATION GROSS SAVINGS	90

	8.3	IMPACT EVALUATION NET SAVINGS	97			
	8.4	PROCESS EVALUATION	97			
	8.5	FINANCIAL REPORTING	97			
9	REN	EWABLE ENERGY PROGRAM	99			
	9.1	PROGRAM UPDATES	99			
	9.2	IMPACT EVALUATION GROSS SAVINGS	99			
	9.3	IMPACT EVALUATION NET SAVINGS	.105			
	9.4	PROCESS EVALUATION	.106			
	9.5	FINANCIAL REPORTING	.106			
10	HVA	C TUNE-UP PROGRAM	108			
	10.1	PROGRAM UPDATES	.108			
	10.2	IMPACT EVALUATION GROSS SAVINGS	.109			
	10.3	Impact Evaluation Net Savings	.112			
	10.4	PROCESS EVALUATION	.113			
	10.5	FINANCIAL REPORTING	.113			
11	ном	IE ENERGY ASSESSMENT & WEATHERIZATION PROGRAM	115			
	11.1	PROGRAM UPDATES	.115			
	11.2	IMPACT EVALUATION GROSS SAVINGS	116			
	11.3	Impact Evaluation Net Savings	122			
	11.4	PROCESS EVALUATION	123			
	11.5	FINANCIAL REPORTING	123			
12	DIRE	CT LOAD CONTROL PROGRAM	125			
13	LOAD	CURTAILMENT PROGRAM	126			
AP	APPENDIX A: EM&V COMPONENTS					
AP	APPENDIX B: PY3 VERIFICATION SAMPLING					

APPENDIX C: LOW-INCOME MEASURE LIST	,
APPENDIX D: FUEL SWITCHING	ŀ
APPENDIX E: NET-TO-GROSS ANALYSIS	•
APPENDIX F: RESIDENTIAL LIGHTING PROGRAM NET-TO-GROSS ANALYSIS	1
APPENDIX G: ADDITIONAL ENERGY EFFICIENT BEHAVIOR & EDUCATION PROGRAM IMPACT ANALYSIS	•
APPENDIX H: ENERGY EFFICIENCY BEHAVIOR & EDUCATION PROGRAM SAVINGS COUNTED IN OTHER PPL ELECTRIC ENERGY EFFICIENCY PROGRAMS	-
APPENDIX 1: CUSTOM MEASURE PROTOCOL MEASURING IMPACTS OF BEHAVIORALLY BASED ACTIVITIES IN LOW-INCOME ENERGY EDUCATION/ENERGY KIT PROGRAMS	 ,
APPENDIX J: E-POWER WISE PROGRAM AND BEHAVIOR SAVINGS CALCULATIONS	I
APPENDIX K: TRC INCREMENTAL COSTS	I
APPENDIX L: GLOSSARY OF TERMS	
APPENDIX M: LOW-INCOME PARTICIPATION IN NON-LOW INCOME PROGRAMS	
APPENDIX N: PROCESS EVALUATION	

Acronyms

AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ARP	Appliance Recycling Program
C&I	Commercial and industrial
CAC	Central air conditioning
СВО	Community Based Organization
CEC	California Energy Commission
CF	Coincidence factor
CFL	Compact fluorescent lighting
СНР	Combined heat and power
СМР	Custom measure protocol
СОР	Coefficient of performance
C/P	Confidence and precision
CPITD	Cumulative program/portfolio inception-to-date
CSIS	Consumer Service Information System
CSP	Conservation service provider (or curtailment service provider for the LC
	program)
CV	Coefficient of variation
DLC	Direct Load Control
EDC	Electric distribution company
EE&C	Energy efficiency and conservation
EEMIS	Energy Efficiency Management Information System
EER	Energy efficiency rating
EFLH	Effective full load hours
EM&V	Evaluation, measurement, and verification
FDSI	Field Diagnostic Services, Inc.
GNI	Government, non-profit, and institutional
GSHP	Ground-source heat pump
GWSHP	Groundwater-source heat pumps
HSPF	Heating seasonal performance factor
HVAC	Heating, ventilating, and air conditioning
IPMVP	International Performance Measurement and Verification Protocol
IQ	Incremental quarter
ISR	In-service rate
kW	Kilowatt
kWh	Kilowatt hour
LED	Light emitting diode
M&V	Measurement and verification

MW	Megawatt
MWh	Megawatt hour
NTG	Net-to-gross
PA PUC	Pennsylvania Public Utility Commission
Penn State	Pennsylvania State University
PV	Photovoltaic
PY1	Program Year 2009, from June 1, 2009 to May 31, 2010
PY2	Program Year 2010, from June 1, 2010 to May 31, 2011
РҮЗ	Program Year 2011, from June 1, 2011 to May 31, 2012
PY4	Program Year 2012, from June 1, 2012 to May 31, 2013
ΡΥΧ ΟΧ	Program Year X, Quarter X
PYTD	Program year-to-date
QA/QC	Quality assurance and quality control
RAP	Resource Action Program Inc.
RTS	Residential Thermal Storage
RTU	Rooftop unit
SEER	Seasonal energy efficiency rating
SSMVP	Site-specific evaluation, measurement, and verification plan
SWE	Statewide Evaluator
T&D	Transmission and distribution
TRC	Total Resource Cost
TRM	Technical Reference Manual
USP	Universal Services Program
VFD	Variable frequency drive
WRAP	Winter Relief Assistance Program
WSHP	Water-source heat pumps

Report Definitions

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

REPORTING PERIODS

Cumulative Program Inception-to-Date (CPITD)

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 PY3 Q3 is the sum of PY1, PY2, PY3 Q1, PY3 Q2, and PY3 Q3 results.

Incremental Quarter (IQ)

The current reporting quarter only. Activities occurring during previous quarters are not included. For example, IQ results for PY3 Q3 will only include results that occurred during PY3 Q3 (and not PY2 Q2).

Program Year-to-Date (PYTD)

The current reporting program year only. Activities occurring during previous program years are not included. For example, PYTD results for PY3 Q3 will only include results that occurred during PY3 Q1, PY3 Q2, and PY3 Q3. It will not include results from PY1 or PY2.

SAVINGS TYPES

Preliminary

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

Reported Gross

Refers to results of the program or portfolio determined by the program administrator (e.g., the electric distribution company (EDC) or the program implementer). Also known as *ex ante*, or before the fact (using the annual evaluation activities as the reference point).

Adjusted Ex Ante Gross

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

Verified Gross

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

TOTAL RESOURCE COST COMPONENTS¹

Administration Costs

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

EDC Costs

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

TRCs

TRCs include EDC evaluation costs, total EDC costs, and participant costs.

Total TRC Benefits

Based upon verified gross kilowatt hour (kWh) and kilowatt (kW) savings. Benefits include avoided supply costs, i.e., reduction in costs of electric energy generation, transmission, and distribution capacity. Natural gas cost is valued at a marginal cost for periods when there is a load reduction.

¹ All Total Resource Cost 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 through the end of Program Year 3 (PY3), defined as June 1, 2011 through May 31, 2012, as well as the cumulative accomplishments of the programs since inception.

The Cadmus Group, Inc. is PPL Electric's independent programs' evaluator, whose tasks include measuring and verifying savings. Cadmus is referred to as the evaluation, measurement, and verification (EM&V) conservation service provider (CSP). The final verified savings for PY3 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 progress toward compliance goals, energy and demand impacts, net-to-gross (NTG) ratios, finances, and cost-effectiveness. The second section includes program-specific details, including program updates, impact evaluation findings, and process evaluation findings.

Ten programs in PPL Electric's portfolio claimed savings in PY3:

- 1. The Appliance Recycling Program (ARP) offers customers incentives to recycle outdated refrigerators, freezers, and room air conditioners.
- 2. The Efficient Equipment Incentive Program offers prescriptive rebates to residential and non-residential customers.
- 3. The Custom Incentive Program offers custom incentives to non-residential customers per kilowatt hour (kWh) saved in the first year of participation.
- 4. The Residential Lighting Program (formerly Compact Fluorescent Lighting (CFL) Campaign) is an upstream program offering incentives to manufacturers to buy down the cost of CFLs; manufacturers and retailers then lower the cost of CFLs to consumers.
- 5. The Renewable Energy Program encourages PPL Electric customers to install a solar photovoltaic (PV) array or ground-source heat pump (GSHP) through financial incentives that reduce the upfront system costs.
- The 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 E-Power Wise Program provides low-income customers with information about energy use, as well as with home energy kits.
- 8. The HVAC Tune-Up Program offers services to commercial and small industrial customers with an existing split or packaged HVAC rooftop unit(s).
- 9. The Home Energy Assessment & Weatherization Program provides residential customers with information about their homes' energy performance and gives recommendations on the most effective, highest priority energy efficiency actions they can take to save energy in their homes.
- 10. The Energy Efficiency Behavior & Education Program encourages customers to take energysaving actions by sending periodic reports with energy-saving tips and usage comparisons to other peer customers.

The Direct Load Control Program and Load Curtailment Program will only claim savings in PY4, from June 1 through September 30, 2012, the only period when peak load reductions apply. PPL Electric began recruiting participants for the Direct Load Control Program in PY2 Q4, and began recruiting participants for the Load Curtailment Program in PY3 Q1.

1.1 Summary of Progress Toward Compliance Targets

The energy savings² compliance target for PPL Electric is 1,146,000 megawatt hours (MWh)/yr and must be achieved by May 31, 2013 per Act 129. Based on cumulative portfolio inception-to-date (CPITD) verified gross energy savings,³ PPL Electric has achieved 87% of the energy savings compliance target through May 31, 2012 (Figure 1-1). The PA PUC will determine compliance using CPITD verified gross energy savings.

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

³ See the Report Definitions for an explanation of how CPITD verified gross savings are calculated.



The system peak demand reduction⁴ compliance target⁵ for PPL Electric is 297 megawatts (MW) per Act 129 and must be achieved by May 31, 2013. Based on CPITD verified gross demand reduction, PPL Electric has achieved 48% of the demand reduction compliance target (Figure 1-2). The PA PUC will determine compliance using CPITD verified gross demand reduction.

⁴ Herein, demand reduction refers to the EDC's system peak demand reduction in its top 100 hours of highest demand, June 1, 2012 through September 30, 2012, as defined by the PA PUC, and is measured in kilowatts (kW) or MW.

⁵ 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.



Figure 1-2: Portfolio CPITD Demand Reduction

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.⁶ There are 54 measures available specifically to the *low-income sector*. This includes measures that at least one person installed. There are 146 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. This exceeds PPL Electric's low-income compliance target of 8.64% (the fraction of the electric consumption of the utility's low-income households divided by the total electricity consumption in the PPL Electric territory). These values are shown in **Table 1-1**. Appendix C provides a table to summarize the measure categories used to determine the proportion of measures available to the low-income population.⁷

⁶ Act 129 includes a provision requiring EDCs 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 for energy or demand savings.

⁷ Statewide Evaluator (SWE) Guidance Memos provided instruction to catalog and collapse all measures into measure-type groups. The method used to determine the proportion follows SWE instructions for the Phase 2 portfolio.

	Low-Income Sector	All Sectors	% Low-Income
Number of Measures Offered	54	146	36.99%
Electric Consumption (MWh/yr) per PaPUC's Low-Income Working Group	3,376,606	39,090,157	8.64% (compliance target)

Table 1-1: Low-Income Sector Compliance Metrics

The CPITD reported gross energy savings for low-income sector programs (excluding low-income participation in non-low-income programs) is 16,533 MWh/yr; this is 1.6% 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 75,915 MWh/yr; this is 7.3% of the CPITD total portfolio reported gross energy savings.⁸

The CPITD verified gross energy savings achieved for designated low-income programs (including only Low-Income WRAP and E-Power Wise, and excluding low-income participation in non-low-income programs) is 17,347 MWh/yr; this is 1.7% of the CPITD total portfolio verified gross energy savings.

Including low-income customer participation in non-low-income programs, the CPITD verified energy savings achieved is 77,209 MWh/yr; this is 7.7% of the CPITD total portfolio verified gross energy savings. The 77,209 MWh/yr includes both the designated low-income programs (Low-Income WRAP and E-Power Wise) and low-income participation in non-low-income programs.^{9, 10}

Act 129 mandates that a minimum of 10% of the required energy and demand targets be obtained from 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.

⁸ This percent is determined through survey data, following procedures in Guidance Memo 017. Summary tables can be found in Appendix M: Low-Income Participation in Non-Low Income Programs

⁹ The percent of low-income participation in non-low-income programs is determined through survey data, following procedures in Guidance Memo 017. For each program respectively, the percentage of low-income participants in a given program is multiplied by the total verified energy savings in that program to determine the savings attributable to the low-income population.

¹⁰ 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 low-income participants in a given program by the total program 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 in PY3 was \$1,397,000.

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, PPL Electric achieved 116% of the target. These values are shown in **Figure 1-3**.





The demand reduction compliance target¹¹ for the GNI sector for PPL Electric is 29.7 MW. Based on CPITD verified gross demand reduction, PPL Electric achieved 90% of the target. These values are shown in **Figure 1-4**.

¹¹ The demand reduction compliance target is set at the generation level, and therefore the reported gross demand reduction for GNI includes the T&D gross-up for comparison to the target.



Figure 1-4: Government, Nonprofit, and Institutional Sectors CPITD Demand Reduction

1.1.2 PY3 Sampling Plan

PY3 sampling plans were developed early in PY3 for each program, and are summarized in Appendix B: PY3 Verification Sampling. These sampling plans guided the sample selection for each quarter. The sampling plans reflect the SWE's sampling guidelines and were based on the five following primary instructions:

- 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.¹²
- 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.

¹² 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.

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 B: PY3 Verification Sampling, includes additional details by program and sector, and provides phone survey call statistics. Phone survey results are discussed by program in Appendix N, Process Evaluation.

1.2 Summary of Energy Impacts

A summary of the reported and verified energy savings by program for PY3 is presented in Figure 1-5.



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

A summary of the cumulative (inception to date) reported and verified energy savings by program is presented in Figure 1-6.



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

A summary of energy impacts by program through the end of PY3 is presented in **Table 1-2** and **Table 1-3**. A participant is defined by unique job identification number. The level at which the unique identifier is assigned depends on the program. For example, in the Efficient Equipment Incentive Program, the non-residential lighting identifier is assigned at the project level, and not at the fixture level. In the same program, each residential appliance rebate application is assigned a unique identifier. The definitions can be found in Appendix B: PY3 Verification Sampling, which discusses the sampling plan.

	Parti	cipants	Reported Gros (MV	s Energy Savings /h/yr)
Program	PYTD	CPITD	PYTD	CPITD
Appliance Recycling	12,948	30,771	22,330	56,266
Residential Lighting ¹	397,037	1,089,304	127,720	335,558
Custom Incentive ²	132	358	96,291	112,469
Energy Efficiency Behavior & Education ³	101,468	151,468	29,203	29,203
Efficient Equipment Incentive (lighting and non-lighting measures)	43,156	183,986	225,599	467,990
E-Power Wise	2,693	6,743	1,610	3,347
WRAP	4,545	9,649	6,961	13,185
Renewable Energy	117	1,830	2,627	13,846
HVAC Tune-Up	722	1,433	817	1,285
Home Energy Assessment & Weatherization	1,772	3,063	2,118	2,975
TOTAL PORTFOLIO ⁴	564,590	1,478,605	515,275	1,036,103

Table 1-2: EDC Reported Participation and Gross Energy Savings by Program

NOTES:

 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, and 6.04 in PY3). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at giveaway events.

2. The cumulative number of participants in the Custom Incentive Program includes those for projects that are still in the technical study phase, those in progress, and those that have been cancelled. Participants in these three categories do not contribute to the achieved savings. Exclusive of these three categories, the total cumulative participants is 163.

3. The CPITD energy-savings values reported here exclude savings that occurred prior to the current program year. Annual savings in this program are not considered to be cumulative. Participants are considered to be cumulative.

 Participants exclude customers who were enrolled in the Direct Load Control Program (n=34,960) and the Load Curtailment Program (n=98) as of the end of PY3, because those programs did not claim savings in PY3.

Program	PYTD Reported Gross Savings (MWh/yr)	PYTD Adjusted Ex Ante Gross Savings (MWh/yr)	PYTD Energy Realization Rate	PYTD Verified Gross Savings (MWh/yr)	PYTD Achieved Precision (90% Conf.)	CPITD Verified Gross Savings (MWh/yr)
Appliance Recycling	22,330	22,298	84.4%	18,814	3.53%	52 ,98 5
Residential Lighting	127,720	127,720	100.1%	127,802	N/A ²	335,640
Custom Incentive	96,291	96,291	103.5%	99,627	1.10%	116,359
Energy Efficiency Behavior & Education	29,203	29,203	100.6%	29,370	N/A ²	29,370
Efficient Equipment Incentive	225,599	227,248	95.3%	216,620	3.75%	429,906
E-Power Wise	1,610	1,590	93.7%	1,490	1.80%	3,613
WRAP	6,961	7,709	97.9%	7,548	N/A ¹	13,735
Renewable Energy	2,627	2,942	80.9%	2,380	4.50%	16,958
HVAC Tune-Up	817	817	100.0%	817	N/A ²	1,285
Home Energy Assessment & Weatherization	2,118	2,145	100.0%	2,144	3.40%	2,837
TOTAL PORTFOLIO ³	515,275	517,963	97.8%	506,612	1.62%	1,002,688

Table 1-3: Verified Gross Energy Impacts by Program¹

NOTES:

1. The values in this table refer to savings at the point of consumption; however, due to line losses, savings at the point of generation are systematically larger. Energy savings targets refer to MWh/yr values at the point of consumption.

 These programs' evaluations were based on reviewing a census of program records or participants, so their realization rates are not subject to sampling error. Evaluation strategies are discussed in detail in the program-specific sections of this report.

The realization rates in this table are rounded to the nearest tenth of a percent 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.

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 PY3.¹³

In PY3, PPL Electric issued over 39,000 rebates to residential customers. Of those, only 192 (0.49%) 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 27 households surveyed, 21 (78%) reported they replaced a total of 23 gas devices.

- Of these 23 replaced devices, 14 (61%) were replaced because they were broken, did not work correctly, or were old and in need of replacement. Eight units (35%) were replaced because of the cost of operation or efficiency.
- Fourteen of the 23 replaced devices were furnaces, clothes dryers, and a cooktop (61%). Please note that PPL Electric does not provide Act 129 rebates for clothes dryers or cooktops.
- For nine of the 23 replaced devices (39%), customers reported replacing gas water heaters with an electric heat pump hot water heater, and receiving a PPL Electric rebate. Of the nine, two respondents indicated that the rebate was very important in their decision to purchase a heat pump water heater.

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

¹³ 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 for PY3 is presented in **Figure 1-7**.¹⁴ The reported impacts shown in Figure 1-7 do not reflect line loss. Line loss is included only in figures that show verified impacts and progress toward meeting the compliance targets for demand reduction.



Figure 1-7: PYTD Reported and Verified Demand Reduction by Program (MW)

¹⁴ The reported gross demand reduction from PPL Electric's EEMIS reporting database are determined at the customer meter level, and therefore the program year-to-date (PYTD) 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 PYTD verified gross demand reduction does include the gross-up.

A summary of the cumulative reported and verified demand reduction¹⁵ by program is presented in **Figure 1-8**.



Figure 1-8: CPITD Reported and Verified Demand Reduction by Program (MW)

A summary of demand reduction impacts by program through the end of PY3 is presented in Table 1-4 and Table 1-5.

¹⁵ 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.

	Parti	cipants	Reported Gross D (N	emand Reduction
Program	PYTD	CPITD	PYTD ¹	CPITD ²
Appliance Recycling	12,948	30,771	3.60	9.89
Residential Lighting ³	397,037	1,089,304	6.80	19.19
Custom Incentive ⁴	132	358	11.54	14.54
Energy Efficiency Behavior & Education ⁵	101,468	151,468	0	0
Efficient Equipment Incentive (lighting and non-lighting measures)	43,156	183,986	51.78	96.47
E-Power Wise	2,693	6,743	0.38	0.62
WRAP	4,545	9,649	0	0.77
Renewable Energy	117	1,830	0.74	2.30
HVAC Tune-Up	722	1,433	0.60	1.08
Home Energy Assessment & Weatherization	1,772	3,063	0.19	0.23
TOTAL PORTFOLIO ⁶	564,590	1,478,605	75.63	145.09

Table 1-4: EDC Reported Participation and Gross Demand Reduction by Program

NOTES:

1. The reported gross demand reductions from PPL Electric's EEMIS reporting database were determined at the customer meter, and therefore the PYTD reported gross demand reduction does not include the gross-up for transmission and distribution losses.

 For CPITD-reported demand reduction, the MW values from PY1 and PY2 include the transmission and distribution grossup, while PY3 values do not. Starting in PY3, PPL Electric removed the transmission and distribution gross-up from reported demand reduction to bring data into accordance with the EEMIS tracking database.

3. 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, and 6.04 in PY3). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at give-away events.

4. The cumulative number of participants in the Custom Incentive Program includes those with projects that are still in the technical study phase, those in progress, and those that have been cancelled. Participants in these three categories do not contribute to the achieved savings. Exclusive of these three categories, the total cumulative participants is 163.

5. The CPITD energy-savings values reported here exclude savings that occurred prior to the current program year. Annual savings in this program are not considered to be cumulative. Participants are considered to be cumulative.

6. Participants exclude customers who were enrolled in the Direct Load Control Program (n=34,960) and the Load Curtailment Program (n=98) as of the end of PY3, because those programs did not claim savings in PY3.

Program	PYTD Reported Gross Reduction (MW) ¹	PYTD Adjusted <i>Ex Ante</i> Gross Reduction (MW) ²	PYTD Demand Realization Rate	PYTD Verified Gross Reduction (MW) ²	PYTD Achieved Precision (90% Conf.)	CPITD Verified Gross Reduction (MW) ²
Appliance Recycling	3.60	3.90	84.4%	3.29	3.5%	10.40
Residential Lighting	6.80	7.37	87.2%	6.42	N/A ³	18.81
Custom Incentive	11.54	12.23	98.8%	12.08	0.6%	14.12
Energy Efficiency Behavior & Education	0.00	0.00	-	0.00	N/A ³	0.00
Efficient Equipment Incentive	51.78	57.89	92.0%	53.26	3.8%	92.95
E-Power Wise	0.38	0.42	93.7%	0.39	1.8%	0.57
WRAP	0.00	0.95	108.0%	1.03	N/A ³	1.79
Renewable Energy	0.74	0.72	98.0%	0.71	7.3%	3.61
HVAC Tune-Up	0.60	0.65	100.0%	0.65	N/A ³	1.13
Home Energy Assessment & Weatherization	0.19	0.17	100.2%	0.17	3.5%	0.27
TOTAL PORTFOLIO ⁴	75.63	84.29	92.5%	77.99	2.6%	143.64

Table 1-5: PYTD Verified Gross Demand Reduction by Program

NOTES:

1. The reported gross demand reductions from PPL Electric's EEMIS reporting database were determined at the customer meter, and therefore the PYTD-reported gross demand reduction does not include the gross-up for transmission and distribution losses.

2. The EM&V CSP included the transmission and distribution gross-up as an *ex ante* adjustment to the reported savings. Therefore, both the *ex ante* adjusted savings and the *ex post* verified savings include the transmission and distribution gross-up.

3. These programs' evaluations were based on reviewing a census of program records or participants, so their realization rates are not subject to sampling error. Evaluation strategies are discussed in detail in the program-specific sections of this report.

4. The realization rates in this table are rounded to the nearest tenth of a percent 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.

1.5 Summary of PY3 Net-to-Gross Ratios

Per the 2011 Total Resource Cost (TRC) Order, EDCs are required to conduct NTG research. NTG ratios are not applied to gross savings and are not used for compliance purposes, but are used for future program planning purposes. Table 1-6 presents a summary of NTG ratios by program. Appendix E: Net-to-Gross Analysis provides additional details about the methods used to determine the NTG ratio. Non-participant Spillover Secondary Research

Cadmus conducted secondary research exploring non-participant spillover. Various studies reviewed for this research estimated free-ridership, participant "like" and "unlike" spillover, and non-participant

"like" and "unlike" spillover. To estimate the range of non-participant spillover that might be expected from different measures, we cataloged the survey research, program and/or non-participant spillover reported as a percent of savings or total kWh savings. Most estimates were based on self-report methods that were tailored to the sponsoring utility, and the individual program or the measure of interest. Non-participant surveys were typically conducted with design professionals or equipment vendors involved in the installations.

To estimate non-participants spillover, a typical approach applied the percentage of spillover (determined through survey research) to the program savings tracked in a database. Spillover was calculated for each design professional or equipment vendor. The results were then extrapolated to the program's kWh savings recorded in the database which were not included in the survey sample.

Another author reported the baseline sales used to estimate spillover effects were gathered via 100 surveys of nonparticipating retailers. The program effects sales data were gathered from 5 program retailers accounting for 70% to 80% of program volume.

A number of report authors stated there was large uncertainty in their spillover estimates or that findings were not significant. These either did not include the spillover estimate in the final NTG analysis or recommended using a NTG value of 1.

Table E-4 summarizes the findings from several studies. Where a study reported savings both at the program and the measure level, the measure level savings are included in the table below. The table is sorted by sector and measure, to more easily see the range of results. **Table E-5** provides additional study details.

Study					Non-	Population Savings Impact
	Utility ^{1,2}	Location	Measure	Sample Size	Spillover	(kWh) ³
Commerci	al Sector					_
1	Massachusetts PAs	NE	Motors	24	46%	358,092
2	Connecticut Light & Power	NE	Motors	16	0%	0
3	NYSERDA	NE	Motors	115	15%	258 (GWh)
1	Massachusetts PAs	NE	HVAC	41	0%	0
2	Connecticut Light & Power	NE	HVAC	60	4%	395,726
1	Massachusetts PAs	NE	VSD	63	13%	2,235,383
2	Connecticut Light & Power	NE	VSD	28	14%	344,868
1	Massachusetts PAs	NE	Lighting	134	0%	0

Table E-4: Summary of Non-participant Spillover Secondary Research

		- <u>J</u>	,		<u> </u>	<u> </u>
Study ID	Utility ^{1,2}	Location	Measure	Sample Size	Non- participant Spillover	Population Savings Impact (kWh) ³
2	Connecticut Light & Power	NE	Lighting	151	3%	1,700,580
4	California IOUs	w	Lighting - High Bay (mainly T5HO fixtures)	729	23-27%	15.1 - 27.2 (GWh)
1	Massachusetts PAs	NE	Compressed Air	17	3%	100,809
2	Connecticut Light & Power	NE	Compressed Air	22	4%	162,132
1	Massachusetts PAs	NE	Refrigeration	4	0%	0
2	Connecticut Light & Power	NE	Refrigeration	6	0%	0
5	California IOUs	w	New Construction	109	22%	21,397,000
6	PG&E	w	Split A/C Remote Condensing Unit Evaporative Coolers Water Chillers Evaporative Condensers Window Film Cooling Towers Package Terminal	1,337	13%	Avoided cost used as a proxy for impact
6	PG&E	w	T8 Fixtures HID CFLs LEDs Electronic Ballasts Fluorescents Occupancy Sensors	2,796	7%	Avoided cost used as a proxy for impact
7	National Grid	NE	HVAC Programmable Thermostats VFDs Motors Lighting Compressed Air Process Cooling Refrigeration	233	9%	123,232
Residential						
8	Focus on Energy	MW	Boiler Tune-Up	-	2%	932 (Therms)
8	Focus on Energy	MW	Hot water heating equipment	-	25%	21 (Therms)
8	Focus on Energy	MW	HVAC	-	1%	42 (Therms)
9	Northeast Utility	NE	Insulation	1,202	28%]

Study ID	Utility ^{1, 2}	Location	Measure	Sample Size	Non- participant Spillover	Population Savings Impact (kWh) ³
9	Northeast Utility	NE	Air Sealing	1,202	28%	-

NOTES:

1. Massachusetts PAs included in the nonparticipant study cited here include: National Grid, NSTAR, WMECO, Unitil, and Cape Light.

2. Connecticut Light and Power was the recipient of a study which utilized nonparticipant spillover findings from National Grid, Unitil, and United Illuminating.

3. The savings extrapolated to the entire population takes the attributed non-participant spillover rate and applies it to the entire population gross savings. All values are in kWh unless otherwise stated:

Study ID	Study-Author	Study Year	Study Name	Analytic Method
1	TetraTech	2011	2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
2	PA Consulting Group	2008	2007 Commercial and Industrial Programs Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
3	Quantec / Summit Blue	2007	2007 Commercial & Industrial Market Effects Evaluation	Self-report survey, engineering algorithms
4	KEMA / Itron	2010	2010 High Bay Lighting Market Effects Study Final Report	Baseline comparison, utility data review, surveys, in-depth interviews
5	RLW Analytics	2003	Final Report 1999-2001 Building Efficiency Assessment (BEA) Study	Self-report survey, DOE-2 engineering models, and on-site audits
6	Quantum Consulting	1999	Pacific Gas & Electric Company 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies	Self-report survey, on-site audit
7	PA Consulting Group	2002	National Grid 2001 Commercial and Industrial Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
8	TetraTech	2010	CY10 Apartment and Condo Efficiency Services Market Effects	Baseline comparison, contractor survey
9	Cadmus	2012	Report is not publicly available	Self-report survey / discrete choice model

Table E-5: Non-Participant Spillover Secondary Research - Study Details

Appendix F: Residential Lighting Program Net-to-Gross Analysis provides details about the Residential Lighting Program NTG approach and findings. Non-participant spillover was not quantified in PY3.

Program Name	NTG Ratio PY3	NTG Categories Included
Appliance Recycling	63%	Participant spillover, freeridership
Residential Lighting	70%	Freeridership, spillover ¹
Custom Incentive ²	31%	Participant spillover, freeridership
Energy Efficiency Behavior & Education	N/A	Verified savings estimates computed using a regression analysis with participants and non-participants account for freeridership and spillover in program homes
Efficient Equipment Incentive - Residential	65%	Participant spillover, freeridership
Efficient Equipment Incentive - Commercial, Non-Lighting	33%	Participant spillover, freeridership. The low NTG Ratio is driven by two large VSD projects. Please see the discussion following Table 6-16.
Efficient Equipment Incentive - Commercial, Lighting	81%	Participant spillover, freeridership
Efficient Equipment Incentive Direct Discount	90%	Participant spillover, freeridership
E-Power Wise	N/A	Low-income program at no cost to customers
WRAP	N/A	Low-income program at no cost to customers
Renewable Energy	N/A	The sample was insufficient to calculate a program NTG ratio
HVAC Tune-Up ³	100%	Freeridership (contractors)
Home Energy Assessment & Weatherization	83%	Participant spillover, freeridership
TOTAL PORTFOLIO ⁴	66%	

Table 1-6: PY3 NTG Ratios by Program

NOTES:

1. The NTG analysis for the Residential Lighting Program includes spillover. It is not possible to identify the impacts of participant versus non-participant spillover because as an upstream program, the participants are not known.

2. This is the NTG ratio from PY2 based on self-reported data from participants. An estimate of PY3 and PY4 NTG ratios will be determined during PY4 through surveys of self-reported data from participants.

3. Freeridership results from PY2 contractor interviews were used to estimate the PY3 NTG ratio; this is a midstream program.

4. The portfolio NTG ratio was calculated by multiplying the NTG ratio for each program by the gross *ex post* verified savings for that particular program. The resultant net savings for each program were then summed and divided by the total gross *ex post* verified savings for those programs which have an applicable NTG ratio.

1.6 Summary of Portfolio Finances and Cost-Effectiveness

A breakdown of the portfolio finances is presented in Table 1-7.

	Incremental Quarter (IQ) (\$1,000)	PYTD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$7,258	\$43,013	\$94,025
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$7,258	\$43,013	\$94,025
Design & Development	\$145	\$525	\$3,215
Administration ¹	\$605	\$2,270	\$7,615
Management ²	\$9,685	\$28,553	\$39,958
Marketing ³	\$782	\$2,886	\$10,154
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$11,217	\$34,235	\$60,941
EDC Evaluation Costs	\$642	\$2,248	\$7,691
SWE Audit Costs	\$351	\$1,551	\$1,643
Total EDC Costs ⁴	\$19,468	\$81,046	\$164,300
Participant Costs ⁵	N/A	\$131,450	\$290,394
Total TRC Costs ⁶	N/A	\$212,496	\$454,694
Discounted TRC Costs ⁷	N/A	\$212,496	\$408,477
Total Lifetime Energy Benefits	N/A	\$448,494	\$763,547
Total Lifetime Capacity Benefits	N/A	\$24,692	\$41,707
Total TRC Benefits ⁸	N/A	\$473,186	\$900,513
Discounted TRC Benefits	N/A	\$473,186	\$805,553
TRC Ratio ⁹	N/A	2.23	1.98

Table 1-7: Summary of Portfolio Finances

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/programCSPs.
- 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 to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC costs includes total EDC costs and participant costs.
- For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back to PY1.
- 8. Total TRC benefits equal the sum of total lifetime energy benefits and total lifetime capacity benefits, which are based on verified gross kWh and kW savings. These benefits include avoided supply costs, i.e., the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at a marginal cost for periods when there is a load reduction.
- 9. The TRC ratio equals total discounted TRC benefits divided by total discounted TRC costs.

1.7 Summary of Cost-Effectiveness by Program

TRC ratios are calculated by dividing total TRC discounted benefits by total discounted TRC costs. **Table 1-8** shows the TRC ratios by program and by other factors used in the TRC ratio calculation.

- The MWh/yr and MW values for the Efficient Equipment Incentive Program do not sum to the TRC benefits value because there are gas benefits for this program for efficient gas furnace rebates (Residential Thermal Storage (RTS) measure code).
- The MWh/yr and MW values for the HVAC Tune-Up Program represent the benefits from net savings, as some measures had negative savings. For the TRC benefits calculation, only positive benefits are included, while negative benefits are included in TRC costs. This procedure is specified in the California Standard Practice Manual. Therefore, the sum of MWh/yr benefits and MW benefits do not equal TRC benefits.
- The EM&V CSP estimated that the total Energy Efficiency Behavior & Education Program savings counted in other downstream rebate programs in PY3 was 465 MWh/yr or 1.6% of PY3 savings. To avoid double-counting, these savings were subtracted from the portfolio savings before determining the portfolio-level TRC. The program-level TRC was calculated without removing any savings.

Table	1-8: PYTD	TRC Ratios	s by Program
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	TRC Discounted Bonefits	TRC Discounted Costs			Line Loss
Program	(\$1,000)	(\$1,000)	TRC Ratio	Discount Rate	Factor ¹
Appliance Recycling	\$16,638	\$2,626	6.34	8.00%	Multiple
Residential Lighting	\$88,076	\$11,493	7.66	8.00%	8.33%
Custom Incentive	\$101,365	\$50,272	2.02	8.00%	Multiple
Energy Efficiency Behavior & Education	\$2,920	\$1,137	2.57	8.00%	8.33%
Efficient Equipment Incentive (lighting and non-lighting measures)	\$245,970	\$104,961	2.34	8.00%	Multiple
E-Power Wise	\$1,105	\$222	4.97	8.00%	8.33%
WRAP	\$11,055	\$9,680	1.14	8.00%	8.33%
Renewable Energy	\$2,861	\$8,980	0.32	8.00%	Multiple
HVAC Tune-Up	\$426	\$150	2.84	8.00%	Multiple
Home Energy Assessment & Weatherization	\$2,816	\$2,249	1.25	8.00%	8.33%
Direct Load Control	\$0	\$6,152	N/A	8.00%	N/A
Load Curtailment	\$0	\$3,945	N/A	8.00%	N/A
Portfolio Level Costs ²	\$0	\$10,630	N/A	8.00%	N/A
TOTAL PORTFOLIO ³	\$473,186	\$212,496	2.23	8.00%	Multiple

NOTES:

1. The line loss factor for the large C&I sector Is 4.1205%, while it is 8.33% for all other sectors.

2. Consists of Design and Development, Management, Administration, Evaluation, Marketing and Audit costs that cannot be attributed to one program.

3. 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.

2 Appliance Recycling Program

The ARP offers free pick up and recycling of operating but inefficient refrigerators, freezers, and room air conditioners. ARP is administered by JACO, an independent CSP under contract with PPL Electric. PPL Electric's overarching goal with the ARP is to prevent the continued operation of older, inefficient appliances by offering an incentive and free pick-up service to customers. The program's primary objectives include:

- 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 74,537 MWh and demand reduction of 9.59 MW.

2.1 Program Updates

The program launched in December 2009. After 30 months of operation, the ARP was on track to meet its planned MWh/yr savings. At the end of PY3 (May 31, 2012), ARP had achieved 71% of its planned 74,537 MWh/yr.¹⁶

To comply with changes to the TRM, PPL Electric began tracking replaced appliances on June 1, 2011, by asking customers through the sign-up process if they replaced their recycled appliance with a new one. In PY3, PPL Electric did not differentiate between ENERGY STAR and non-ENERGY STAR replacement appliances in an effort to keep data tracking and the sign-up process simple and streamlined, and because the 2011 TRM does not have a protocol for replacement with a non-ENERGY STAR appliance. Verified replacement rates were determined through PY3 evaluation surveys.

¹⁶ All goals are based on PPL Electric's revised EE&C Plan (Docket No. M-2009-2093216), filed with the PA PUC on May 25, 2012.

2.2 Impact Evaluation Gross Savings

2.2.1 Reported Gross Savings

Table 2-1 shows the cumulative reported results by sector through the end of PY3. As expected, the vast majority of participants were in the residential sector, with a small number of small commercial, large commercial, and GNI participants as well.

Table 2-2 breaks out the program's PY3 participation, savings, and incentives by guarter.

Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	incentives (\$1,000)
30,046	54,868	9.93	\$1,269
0	0	0	\$9
660	1,281	0.24	\$1
13	29	0.01	\$0
52	86	0.01	\$0
30,771	56,265	10.19	\$1,279
- -	Participants 30,046 0 660 13 52 30,771	Reported Gross Participants Energy Savings (MWh/yr) 30,046 54,868 0 0 660 1,281 13 29 52 86 30,771 56,265	Reported Gross Energy Savings (MWh/yr)Reported Gross Demand Reduction (MW)30,04654,8689.930006601,2810.2413290.0152860.0130,77156,26510.19

Table 2-1: CPITD Appliance Recycling Program Reported Results by Sector

1. Summing the sector level reported gross savings will not equal the program level savings; these totals differ by .3 MW. The difference is due to a change in the data tracking and reporting method from PY2 to PY3.

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY3 Q1	3,121	5,300	0.88	\$199
PY3 Q2	3,702	6,343	1.01	\$202
PY3 Q3	2,886	4,961	0.82	\$145
PY3 Q4	3,239	5,725	0.89	\$108
PY3 Total	12,948	22,330	3.60	\$653
CPITD Total	30,771	56,266	9.89	\$1,279

Table 2-2: PY3 Appliance Recycling Program Reported Results by Quarter

2.2.2 EM&V Sampling Approach

A random sample of participants was selected for telephone survey verification to exceed 90/10 C/P for the program year (n=75) as shown below in **Table 2-3**. 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.

Stratum	Strata Boundaries	Population Size	Coefficient of Variation Assumed in Sample Design	Target Relative Precision (90% conf.)	Target Sample Size	Achieved Sample Size	Evaluation Activity
Participants	None	9,536 ¹	0.5	10%	70	75	Process and Impact
Program (records review)	None	15,158	NA	NA	Census	Census	Process and Impact
Program Total		15,158	0.5	10%	70	75	
NOTES:		·	· · · · · ·	·			·

 Table 2-3: Appliance Recycling Program Sampling Strategy for PY3

1. The sample for the participant survey was drawn in PY3 Q3 so the full participant population of 15,158 units was not yet available. However, the sample is representative of the full population since there were no significant differences in participants from Q1 through Q3 and in Q4.

2.2.3 Records Review

The EM&V CSP also inspected a census of PY3 annual participant records from EEMIS. 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.

2.2.4 Ex Ante Adjustment Methodology and Findings

Savings for recycled appliances are deemed on a per-unit basis, in accordance with the 2011 TRM. No TRM *ex ante* adjustments were made for refrigerators or freezers as none were required to be in line with the TRM. Adjustments were made to *ex ante* reported savings to make room air conditioner savings values meet 2011 TRM specifications. For room air conditioners, the 2011 TRM savings are based on the geographic location of each participant's home and the corresponding savings assumption in the TRM. The savings are 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 with a final weighted savings value of 295 kWh/yr per unit for room air conditioners. **Table 2-4** below details the TRM savings assumptions for each city represented in the PY3 participant population, as well as the number of room air conditioning units picked up from each city. The overall weighted average savings value is also provided.

Measure	City	EFLH ¹ (Hrs)	Capacity (BTUH)	EER ¹	Energy Impact (kWh/yr)	CF ¹	Demand Impact (kW)	Effective Useful Life (Years)	Frequency - PY3 Annual Participants
	Allentown	243	10,000	9.07	268	0.58	0.64	4	417
Room Air	Harrisburg	288	10,000	9.07	318	0.58	0.64	4	487
Conditioner	Scranton	193	10,000	9.07	213	0.58	0.64	4	274 .
Retirement	Williamsport	204	10,000	9.07	225	0.58	0.64	4	207
	Philadelphia	320	10,000	9.07	353	0.58	0.64	4	3
Weighted ave	erage per-unit sav	ings		<u> </u>	295 kWh/yr			_	
NOTES:	· · <u></u>		· · · · ·		1	•	·		

Table 2-4: Room Air Conditioner Retirement – Savings Assumptions and Participation by City

1. See Acronyms. EFLH stands for Effective Full Load Hours; EER stands for Energy Efficiency Rating; CF stands for coincidence factor.

2.2.5 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 their refrigerator or freezer (70% replacement rate) than reported to the ARP CSP through the sign-up process (15% 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 2-5** summarizes the survey results and energy and demand adjustments.

Measure Category	Percent of Sample in Category – EEMIS Reported	Percent of Sample in Category – Survey Verified	kWh/yr Per Unit	KW:Per Unit
Refrigerators & Freezers – Not Replaced	85%	30%	1,659	0.21
Refrigerators & Freezers – Replacement with ENERGY STAR	15%	67%	1,205	0.15
Refrigerators & Freezers – Replacement with Standard Efficiency	0%	3%	1,091	0.14

Table 2-5: PY3 Appliance Recycling Program Summary of Survey Verification Results

2.2.6 Savings Realization Rate Methodology

The realization rate for PY3 was calculated 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. For refrigerators and freezers, the *ex post* adjustments are based on survey results, and indicate a discrepancy between the replacement status reported in EEMIS. For room air conditioners, the adjustments are *ex ante* adjustments based on the savings assumptions from the TRM that correspond to the ZIP code where the unit was picked up.

2.2.7 Summary of Evaluation Results

The survey responses regarding appliance replacement were the only finding that had a substantial impact on the PY3 program realization rate.

In the EM&V CSP survey results, significantly more customers reported replacing their 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 PY3 MWh/yr realization rate was 84.4%. Program savings results are provided in Table 2-6 and Table 2-7.

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted <i>Ex Ante</i> Gross Energy Savings (MWh/yr)	Energy Realization Rate	Observed Error Ratio ²	Relative Precision (90% conf.)	Verified Gross Energy Savings (MWh/yr)
Program Total	22,330	22,298	84.4%	20.8%	3.5%	18,814

Table 2-6: PY3 Appliance Recycling Program Summary of Program-Level Energy Savings¹

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. Since the realization rate was calculated with a ratio estimator, the EM&V CSP reports the error ratio instead of the coefficient of variation. The error ratio is used in place of the coefficient of variation in sample planning.

Savings Type	Reported Gross Reduction (MW)	Adjusted Ex Ante Gross Reduction (MW)	Realization Rate	Observed Error Ratio	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Total Program Savings at Meter	3.60	3.60	84.4%	20.8%	3.5%	3.04
Total Program Savings at Generator ¹	3.90	3.90 ¹	84.4% ¹	20.8%	3.5% ¹	3.29 ¹

Table 2-7: PY3 Appliance Recycling Program Program-Level Demand Reduction

NOTES:

 This is the value used in reporting program-wide demand savings since refers to MW at the point of generation. (Savings targets for MW refer to values at the point of generation.) Due to line losses, savings at the point of generation are systematically larger than savings at the point of consumption.

2.3 Impact Evaluation Net Savings

2.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP conducted a NTG analysis based on findings from customer telephone surveys conducted in PY3. The EM&V CSP utilized 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 that would have, in the absence of the program, disposed of their appliance in a manner leading to its 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, the program should get credit for savings equal to the consumption of that appliance. If it would not have, the program should get zero credit. This adjustment is applied through a 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 and continued to be used 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/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 non-participant 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.

2.3.2 Net-to-Gross Ratio Findings

Freeridership did not change between PY2 and PY3; both years had an overall freeridership value of 61%.

2.3.3 Spillover Methodology

Participant spillover refers to the participants' installation of measures in addition to those incented by the program, where the program influenced the participant to install the additional measures. To examine spillover attributable to the ARP, survey respondents were asked if they made any energy efficiency improvements or installed any energy efficient measures where they did not receive a program rebate. They were also asked the likelihood 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, per direction from the SWE. Spillover estimates will be used to inform program planning.

2.3.4 Spillover Findings

Some ARP survey respondents stated that they 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 2% spillover for ARP. The overall NTG ratio is 63%.

2.4 Process Evaluation

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

2.5 Financial Reporting

A breakdown of the program finances is presented in Table 2-8.

	IQ (\$1,000)	PYTD {\$1,000}	CPITD (\$1,000)
EDC Incentives to Participants	\$108	\$653	\$1,279
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$108	\$653	\$1,279
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$277	\$1,538	\$3,032
Marketing ³	\$73	\$435	\$860
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$351	\$1,973	\$3,892
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$458	\$2,626	\$5,171
Participant Costs ⁵	N/A	\$0	\$0
Total TRC Costs ⁶	N/A	\$2,626	\$5,171
Discounted TRC Costs ⁷	N/A	\$2,626	\$4,666
Total Lifetime Energy Benefits	N/A	\$15,632	\$37,597
Total Lifetime Capacity Benefits	 N/A	\$1,006	\$2,855
Total TRC Benefits ⁸	N/A	\$16,638	\$44,354
Discounted TRC Benefits	N/A	\$16,638	\$40,452
TRC Ratio ⁹	N/A	6.34	8.67

Table 2-8: Summary of Appliance Recycling Program Finances

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 to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC Costs includes Total EDC Costs and Participant Costs.
- For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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, i.e., 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 Discounted TRC Benefits divided by Total Discounted TRC Costs.

3 Residential Lighting Program

The Residential Lighting Program (formerly called the CFL Campaign) has two components:

- An upstream retail lighting component that provides incentives to CFL and light emitting diode (LED) manufacturers. The upstream incentives then 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 their website.¹⁷
- 2. A give-away component 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 give-away 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. After 29 months of operation, the Residential Lighting Program was ahead of its planned bulb quantity and energy savings, and very close to its planned capacity savings.

¹⁷ See: https://www.pplelectric.com/save-energy-and-money/rebate-and-incentiveprograms/residential/residential-lighting.aspx

3.1 Program Updates

The CFL Campaign program was renamed the Residential Lighting Program in PY3. This change occurred because, in addition to CFLs, the program discounted a limited number of LEDs through its upstream component in PY3.

3.2 Impact Evaluation Gross Savings

3.2.1 Reported Gross Savings

All of the program's participants, savings, and incentives were in the residential sector. **Table 3-1** shows the cumulative reported results by sector through the end of PY3. **Table 3-2** breaks out the program's PY3 participation, savings, and incentives by quarter.

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	1,089,304	335,558	19.19	\$7,392
Small Commercial and Industrial	0	0	0.00	\$69 ¹
CPITD Total	1,089,304	335,558	19.19	\$7,461
NOTES: 1. Some costs and savings were all EE&C'Plan to allocate all savings	located to the Small (s to the Residential se	C&I sector in Program Ye ector. Actual savings pro	ear 1. Subsequently, PPL Ele eviously allocated to Small	ectric revised its C&I were

Table 3-1: CPITD Residential Lighting Program	Reported Results by Sector
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Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY3 Q1	79,532	22,922	1.25	\$535
PY3 Q2	103,138	29,832	1.59	\$277
PY3 Q3	143,917	42,067	2.22	\$1,181
PY3 Q4	115,151	32,899	1.74	\$843
PY3 Total	441,738	127,720	6.80	\$2,836
CPITD Total	1,089,304	335,558	19.19	\$7,461

Table 3-2: PY3 Residential Lighting Program Reported Results by Quarter

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 savings in EEMIS were computed using the algorithms specified in the 2011 TRM.

This is illustrated in **Table 3-3**, where the population size, target sample size, and achieved sample size are all 60,078 records.

Stratum	Strata Boundaries	Population Size	Assumed Coefficient of Variation (C _v)	Precision Target	Target Sample Size	Achieved Sample Size	Evaluation Activity
All	NA1	60,078	NA ¹	NA ¹	60,078	60,078	Full database review
Program Total	NA1	60,078	NA1	NA ¹	60,078	60,078	
NOTES: 1. Since this p	rogram's evalu	ation did not i	nclude sampling	. Cv and precis	ion are not m	eaningful.	- <u></u>

Table 3-3: Residential Lighting Program Sampling Strategy for PY3

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 derived using incorrect algorithms from the 2011 TRM. The EM&V CSP reviewed a census of program records to make this correction.

The EM&V CSP found that, for LEDs only, the gross energy and demand savings in EEMIS were not computed using the algorithms specified in the 2011 TRM. Specifically, the values in EEMIS were derived using incorrect in-service rate (ISR) factors. EEMIS under-reported the energy savings because it used the same ISR for LEDs as for CFLs (84%), instead of 95% for LEDs as stated in the TRM. EEMIS over-reported the demand savings because it used a 100% ISR instead of 95% for LEDs as stated in the TRM. The *ex ante* adjustments corrected for these discrepancies in the ISR. However, since relatively few program LEDs were sold during PY3, the *ex ante* savings adjustments were negligible.

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. The EM&V CSP computed the *ex post* savings based on differences identified between the energy and demand savings recorded in EEMIS and the energy and demand savings the EM&V CSP computed using the deemed CFL and LED savings algorithms given in the TRM. This methodology is explained in greater detail in the Savings Realization Rate Methodology section below.

The EM&V CSP found relatively few discrepancies for energy savings, and numerous discrepancies for demand savings. For both energy and demand savings, 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 PY3 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.

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 CFL and LED manufacturers to implement lighting promotions in retail stores, but does not have any direct contact with participating retailers. Thus, on a monthly basis, participating manufacturers collect CFL and LED sales data on the approved, program-discounted energy efficient bulbs from participating retailers. The manufacturers then send their sales data to the program CSP, who reformats and uploads these disparate datasets to their own internal program database. Finally, the program CSP uploads the monthly (participation) sales data from its database to EEMIS. EEMIS also includes a separate measures table with descriptive details about discounted CFLs and LEDs. Only data from the Residential Lighting Program CSP's database and from EEMIS were available for the EM&V CSP to review.

Due to the upstream nature of the Residential Lighting Program, there is no way to know which PPL Electric customers purchased CFLs or LEDs 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 CFLs and LEDs themselves; no data is collected about participating Residential Lighting Program customers. Each record in EEMIS is a unique combination of:

- CFL/LED SKU,
- Retailer name and store identifier where each CFL/LED was sold,
- Date each CFL/LED was sold to retail customers,
- CFL/LED manufacturer,
- CFL/LED wattage,
- Wattage of an equivalent incandescent light bulb, and
- Additional CFL/LED characteristics.

Both EEMIS and the Residential Lighting Program CSP produce reports in standardized formats. The EM&V CSP used these standardized reports to develop a mostly automated system for conducting Residential Lighting Program records reviews and analyzing the associated realization rate.

Following the process described above, the EM&V CSP reviewed a census of PY3 Residential Lighting Program records from EEMIS, data which had been imported from the program CSP's participation database. For each record, the EM&V CSP calculated energy and demand savings values based on input

values from the program CSP's measures table, and compared them to the energy and demand savings values in EEMIS.

3.2.6 Summary of Evaluation Results

The EM&V CSP's energy and demand savings calculations, based on inputs from the program CSP's participation database, matched EEMIS recorded energy (kWh/yr) savings values for 58,007 out of the total 60,078 PY3 records (i.e., values for variables matched for 97% of the records), and matched EEMIS recorded demand (kW) savings values for 24,447 out of the total 60,078 PY3 records (i.e., values for variables matched for 97% of the records), and matched EEMIS recorded demand (kW) savings values for 24,447 out of the total 60,078 PY3 records (i.e., values for variables matched for 41% of the records). Upon further investigation, the EM&V CSP found that the mismatches were due to errors with the savings algorithm input values in the program implementation CSP's database.

The few mismatched energy savings values resulted in a PY3 energy savings realization rate of 100.1%, as shown in **Table 3-4**. The large number of mismatched savings values for demand resulted in a PY3 realization rate for demand savings of 87.2%, as shown in **Table 3-5**.

Stratum	Reported Gross Savings (MWh/yr)	Adjusted <i>Ex</i> Ante Gross Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision (90% conf.)	Verified Gross Savings (MWh/yr)
All	127,720	127,720	100.1%	N/A ²	N/A ²	127,802
Program Total	127,720	127,720	100.1%	N/A ²	N/A ²	127,802
NOTES: 1. Values in th consumptic	is table refer to savin	gs at the point of	consumption. (Si	avings targets for N	Wh refer to value larger.	s at the point of

Table 3-4: PY3 Residential Lighting Program, Evaluation Results for Energy Savings¹

2. Since this program's evaluation did not include sampling, Cv and precision are not meaningful.

Savings Type	Reported Gross Reduction (MW)	Adjusted <i>Ex</i> Ante Gross Reduction (MW)	Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Total Program Savings at Meter	6.8	6.8	87.2%	N/A ¹	N/A ¹	5.9
Total Program Savings at Generator ²	7.4 ²	7.4 ²	87.2%	N/A ¹	N/A ¹	6.4 ²

Table 3-5: PY3 Residential Lighting Program, Evaluation Results for Demand Reduction

NOTES:

1. Since this program's evaluation included the census and did not use sampling, Cv and precision are not meaningful.

2. This is the value used in reporting program-wide demand savings since it refers to MW at the point of generation. (Savings targets for MW refer to values at the point of generation.)

3.3 Impact Evaluation Net Savings

3.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP conducted a NTG analysis based on findings from customer telephone surveys conducted in PY3. The analysis incorporated all 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.

The Residential Lighting Program's freeridership, spillover, and NTG methodologies and findings are discussed in more detail in Non-participant Spillover Secondary Research

Cadmus conducted secondary research exploring non-participant spillover. Various studies reviewed for this research estimated free-ridership, participant "like" and "unlike" spillover, and non-participant "like" and "unlike" spillover. To estimate the range of non-participant spillover that might be expected from different measures, we cataloged the survey research, program and/or non-participant spillover reported as a percent of savings or total kWh savings. Most estimates were based on self-report methods that were tailored to the sponsoring utility, and the individual program or the measure of interest. Non-participant surveys were typically conducted with design professionals or equipment vendors involved in the installations.

To estimate non-participants spillover, a typical approach applied the percentage of spillover (determined through survey research) to the program savings tracked in a database. Spillover was calculated for each design professional or equipment vendor. The results were then extrapolated to the program's kWh savings recorded in the database which were not included in the survey sample.

Another author reported the baseline sales used to estimate spillover effects were gathered via 100 surveys of nonparticipating retailers. The program effects sales data were gathered from 5 program retailers accounting for 70% to 80% of program volume.

A number of report authors stated there was large uncertainty in their spillover estimates or that findings were not significant. These either did not include the spillover estimate in the final NTG analysis or recommended using a NTG value of 1.

Table E-4 summarizes the findings from several studies. Where a study reported savings both at the program and the measure level, the measure level savings are included in the table below. The table is sorted by sector and measure, to more easily see the range of results. Table E-5 provides additional study details.

Table E-4: Summary of Non-participant Spillover Secondary Research

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Study ID	Utility ^{1,2}	Location	Measure	Sample Size	Non- participant Spillover	Population Savings Impact (kWh) ³
Commerci	al Sector		·			
1	Massachusetts PAs	NE	Motors	24	46%	358,092
2	Connecticut Light & Power	NE	Motors	16	0%	0
3	NYSERDA	NË	Motors	116	15%	258 (GWh)
1	Massachusetts PAs	NE	HVAC	41	0%	0
2	Connecticut Light & Power	NE	HVAC	60	4%	395,726
1	Massachusetts PAs	NE	VSD	63	13%	2,235,383
2	Connecticut Light & Power	NE	VSD	28	14%	344,868
1	Massachusetts PAs	NE	Lighting	134	0%	0
2	Connecticut Light & Power	NE	Lighting	151	3%	1,700,580
4	California IOUs	w	Lighting - High Bay (mainly T5HO fixtures)	729	23-27%	15.1 - 27.2 (GWh)
1	Massachusetts PAs	NE	Compressed Air	17	3%	100,809
2	Connecticut Light & Power	NE	Compressed Air	22	4%	162,132
1	Massachusetts PAs	NE	Refrigeration	4	0%	0
2	Connecticut Light & Power	NE	Refrigeration	6	0%	0
5	California IOUs	w	New Construction	109	22%	21,397,000
6	PG&E	W	Split A/C Remote Condensing Unit Evaporative Coolers Water Chillers Evaporative Condensers Window Film Cooling Towers Package Terminal	1,337	13%	Avoided cost used as a proxy for impact
6	PG&E	W	T8 Fixtures HID CFLs LEDs Electronic Ballasts Fluorescents Occupancy Sensors	2,796	7%	Avoided cost used as a proxy for impact

Study ID	Utility ^{1,2}	Location	Measure	Sampl <u>e S</u> ize (Non- participant Spillover	Population Savings'Impact (kWh) ³
7	National Grid	NE	HVAC Programmable Thermostats VFDs Motors Lighting Compressed Air Process Cooling Refrigeration	233	9%	123,232
Residential						
8	Focus on Energy	MW	Boiler Tune-Up		2%	932 (Therms)
8	Focus on Energy	MW	Hot water heating equipment		25%	21 (Therms)
8	Focus on Energy	MW	HVAC	-	1%	42 (Therms)
9	Northeast Utility	NE	Insulation	1,202	28%	-
9	Northeast Utility	NE	Air Sealing	1,202	28%	-
NOTES			·	·		• ••• <u>•</u> -

1. Massachusetts PAs included in the nonparticipant study cited here include: National Grid, NSTAR, WMECO, Unitil, and Cape Light.

2. Connecticut Light and Power was the recipient of a study which utilized nonparticipant spillover findings from National Grid, Unitil, and United Illuminating.

3. The savings extrapolated to the entire population takes the attributed non-participant spillover rate and applies it to the entire population gross savings. All values are in kWh unless otherwise stated.

Study ID	Study Author	Study Year	Study Name	Analytic Method
1	TetraTech	2011	2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
2	PA Consulting Group	2008	2007 Commercial and Industrial Programs Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
3	Quantec / Summit Blue	2007	2007 Commercial & Industrial Market Effects Evaluation	Self-report survey, engineering algorithms
4	KEMA / Itron	2010	2010 High Bay Lighting Market Effects Study Final Report	Baseline comparison, utility data review, surveys, in-depth interviews
5	RLW Analytics	2003	Final Report 1999-2001 Building Efficiency Assessment (BEA) Study	Self-report survey, DOE-2 engineering models, and on-site audits
6	Quantum Consulting	1999	Pacific Gas & Electric Company 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies	Self-report survey, on-site audit

Table E-5: Non-Participant Spillover Secondary Research - Study Deta	ails
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7	PA Consulting Group	2002	National Grid 2001 Commercial and Industrial Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
8	TetraTech	2010	CY10 Apartment and Condo Efficiency Services Market Effects	Baseline comparison, contractor survey
9	Cadmus	2012	Report is not publicly available	Self-report survey / discrete choice model

Appendix F: Residential Lighting Program Net-to-Gross Analysis.

3.3.2 Net-to-Gross Ratio Findings

Based on participants' answers to a battery of freeridership questions, the weighted mean freeridership rate for CFLs purchased by respondents who were aware of the program was 52%, with an upper bound of 61% and a lower bound of 44%.

The EM&V CSP then observed that some of the recent PY3 CFL purchasers who were unaware of the Residential Lighting Program were nevertheless likely influenced by it, while others were not. Respondents who bought CFLs and were unknowingly influenced by the program are considered spillover, while those unaware respondents who bought program CFLs but were not influenced by the program are free-riders. The EM&V CSP reasoned that, at most, freeridership among recent program CFL purchasers who were unaware of the program was 52% (the average of those who were aware of the program). At the low end, freeridership for recent purchasers who were unaware of the program was 44% (the same lower bound as for recent purchasers who were aware of the program).

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 70%. The Residential Lighting Program's NTG result was then corroborated with the results from recently published upstream CFL program evaluations conducted in other areas of the country.

3.4 Process Evaluation

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

3.5 Financial Reporting

A breakdown of the program finances is presented in Table 3-6.

	IQ (\$1,000)	РҮТD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$843	\$2,836	\$7,461
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$843	\$2,836	\$7,461
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$484	\$1,892	\$4,016
Marketing ³	\$7	\$22	\$168
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$491	\$1,914	\$4,184
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$1,334	\$4,750	\$11,645
Participant Costs ⁵	N/A	\$6,743	\$17,889
Total TRC Costs ⁶	N/A	\$11,493	\$29,534
Discounted TRC Costs ⁷	N/A	\$11,493	\$26,969
Total Lifetime Energy Benefits	N/A	\$86,423	\$185,104
Total Lifetime Capacity Benefits	 N/A	\$1,653	\$4,387
Total TRC Benefits ⁸	N/A	\$88,076	\$208,501
Discounted TRC Benefits	N/A	\$88,076	\$189,491
TRC Ratio ⁹	N/A	7.66	7.03

Table 3-6. Summary of Residential Lighting Program Finances

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.
- 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.
- Per the 2011 Total Resource Cost Test Order, the net participant costs are the costs to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC Costs includes Total EDC Costs and Participant Costs.
- 7. For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 Discounted TRC Benefits divided by Total Discounted TRC Costs.

4 Custom Incentive Program

The Custom Incentive Program provides a delivery channel and financial incentives to all sectors, focusing largely on commercial and industrial (C&I) customers interested in installing individual equipment measures or systems not covered by other PPL Electric programs. These include energy efficiency projects, retro-commissioning, equipment optimization, and operational and process improvements that result in cost-effective energy efficiency savings. To qualify for financial incentives, eligible customers are required to provide documentation that their proposed efficiency upgrades pass PPL Electric's cost-effectiveness threshold and technical criteria.

Through the program, PPL Electric offers incentives based on avoided or reduced kWh resulting from the project. Incentives are subject to an annual cap for each project and for each participating customer. Incentives are also capped at 50% of the incremental cost of the project.

PPL Electric also provides incentives for a portion of the cost of a technical study, and may provide additional reimbursement following successful implementation of a cost-effective project. Note that not all participants that receive a custom incentive will also receive a technical study reimbursement. Customers may forego the technical study reimbursement and apply directly for a custom incentive.

The Custom Incentive Program theory can be summarized as follows: By providing rebates for highefficiency equipment not included in other PPL Electric programs, the Custom Incentive Program will increase the market saturation and acceptance of high-efficiency equipment. Customers will learn of the energy benefits and achieve energy and demand savings by installing qualifying equipment. Increased market penetration of high-efficiency equipment will further increase sales, achieving additional energy and demand savings.

4.1 Program Updates

In the EE&C plan revised in February 2012, PPL Electric announced several changes to the program, including reallocating approximately \$13 million in small C&I program costs from the Custom Incentive Program to the Efficient Equipment Incentive Program. PPL Electric also proposed to reallocate approximately \$10 million large C&I direct program costs from the Efficient Equipment Incentive Program to the Custom Incentive Program. This was done to reflect market conditions, including customer response to the program offerings. Small C&I customers generally have the types of projects that are eligible for prescriptive rebates, while there has been large demand for incentives for projects that fall outside of the Efficient Equipment Incentive Program among large customers. The rebate structure for C&I Custom Incentive Program technical studies was also revised.

PPL Electric plans to accept applications until funding is exhausted for a sector. All projects must be operational by May 31, 2013 to receive an incentive. Projects that require pre-installation metering will be accepted until March 31, 2013. As funding for large C&I customers is exhausted, there is a waiting list

for this sector. Applications will be taken off the waiting list if approved projects do not materialize and those funds become available for another project. This has been the case for large C&I applications since June 1, 2011. A total of 131 projects were placed on a waiting list (many prior to PY3), of which 16 were cancelled, 59 moved to active status, and 56 were already accomplished and paid.

4.2 Impact Evaluation Gross Savings

4.2.1 Reported Gross Savings

As can been seen in **Table 4-1**, the sector with the highest participation is small C&I. However, due to the small average project size for this sector, it is the large C&I and the GNI sectors that together contribute the majority of the program savings.

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)			
Residential	1	18	0.002	\$0 ¹			
Small Commercial and Industrial	135	5,798	1.875	\$575			
Large Commercial and Industrial	144	57,962	7.659	\$4,848			
Government, non-profit, and institutional	78	48,691	4.824	\$1,671			
CPITD Total	358	112,469	14.361	\$7,094			
NOTES: 1. One PY2 project was reclassified from the residential sector.							

Table 4-1: CPITE	Custom	Incentive	Program	Reported	Results by S	iecto r
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The difference is due to a change in the data tracking and reporting method from PY2 to PY3. **Table 4-2** shows the number of participants, energy and demand savings, and incentives paid by quarter

2. Summing the sector level reported gross savings will not equal the program level savings; these totals differ by .18 MW.

in PY3.

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY3 Q1	39	12,019	2.64	\$972
PY3 Q2	42	18,625	1.86	\$1,878
PY3 Q3	26	22,735	2.53	\$1,490
PY3 Q4	25	42,913	4.51	\$1,340
PY3 Total	132	96,291	11.54	\$5,680
CPITD Total	358	112,469	14.54	\$7,094

Table 4-2: PY3 Custom Incentive Program Reported Results by Quarter

4.2.2 EM&V Sampling Approach

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 large amount 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.

A sample of small projects was selected for verification at the close of PY3 Q3. Savings for this sample were verified, and a realization rate was determined based on this sample. The EM&V CSP applied the realization rate to the population of the projects in the small project stratum.

Incentives were paid for 107 projects in the Custom Incentive Program in PY3. Of these, 38 were placed in the large stratum and were verified. The remaining projects were defined as small projects. There were a total of 69 small projects in PY3, from which a sample of six were selected and verified.

Table 4-3 shows the sampling strategy for PY3.

Stratum	Strata Boundaries (kWh)	Population Size ¹	Error Ratio Assumed in Sample Design ²	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Large	>500,000	38	N/A ³	N/A ³	38	38	Onsite EM&V
Small	<500,000	69	0.5	80/20	10	6	Onsite EM&V
Program Total		107			48	44	

NOTES:

1. The population size referenced here is not the same as the participants included in other tables in this report. The population from which sampling was done includes only those projects for which savings were claimed in PY3. The participant count includes projects that were categorized as Tech Study and projects that have been cancelled.

2. 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.

3. This evaluation included the census of program participants in the large stratum. As a result, the savings estimate in this stratum is not subject to sampling error. The Cv and confidence and precision do not apply to the large stratum.

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. The EM&V CSP does not prepare a separate *ex-ante* adjustment analysis for these projects.

4.2.4 Ex Post Adjustment Methodology and Findings

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

This process involves developing a site-specific measurement and verification (M&V) plan (typically in *coordination with the C&I CSP*). The EM&V CSP performs post-installation inspections. Pre-installation inspections are conducted by the EM&V CSP whenever possible. For the Custom Incentive Program, the EM&V CSP is involved early in the application process. The C&I CSP informs the EM&V CSP when an application is received that is likely to fall into the large strata. This enables the EM&V CSP to evaluate large projects at a high level of rigor, often collecting pre-installment measurements without duplication of effort between customers, the C&I CSP, trade allies, and the EM&V CSP.

Verified savings for most custom projects are based on metered data collected by the customer, 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 have been determined by following SSEMVPs. In some cases, PPL Electric delays full or partial 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 29 large strata projects (44% of total savings), the realization rate is 100%. This group made up a smaller portion of total savings than in PY2 (73% of savings in PY2). Substantially more savings in PY3 were incentivized prior to verification due to the inclusion of two large combined heat and power (CHP) projects (Projects 200 and 218). 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 CSPs involvement in reviewing interim savings estimates.

For the remaining nine large strata projects (50% of total savings), PPL Electric paid the incentive and claimed savings before verification was complete. Verification has since been completed. The realization rate for these projects exceeds 100% for energy, indicating that the claimed savings were conservative on average.

There were 69 projects in the small strata. A sample of six were verified. A slightly larger sample was envisioned, but the addition of several very large projects to the large strata resulted in the large strata

contributing 94% of claimed savings. The small projects contribute only 6% of program savings, so they have a relatively modest impact on the program realization rate.

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

4.2.6 Summary of Evaluation Results

As can been seen in **Table 4-4**, the realization rate for energy savings was higher for large strata projects (104%) than for small strata projects (92%). The total program realization rate for energy savings is 103.5% in PY3. The demand realization rates, seen in **Table 4-5**, were similar between the two strata and the realization rate for the program was 98.7% for demand. The relative precision in the results is extremely low (i.e., the results are very precise) because a census of large projects was evaluated and this strata accounted for a very high (94%) percentage of savings in PY3.

Stratum	Reported Gross Savings (MWh/yr)	Adjusted <i>Ex</i> Ante Gross Savings (MWh/yr)	Energy Realization Rate	Observed Error Ratio	Relative Precision (90% conf.)	Verified Gross Savings (MWh/yr)
Large	90,241	90,241	104%	43% ²	Census	94,087
Small	6,050	6,050	92%	76%	48.8%	5,540
Program Total ³	96,291 ³	96,291 ³	103.5%	45%	1.1%	99,627 ³
	· · · · · · · · · · · · · · · · · · ·					

Table 4-4: PY3 Custom Incentive Program Evaluation Results for Energy Savings¹

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. This error ratio only reflects the 9 projects for which PPL Electric paid the incentive prior to verification.

3. This is the value used in reporting program-wide energy savings. (Savings targets for MWh refer to values at the point of consumption.)

Stratum	Reported Gross Reduction (MW)	Adjusted <i>Ex Ante</i> Gross Reduction (MW)	Demand Realization Rate	Observed Error Ratio	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Large	10.67	11.31	98.7%	58% ²	Census	11.16
Small	0.87	0.92	99.5%	34%	21.8%	0.92
Program Total	11.54	12.23	98.7%	56%	0.6%	12.07 ³

Table 4-5: PY3 Custom Incentive Program Evaluation Results for Demand Reduction¹

NOTES:

1. Adjusted *ex ante* and verified values in this table refer to savings at the point of generation. Due to line losses, savings at the point of consumption are systematically lower. Reported gross values are reported at the point of consumption in Order to accurately reflect the tracking method used in PPL Electric's EEMIS database.

2. This error ratio only reflects the 9 projects for which PPL Electric paid the incentive prior to verification.

3. This is the value used in reporting program-wide demand savings. (Savings targets for MW refer to values at the point of generation.)

4.3 Impact Evaluation Net Savings

4.3.1 Net-to-Gross Ratio Methodology

The NTG ratio was determined for PY2 through self-report surveys with a sample of participants. The survey included spillover and freeridership questions. The freeridership battery of survey questions were tailored to participants of the Custom Incentive Program. These questions were used to develop a freeridership score through a scoring matrix. No adjustments for the NTG ratio were applied to savings, as specified by the PA PUC. Information obtained by computing the NTG ratio will only be used to refine and improve program delivery.

Participant spillover refers to a participant's installation of measures in addition to those incented by the program, where the program influenced the participant to install the additional measures. PY2 survey respondents were asked if they installed any other measures without receiving a rebate. They were also asked if program participation influenced their decision to install the additional measures.

No new NTG surveys were conducted for PY3. An estimate of PY3 and PY4 NTG ratios will be determined during PY4 through surveys of self-reported data from participants. In the interim, use of the PY2 NTG ratio in PY3 is reasonable and conservative. The percentage of retroactive projects is expected to decrease as the program matures, so some increase in the NTG ratio is expected from PY2 to PY3 and PY4.

4.3.2 Net-to-Gross Ratio Findings

Surveys were conducted in PY2 with 19 participants who completed projects in PY2. Once the freeridership scores were determined for each participant, a savings-weighted score was computed. That is, each individual score was multiplied by that participant's verified savings to determine a savings weighted score. In this way, scores for very large projects carry greater weight than scores for much smaller projects. The savings weighted freeridership score was 69% for this program. In PY2, Custom Incentive Program participants did not report installing any other measures without receiving a rebate. Therefore, there is no participant spillover attributable to this program. Since there were no spillover savings, the NTG ratio for the program was 31%.

4.4 Process Evaluation

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

4.5 Financial Reporting

A breakdown of the program finances is presented in Table 4-6.

	IQ {\$1,000}	PYTD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$1,340	\$5,680	\$7,094
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$1,340	\$5,680	\$7,094
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$630	\$2,378	\$2,931
Marketing ³	\$1	\$8	\$8
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$631	\$2,386	\$2,939
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$1,970	\$8,066	\$10,033
Participant Costs ⁵	N/A	\$42,206	\$48,018
Total TRC Costs ⁶	N/A	\$50,272	\$58,051
Discounted TRC Costs ⁷	N/A	\$50,272	\$50,310
Total Lifetime Energy Benefits	N/A	\$97,441	\$95,681
Total Lifetime Capacity Benefits	N/A	\$3,924	\$4,054
Total TRC Benefits ⁸	N/A	\$101,365	\$115,218
Discounted TRC Benefits	N/A	\$101,365	\$99,735
TRC Ratio ⁹	N/A	2.02	1.98

Table 4-6: Summary of Custom Incentive Program Finances

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 to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC Costs includes Total EDC Costs and Participant Costs.
- 7. For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 Discounted TRC Benefits divided by Total Discounted TRC Costs.

5 Energy Efficiency Behavior & Education Program

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

The program has an experimental design. The program's implementation CSP randomly assigns homes eligible for the program to program treatment and control groups. Homes in the treatment group receive Home Energy Reports, while homes in the control group do not.

5.1 Program Updates

In PY3, the Energy Efficiency Behavior & Education Program sent Home Energy Reports to approximately 55,000 new homes (expansion group) and 50,000 homes that received their first reports in PY2 (legacy group). Each legacy and expansion group home that did not opt out of the program and whose account remained active in PY3 would have received seven reports. Except for the expansion in the number of participants, there were not any significant changes to the program in PY3.

5.2 Impact Evaluation Gross Savings

5.2.1 Reported Gross Savings

The implementation CSP reported gross savings in PY3 of 29,203 MWh/yr. **Table 5-1** shows the cumulative reported results through the end of PY3.

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	151,468	29,203	0	\$0
CPITD Total	151,468	29,203	0	\$0

Table 5-1: CPITD Energy Efficiency Behavior & Education Program Reported Results by Sector

Table 5-2 shows the PY3 reported gross savings and number of participants by quarter. The quarterly results reflect a reporting convention, as participants enrolled in the program in PY3 Q1 but participation and savings are only reported semiannually.

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY3 Q1	0	0	0	\$0
PY3 Q2	101,468	11,668	0	\$0
Рүз Q3	0	0	0	\$0
PY3 Q4	0	17,535	0	\$0
PY3 Total	101,468	29,203	0	\$0
CPITD Total ¹	151,468	29,203	0	\$0
NOTES	4	<u></u>		

Table 5-2: PY3 Energy Efficiency Behavior & Education Program Reported Results by Quarter

1. The CPITD energy savings values reported here 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

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 bills (consumption data) between June 2009 and May 2012 and expansion group bills between June 2010 and May 2012.

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

Stratum	Strata Boundaries	Population Size	Coefficient of Variation (C _v) Assumed 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	46,515	N/A ¹	N/A ¹	N/A ¹	N/A ¹	Difference-in- differences regression analysis of monthly ADC
Expansion Group	Received first home energy report in PY3	53,491	N/A ³	N/A ¹	N/A ¹	N/A ¹	Difference-in- differences regression analysis of monthly ADC
Program Total		100,006					

Table 5-3: Energy Efficiency Behavior & Education Program Sampling Strategy for PY3

NOTES:

This evaluation was done on a census of program treatment group and control group homes. As a result, the final savings 1. estimate is not subject to sampling error. 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, 2011.

The final estimation sample for the impact analysis included homes that opted out of the program, but omitted those whose accounts became inactive during the treatment period.¹⁸ **Table 5-4** shows the numbers of treatment and control group homes in the estimation sample.

	Legacy Group	Expansion
Treatment Group Homes	43,261	49,651
Control Group Homes	43,129	22,573
Total Homes ¹	86,390	72,224

NOTES:

 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 PY3. The EM&V CSP accounted for savings in months before the account became inactive in the homes with inactive accounts. See Appendix G.

5.2.3 Ex Ante Adjustments Methodology and Findings

The implementation CSP was responsible for calculating the *ex ante* savings estimates. Total *ex ante* savings in PY3 were 29,203 MWh/yr¹⁹ based on analyzing the bills of program treatment and control group homes.

There were no TRM adjusted *ex ante* 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 savings.²⁰ Billing analysis—using data on monthly average daily energy use in treatment group and control group homes before and after the treatment—was used to estimate the program savings. Separate regression analyses of legacy and expansion group homes were conducted.

¹⁸ In homes with accounts that became inactive, savings in months before the account become inactive were included in the estimate of program savings.

¹⁹ The implementation CSP reported legacy group savings of 13,687 MWh and expansion group savings of 15,516 MWh in PY3.

²⁰ 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.

The EM&V CSP employed difference-in-differences regression of monthly average daily electricity consumption with fixed effects to estimate the program energy savings. The details of the regression analysis are fully described in Appendix G: Additional Energy Efficient Behavior & Education Program Impact Analysis.

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

5.2.6 Summary of Evaluation Results

Table 5-5 shows the program realization rate in PY3. The implementation CSP reported *ex ante* program savings of 29,203 MWh/yr. The *ex post* verified savings were estimated as 29,370 MWh/yr, which implies a realization rate of 101% in PY3.

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted Ex Ante Gross Energy Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C _v) or Proportion	Relative Precision	Verified Net Energy Savings (MWh/yr)
All	29,203	29,203	100.6%	N/A ²	N/A²	29,370
Legacy Group	13,687	13,687	100.5%	N/A ²	N/A ²	13,760
Expansion	15,516	15,516	100.6%	N/A ²	N/A ²	15,610
Program Total ³	29,203 ³	29,203 ³	100.6%	N/A ²	N/A ²	29,370 ³

Table 5-5: PY3 Energy Efficiency Behavior & Education Program, Evaluation Results for Energy Savings¹

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. 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.

3. This is the value used in reporting program-wide energy savings. (Savings targets for MWh refer to values at the point of consumption.)

5.3 Impact Evaluation Net Savings

5.3.1 Net-to-Gross Ratio Methodology

There is not a NTG calculation separate from the estimate of program savings. 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, and thus this type of spillover was not accounted for.

5.4 Process Evaluation

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

5.5 Financial Reporting

A breakdown of the program finances is presented in Table 5-6.

	IQ (\$1,000)	РҮТД (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$0	\$0	\$0
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$0	\$0	\$0
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$756	\$1,137	\$2,095
Marketing ³	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$756	\$1,137	\$2,095
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$756	\$1,137	\$2,095
Participant Costs ⁵	N/A	\$0	\$0
Total TRC Costs ⁶	N/A	\$1,137	\$2,095
Discounted TRC Costs ⁷	N/A	\$1,137	\$1,872
Total Lifetime Energy Benefits	N/A	\$2,920	\$3,645
Total Lifetime Capacity Benefits	N/A	\$0	\$0
Total TRC Benefits ⁸	N/A	\$2,920	\$4,153
Discounted TRC Benefits	N/A	\$2,920	\$3,645
TRC Ratio ⁹	N/A	2.57	1.95

Table 5-6: Summary of Energy Efficiency Behavior & Education Program Finances

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 to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC Costs includes Total EDC Costs and Participant Costs.
- For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 Discounted TRC Benefits divided by Total Discounted TRC Costs.

6 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 include:

- 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 savings.

6.1 Program Updates

In PY3, the Efficient Equipment Incentive Program added the direct discount delivery channel for small commercial customers in PY3 Q2. Under this option, trade allies recruit customers, install efficient lighting equipment, and apply for incentives directly from PPL Electric. The direct discount delivery path targets small C&I and GNI customers. The traditional standard delivery option, where the customer is responsible for preparing and submitting incentive applications, was maintained in PY3.

In PY3, PPL Electric began promoting measures with limited time offers in order to improve participation among the small C&I sector. In addition, rebates for ductless heat pumps were added and faucet aerators were removed from the program.

6.2 Impact Evaluation Gross Savings

6.2.1 Reported Gross Savings

Table 6-1 shows the cumulative reported results by sector through the end of PY3.. **Table 6-2** breaks out the program's PY3 participation, savings, and incentives paid by quarter. **Table 6-1** and **Table 6-2** include all program measures, that is, both lighting and non-lighting measures.

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ² (\$1,000)
Residential	169,645	55,852	8.11	\$14,094
Small Commercial and Industrial	9,368	213,314	52.84	\$32,332
Large Commercial and Industrial	491	117,212	16.91	\$4,792
Government, non-profit, and institutional	4,482	81,594	18.62	\$3,075
CPITD Total ³	183,986	467,972	96.48	\$54,293

Table 6-1: CPITD Efficient Equipment Incentive Program¹ Reported Results by Sector

NOTES:

1. The results in this table include both the lighting and non-lighting mesures' results.

2. Includes \$376,006 of incentives paid out through the Efficient Equipment Program, but the savings have been counted towards the Home Assessment & Weatherization Program. PPL Electric is looking into changing this allocation for PY4.

^{3.} Summing the sector level reported gross savings will not equal the program level savings; these totals differ by 2 MWh/yr. The difference is due to a change in the data tracking and reporting method from PY2 to PY3.

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ² (\$1,000)
PY3 Q1	16,092	66,169	12.67	\$9,257
PY3 Q2	1,707	69,569	20.68	\$7,299
PY3 Q3	19,623	42,150	8.46	\$4,228
PY3 Q4	5,734	47,711	9.98	\$4,853
PY3 Total	43,156	225,599	51.78	\$25,637
CPITD Total	183,986	467,970	96.47	\$54,293

 Table 6-2: PY3 Efficient Equipment Incentive Program¹ Reported Results by Quarter

NOTES:

1. The results in this table include both the lighting and non-lighting results.

2. Includes \$376,006 of incentives paid out through the Efficient Equipment Program, but the savings have been counted towards the Home Assessment'& Weatherization Program. PPL Electric is looking into changing this allocation for PY4.

PPL Electric launched the direct discount delivery channel during PY3. The impact of this program delivery channel is summarized in **Table 6-3**. Note that since this channel is a part of Efficient Equipment Incentive Program lighting, its savings are included in the lighting impact figures throughout this report.

Savings Type	Reported Gross Savings	Adjusted <i>Ex Ante</i> Savings	Energy Realization Rate	Relative Precision	Verified Gross Energy Savings
Energy (MWh/yr)	21,802	21,802	103%	12.45%	22,394
Demand (MW)	4.88	4.88	97%	20.07%	4.75
NOTES: 1. Direct discount	savings are included	in the commercial light	ting savings totals pre	sented elsewhere in th	is section.

Table 6-3: Direct Discount Delivery Channel Energy and Demand Savings¹

6.2.2 EM&V Sampling Approach

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

The strata definitions for the residential and non-residential sectors are defined in Table 6-4.

Sector	Stratum	Measure Groups Included			
	Large	Commercial lighting			
Non-residential	Medium	Commercial refrigeration and motors			
	Small	HVAC, appliances, office equipment, other			
· · · · · · · · · · · · · · · · · · ·	Large	HVAC (ASHP, CAC, Room AC, programmable thermostats)			
Residential	Medium	Appliances, HPWH			
	Small	RTS, commercial refrigeration, office equipment, other			

Table 6-4: Strata Definitions

6.2.3 Sampling Approach: Non-lighting Measures

The sampling strategy for these strata is shown in **Table 6-5**. Batch sampling was applied to maximize resources. The sample plan for PY3 was based on the final number of measures installed in PY2, along with respective *ex post* verified savings and the coefficient of variation (C_v) . The EM&V sample plan assumed a C_v of 0.5, and aimed for 85/15 C/P by strata and program. A stratified ratio approach was used for separate samples in the residential and non-residential sectors (as defined in **Table 6-4**).

- For residential records, 50% of the sample was drawn from the large stratum, 30% from the medium stratum, and 20% from the small stratum.
- For non-residential measures, lighting makes up the largest stratum and is discussed separately below. Within the non-lighting sample, 80% of the sample was drawn from the medium stratum and 20% from the small stratum.

Stratum	Sector Boundaries	Population Size	Error Ratio Assumed in Sample Design	Target Levels of C/P	Target Sample Size	Achieved Sample Size	Evaluation Activity
Residential	Residential customers	37,613	0.5	90/10 at sector	70	79	Records Review
					70	99	Surveys
Non- residential non-lighting	Small C&I, Large C&I, GNI customers with non-lighting projects	9,570	0.5	85/15 in each of two strata (medium and small)	50	50	Records
					50	49	Surveys
					50	53	Site Visits

Table 6-5: Efficient Equipment Incentive Program Non-Lighting Sampling Strategy for PY3

6.2.4 Sampling Approach: Non-Residential Lighting

The EM&V CSP used a stratified ratio approach for the Efficient Equipment Incentive Program nonresidential lighting. Commercial lighting is the largest stratum in the Efficient Equipment Incentive Program, and contributes the majority of savings to the program and portfolio. Because there is large variation in project size and associated savings, this stratum was again divided into three strata.

The sampling approach used the following procedure:

- 1. Using the previous year's C_v of 0.55, determine the sample size needed to report results at the 90/10 C/P level.
- 2. Sort all projects in the sample frame from largest to smallest kWh/year savings.

- 3. Define three strata; large, comprising of the largest projects in the sorted list that account for 50% of the savings; medium, the next projects in the list accounting for the next 30% of savings; and small, the remaining projects accounting for the last 20% of savings.
- 4. Draw 50% of the sample from the large stratum, 30% from the medium, and 20% from the small.

The sampling strategy for the Efficient Equipment Incentive Program non-residential lighting is shown in **Table 6-6** below.

Non- Residential Lighting Stratum	Strata Boundaries	Population Size	Assumed Error Ratio	Precision Target (90% conf.)	Target Sample Size	Achieved Sample Size	Evaluation Activity
Large	Largest Projects, 50% of Savings	272	0.55	10%	61	61	Site visit, file review, some metering
Medium	Medium Projects,, 30% of savings	659	0.55	15%	35	35	Site visit, file review, some metering
Small	Small Projects, 20% of Savings	2,467	0.55	20%	24	24	Site visit, file review, some metering
Non- Residential Lighting Total		3,398	0.55	10%	120	120	

Table 6-6: Efficient Equipment Incentive Program Non-Residential Lighting Sampling Strategy for PY3

6.2.5 Program Measurement and Verification Methodology

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. A sample of non-residential measures was also verified 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, EEMIS reported savings were adjusted 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 savings 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 and installed equipment, and relies solely on information in the EEMIS tracking database.

 Second, additional adjustments were made to the TRM-adjusted *ex ante* savings to compute the verified *ex post* savings. These adjustments reflect the results of M&V activities and account for such things as systems information (efficiency, tonnage, and features), installation rates, and equipment qualifications collected through surveys, site visits, and records reviews.

Measurement and Verification: Non-Residential Lighting Measures

The M&V activities for non-residential measures included in the sample were:

- 1. Reviewing application files for data accuracy and compliance with TRM requirements.
- 2. Conducting on-site reviews at customer facilities of a sample of the lighting equipment contributing to the application savings to determine the as-built condition for the project.
- 3. Conducting metering studies or interval data analysis at selected facilities to determine actual lighting operating hours.
- 4. Conducting interviews with customers to determine baseline and retrofit fixtures and estimate operating hours.
- 5. Based on the findings from the previous steps, revising the 2011 TRM's Appendix C inventory to re-calculate the application savings; this is 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 ±50% of the TRM value.

Metering studies are planned to report results within a building at the 90/20 C/P level, and use a stratified sample approach to select lines in a building's lighting inventory for meter placement. *Ex post* savings are always based on metering studies when the data are available. In PY3, the EM&V CSP metered operating hours for nine projects out of a sample size of 120 projects.

6.2.6 Ex Ante Adjustment Methodology

Ex Ante Adjustment Methodology: Non-Lighting Measures

Ex ante savings reported in EEMIS were updated wherever possible based on actual participation captured in EEMIS. These adjustments account for TRM savings calculations that vary by location, configuration, hot water fuel, or equipment information such as size or efficiency. In addition, these updates account for any updates in savings calculations made to the TRM since PPL Electric's plan was approved, including changes to TRM algorithms. These adjustments are based solely on information provided by participants and reported in EEMIS, such as ZIP codes (for location adjustments),

manufacturer and model information, and water heating fuel type or capacity. In instances where the participants did not provide this information, a weighted average savings was calculated using inputs from the participants who did provide the information.

To accurately capture the savings associated with high-efficiency gas furnaces, a billing analysis was conducted for the census of RTS customers who received rebates for that measure in PY2. The average savings from customers in PY2 was applied to the PY3 customers as the *ex ante* adjustment value.

Thermostats in non-residential settings were assigned zero savings during the TRM adjusted *ex ante* review, as they are not in the TRM.

For residential systems, the rebate form for thermostats did not capture the heating system type. Therefore, the residential appliance saturation survey data was used to determine the number of customers who have heat pumps, as these systems do not have heating savings. An average savings, weighted by heating system type, was applied across all residential customers who received the rebate.

Table 6-7 outlines the factors adjusted using EEMIS reported information in calculating TRM-adjusted *ex ante* savings. All records were assigned an *ex ante* adjusted savings.
Measure	Factors
Room Air Conditioners	Location (EFLH)
Central Air Conditioning	Location (EFLH), Capacity, SEER, EER
Air Source Heat Pump	Location (EFLH), Capacity, SEER, EER, HSPF/COP
(DX) Packaged AC	Location (EFLH), Capacity, EER
Ductless Heat Pumps	Location (EFLH), Capacity, SEER, EER, HSPF, Room
Water-Cooled Chiller	Location (EFLH), Capacity, Efficiency (kW per Ton)
Programmable Thermostats	Location (EFLH), Sector, Heating system type
RTS Fuel Switching – Gas Furnace	Deemed savings based on PY2 billing analysis results
ENERGY STAR Refrigerators	Configuration (location of freezer compartment)
ENERGY STAR Clothes Washers	Water heating fuel
ENERGY STAR Light Fixtures	Fixture type
LED Traffic Light	Fixture type
ENERGY STAR Dishwashers	Water heating fuel
ENERGY STAR Dehumidifier	Pints per day
Heat Pump Hot Water Heaters	Energy Factor
ENERGY STAR Computers	None (deemed savings value)
ENERGY STAR Monitors	None (deemed savings value)
ENERGY STAR Fax	None (deemed savings 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

Table 6-7: Summary of Ex Ante Adjustments to Reported Savings

For some measures, there is no additional information available in the EEMIS tracking database that can be used to update calculated savings. For those measures, all adjustments were made to the *ex post* savings. Such measures include motors, variable frequency drives (VFDs), and large commercial HVAC.

Ex Ante Adjustment Methodology: Non-Residential Lighting Measures

The EM&V CSP did not make any *ex ante* adjustments to the Efficient Equipment Incentive Program non-residential lighting measures in PY3.

6.2.7 Ex Post Adjustment Methodology

Ex Post Adjustment Methodology: Non-Lighting Measures

The realization rates for all measures incorporate installation rates, adjustments for non-qualifying equipment, and adjustments for equipment details determined through the records reviews, surveys, and site visits.

The records reviews involved verifying information from EEMIS using rebate application forms, customer-submitted supporting documentation, implementation 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 for all equipment. Records reviews were also used to verify whether the rebated measure qualified for the program. This uncovered several instances where a customer received a rebate for a measure other than what was purchased and installed. For example, in one instance, EEMIS recorded that a customer received a rebate for a room air conditioning, but the rebate form showed that the customer actually purchased a refrigerator. The realization rate reflects these issues. While all sampled records were reviewed for quality assurance purposes, only records reviewed with valid TRM-adjusted *ex ante* savings were used in calculating the final realization rate.

Over the course of PY3, the EM&V CSP conducted site visits of a sample of non-residential customers for verification purposes. These site visits, along with records reviews, confirmed open variables necessary for calculating savings. In a separate sample, telephone surveys were used to verify the number of units installed and the addresses where the units were installed. For selected measures, information about open variables was also collected through surveys.

Table 6-8 shows a summary of elements verified or validated for each measure as part of records verification, in addition to installation and qualification rates.

Measure	Record Verified Elements	Survey Verified Elements	Site Visit Verified Elements ¹
Central Air Conditioners	SEER, capacity (tons), EER	SEER, capacity (tons), building type	SEER, capacity (tons), building type
Air Source Heat Pumps	SEER, capacity (tons), HSPF	SEER, capacity (tons), HSPF, building type	SEER, capacity (tons), HSPF, building type
Heat Pump Water Heaters	Energy factor	Energy factor	
Room Air Conditioners	ENERGY STAR qualified		ENERGY STAR qualified
DX) Packaged AC Capacity (tons), EER EER, capacit		EER, capacity (tons), building type	EER, capacity (tons), building type
Water-Cooled Chiller	/ater-Cooled Chiller Capacity (tons), Efficiency (kW (per ton)		Capacity (tons), Efficiency (kW per ton), building type

Table 6-8: Summary of Verification Elements

Measure	Record Verified Elements	Survey Verified Elements	Site Visit Verified Elements ¹
ENERGY STAR Lighting	ENERGY STAR qualified, fixture type, Watts	Fixture type	ENERGY STAR qualified, fixture type, Watts
ENERGY STAR Dehumidifiers	ENERGY STAR qualified, pints per day		ENERGY STAR qualified, pints per day
ENERGY STAR Clothes Washers	ENERGY STAR qualified, hot water fuel type	Hot water fuel type	ENERGY STAR qualified, hot water fuel type
ENERGY STAR Dishwashers	ENERGY STAR qualified, hot water fuel type	Hot water fuel type	ENERGY STAR qualified, hot water fuel type
Programmable Thermostats	Heating fuel	End-uses controlled, heating fuel	
ENERGY STAR Refrigerators	ENERGY STAR qualified, configuration		ENERGY STAR qualified, configuration
ENERGY STAR Office Equipment	ENERGY STAR qualified, fixed value or images per minute		ENERGY STAR qualified, fixed value or images per minute
ENERGY STAR Ice Makers	ENERGY STAR qualified, ice harvest rate, compressor types		ENERGY STAR qualified, ice harvest rate, compressor types
LED Traffic Light	Fixture type		Fixture type
Motors and VFDs	Horsepower, efficiency, motor type (ODP/TEFC), operating hours	Horsepower, efficiency, motor type (ODP/TEFC), operating hours	Horsepower, efficiency, motor type (ODP/TEFC), operating hours
Commercial Refrigeration Measures	Volume, horsepower, case length, case type (refrigerator/freezer), tonnage	Case type, door type, tonnage, horsepower, size, fan motor information	Volume, horsepower, case length, case type, door type, tonnage, horsepower, size, fan motor information
ENERGY STAR Office Equipment	ENERGY STAR qualified , images per minute (where applicable)		ENERGY STAR qualified , images per minute (where applicable)
Commercial HVAC			Full-load and part-load efficiency, building type
Ductless Heat Pumps	SEER, capacity (tons)	SEER, capacity (tons)	SEER, capacity (tons), indoor and outdoor unit information
NOTES:	·	I <u></u>	
1. Site visits only verify	y non-residential measures		

Ex Post Adjustment Methodology: Non-Residential 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

In addition, applicants sometimes used the wrong version of the TRM Appendix C: PA Lighting Inventory Form, which can introduce errors in the savings calculations.

The largest factors affecting the Efficient Equipment Incentive Program non-residential lighting realization rate are discrepancies in annual operating hours (EFLH). The discrepancies appear to occur because of misunderstanding the TRM (selecting the wrong building type), misapplying the TRM (selecting different building types to populate usage group hours), and ignoring the TRM (using the applicant's best guess for true hours). There is some evidence that over time, the applicants are reducing the error in EFLH values. **Table 6-9** line 4 shows that the ratio of reported to TRM hours has declined each quarter in PY3 and is now 109% on an annual basis.

While the EM&V CSP uses the TRM hours-of-use (except when metering), there is some evidence that these understate actual hours. Line 5 in **Table 6-9** indicates that the TRM hours-of-use values are underreporting true values by 5% to 13%.

		Q1	Q2	Q3	Q4	Annual
1	Reported Hours	5,211	6,307	5,864	4,244	5,456
2	EM&V Estimate Hours	4,457	6,101	5,945	4,657	5,271
3	TRM Hours	4,258	5,763	5,278	4,782	5,020
4	Reported/TRM	122%	109%	111%	89%	109%
5	EM&V/TRM	105%	106%	113%	97%	105%

Table 6-9: MWh-Weighted Average Lighting Hours of Use, Standard Path Lighting Projects

6.2.8 Savings Realization Rate Methodology

Using information and data collected from site visits, file reviews, interviews, posted schedules, and in some case hourly meter data, the EM&V CSP developed verified savings for each project in the evaluation sample. The ratio of the EM&V CSP savings to the program reported savings for the sample of projects is the program realization rate. *Ex post* savings were determined by multiplying *ex ante* savings by the realization rate.

6.2.9 Summary of Evaluation Results

The following tables summarize the realization rate for each stratum, 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 6-10** provides energy savings estimates by measure group. Demand savings are provided in **Table 6-11** and **Table 6-12**.

Stratum	Reported Gross Savings (MWh/yr)	Adjusted Ex Ante Savings (MWh/yr)	Energy Realization Rate	Relative Precision (85% conf.)	Verified Gross Savings (MWh/yr)
Residential Small	2,439	2,741	103.4%	1.7%	2,834
Residential Medium	8,960	7,493	98.3%	2.7%	7,364
Residential Large	1,874	4,505	99.6%	2.5%	4,487
Non-residential Non-lighting Small	1,639	1,320	65.2%	18.0%	860
Non-residential Medium	6,156	6,659	100.9%	19.0%	6,718
Non-residential Large (Lighting) ²	204,530	204,530	95.0%	3.6%	194,357
Program Total ³	225,599	227,248	95.3%	3.28%	216,620

Table 6-10: PY3 Efficient Equipment Incentive Program Energy Savings by Measure Group¹

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. The relative precision for the non-residential lighting stratum at 90% confidence is 4.1%.

3. The program level relative precision at 90% confidence is 3.75%.

		-	•			
Savings Type	Reported Gross Reduction (MW)	Adjusted Ex Ante Gross Reduction (MW)	Demand Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Total Program Savings at Meter	51.78	53.45	92.0%	76%	3.8%	49.17 ¹
Total Program Savings at Generator ²	51.78 ¹	57.89 ¹	92.0%	76%	3.8%	53.26 ²

Table 6-11: PY3 Efficient Equipment Incentive Program Evaluation Results for Demand Reduction

NOTES:

1. This is the total demand reduction obtained by adding sector level estimates. The value obtained by adding measure level estimates differs slightly. See discussion in the previous section.

2. This is the value used in reporting program-wide demand savings since it refers to MW at the point of generation. (Savings targets for MW refer to values at the point of generation.)

Stratum	Reported Gross Reduction (MW)	Adjusted Ex Ante Reduction (MW)	Demand Realization Rate	Relative Precision (85% conf.)	Verified Gross Reduction (MW)
Residential Small	0.201	0.221	104.8%	2.3%	0.231
Residential Medium	1.354	1.221	97.7%	5.3%	1.193
Residential Large	1.212	2.058	36.4%	77.4%	0.750
Non-residential Non-lighting Small	0.607	0.654	74.0%	17.5%	0.484
Non-residential Medium	0.531	1.423	96.5%	26.7%	1.374
Non-residential Large (Lighting) ²	47.875	47.875	94.3%	3.4%	45.150
Program Total ³	51.780	53.452	92.0%	3.3%	49.181
		·			

Table 6-12: PY3 Efficient Equipment Incentive Program Demand Reduction by Measure Group¹

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. The relative precision for the non-residential lighting stratum at 90% confidence is 3.86%.

3. The program level relative precision at 90% confidence is 3.78%.

Summary of Evaluation Results: Non-lighting Measures

A summary of the factors impacting the realization rates for each measure group is provided below.

<u>Appliances</u>

Appliances are part of the residential medium stratum and the non-residential small stratum. Verification of appliances primarily consisted of records reviews to validate the quantity, verify qualification, and determine the configuration of the appliances. Surveys were used to determine the water heating fuel types for dishwashers and clothes washers, while also verifying the quantity and installation rate. These adjustments had a minor impact on the realized savings for the majority of measures. However, in the case of clothes washers, 35 records that were reported to have an electric water heater (out of 60 that were verified) were found to have a gas or other type of water heater, which reduced the savings.

<u>HVAC</u>

HVAC equipment is in the residential large stratum and the non-residential small stratum. HVAC realization rates reflect the impact of verified SEER and EER, capacity, and heating seasonal performance factor (HSPF) adjustments. For non-residential customers, the commercial building type was also determined through records reviews, site visits, or surveys. Manufacturer and model numbers were referenced in the AHRI database to verify capacity and efficiency values.

Commercial Refrigeration

Commercial refrigeration measures are in the non-residential medium stratum. For commercial refrigeration measures, verification consisted of reviewing the volume, horsepower, case length, case type, door type, tonnage, horsepower, size, and fan motor information when this data was available. The EM&V CSP researched the manufacturer and model number online, as it is not provided in EEMIS and not consistently provided in the records. When this information was available online, the algorithms in the TRM were used to calculate savings. *Ex post* savings for commercial refrigeration measures vary widely from the *ex ante* savings, but it is not possible to identify why the savings differ since the records do not contain savings calculations.

Motors/VFDs

Motors and VFDs are in the non-residential medium stratum. For motors, verification consisted of a review of horsepower, efficiency, motor type (ODP/TEFC), and operating hours. Two motors projects and four VFD projects were verified (projects can include more than one motor or VFD). During the site visit for one project, the efficiency of the motors was found to be lower than documented. For a second project, the facility received a rebate for two motors and two VFDs. The EM&V CSP reduced the hours-of-use for one of the two motors, because both were serving the same load and one motor was only used during peak demand.

For one of the verified VFD projects, the hours were listed as office, but the facility was a school. The efficiency of the installed VFD was lower than listed, and one VFD was used as backup in a duplex instead of single configuration. For another VFD project, the verified savings were zero because the site visit revealed that the customer had replaced a VFD, and it was not a new application of a VFD. Another VFD project was a unique application of VFDs for which operating hours were not specified in the TRM. *Ex post* savings were based on operating hours reported by the facility during the site visit.

Office Equipment

Office equipment is in the residential and non-residential small stratum. Verification consisted of reviewing the quantity, qualification, and variables used in the TRM for calculating savings, such as images per minute for copiers, printers, and scanners. Overall, these adjustments had a minor impact on the realization rate.

Other Non-Lighting Measures

The remaining measures include ENERGY STAR indoor light fixtures, LED traffic lamps, heat pump water heaters, and ice makers. Most of these measures are in the residential and non-residential small strata, except for ice makers which are in the non-residential medium stratum. Verification consisted of reviewing quantity and qualification. Review of ENERGY STAR indoor light fixtures and LED traffic lamps also consisted of validating the fixture type, while review of heat pump water heaters validated the

energy factor and review of ice makers validated ice harvest rate and compressor type. Overall, these adjustments had a minor impact on the realization rate.

Summary of Evaluation Results: Non-Residential Lighting Measures

The evaluation results for the Efficient Equipment Incentive Program non-residential lighting are summarized in **Table 6-13** and **Table 6-14**. The calculations for the annual realization rates and savings, as well as the statistical metrics, follow the procedures described in *The California Evaluation* Framework²¹. The Framework recommends using an error ratio in lieu of a CV, as shown in the tables that follow.

Table 6-13: PY3 Efficient Equipment Incentive Program Detailed Results for Non-Residential Lighting
Energy Savings ¹

Stratum	Reported Gross Savings (MWh/yr)	Adjusted <i>Ex Ante</i> Savings (MWh/yr)	Energy Realization Rate ²	Observed Error Ratio ²	Relative Precision (90% conf.) ²	Verified Gross Savings (MWh/yr)
Large	102,265	102,265	NA ²	NA ²	NA ²	97,155
Medium	61,359	61,359	NA ²	NA ²	NA ²	58,293
Small	40,906	40,906	NA ²	NA ²	NA ²	38,862
Program Total	204,530	204,530	95%	0.34	4%	194,311

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.

²¹ TecMarket Works, et al. The California Evaluation Framework, 327-559. Southern California Edison, 2004.

Stratum	Reported Gross Reduction (MW)	Adjusted Ex Ante Reduction (MW)	Demand Realization Rate ²	Observed Error Ratio ²	Relative Precision (90% conf.) ²	Verified Gross Reduction (MW)
Large	23.94	23.94	NA	NA	NA	22.59
Medium	14.36	14.36	NA	NA	NA	13.55
Small	9.57	9.57	NA	NA	NA	9.03
Non-Residential Lighting Total	47.87	47.87	94%	0.69	4%	45.17

 Table 6-14: PY3 Efficient Equipment Incentive Program Detailed Results for Non-Residential Lighting

 Demand Reduction¹

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 Evoluation 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.

6.3 Impact Evaluation Net Savings

6.3.1 Net-to-Gross Ratio Methodology

The NTG ratio was determined through self-report surveys with a sample of participants. The EM&V CSP conducted four separate surveys with: residential participants; direct discount delivery channel participants; non-residential lighting participants; and non-residential non-lighting participants. The surveys included spillover and freeridership questions.

6.3.2 Freeridership Methodology

The freeridership battery of survey questions was tailored to fit the measures installed by participants of the Efficient Equipment Incentive Program. These questions were used to develop a freeridership score through a scoring matrix. More detail about the freeridership analysis and the scoring matrix is included in Appendix E: Net-to-Gross Analysis. No adjustments for the NTG ratio were applied to savings, as specified by the PA PUC. Information obtained by computing the NTG ratio will be used only to refine and improve program delivery.

6.3.3 Spillover Methodology

Spillover refers to reductions in energy consumption or demand caused by the presence of and participation in the energy efficiency program. These are savings beyond those achieved by participants in the program for the rebated measures installed. Participant spillover refers to the participants' installation of measures in addition to those incented by the program, where the program influenced participants to install the additional measures.

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. More detail about the spillover analysis is included in Appendix E: Net-to-Gross Analysis.

6.3.4 Net-to-Gross Ratio Findings

Table 6-15 shows the results of a freeridership analysis for the Efficient Equipment Incentive Program based on a sample of participants in each of four groups. Residential survey responses were used for an overall program-sector estimate, while non-residential customers were analyzed in three separate groups. The first non-residential group includes customers who received incentives for commercial lighting projects, the second group includes customers who participated in the direct install delivery channel, and the third non-residential group includes all other non-residential participants.

Participant Group	Respondents	Freeridership Score
Residential	99	35%
Non-residential (lighting)	71	19%
Non-residential (Direct Discount)	49	10%
Non-residential (non-lighting)	49	72%

Table 6-15: Summary of Freeridership Scores in the Efficient Equipment Incentive Program

A key driver of the high freeridership for the non-residential non-lighting group is the four respondents who installed variable speed drives (VSDs): two were 100% free-riders and two were 50% freeriders. The savings for VSDs represented 92.3% of the total non-lighting survey respondent program savings.

6.3.5 Spillover Findings

The analysis of responses yielded an overall score of 0.1% for residential spillover and 0.0% for nonresidential spillover. The summary of NTG results is presented in **Table 6-16**. The residential and nonresidential (non-lighting) analyses were calculated at the 90% confidence level.

Participant Group	Respondents	Freeridership Score	Participant Spillover ¹	NTG	NTG Precision
Residential	99	35%	0.1%	65%	± 5%
Non-residential (non-lighting)	49	67%	0.0%	33% ²	± 7%
Non-residential (Direct Discount)	49	10%	0.0%	90% ²	± 6%
Non-residential (lighting)	71	19%	0.0%	81% ²	± 5%
NOTES:	·	·······			•
1. Spillover was only identified in	the residential se	ctor.			
2. Results weighted by program e	energy savings.				

Table 6-16: Summary of NTG for Efficient Equipment Incentive Program

Details of the freeridership and spillover analyses are presented in Appendix E: Net-to-Gross Analysis.

6.4 Process Evaluation

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

6.5 Financial Reporting

A breakdown of the program finances is presented in Table 6-17.

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	IQ (\$1,000)	РҮТД (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants ¹	\$4,853	\$25,637	\$54,293
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$4,853	\$25,637	\$54,293
Design & Development	\$0	\$0	\$0
Administration ²	\$0	\$0	\$0
Management ³	\$1,620	\$6,206	\$7,045
Marketing ⁴	\$6	\$1	\$31
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$1,626	\$6,207	\$7,076
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁵	\$6,479	\$31,844	\$61,369
Participant Costs ⁶	N/A	\$73,116	\$160,312
Total TRC Costs ⁷	N/A	\$104,961	\$221,680
Discounted TRC Costs ⁸	N/A	\$104,961	\$198,452
Total Lifetime Energy Benefits	N/A	\$228,629	\$398,553
Total Lifetime Capacity Benefits	N/A	\$17,342	\$28,348
Total TRC Benefits ⁹	N/A	\$245,970	\$480,215
Discounted TRC Benefits	N/A	\$245,970	\$428,621
TRC Ratio ¹⁰	N/A	2.34	2.16

Table 6-17: Summary of Efficient Equipment Incentive Program Finances

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.

- Costs that occurred prior to PY3 Q4 are treated as incentives. All costs that occurred after PY3 Q4 are treated as management costs.
- 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.
- Per the 2011 Total Resource Cost Test Order, the net-participant costs are the costs to the end-use customer (net participant costs = full/incremental-cost minus incentives).
- 7. Total TRC Costs includes Total EDC Costs and Participant Costs.
- 8. For the PY.TD column, 'both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 DiscountedTRC Benefits divided by Total Discounted TRC Costs.

7 E-Power Wise Program

The E-Power Wise Program provides low-income customers with energy efficiency education to enable them to make informed energy use choices. 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 E-Power Wise Program claimed savings for the first time in PY2 Q3.

The program uses a train-the-trainer model, where 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, 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 objectives of the E-Power Wise Program include:

- 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; and
- Obtain participation by 9,048 customers and achieve energy savings of 4,268 MWh/yr.

7.1 Program Updates

PPL Electric introduced a new, direct mail delivery channel to customers in PY3 Q4. This alternative delivery method enables eligible customers to receive an energy savings kit directly from the implementation CSP. Program goals were increased in anticipation of participants entering through the direct mail delivery channel.

7.2 Impact Evaluation Gross Savings

7.2.1 Reported Gross Savings

Table 7-1 shows the cumulative reported results through the end of PY3.

Sector	Participants (Households receiving kits)	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Low-Income	6,743	3,347	0.62	\$429
Program Total	6,743	3,347	0.62	\$429

Table 7-1: CPITD E-Power Wise Program Reported Results by Sector

Table 7-2 shows the program participation and reported gross savings by quarter for PY3.

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000) ¹
PY3-Q1	599	334	0.08	\$42
PY3 Q2	644	408	0.09	\$37
PY3 Q3	221	133	0.03	\$0
PY3 Q4	1,229	735	0.18	\$0
PY3 Total	2,693	1,610	0.38	\$79
CPITD Total	6,743	3,347	0.62	\$429

Table 7-2; PY3 E-Power Wise Program Reported Results by Quarte	Table 7-2: PY3	E-Power Wise	Program Repo	rted Results b	v Quarter
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 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.

7.2.2 EM&V Sampling Approach

The EM&V methodology includes records verification and surveys. Sampling to meet EM&V requirements was designed to meet a target of 90/10 C/P for all programs in the low-income portfolio. Discussion on the sample sizes used for records verification activities and participant surveys are provided below.

Record Review Sample Sizes

The sampling strategy for the E-Power Wise Program QA/QC records reviews is presented in Table 7-3.

Stratum	Strata Boundaries ¹	Population Size	C _v Assumed in Sample Design	Target Levels of C/P	Target Sample Size	Achieved Sample Size	Evaluation Activity
Agency-based Records Review	N/A	2,109	0.5	90/10	70	70	Process and Impact
Direct-mail Records review	N/A	584	0.5	90/10	70	70	Process and Impact
EEMIS Records Review	N/A	2,693	N/A ²	N/A ²	Census	Census	Process and Impact
Program Total	N/A	2,693	N/A ²	90/10	70 ³	70 ³	Process and Impact

Table 7-3: E-Power Wise Program Sampling Strategy for PY3

1. Since the E-Power Wise Program has a single fixed participation level, stratification was not used for this program's evaluation.

2. Variability and precision targets are not relevant for census reviews.

3. The target for the two surveys was 70 participants. This target does not include the census review of EEMIS records.

The EM&V CSP conducted a QA/QC review of a random sample of 70 CBO agency-based participant enrollment forms from PY3 Q1-Q3, and of 70 direct mail participant enrollment forms in PY3 Q4 (with 90/10 C/P). The EM&V CSP also conducted quarterly records reviews comparing the implementation CSP's electronic database with EEMIS, as described in the program EM&V methodology.

To verify behavior changes associated with the program, the EM&V CSP conducted telephone surveys with a random sample of 66 participants who entered the program through the direct mail delivery channel. Additionally, the census of participant kit surveys that were returned (361 total) were included in the analysis.

Survey Sample Sizes

Two surveys were conducted in PY3 to gather the data to complete the engineering calculations. These were:

- 1. Participant kit surveys (written surveys) sent home with the participants as part of the kit and returned to the implementation CSP throughout the year.
- 2. Participant surveys conducted by phone with participants who enrolled in the program through the direct mail delivery channel.

All of the kit surveys returned by PY3 participants were included in the program evaluation. Phone surveys were conducted with a random sample of 66 customers who participated in the direct mail delivery channel, meeting a 90/10 C/P. This sample was achieved by providing the survey firm with a randomized list of participants to call from each group. **Table 7-4** presents the delivery method, sample size, and functions of each of the surveys used in this evaluation.

					Impac	t Evaluation	
Survey	Survey Delivery Method Frequency		Sample Size	Process Evaluatio n	Measure Installation Energy Savings	Behavior Change Energy Savings	
Agency-based Participant Kit	included in kit	All quarters	252 (all)	Yes	Yes	No	
Direct-mail Participant Kit	Included in kit	All quarters ¹	109 (all)	Yes	Yes	No	
Direct-mail Participant ²	Phone	PY3 Q4	66	Yes	No	Yes – Direct-mail delivery channel only	

Table 7-4: Survey Data Collection for E-Power Wise Program

IUTES:

1. The direct-mail delivery channel became available to participants in Q4.

2. Agency-based participant phone surveys were conducted one time in PY2. Behavior change energy savings calculated from PY2 agency-based participant surveys are used for PY3 and PY4 annual reports.

7.2.3 Ex Ante Adjustment Methodology and Findings

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

- 1. The first, which adjusts the reported savings (presented in Table 7-5) from EEMIS to the savings specified in the TRM, results in adjusted *ex ante* savings.
- 2. The second adjustment incorporates the results of the program's QA/QC records reviews, the measure installation rate, and behavioral change findings from the returned surveys and telephone surveys, 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 results from each adjustment are reported separately.

The TRM *ex ante* adjustment modifies the savings reported in EEMIS (reported *ex ante* savings) based on actual kit measure characteristics. This adjustment accounts for differences between planning *assumptions and the equipment that was actually distributed to participants, and brings the reported* savings into alignment with the TRM. The results of this adjustment to the population are the adjusted *ex ante* savings, and are used to determine the program's realization rate.

 Table 7-5 shows the results of the TRM-adjusted ex ante calculations for the seven measures included in each kit.

		Reported Ex Ante Savings (kWh/yr)						Adjusted Ex Ante							
Sector	Measure		21	Q2		23	Q4	Savings (kWh/yr)	Factors						
	Energy Education	1	81	181	181	146 ¹	146	146	Behavior-based CMP.						
1	Faucet Aerator Bath	45 61 ²		61	61		61		61		61 61		61	61	2011 TRM value (1.5 gpm) ⁴
	Faucet Aerator – Kitchen	45	61 ³	61	61		61	61	2011 TRM value (1.5 gpm) ⁴						
Low- Income	Low-flow Showerhead	47	2175	217	217		217	231	2011 TRM adjusted value (2 gpm) ⁵						
	CFL 15W	41		41		11	41	40	2011 TRM adjusted value (15W CFL)						
	CFL 20W	ţ	50	50	50 5		50		50	49	2011 TRM adjusted value (20W CFL)				
	Electroluminescent Nightlight	20	22	22	22		22		22	26	2011 TRM value of 26 kWh/unit				

Table 7-5: Reported and Adjusted Ex Ante Savings per Technology and per Unit

1. The deemed savings value changed in EEMIS in Q3. A change order for this component was made in January 2012. The adjusted savings was made effective for installations on or after June 2011.

2. The deemed savings value changed in EEMIS in Q1. The deemed savings in EEMIS was updated to reflect the 2011 TRM.

3. The deemed savings value changed in EEMIS in Q1. The deemed savings in EEMIS was updated to reflect the 2011 TRM.

4. The kitchen and bath aerators have rated gpms (kitchen = 2.0 gpm, bath = 1.0 gpm) that differ from the gpm provided in the 2011 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).

5. An adjustment was made to the 'GPMIow' variable of the calculation provided in the TRM for calculating low-flow showerhead energy savings. The TRM assumed a GPMIow 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.

7.2.4 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 record review activities. Second, this adjustment modifies the savings to reflect the installation rates determined through the participant returned surveys, and the behavior savings determined through participant phone surveys.

QA/QC Records Review

The EM&V CSP derived the QA/QC final PY3 realization rate from a review of all PY3 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 only counting 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 databases and to verify that the program was only counting one kit per household.

A total of 2,693 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. As a result of the QA/QC records reviews findings, the total number of participants in the program was reduced to 2,593. This represents a 96% QA/QC realization rate for the program.

Table 7-6 shows the QA/QC realization rates for the number of kits verified in the PY3 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.

Sector	Measure	Kits in EEMIS	QA/QC Realization Rate	Kits Counted for Savings
Low-Income	Kit (including all measures)	2,693	96%	2,593

Table 7-6: QA/QC Realization Rate for PY3 E-Power Wise Program

Participant Surveys Methodology

Customer-returned survey results were used to calculate *ex post* per-unit savings for each of the measures contained in the kit. Customer phone surveys were used to estimate savings associated with behavior changes. For measure savings, installation rates were included as inputs to the algorithms specified in the TRM. Energy savings attributed to behavior changes were calculated using the SWE approved custom measure protocol (CMP) for this program. The CMP is included in Appendix I: Custom Measure Protocol Measuring Impacts of Behaviorally Based Activities in Low-Income Energy Education/Energy Kit Programs, and the calculations are presented in Appendix J: E-Power Wise Program and Behavior Savings Calculations.

Participant Kit Surveys

Each kit distributed through the program includes the participant survey (with text reviewed and approved by PPL Electric). In addition to questions designed to gauge satisfaction with the E-Power Wise Program, 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. Participant self-reported data collected through the surveys was used to verify measure installation; however, the paper surveys included in the kits did not contain many of the questions needed to collect the data necessary for the behavior energy savings calculations.

In total, 252 mail-in surveys were returned by the participants who received the kit from the CBO agency, and 109 were returned by direct mail participants, for a total of 361 mail-in surveys included in the program evaluation. In addition, phone surveys were conducted with 66 direct mail participants.

Participant Phone Surveys

The phone survey was designed to gather the specific data necessary to conduct savings calculations associated with behavioral changes. Specifically, the phone survey collected data to determine the following:

- Reduction of hot water heater temperature setting (calculation based on yes/no response to account for the likelihood that participants are unable to report the degree reduction accurately).
- Location of clothes washing equipment (in the home or at commercial or community locations).
- Percent of clothes (washing loads) washed in cold water before and after participation in the program.
- Reduction in space heating temperature setting (calculation based on yes/no response to account for the likelihood that participants are unable to report the degree reduction accurately).
- Increase in space cooling temperature setting (calculation based on yes/no response to account for the likelihood that participants are unable to report the degree reduction accurately).

Summary of Survey Findings

Survey findings for each of the measure and behavior changes attributable to the program are provided below. In total, 361 participant kit surveys were returned by program participants. **Table 7-7** presents the PY2 and PY3 installation rates for each of the energy saving kit items. ISR are presented as a percent of participants who answered the question, and not a percent of the total number of people surveyed.

·····	Kit Delivery Method									
	PY2 CBO Age	псу-	PY3 CBO Age	ncy	PY3 Direct N	vlail				
Measure Installed	Sample Count (n)	ISR	Sample Count (n)	ISR	Sample Count (n)	ISR				
Bathroom Aerator	782	86%	246	81%	100	81%				
Kitchen Aerator	782	72%	246	70%	100	67%				
Showerhead	829	86%	248	80%	109	80%				
20W CFL ¹	812	94%	242	94%	100	89%				
15W CFL ¹	819	96%	244	96%	99	95%				
Nightlight	832	95%	247	96%	109	94%				
NOTES:	<u></u>									

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

1. The TRM provides an ISR of 84% for ENERGY STAR CFL bulbs. However, because the ISR's determined through the surveys for this program are more specific to this population, these ISR's were used in place of the ISR provided in the TRM.

7.2.5 Savings Realization Rate Methodology

Because of the relatively small savings impact of the program compared to the overall consumption of the participant group, savings for measure installations and behaviors were estimated 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 J: E-Power Wise Program and Behavior Savings Calculations.

Phone surveys were used to determine key participant characteristics that define baseline consumption, including the fuel source for their water heater, the presence of air conditioning equipment, the number and age of household occupants, and pre-installation usage factors.

The adjustment for a savings realization rate was derived from two components: the QA/QC records reviews and the participant surveys. Note that while QA/QC records reviews were conducted on a quarterly basis, agency-based participant phone surveys were conducted one time, in PY2 Q3. Direct mail participant phone surveys were conducted one time in PY3 Q4.²² Participant surveys were completed throughout the year in the form of paper surveys that were distributed to the participants in the program kits and mailed back to the implementation CSP. Participant survey data regarding measure installation rates and secondary data on measure characteristics were used in the algorithms to calculate verified savings for each measure.

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

7.2.6 Summary of Evaluation Results

Table 7-8 and **Table 7-9** contain precision calculations that are valid at the program level and were used for calculating final verified program savings.

²² These phone surveys were conducted with pilot direct mail delivery channel participants one time in August 2012, within three months of their participation in the program. These survey results were used to determine the energy education savings from direct mail delivery channel participants.

	Reported Gross Savings (MWh/yr)	Adjusted <i>Ex Ante</i> Savings (MWh/yr)	Energy Realization Rate	Error Ratio	Precision (90% conf:)	Verified Gross Savings (MWh/yr)
Program Total	1,610	1,590	94%	0.22	1.8%	1,490
NOTES:	1,610	1,590	94%	0.22	1.8%	1,2

Table 7-8: PY3 E-Power Wise Evaluation Results for Energy Savings¹

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. (Savings targets for MWh refer to values at the point of consumption.)

Table 7-9: PY3 E-Power Wise Evaluation Resul	Its for Demand Reduction ¹
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	Reported Gross Reduction (MW)	Adjusted <i>Ex Ante</i> Reduction (MW)	Demand Realization Rate ²	Error Ratio	Precision (90% conf.)	Verified Gross Reduction (MW)
Program Total	0.38	0.42	94%	0.22	1.8%	0.39
NOTES:	,,					
 Values in th systematica point of gen 	is table refer to saving: Ily smaller. (Although t eration.)	s at the point of genera his program has no der	tion. Due to line lo nand reduction tai	sses, savings rget, MW red	at the point of ductions refer to	consumption are values at the
2. There were demand sav	no program level dema ings. This table applies	and goals for this progra the kWh realization rai	am. Therefore, the te to the <i>ex ante</i> a	e EM&V CSP djusted MW	did not specifica reduction.	lly evaluate

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 returned surveys and TRM algorithms. Table 7-10 shows the savings attributable to each of the measures. These savings may be used to inform discussions that do not critically rely on precision estimates for program-wide savings.

Measure Installed	PY2 Per-Unit Savings (kWh/yr)	PY3 Agency-Based Per-Unit Savings (kWh/yr)	PY3 Direct Mail Per-Unit Savings (kWh/yr)
Bathroom Aerator	44	49	49
Kitchen Aerator	52	42	41
Showerhead	199	184	184
20W CFL	54	55	52
15W CFL	46	46	45
Nightlight	25	25	24
NOTES			

Table 7-10: E-Power Wise Program Measure Savings Per Distributed Unit¹

These savings values account for installation rates. The savings per distributed unit is the savings per installed unit times 1. the installation rate.

Behavior Savings

Direct mail participant phone surveys were designed to capture the data necessary to complete the algorithms developed for this program's CMPs, presented in Appendix I: Custom Measure Protocol Measuring Impacts of Behaviorally Based Activities in Low-Income Energy Education/Energy Kit Programs). The program claimed savings that are attributable to all behavioral changes. However, the program was designed to change multiple behaviors. Data for each of these behaviors were collected, and the results are presented individually in Appendix J: E-Power Wise Program and Behavior Savings Calculations. The overall savings for the behavior changes are shown in **Table 7-11**.

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Behavior Savings	Per-unit Savings (kWh/yr)				
Agency-based ¹ (Participants receiving the kit from CBO agency)	146				
Direct-mail ² (Participants receiving the kit through direct mail)	208				
NOTES:					
1. Behavioral savings were determined through participant phone surveys conducted one time in PY2.					
Direct-mail behavior savings was determined through participant phone surveys conducted one time in PY3.					

Program Measure Savings Results

A weighted-average, survey-verified, savings value for each kit item and behavior change was calculated 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 7-12**.

Sector	Measure	Kits in EEMIS	QA/QC Realization Rate	Survey Verified Savings Per Unit (kWh/yr)	Energy Realization Rate (%) ¹
	Energy Education	2,693	96%	160 ²	109%
	Faucet Aerator Bath	2,693	96%	49	81%
	Faucet Aerator – Kitchen	2,693	96%	42	69%
Low-income	Low-flow Showerhead	2,693	96%	184	80%
	CFL 15W	2,693	96%	46	114%
	CFL 20W	2,693	96%	54	111%
_	Electroluminescent Nightlight	2,693	96%	25	91%

Table 7-12: PY3 Summary of Savings and Realization Rates for E-Power Wise Program Measures

NOTES:

1. These realization rates reflect ratio between adjusted Ex ante and Ex post verified savings.

2. This survey-verified value includes the sum of behaviors for which the program is claiming energy savings: water heater plus home temperature energy savings.

Since the sample was drawn at the kit/customer-level, the estimates above are not mutually independent. For example, the sampling error associated with faucet aerators is not independent of the sampling error associated with CFLs, as the same customers were queried for each measure's verification. This presents no problem when an individual measure's savings estimate is considered in isolation; each estimate in the table above is valid. Program-level precision estimates, however, would be invalid if the individual results were rolled up for a program total without accounting for the dependencies between measures in the sampling error. Because of this, the EM&V CSP's final estimate of program-wide savings employed a single realization rate, calculated by first rolling up savings to the kit/customer level (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. Since this approach employs a single realization rate, rather than a collection of interdependent realization rates, standard variance calculations yield valid program-wide precision estimates.

7.3 Impact Evaluation Net Savings

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

7.4 Process Evaluation

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

7.5 Financial Reporting

A breakdown of the program finances is presented in Table 7-13.

	IQ (\$1,000)	РҮТD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants ¹	\$0	\$79	\$429
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$0	\$79	\$429
Design & Development	\$0	\$0	\$0
Administration ²	\$0	\$0	\$0
Management ³	\$100	\$143	\$204
Marketing ⁴	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$100	\$143	\$204
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁵	\$100	\$222	\$633
Participant Costs ⁵	N/A	\$0	\$0
Total TRC Costs ⁷	N/A	\$222	\$633
Discounted TRC Costs ⁸	N/A	\$222	\$574
Total Lifetime Energy Benefits	N/A	\$1,000	\$2,021
Total Lifetime Capacity Benefits	N/A	\$105	\$129
Total TRC Benefits ⁹	N/A	\$1,105	\$2,404
Discounted TRC Benefits	N/A	\$1,105	\$2,150
TRC Ratio ¹⁰	N/A	4.97	3.74

	Table 7-3	13: Summary	of E-Power	Wise Program	Finances
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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.

- Costs that occurred prior to PY3 Q4 are treated as incentives. All costs that occurred after PY3 Q4 are treated as management costs.
- 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.
- S. Per the 2011 Total Resource Cost Test Order, the Total EDC Costs refer to EDC incurred expenses only.
- Per the 2011 Total Resource Cost Test Order, the net participant costs are the costs to the end-use customer (net participant costs = full incremental cost minus incentives).
- 7. Total TRC Costs includes Total EDC Costs and Participant Costs.
- 8. For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 DiscountedTRC Benefits divided by Total Discounted TRC Costs.

8 Winter Relief Assistance Program (WRAP)

The PPL Electric Universal Services Program (USP) WRAP designed for income-qualifying customers existed prior to Act 129 and has offered services since 1985. WRAP is designed to reduce electric 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 pre-approved list of cost-effective measures is used along with other criteria to determine if appliances and other larger equipment can be cost-effectively replaced. Implementing agencies either use in-house contractors or they 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, but are tracked 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 and customers that 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.

8.1 Program Updates

There were no changes to the program in Program Year 3.

8.2 Impact Evaluation Gross Savings

8.2.1 Reported Gross Savings

Table 8-1 shows the cumulative reported results through the end of PY3. **Table 8-2** shows the PY3 program participation and savings claimed by quarter.

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Low-Income	9,649	13,185	0.77	\$18,182
Program Total	9,649	13,185	0.77	\$18,182

Reporting.Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW) ¹	Inceritives (\$1;000) ²
PY3 Q1	548	684	0	\$2,987
PY3 Q2	744	1,159	0	\$1,964
PY3 Q3	1,359	2,109	0	\$1,824
PY3 Q4	1,894	3,009	0	\$0
PY3 Total	4,545	6,961	0	\$6,775
CPITD Total	9,649	13,185	0.77	\$18,182

Table 8-2: PY3 WRAP Reported Results by Quarter

NOTES:

1. Starting in PY3 The EM&V CSP began calculating the demand savings for WRAP as an *ex ante* adjustment. Therefore, the gross reported demand savings for PY3 are close to zero. This is because the only measure for which EEMIS includes demand savings is Heat Pump Water Heaters. The .77 MW of demand reduction for CPITD reflects the difference in method from PY2 to PY3. See Table 8-8 for the PY3 *ex ante* adjusted demand savings.

2. Because incentives are not paid directly to participants in this program, incentive costs reflect the total cost of installing measures including hardware, labor, audit, and inspection. Beginning in PY3 Q3, the cost of the weatherization measures (given to participants for free) will no longer be classified as an incentive, consistent with the PA PUC's August 2011 TRC Order. These will become direct program costs in the "Management" category.

8.2.2 EM&V Sampling Approach

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

The Act 129 PY3 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 billing/consumption analysis).

Sampling to meet EM&V requirements was designed to meet the target confidence and precision level 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 sector as a whole.

The PY3 sample size for the Act 129 WRAP records reviews is 46 records, or approximately 11 records per quarter. In Q1, the EM&V CSP selected a sample of three baseload, four low cost, and four full-cost jobs for review, from a population of 265 baseload jobs, 135 low-cost jobs, and 148 full-cost jobs. During PY3 Q2, the SWE expressed concern about whether PPL Electric was conducting a sufficient level of field inspections for Act 129 WRAP installations, and whether the EM&V CSP was reviewing the field

inspection data for accuracy and process improvements. To address the SWE's concerns regarding field inspection data, starting with the Q2 extract, each quarterly sample was stratified as shown in **Table 8-3**.

Stratum	Strata Boundaries	Population Size	CV Assumed in Sample Design	Target Levels of C/P	Target Sample Size	Achieved Sample Size	Evaluation Activity
Baseload	Received field inspection	5	0.5	90/10	3	3	Records Review
Baseload	Did not receive field inspection	1,433	0.5	90/10	3	3	Records Review
Low Cost	Received field inspection	45	0.5	90/10	12	12	Records Review
Low Cost	Did not receive field inspection	738	0.5	90/10	3	3	Records Review
Full Cost	Received field inspection	411	0.5	90/10	12	11	Records Review
Full Cost	Did not receive field inspection	1,367	0.5	90/10	3	3	Records Review
Program To	tal	3,997		90/10	36	35	

Table 8-3: WRAP Sampling Strategy for PY3

8.2.3 Ex Ante Adjustments Methodology and Findings

Savings for Act 129 WRAP are deemed by job type. During PY3 Q1, Penn State's CSIS calculated savings for USP WRAP using a billing 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 starting in mid-September 2011. Savings deemed for all PY3 participants prior to this period were those in effect in EEMIS at the close of PY2.

Also in PY3 Q1, the EM&V CSP conducted a parallel, preliminary billing analysis of PY1 Act 129 WRAP participants in anticipation of and preparation for the full billing analysis of all PY1 and PY2 participants scheduled for April 2012. The savings estimates per job type computed by the EM&V CSP and Penn State were quite different. In the ensuing discussion about the differences, PPL Electric identified a problem in the data extraction process for the USP WRAP analysis, involving the inadvertent exclusion of a large number of eligible records. PPL Electric remedied the problem, re-extracted the data, and Penn State re-ran the billing analysis. With all eligible records included, the new savings estimates per job type followed expected savings patterns (i.e., lower savings for baseload jobs and highest savings for full-cost jobs) and tracked the savings estimated by the EM&V CSP in the preliminary billing analysis of PY1 Act 129 WRAP participant data.

The new Penn State savings estimates were recorded in EEMIS for PY3 Q4 participants and, at the close of PY3, all PY3 jobs with installation dates in PY3 received an *ex ante* TRM adjustment so that savings for all jobs were deemed using the revised Penn State estimates. These estimates are provided in **Table 8-4** below.

Јор Туре	Installed During PY2	PY3 Q1 Deemed Savings (kWh/yr)	Original Penn State Savings Estimates (kWh/yr)	Revised Penn State Savings Estimates (kWh/yr)
Baseload	1,042	1,042	1,693	1,312
Low Cost	1,588	1,588	1,898	1,604
Full Cost	1,306	1,306	1,652	2,496

Table 8-4: WRAP Savings Estimates Used During PY3

Savings for all jobs were calculated using the deemed savings per job in effect during the program year in which the measures were installed. Twenty-seven percent of all jobs claimed in PY3 had installation dates in PY2; therefore, savings for these jobs were calculated using the deemed savings estimates in effect at the close of PY2. Additionally, one heat pump water heater recorded in PY3 was installed in PY2 (March 2011), so there were no savings claimed for that measure.

In the final, revised Penn State estimates, savings for all three job types increased over the PY3 Q1 deemed savings, and the deemed savings value for full-cost jobs nearly doubled. The values for baseload and low-cost jobs decreased from those used in the original estimates.

8.2.4 Ex Post Adjustment Methodology and Findings

PY3 EM&V included data review and verification of a random sample of contractor reports, WRAP V records, and EEMIS data. The review confirmed that PPL Electric correctly reported measures and savings in EEMIS, based on comparisons with the contractor reports and the WRAP V database. In PY3, the EM&V CSP selected a random sample of records from PY3 participants. Discussed in more detail in , the sample was stratified by job type and whether there was a field inspection. 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. 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) are not 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 are deleted from the job counts.

For sites with multiple records spread over different program years, the EM&V CSP reviewed the records at the end of PY3, examining the job types recorded at each site. If a more comprehensive job type was recorded in PY3, the EM&V CSP added the incremental savings over those already claimed in the prior

program year. If the same or a less comprehensive job type was recorded in PY3, the EM&V CSP excluded those job types from the counts, as the maximum savings were already claimed for that job. Where that was the case, incremental savings for the most comprehensive job type was added (additional measures were installed). These adjustments and the incremental kWh/yr are shown in the tables below. Table 8-5 shows that there were 110 jobs with measures installed in more than one year or more than one guarter in PY3.

Measures Installed In:	Job Type	Multiple Jobs Per Site Spanning Two Program Years	Multiple Jobs Per Site Within PY3	Total Adjustment to N's
	Baseload	3	1	4
PY2	Low Cost	0	2	2
	Full Cost	10	0	10
	Baseload	13	11	24
РҮЗ	Low Cost	0	35	35
 	Full Cost	32	3	35
Total		58	52	110

Table 8-5: Adjustments for Sites With Records Entered In Multiple Quarters or Years

Table 8-6 details the incremental adjustments to savings for 19 households where work spanned multiple years.

		Baseload to Full Cost						
Measures Installed In:	Job Type	N	Per Job Incremental kWh/yr Adjustment	Incremental kWh/yr Adjustment	N	Per Job Incremental kWh/yr Adjustment	incremental kWh/yr Adjustment	Total Incremental Adjustment
PY2	Full Cost	4	264	1,056	4	0	0	1,056
РҮЗ	Full Cost	15	1,454	21,810	12	908	10,896	32,706
Total		19		22,866	16		10,896	33,762

Table 8-6: Incremental Adjustment for Sites With Records Entered Over Multiple Years

As shown in **Table 8-6**, there is no incremental adjustment for the four records (households) with installation dates in PY2 that moved from low-cost to full-cost jobs, because the deemed savings estimate in effect in PY2 for full-cost jobs (1,306 kWh/yr) is less than the deemed savings estimate for low-cost jobs (1,588 kWh/yr).

8.2.5 Savings Realization Rate Methodology

PY3 EM&V included data review and verification of a random sample of contractor reports, WRAP V records, and EEMIS data. The review confirmed that PPL Electric correctly reported measures and savings in EEMIS, based on comparisons with the contractor reports and the WRAP V database. In PY3,

the EM&V CSP selected a random sample of records from PY3 participants. Discussed in more detail in section 8.2.2 above, the sample was stratified by job type and by whether a site inspection had occurred. 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.

Additionally, program installations for some sites required multiple, separate visits from the installation contractor, and were recorded as separate jobs in the PPL Electric USP 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) were not 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.

For sites with multiple records spread over different program years, the EM&V CSP reviewed the records at the end of PY3. The EM&V CSP examined the job types recorded at each site. If a more comprehensive job type was recorded in PY3, the incremental savings over those already claimed in the prior program year were added back to the energy savings and demand reductions. If the same or a less comprehensive job type was recorded in PY3, those job types were excluded from the counts, as the maximum savings had already been claimed for that job.

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

8.2.6 Summary of Evaluation Results

In PY3, Act 129 WRAP realized 98% of the *ex ante* adjusted energy savings, as shown in **Table 8-7**. This includes savings of 17,226 kWh/yr associated with the installation of 10 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.

Stratum	Reported Gross Savings (MWh/yr)	Adjusted Ex Ante Gross Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision ²	Verified Gross Energy Savings (MWh/yr)
Baseload	2,374	2,113	98%	N/A ²	0%	2,078
Low Cost	1,618	1,466	96%	N/A ²	0%	1,407
Full Cost	2,952	4,112	98%	N/A ²	0%	4,046
Heat Pump Water Heater	17	17	100%	N/A ²	0%	17
Program Total	6,961	7,709	98%	N/A	0%	7,548

Table 8-7: PY3 WRAP Evaluation Results for Energy Savings¹

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. (Savings targets for MWh refer to values at the point of consumption.)

2. This analysis was conducted at the census level, so there is no sampling error (precision = 0%). The same census-based analysis will be conducted in PY4, so the CV is not needed for evaluation planning.

Table 8-8 and Table 8-9 summarize the evaluation results for demand reduction. 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)/Hours Per Year

Where:

kWh=Deemed kWh per job typeCF=Coincidence factor; 0.99693903Hours 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 0.175 kW per measure.

Savings Type	Reported Gross Reduction (MW)	Adjusted <i>Ex Ante</i> Gross Reduction (MW)	Demand Realization Rate	Relative Precision	Verified Gross Reduction (MW)
Total Program Savings at Generator ¹	0.002	0.95	108%	N/A ²	1.03
Total Program Savings at Meter	0.002	0.88	108%	N/A ²	0.95
10			· · · · ·		

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NOTES:

1. This is the value used in reporting program-wide demand savings. (Savings targets for MW refer to values at the point of generation.)

2. This analysis was conducted at the census level, so there is no sampling error (precision = 0%). The same census-based analysis will be conducted in PY4, so the Cv is not needed for evaluation planning.

Stratum	Reported Gross Reduction (MW)	Adjusted Ex Ante Gross Reduction (MW)	Demand Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision ²	Verified Gross Reduction (MW)
Baseload	0	0.241	88%	N/A ²	0%	0.236
Low Cost	0	0.167	87%	N/A ²	0%	0.160
Full Cost	0	0.468	137%	N/A ²	0%	0.460
Heat Pump Water Heater	0.002	0.002	100%	N/A ²	0%	0.002
Program Total	0.002	0.877	108%	N/A	0%	0.950

Table 8-9: PY3 WRAP Stratum-Level Evaluation Results for Demand Reduction¹

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. This analysis was conducted at the census level, so there is no sampling error (precision = 0%). The same census-based analysis will be conducted in PY4, so the Cv is not needed for evaluation planning.

8.3 Impact Evaluation Net Savings

There is no freeridership or spillover assumed for this low-income weatherization program. Measures are installed at no cost to income-eligible customers.

8.4 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 duplicating efforts. There were no changes to Act 129 WRAP in PY3.

8.5 Financial Reporting

A breakdown of the program finances is presented in Table 8-10.

	IQ (\$1,000)	РҮТД (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants ¹	\$0	\$6,775	\$18,182
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$0	\$6,775	\$18,182
Design & Development	\$0	\$0	\$0
Administration ²	\$0	\$0	\$0
Management ³	\$2,358	\$2,905	\$3,966
Marketing ⁴	\$0	\$0	\$1
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$2,358	\$2,905	\$3,967
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁵	\$2,358	\$9,680	\$22,149
Participant Costs ⁶	N/A	\$0	\$0
Total TRC Costs ⁷	N/A	\$9,680	\$22,149
Discounted TRC Costs ⁸	N/A	\$9,680	\$20,069
Total Lifetime Energy Benefits	N/A	\$10,752	\$16,939
Total Lifetime Capacity Benefits	N/A	\$303	\$524
Total TRC Benefits ⁹	N/A	\$11,055	\$19,599
Discounted TRC Benefits	N/A	\$11,055	\$17,463
TRC Ratio ¹⁰	N/A	1.14	0.87

Table 8-10: Summary of WRAP Finances

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.

- Costs that occurred prior to PY3 Q4 are treated as incentives. All costs that occurred after PY3 Q4 are treated as management costs.
- 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.
- Per the 2011 Total Resource Cost Test Order, the net participant costs are the costs to the end-use customer (net participant costs = full incremental cost minus incentives).
- 7. Total TRC Costs includes Total EDC Costs and Participant Costs.
- 8. For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 DiscountedTRC Benefits divided by Total Discounted TRC Costs.

9 Renewable Energy Program

The Renewable Energy Program (now closed to new applicants) encouraged PPL Electric customers to install a solar PV array or GSHP at their home or institutional building. This program offered a financial incentive in the form of a rebate that reduces upfront 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 included:

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

9.1 Program Updates

In PY3, the Renewable Energy Program provided incentives to two institutional PV projects and 15 institutional GSHP projects that reserved incentives before the program closed. The program closed after exceeding participation goals and exhausting funding.

9.2 Impact Evaluation Gross Savings

9.2.1 Reported Gross Savings

Table 9-1 shows the reported results by sector. Rebates were only provided to GNI customers during PY3.

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)	
Residential	1,627	6,451	0.58	\$1,795	
Small Commercial and Industrial	6	68	0.01	\$97	
Large Commercial and Industrial	1	11	0.00	\$0	
Government, non-profit, and institutional	196	7,227	1.75	\$3,114	
CPITD Total ¹	1,830	13,757	2.34	\$5,007	
	-J				

Table 9-1: CPITD Renewable Energy Program Reported Results by Sector

NOTES:

Summing the sector level reported gross savings will not equal the program level savings; these totals differ by 89
MWh/yr. The difference is due to a change in the data tracking and reporting method from PY2 to PY3. The CPITD sector
level MW value reported here differs from the overall program level because of rounding.

Table 9-2 shows the number of participants, energy and demand savings, and incentives paid by quarter in PY3.

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY3 Q1	0	0	0.00	\$126
PY3 Q2	1	279	0.16	\$500
PY3 Q3	57	2,119	0.56	\$500
PY3 Q4	59	229	0.02	\$97
PY3 Total	117	2,627	0.74	\$1,224
CPITD Total	1,830	13,846	2.30	\$5,007

9.2.2 EM&V Sampling Approach

Table 9-3 shows the sampling strategy for PY3. The sample was designed to meet 85/15 C/P at the program level. 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 10 projects, necessary to meet the C/P target.

Stratum	Strata Boundaries	Population Size	Assumed Coefficient of Variation (C _v) or Proportion in Sample Design	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
					2	2	records review
Institutional PV rebates	GNI customers	2	0.5	85/15	2	0	Surveys
					2	1	site visits
					15	15	records review
Institutional GSHP rebates	GNI customers	15	0.5	85/15	8	2	surveys
					8	8	site visits
					17	17	records review
Program Total	GNI	17	0.5	85/15	10	2	surveys
					10	9	site visits

Table 9-3: Renewable Energy Program Sampling Strategy for PY3

Two savings adjustments were necessary to calculate a realization rate. The first results in the TRMadjusted *ex ante* savings. The second results in the *ex post* verified savings. Both methodologies are explained below, and the results from each adjustment are reported separately.

9.2.3 Ex Ante Adjustments Methodology and Findings

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

For GSHPs, the PY3 EEMIS tracking database reported savings that were calculated based on capacity and efficiency values found in the customer's application, so the only TRM *ex ante* adjustments made were for location and building type. The reported savings in EEMIS were calculated using the cooling and heating EFLH values for residential homes in Scranton. The EM&V CSP accounted for the location variation of all program participants in the adjusted *ex ante* savings. Cities were mapped by ZIP code to the TRM reference tables.
For PV, the energy savings recorded in EEMIS were based on PVWatts version 1,²³ where data (including system location, capacity, azimuth, and tilt) were entered based on the customer application. Assumptions were made regarding inverter efficiency, shading, and the module derate factor. The adjusted *ex ante* savings used information from EEMIS to adjust the reported savings to account for inverter efficiency and the module derate factor.

The EM&V CSP verified inverter efficiencies using the California Energy Commission (CEC) list of approved inverters.²⁴ Module derate factors were calculated by taking a ratio of the module rating reported on the CEC list of approved modules²⁵ to the manufacturer module rating. Because shading data was not collected on the rebate form or interconnect form, shading was not included in the adjusted *ex ante* savings calculations.

PVWatts version 1 was used to calculate the adjusted *ex ante* annual savings. Adjusted *ex ante* peak demand savings were calculated using the hourly data output from PVWatts version 1 and by taking a weighted average capacity factor for each site across the hours from 12:00 p.m. to 6:00 p.m. for June through September weekdays excluding holidays, as this was the time period specified in the TRM for peak demand impacts.

9.2.4 Ex Post Adjustments Methodology and Findings

To calculate the realization rate, the EM&V CSP verified installation rates and qualifying equipment using records data, survey 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 database²⁶ for systems with valid manufacturer and model numbers. Where the EM&V CSP was unable to verify the efficiency due to incorrect model numbers, or models could not be found in any of the databases, results were extrapolated from the sample verified.

For a sample of measures, site visits verified that the reported equipment type and quantity were installed. During PV site visits, the generation meter for the system was recorded, and the *ex post*

²³ United States National Renewable Energy Laboratory. *PV Watts version* 1. Available online: http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/.

²⁴ California Energy Commission. *List of Eligible Inverters per SB1 Guidelines.* Available online: http://www.gosolarcalifornia.ca.gov/equipment/inverters.php.

²⁵ California Energy Commission. *List of Eligible SB1 Guidelines Compliant Photovoltaic Modules*. Last Updated November 1, 2012. Available online: http://www.gosolarcalifornia.ca.gov/equipment/pv_modules.php.

²⁶ http://www.ahridirectory.org/ahridirectory/pages/wbahp/defaultSearch.aspx

evaluated savings were adjusted based on this reading, per the methodology in the CMP. The EM&V CSP calculated the *ex post* evaluated savings for projects where a site visit was conducted.

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 adjusted *ex ante* to the evaluated *ex post* savings.

9.2.5 Savings Realization Rate Methodology

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

During records reviews for GSHPs, the EM&V CSP verified capacities, EER values, and COP values using the AHRI database²⁷ for systems with valid manufacturer and model numbers. Where the EM&V CSP was unable to verify the efficiency due to incorrect model numbers, or models could not be found in any of the databases, results were extrapolated from the sample verified.

For a sample of measures, site visits verified that the reported equipment type and quantity were installed. During PV site visits, the generation meter for the system was recorded, and the *ex post* evaluated savings were adjusted based on this reading, per the methodology in the CMP. The EM&V CSP calculated the *ex post* evaluated savings for projects where a site visit was conducted.

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

9.2.6 Summary of Evaluation Results

 Table 9-4, Table 9-5, and Table 9-6 summarize the evaluation results for energy and demand savings for the Renewable Energy Program.

²⁷ http://www.ahridirectory.org/ahridirectory/pages/wbahp/defaultSearch.aspx

Stratum	Reported Gross Savings (MWh/yr)	Adjusted <i>Ex Ante</i> Gross Savings (MWh/yr)	Energy Realization Rate	Observed Error Ratio ²	Relative Precision (90% conf.)	Verified Gross Savings (MWh/yr)
Institutional PV	1,711	1,559	108.8%	9.7%	5.2%	1,696
Institutional GSHP	916	1,382	49.5%	45.4%	8.8%	684
Program Total ³	2,627 ³	2,942 ³	80.9%	22.2%	4.5%	2,380 ³

Table 9-4: PY3 Renewable Energy Program Evaluation Results for Energy Savings¹

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. When the realization rate is obtained through a ratio estimator, the Error Ratio should be used instead of the CV.

3. These are the values used in reporting program-level energy savings. (Savings targets for MWh refer to values at the point of consumption.)

Table 9-5. PV3	Renewable	Energy Program	Evaluation	Results for	Demand Reduction
	NEILCAADAC	LICEBYTTOSTAN	Louidation	nesures for	Demand Reduction

Savings Type	Reported Gross Reduction (MW)	Adjusted <i>Ex Ante</i> Gross Reduction (MW)	Demand Realization Rate	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Total Program Savings at Generator ¹	0.74	0.72	98.0%	7.3%	0.71
Total Program Savings at Meter	0.74	0.67	98.0%	7.3%	.655
NOTES:				····	

1. This is the value used in reporting program-wide demand savings. (Savings targets for MW refer to values at the point of generation.)

Table 9-6: PY3	Renewable Energy	Program	Evaluation	Results for	Demand	Reduction ¹
1001C 2-01 L 12	NELICWONIE LITEIBY	FIUSIAIII	LAGINGTIOL	NC30163 TOT	Demana	Coucton

Stratum	Reported Gross Reduction (MW)	Adjusted Ex Ante Reduction (MW)	Demand Realization Rate	Observed Error Ratio ²	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Institutional PV	0.479	0.360	109.5%	9.7%	5.1%	.394
Institutional GSHP	0.260	0.307	85.1%	76.3%	16.5%	.261
Program Total	0.739	0.667	98.0%	33.1%	7.3%	.655
NOTES:	±		<u>·</u>	<u> </u>		<u> </u>

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. When the realization rate is obtained through a ratio estimator, the Error Ratio should be used instead of the CV.

For institutional GSHP PY3 projects, the realization rate was $49.5\% \pm 8.8\%$ for energy savings and $85.1\% \pm 16.5\%$ for peak demand savings, with 90% confidence. The realization rates were less than 100% due to three factors:

- 1. Distinguishing between water-source heat pumps (WSHPs), groundwater-source heat pumps (GWSHPs), and GSHPs. The type of geothermal system impacts many inputs used to calculate savings: EER, COP, cooling capacity, and heating capacity. Sometimes it was possible to determine the system type based on the information included in the records, but not always. When this information was not included in the records, it was assumed to be a GSHP, which is the most common. However, most efficiency values reported in EEMIS assumed the system was a GWSHP, which is more efficient than a GSHP, but the capacity of a GWSHP is smaller than a GSHP.
- 2. Ground loop pump. The TRM methodology subtracts out the electricity used by the ground loop pump. This pump was not taken into account in the reported energy savings or reported demand reduction, but was included in the verified energy savings and verified demand reduction, and can result in significantly lower savings. This information was collected during the site visits.
- 3. Baseline system type for rooftop units (RTUs). Some RTUs only provide cooling and do not provide heating. In these instances, the reported savings were calculated using an ASHP system as baseline; however, for the verified savings a wet surface air cooler system was used as baseline system type. This information could sometimes be found during the records review, if the AHRI data was included. Otherwise, it was found by looking up the manufacturer and model number.

For non-residential PV system PY3 projects, the realization rate was $108.8\% \pm 5.2\%$ for energy savings and $109.5\% \pm 5.1\%$ for peak demand reduction, with 85% confidence. The EM&V CSP was able to conduct a site visit for one of the two PV projects; therefore, the verified non-residential projects from PY2 were combined with the PY3 sample to determine the PY3 realization rate. In PY2, the realization rate for non-residential projects was $112\% \pm 1\%$ for both energy and peak demand savings, with 85% confidence. This was because the generation meter reads taken during the site visits were greater than the output predicted by PVWatts version 1, resulting in an increase in energy and demand savings.

9.3 Impact Evaluation Net Savings

9.3.1 Net-to-Gross Ratio Methodology

The EM&V CSP determined the NTG ratio through self-report surveys with a sample of PY3 participants. The freeridership portion of survey questions were tailored to participants of the Renewable Energy Program. Responses from the survey questions were used to develop a freeridership score using a scoring matrix. No adjustments to the NTG ratio were applied to savings, as specified by the PA PUC. The information obtained by computing the NTG ratio will only be used to refine and improve program delivery.

To examine spillover attributable to the Renewable Energy Program, survey respondents were asked if they made any energy efficiency improvements or installed any energy efficient measures where they did not receive a program rebate. They were also asked the likelihood that they would have installed those measures if they had not participated in the program. No adjustments were made to the *ex post* savings to incorporate spillover, per direction from the SWE.

9.3.2 Net-to-Gross Ratio Findings

Of the 18 Renewable Energy Program participants in PY3, zero PV customers and two GSHP customers completed the survey. The two surveys were completed in summer 2012, sampling customers from PY3 Q1 through Q4. The sample was insufficient to calculate program freeridership.

One of the two survey respondents stated they made energy efficiency improvements without receiving a rebate. This respondent reported installing a room air conditioning unit, but reported that the Renewable Energy Program was not at all influential in their decision.

9.4 Process Evaluation

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

9.5 Financial Reporting

A breakdown of the program finances is presented in Table 9-7.

	IQ (\$1,000)	PYTD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$97	\$1,224	\$5,007
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$97	\$1,224	\$5,007
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$0	\$33	\$202
Marketing ³	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$0	\$33	\$202
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$97	\$1,257	\$5,210
Participant Costs ⁵	N/A	\$7,723	\$62,306
Total TRC Costs ⁶	N/A	\$8,980	\$67,516
Discounted TRC Costs ⁷	N/A	\$8,980	\$62,268
Total Lifetime Energy Benefits	N/A	\$2,629	\$19,366
Total Lifetime Capacity Benefits	N/A	\$231	\$1,211
Total TRC Benefits ⁸	N/A	\$2,861	\$22,140
Discounted TRC Benefits	N/A	\$2,861	\$20,577
TRC Ratio ⁹	N/A	0.32	0.33

Table 9-7: Summary of Renewable Energy Program Finances

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.
- Per the 2011 Total Resource: Cost Test Order, the net participant costs are the costs to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC Costs includes Total EDC Costs and Participant Costs.
- For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 Discounted TRC Benefit's divided by Total Discounted TRC Costs.

10 HVAC Tune-Up Program

The HVAC Tune-Up Program is offered to all small C&I customers with an existing split or packaged HVAC RTU. Owners or tenants occupying an existing building are the primary recipients of program services.

The HVAC Tune-Up Program was 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:

- 1. Refrigeration measures
- 2. Economizer measures
- 3. Thermostat measures

The program offers financial incentives to contractors to help offset the cost to diagnose the HVAC system and make energy-saving retrofits. Participating contractors use the Service Assistant[™] diagnostic tool to analyze the HVAC system. This tool records and reports diagnostic data, which is used to track work completed, and this data is reported by the program implementer. The program implementer also uses this data to estimate the energy savings for each measure reported.

10.1 Program Updates

After two years of operation, the HVAC Tune-Up Program was far behind its original planned savings and participation goals.²⁸ 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, PPL Electric began offering contractors an additional incentive late in PY3 (beginning May 1, 2012). The contractors are now eligible for additional incentives after they service their first 50 qualifying units. Incentives were capped at a total of \$3,000 per contractor and were:

- \$30 each for units 51 through 100
- \$50 each for units 101 through 120
- \$70 each for units 121 through 140

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. HVAC contractors will continue to

²⁸ The original goals planned for 5,770 customers through 2013, with a total reduction of 22,180 MWh and 11 MW.

provide measures to customers and receive rebates until program funding is exhausted. The program is not promoted directly to end-use customers.

10.2 Impact Evaluation Gross Savings

10.2.1 Reported Gross Savings

Table 10-1 shows the cumulative reported results by sector through the end of PY3. No rebates were provided to GNI customers during PY3. The number of measures listed represents the number of incentives provided, which include diagnostic test-in, economizer test and adjustment, refrigerant charge adjustment, and thermostat replacement. The number of participants listed in Table 10-1 represents the number of HVAC systems serviced. Each system may receive more than one incentive.

Sector	Participants ¹	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Small Commercial and Industrial	1,388	1,284	1.12	\$43
Large Commercial and Industrial	45	1	0.00	\$3
Government, non-profit, and institutional	0	0	0.00	\$3
CPITD Total ²	1,433	1,285	1.13	\$48
NOTES:				
1. Number of measures is different from t receive multiple measures.	he number of parti	cipants. A participant	is defined as an HVAC sys	tem which can
2. Summing the sector level reported gros	s savings will not e	qual the program leve	el savings; these totals dif	fer by .5 MW. The

Table 10-1: CPITD HVAC Tune-Up Program Reported Results by Sector

Table 10-2 breaks out the program's PY3 participation, savings, and incentives by quarter.

difference is due to a change in the data tracking and reporting method from PY2 to PY3.

Reporting Period	Participants ¹	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY3 Q1	462	371	0.38	\$20
PY3 Q2	250	408	0.17	\$19
PY3 Q3	0	0	0.00	\$0
PY3 Q4	10	37	0.04	\$0
PY3 Total	722	817	0.60	\$39
CPITD Total	1,433	1,285	1.08	 \$48

Table 10-2: HVAC Tune-Up Program Reported Results by Quarter

1. Number of measures is different from the number of participants. A participant is defined as an HVAC system which can receive multiple measures.

10.2.2 EM&V Sampling Approach

Realization rates for the PY3 HVAC Tune-Up Program were determined through EEMIS records reviews, contractor interviews from PY2 with updated participation data from PY3, and an engineering review of data. The energy and demand savings resulting from tune-up measures were estimated using contractor reported measurements, which serve as inputs to the implementation CSP's proprietary savings estimator. All measurement and savings data reported in PY3 were reviewed for errors and reasonableness of savings.

The sampling strategy for the HVAC Tune-Up Program records reviews is presented in Table 10-3.

Stratum	Strata Boundaries ¹	Population Size	Assumed Coefficient of Variation (Cv) or Proportion in Sample Design ²	Target Levels of Confidence & Precision ²	Target Sample Size	Achieved Sample Size	Evaluation Activity
EEMIS Record Review	N/A	722	N/A	N/A	Census	Census	Impact
Program Total	N/A	722	N/A	N/A	Census	Census	Impact
NOTES:		<u> </u>					
1. Since the HVAC Tu	ne-Up Program	had low partici	pation, stratification	was not used f	or this progr	am's evaluati	on.
2. Variability and pre	cision targets ar	e not relevant	for census reviews.				1

Table 10-3: HVAC Tune-Up Program Sampling Strategy for PY3

The evaluation included a full database review (covering a census of PY3 program participants), so the final savings estimate is not subject to sampling error. Because of this, it is not meaningful to speak of the sampling precision of the verified savings total.

10.2.3 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 their 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 expected performance and measured performance values were used to develop an efficiency index and a capacity index.

The PPL Electric 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. The reported savings were found to be reasonable compared to the standard savings algorithms in the 2011 TRM. The TRM algorithms are intended for systems that do not have any change in refrigerant capacity. As they were found reasonable and were used for PY2, no additional review was completed for the PY3 evaluation.

10.2.4 Ex Post Adjustment Methodology and Findings

Deficiencies in records were discovered during the first review of all reported data. There were 16 initial diagnostic test-in records missing from EEMIS. None of these deficiencies affected the gross reported savings. When the missing records were discovered, the program implementation CSP provided the additional data to the EM&V CSP.

10.2.5 Savings Realization Rate Methodology

The PY2 evaluation revealed that FDSI's energy-savings calculation methodology is sound and rigorous. An engineering review of all reported measures was performed to verify savings claimed in PY3. 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.

10.2.6 Summary of Evaluation Results

In PY3, the HVAC Tune-Up Program realized 100% of the *ex ante* adjusted energy savings, as shown in **Table 10-4**. The majority of energy and demand savings are attributable to the small C&I sector. The large C&I sector reported negative energy savings, because some of the measures improved comfort by decreasing temperature setpoints with no system efficiency improvement.

Sector	Reported Gross Savings (MWh/yr)	Adjusted Ex Ante Gross Savings (MWh/yr)	Energy Realization Rate	Observed CV ⁻	Relative Precision	Verified Gross Savings (MWh/yr)
Small Commercial and Industrial	820	820	100%	N/A	N/A ²	820
Large Commercial and Industrial	-3	-3	100%	N/A	N/A ²	-3
Program Total ³	817	817	100%	N/A	N/A	817

Table 10-4: PY3 HVAC Tune-Up Program Stratum-Level Evaluation Results for Energy Savings¹

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. This evaluation amounted to a full database review (covering a census of PY3 program participants): As a result, the final savings estimate is not subject to sampling error.

3. These are the values used in reporting program-level energy savings. (Savings targets for MWh refer to values at the point of consumption.)

In PY3, the HVAC Tune-Up Program realized 100% of the *ex ante* adjusted demand savings, as shown in **Table 10-5**.

Table 10-5: PY3 HVAC Tune-Up Program Evaluation Results for Demand Reduction by Stratum¹

Stratum	Reported Gross Reduction (MW)	Adjusted <i>Ex Ante</i> Gross Reduction (MW)	Demand Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision	Verified Gross Reduction (MW)
Small Commercial and Industrial	0.595	0.644	100%	N/A ²	N/A ²	0.644
Large Commercial and Industrial	.001	0.001	100%	N/A ²	N/A ²	1.0
Program Total ³	0.595 ³	0.645 ³	100%	N/A	N/A	0.645 ³

NOTES:

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

2. This evaluation amounted to a full database review (covering a census of PY3 program participants). As a result, the final savings estimate is not subject to sampling error.

3. These are the values used in reporting program-level demand savings. (Savings targets for MW refer to values at the point of generation.)

10.3 Impact Evaluation Net Savings

10.3.1 Net-to-Gross Ratio Methodology

The NTG ratio in PY3 was calculated using PY2 research, which assessed freeridership by identifying contractors who were already using a diagnostic tool similar to the tool required by the program. These contractor interviews in PY2 assessed each individual contractor's level of freeridership.

10.3.2 Net-to-Gross Ratio Findings

Only one contractor was considered a freerider in PY2 and that contractor did not participate in PY3. No additional freeridership assessment was conducted in PY3. Results from PY2 were used to estimate the NTG ratio, which is 1.0.

10.4 Process Evaluation

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

10.5 Financial Reporting

A breakdown of the program finances is presented in

Table 10-6.

IQ (\$1,000)	PYTD (\$1,000)	CPITD (\$1,000)
\$0	\$39	\$48
\$0	\$0	\$0
\$0	\$39	\$48
\$0	\$0	\$0
\$0	\$0	\$0
\$4	\$91	\$726
\$0	\$3	\$18
\$0	\$0	\$0
\$4	\$94	\$744
\$0	\$0	\$0
\$0	\$0	\$0
\$4	\$133	\$793
N/A	\$17	\$17
N/A	\$150	\$810
N/A	\$150	\$742
N/A	\$343	\$391
N/A	\$83	\$133
N/A	\$426	\$598
N/A	\$426	\$524
N/A	2.84	0.71
	IQ (\$1,000) \$0 \$1 \$0 \$0 \$1 \$0 \$1 \$1 \$1 \$2 \$2 \$3 \$3 \$4 \$1 \$2 \$3 \$3 \$3 \$4 \$3 \$4 \$4 \$4 \$4 \$1 \$2 \$3 \$3 \$4 \$4 \$4 \$4 \$4 \$5 \$4 \$5 \$4 \$4 \$4	IQ FTID (\$1,000) (\$1,000) \$0 \$39 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$3 \$0 \$3 \$0 \$3 \$0 \$0 \$1 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$133 N/A \$14 \$133 N/A \$150 N/A \$150 N/A \$343 N/A \$426 N/A \$426 N/A \$426 N/A \$284 </td

Table 10-6: Summary of HVAC Tune-Up Program Finances

NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Tatal 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.
- Per the 2011 Total Resource Cost Test Order, the net participant costs are the costs to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC Costs includes Total EDC Costs and Participant Costs.
- For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 Discounted TRC Benefits divided by Total Discounted TRC Costs.

11 Home Energy Assessment & Weatherization Program

The Home Energy Assessment & Weatherization Program was designed to provide PPL Electric residential customers with information on their home's 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.
- 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 \$150 rebate if their home has either main source electric heating or CAC, or \$250 for customers with both main source electric heating and CAC.

The objectives of the Home Energy Assessment & Weatherization Program include:

- Providing customers with the opportunity to participate in a walk-though 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.
- Promoting other PPL Electric energy efficiency programs.
- Obtaining participation of no less 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.

11.1 Program Updates

The Home Energy Assessment & Weatherization Program has been in operation since PY2 Q2. During PY3, PPL Electric eliminated air sealing as a recommended measure. Savings for the measure were deemed, but the data necessary to calculate and verify the savings—air changes per hour from pre- and post-treatment blower door tests—were not collected for customers participating in a \$50 walk-through survey, as the blower door test was only included in the comprehensive audits.

Additionally, PPL Electric added a third comprehensive audit type for customers with neither a main source electric heat nor central air conditioning, in order to provide all customers the benefits of the

information provided in the audit. Such customers were not eligible for an audit rebate, however, nor were they eligible for the bonus, duct sealing, or insulation rebates.

11.2 Impact Evaluation Gross Savings

11.2.1 Reported Gross Savings

 Table 11-1 shows the CPITD reported gross energy savings and incentives paid, and Table 11-2 presents

 PY3 participation and savings by quarter. This program is limited to customers in the residential sector.

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
Residential	3,063	2,975	0.25	\$231
CPITD Total	3,063	2,975	0.25	\$231
NOTES:	- <u>.</u>		······	
1. Summing the s The difference	ector level reported gross is due to a change in the c	savings will not equal the program data tracking and reporting metho	m level savings; these totals differ ad from PY2 to PY3.	⁻ by .02 MW.

Table 11-1: CPITD Home Energy Assessment & Weatherization Program Reported Results by Sector

Participants, energy savings, and demand reductions in PY3 Q1 through Q3 presented in Table 11-1 represent only participation in the audit option of the program. The values for PY3 Q4 include 1,069 weatherization and bonus rebate records that were uploaded into PPL Electric's EEMIS tracking database in Q4. Without the addition of these bonus rebate and weatherization records, there were only 92 participants in Q4, providing reported gross savings of 58 MWh/yr and 0.009 MW, for a PY3 total of 703 participants with 445 MWh/yr of reported gross energy savings and 0.069 MW of reported gross demand reduction. The reported gross CPITD total participants, energy savings and demand reduction would be 2,452 participants, 2,588 MWh/yr, and 0.19 MW without the bonus rebate and weatherization participants and savings.

Table 11-2: PY3 Home Energy Assessment & Weatherization Program Reported Results by Quarter

Reporting Period	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives (\$1,000)
PY3 Q1	196	118	0.01	\$26
PY3 Q2	228	151	0.03	\$28
PY3 Q3	187	118	0.02	\$18
PY3 Q4	1,161	1,731	0.14	\$17
PY3 Total	1,772	2,118	0.19	\$88
CPITD Total	3,063	2,975	0.23	\$231

11.2.2 EM&V Sampling Approach

The EM&V CSP drew a random sample to meet specifications of the PY3 verification sampling plan (see Appendix B). The EM&V CSP conducted telephone surveys with 70 randomly selected customers who participated in PY3. The surveys were used to assess participant satisfaction with the program and sources of program information, as well as to verify the measures and measure quantities recorded in EEMIS. The survey targets were for 35 walk-through participants and 35 audit participants. The EM&V CSP completed surveys for 36 walk-through survey participants and 35 audit participants, as shown in **Table 11-3**.

Stratum	Population Size	CV. Assumed in Sample: Design	Target Levels of C/P	Target Sample Size	Achieved Sample Size	Evaluation Activity
Home Energy Survey	434	0.5	90/10	35	36	Phone Survey
Comprehensive Audit	269	0.5	90/10	35	35	Phone Survey
Weatherization Rebate ¹	107	N/A	N/A	42	42	Phone Survey
Program Total	810	0.5	90/10	112	113	
NOTES: 1. Because the phone su limited to participants	rvey asked ques who had install	tions about the rec	ommendation measures as t	s from the surve he result of reco	ey or audit, th Immendation	e sampling frame was s made during a walk-

Table 11-3: Home Energy Assessment & Weatherization Program Sampling Strategy for PY3

As specified in the PY3 verification sampling plan (Appendix B) and the program's EM&V plan, the EM&V CSP selected a sample of 60 records for verification through records reviews. Records were stratified by audit type: walk-through survey (EEMIS measure code PEU), comprehensive audit of main source electric heat and CAC (PEY1), comprehensive audit of main source electric heat or CAC (PEY2), and

through survey or audit. All such participants were associated with an audit that had occurred in PY2.

audit type: walk-through survey (EEMIS measure code PEU), comprehensive audit of main source electric heat and CAC (PEY1), comprehensive audit of main source electric heat or CAC (PEY2), and comprehensive audit with neither main source electric heat nor CAC (PEY4). The EM&V CSP selected half of the sample points from records that had walk-through surveys. The remaining six points were evenly split between the two comprehensive audit types: all-electric and CAC only.

The EM&V CSP also selected a simple random sample of 10 bonus rebate records and sample of 10 accounts where participants installed recommended weatherization measures for records reviews. Additionally, the EM&V CSP selected a sample from the insulation records of the 30 records with the highest R-values and four records with high square footage installed for review.

The target C/P is 85/15 at the program level. **Table 11-4** shows the annual sample size allocations for each stratum within the Home Energy Assessment & Weatherization Program for the records review samples.

for PY3						
Stratum	Population Size	CV Assumed in Sample Design	Target Levels of C/P	Target Sample Size	Achieved Sample Size	Evaluation. Activity
Home Energy Survey	434	0.5	85/15	23	23	Records review
Comprehensive Audit – MSEH ¹ and CAC	93	0.5	85/15	15	15	Records review
Comprehensive Audit – MSEH or CAC	174	0.5	85/15	20	20	Records review
Comprehensive Audit – No MSEH or CAC	2	0.5	85/15	Census	2	Records review
Bonus Rebate	73	N/A	N/A	10	10	Records review
Weatherization Rebate	737	N/A	N/A	10	10	Records review
Program Total	1,446	0.5	85/15	80	80	;
NOTES: 2. MSEH stands for Main So	urce Electric Hea	t		· · · · ·		

Table 11-4: Home Energy Assessment & Weatherization Program Records Review Sampling Strategy

11.2.3 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 savings estimates published in the TRM that were 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 data recording errors.

Some records in the PY3 tracking data have installation dates that occurred during PY2. 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 savings for aerators in the 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 × 61 kWh/year with a demand reduction of ISR × 0.056 kW, with ISR determined through data collection,"²⁹ the value produced by the algorithm is 0.0056 kW. The EM&V CSP adjusted the *ex ante* deemed savings value for aerators to be 0.0056 kW.

²⁹ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2011. p. 44.

11.2.4 Ex Post Adjustment Methodology and Findings

The TRM-adjusted *ex ante* values do not include adjustments for the ISR. The EM&V CSP accounted for the ISR during the realization rate calculation. The EM&V CSP calculated these values using information collected and analyzed from phone surveys of 71 PY3 survey and audit participants.

The records reviews of the sample with high R-values and square footage revealed that while the square footage and ceiling insulation data was transferred from the rebate forms to the (third party) administrative CSP's database accurately, some of the wall insulation R-values were entered inaccurately. The EM&V CSP informed PPL Electric of this, and PPL Electric is updating the data entry practices with the program implementation CSP and the administrative CSP.

For all records selected into the 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 and audit intake forms. The EM&V CSP documented the differences between the three data sources. Resulting adjustments to measure counts are shown in **Table 11-5**.

Measure	Adjustment to N	<i>Ex Ante</i> Reported Per Unit kWh/yr	<i>Ex Ante</i> Adjusted Per Unit kWh/yr	<i>Ex Post</i> Per Unit kWh/yr	<i>Ex Ante</i> Reported Per Unit kW	<i>Ex Ante</i> Adjusted Per Unit kW	<i>Ex Post</i> Per Unit kW
CFL	-18	50	50	57	0.002	0.002	0.003
Faucet Aerator - Bathroom	15	61	61	60	0.056	0.0056	0.0055
Faucet Aerator - Kitchen	0	61	61	60	0.056	0.0056	0.0055
Pipe Insulation	0	124	124	124	0.011	0.011	0.011
Smart Power Strip	-2	184	184	184	0.013	0.013	0.013
Water Heater Temperature Setback	0	61	0	0	0.01	0	0

 Table 11-5: Home Energy Assessment & Weatherization Program Adjustments to Measure Quantities

 and Per-Unit Savings

Responses captured through telephone surveys were used to calculate a reported ISR for CFLs (95%) and faucet aerators (98%). This reported ISR for CFLs in PY3 is higher than the rate used in the 2011 TRM (84%), as well as being higher than the value found in the phone survey of PY2 participants (85%). Adjusting the ISR for CFLs raises the deemed value for this measure from 50 kWh/yr to 57 kWh/yr and from 0.002 kW to 0.003 kW.

Using the evaluated ISR for aerators of 98% reduces the kWh/yr savings for faucet aerators from 61 kWh/yr to 60 kWh/yr. Adjusting the deemed kW value reduces the demand savings for aerators from 0.0056 kW to 0.0055 kW.

The EM&V CSP adjusted all savings for water heater temperature adjustments to zero, because there is no entry in the 2011 TRM for this measure. Additionally, PPL Electric decided to claim no savings for this

measure because it was too difficult to assess whether the setback temperature had been maintained since the audit, or whether it was reset by the customer after the audit.

11.2.5 Savings Realization Rate Methodology

The realization rate includes adjustments for actual installation rates, failure rates, and corrections to baseline assumptions. 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. The realization rate was calculated as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

11.2.6 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 which 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.

For the weatherization rebates option of the program, the EM&V CSP found no difference between the reported and verified savings claimed by the program; therefore, standard variance calculations were not applicable. The EM&V CSP calculated precision estimates using the exact binomial method instead, which yields very conservative estimates of precision.

 Table 11-6, Table 11-7, and Table 11-8 show the realization rates for energy and demand for the Home

 Energy Assessment & Weatherization Program.

Stratum	Reported Gross Savings (MWh/yr)	Adjusted Ex Ante Gross Savings (MWh/yr)	Energy Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision (90% conf.)	Verified Gross Savings (MWh/yr)
Home Energy Assessment	445	472	99.7%	0.145	1.9%	471
Weatherization Rebates	1,673	1,673	100.0%	N/A ²	4.1% ³	1,673
Program Total	2,118	2,145	99.9%	N/A	3.4%	2,144

Table 11-6: PY3 Home Energy Assessment & Weatherization Program Energy Savings by Stratum¹

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. In light of the PY3 verification results, the EM&V CSP anticipates that the PY4 sample will contain few or no erroneous records. It is therefore likely that the PY4 precision calculations will also use the exact binomial method.

3. The EM&V CSP used record reviews and phone surveys to verify savings for a sample of 45 weatherization projects. All 45 records were found to be error-free, so the EM&V CSP estimated the realization rate to be 100%. Since the sample included no deviations between adjusted *ex ante* and verified savings values, the EM&V CSP calculated precision using the exact binomial method.

Table 11-7: PY3 Home Energy Assessment & Weatherization Program Demand Reduction by Type

Savings Type	Reported Gross Reduction (MW)	Adjusted <i>Ex Ante</i> Gross Reduction (MW)	Demand Realization Rate	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Total Program Savings at Generator ¹	0.191	0.174	100.2%	3.5%	0.174
Total Program Savings at Meter	0.191	0.161	100.2%	3.5%	0.161

NOTES:

1. This is the value used in reporting program-wide demand savings. (Savings targets for MW refer to values at the point of generation.)

Stratum	Reported Gross Reduction (MW)	Adjusted <i>Ex</i> Ante Gross Reduction (MW)	Demand Realization Rate	Observed Coefficient of Variation (C _v)	Relative Precision (90% conf.)	Verified Gross Reduction (MW)
Home Energy Assessment	0.059	0.030	101.1%	0.155	2.1%	0.030
Weatherization Rebates	0.131	0.131	100.0%	N/A ²	4.1% ³	0.131
Program Total	0.191	0.161	100.2%		3.5%	0.161

Table 11-8: PY3 Home Energy Assessment & Weatherization Program Demand Reduction by Stratum¹

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. In light of the PY3 verification results, the EM&V CSP anticipates that the PY4 sample will contain few or no erroneous records. It is therefore likely that the PY4 precision calculations will also use the exact binomial method. The formula typically used to calculate necessary sample sizes (as a function of confidence, precision, and CV) assumes precision will be based on a Wald (or similar) confidence interval. That formula will not yield an appropriate sample sizes in the present context.
- 3. The EM&V CSP-used record reviews and phone surveys to verify savings for a sample of 45 weatherization projects. All 45 records were found to be error-free, so the EM&V CSP estimated the realization rate to be 100%. Since the sample included no deviations between adjusted *ex ante* and verified savings values, the EM&V CSP calculated precision using the exact binomial method.

11.3 Impact Evaluation Net Savings

11.3.1 Net-to-Gross Ratio Methodology

Energy audits are not like some other measures where the customer may install them in the absence of the program, such as with high-efficiency HVAC or ENERGY STAR appliances. It is not very likely that a customer will pay for an audit in the absence of the program; therefore, freeridership was not assessed for the audit option of the Home Energy Assessment & Weatherization Program. Freeridership may exist for customers installing recommended measures, however. Participant surveys were used to assess freeridership for these customers.

To estimate spillover, both 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.

11.3.2 Net-to-Gross Ratio Findings

Surveys with 42 participants who followed through and installed measures recommended as a result of the home energy survey or comprehensive audit collected data to inform the NTG ratio. Respondents were asked about the projects they completed, including whether they would have installed the same measures without the weatherization rebate. Once the freeridership scores were determined for each participant, a savings-weighted score was computed. That is, the individual score was multiplied by the

participant's verified savings to determine a savings-weighted score. In this way, scores for very large projects carry greater weight than scores for much smaller projects. The savings-weighted freeridership score was 18% for this program, and the NTG ratio prior to adjustment for spillover for the program was 82%.

No final adjustment for net savings will be made until required by the PA PUC.

Table 11-9 presents the spillover kWh/yr savings as a percentage of total program savings for these respondents.

Program	Spillover Savings (kWh/yr)	Program Savings (kWh/yr)	Spillover
Home Energy Assessment & Weatherization	304	46,444	0.7%

Table 11-9: Home Energy Assessment & Weatherization Program Spillover Savings

The analysis of responses yielded an overall spillover of 0.7%. **Table 11-10** provides a summary of the NTG results adjusted for spillover. The analysis was calculated at the 90% confidence level.

Table 11-10: Summary	of NTG for Home Energy	Assessment &	Weatherization Program
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Program	Freeridership Score	Participant Spillover	NTG	NTG Precision
Home Assessment & Weatherization	18%	0.7%	83%	±10%

11.4 Process Evaluation

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

11.5 Financial Reporting

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

	IQ (\$1,000)	PYTD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$17	\$88	\$231
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$17	\$88	\$231
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$72	\$484	\$1,089
Marketing ³	\$1	\$30	\$30
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$73	\$515	\$1,119
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$90	\$603	\$1,351
Participant Costs ⁵	N/A	\$1,646	\$1,853
Total TRC Costs ⁶	N/A	\$2,249	\$3,204
Discounted TRC Costs ⁷	N/A	\$2,249	\$2,814
Total Lifetime Energy Benefits	N/A	\$2,760	\$2,859
Total Lifetime Capacity Benefits	N/A	\$56	\$75
Total TRC Benefits ⁸	N/A	\$2,816	\$3,378
Discounted TRC Benefits	N/A	\$2,816	\$2,934
TRC Ratio ⁹	N/A	1.25	1.04

Table 11-11: Summary of Home Energy Assessment & Weatherization Program Finances

NOTES

Per PUC direction, TRC inputs and calculations are required in the Annual Report only and should comply with the 2011 Total Resource Cast 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.
- Per the 2011 Total Resource Cost Test Order, the net participant costs are the costs to the end-use customer (net participant costs = full incremental cost minus incentives).
- 6. Total TRC Costs includes Total EDC Costs and Participant Costs.
- For the PYTD column, both Total and Discounted TRC Costs and Benefits are discounted to PY3 and are therefore equal. For the CPITD column, Total TRC Costs and Benefits are also discounted to PY3. However, Discounted TRC Costs or Benefits row values are discounted back 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 Discounted TRC Benefits divided by Total Discounted TRC Costs.

12 Direct Load Control Program

PPL Electric began recruiting participants for the Direct Load Control Program in PY2 Q4, and as of the end of PY3 there were 34,960 participants enrolled. However, there are no savings claimed in PY3 because the program will only claim savings in PY4, from June 1 through September 30, 2012, the only period when peak load reductions apply.

There were costs associated with recruitment of participants and other general program management. A breakdown of the program finances is provided in **Table 12-1**. The TRC will be calculated as part of the PY4 Annual Report.

	IQ (\$1,000)	PYTD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$0	\$0	\$0
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$0	\$0	\$0
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$1,065	\$6,152	\$7,141
Marketing ³	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$1,065	\$6,152	\$7,141
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$1,065	\$6,152	\$7,141
Participant Costs ⁵	N/A	N/A	N/A
Total TRC Costs ⁵	N/A	N/A	N/A

Table 12-1: Summary of Direct Load Control Program Finances

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. The TRC for the Direct Load Control Program will be carried out as part of the PY4 Annual Report.

13 Load Curtailment Program

PPL Electric began recruiting participants for the Load Curtailment Program in PY3 Q1, and as of the end of PY3 there were 98 participants enrolled. However, there are no savings claimed in PY3 because the program will only claim savings in PY4, from June 1 through September 30, 2012, the only period when peak load reductions apply.

There were costs associated with recruitment of participants and other general program management. A breakdown of the program finances is provided in **Table 13-1**. The TRC will be calculated as part of the PY4 Annual Report.

	IQ (\$1,000)	PYTD (\$1,000)	CPITD (\$1,000)
EDC Incentives to Participants	\$0	\$0	\$0
EDC Incentives to Trade Allies	\$0	\$0	\$0
Subtotal EDC Incentive Costs	\$0	\$0	\$0
Design & Development	\$0	\$0	\$0
Administration ¹	\$0	\$0	\$0
Management ²	\$1,830	\$3,945	\$4,096
Marketing ³	\$0	\$0	\$0
Technical Assistance	\$0	\$0	\$0
Subtotal EDC Implementation Costs	\$1,830	\$3,945	\$4,096
EDC Evaluation Costs	\$0	\$0	\$0
SWE Audit Costs	\$0	\$0	\$0
Total EDC Costs ⁴	\$1,830	\$3,945	\$4,096
Participant Costs ⁵	N/A	N/A	N/A
Total TRC Costs ⁵	N/A	N/A	N/A

Table 13-1: Summary of Load Curtailment Program Finances

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.

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

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

8. Includes the marketing CSP and marketing costs by program CSPs.

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

10. The TRC for the Direct Load Control Program will be carried out as part of the PY4 Annual Report.

Appendix A: EM&V Components

Introduction

PPL Electric's program evaluation and continuous improvement process has three basic components: activity tracking, QA/QC, and EM&V.

Activity Tracking

PPL Electric's EEMIS is the infrastructure for tracking all program activities and transactions, including participant information, measure installations, participant costs, incentive payments, and other technical data related to individual projects.

The EEMIS database tracks all transactions, including date enrolled, participant's customer number and name, date of measure installation, name of measure, name of program, key measure-specific information to verify eligibility or determine savings (such as seller, manufacturer, model number, serial number, capacity, or efficiency rating), incentives paid, and other information as required. It also calculates *ex ante* reported gross savings for some measures by multiplying the quantity by deemed savings listed in a Measures Table. EEMIS records savings reported by CSPs for other programs (e.g., Appliance Recycling Program, CFL Campaign).

Quality Assurance/ Quality Control

QA/QC is integral to PPL Electric's program delivery processes and customer and CSP relationsmanagement processes. To ensure the highest standards, PPL Electric has incorporated a plan in its portfolio describing the QA/QC procedures for each program.

Quality assurance involves activities designed to ensure that an effective process and the necessary resources are in place for the implementation process to operate efficiently and for the Plan to meet its objectives. Quality assurance provides the basis for establishing an effective implementation process and, more importantly, preserving the institutional memory of program operation and maintenance.

Quality control measures ensure that the outcomes and results of the implementation process conform to performance expectations for each program and for the portfolio as a whole. The quality control component of the QA/QC process includes developing a set of reliable key performance indicator (KPIs) which may include process efficiency, data integrity and accuracy, energy and demand savings, and customer satisfaction.

Evaluation, Measurement, and Verification

The key objective in impact evaluations (encompassing EM&V activities) is to determine, at the specified statistical levels of confidence and precision in the Audit Plan, the *ex post* gross and net energy (MWh/yr) and peak demand savings (MW) attributable to each program in PPL Electric's portfolio.

Measurement of gross MWh/yr and MW impacts for each program and for the portfolio as a whole are based on actual program impacts as defined in the TRM, Audit Plan, and PPL Electric's Evaluation Plan. These impacts were assessed using the procedures prescribed in the Audit Plan and PPL Electric's Evaluation Plan.

In addition, the impact evaluation estimated the *ex post* savings impacts of program measures that have fully deemed, partially deemed, or non-deemed savings. Econometric models of electricity consumption will be used to estimate some measure impacts, based on the definitions from the Act 129 Glossary of Terms (outlined as follows):

- *Ex Ante* Savings Estimate (Reported Gross Savings): Savings calculated based on the data in the utility's tracking system and reported to the Act 129 SWE. Note that these savings may not be the same as those in the utility's initial plan due to changes in TRM values, other planning assumptions, and actual participation.
- Ex Ante Adjusted Savings Estimate (Adjusted Reported Gross Savings): Reported ex ante savings adjusted prior to verification. Adjustments bring the savings into line with the TRM deemed or partially deemed savings.
- **Ex Post Gross Verified Savings Estimate**: Saving estimates reported by an evaluator after the M&V process has been completed.
- Savings Realization Rate: This term is used in several contexts in the development of reported program savings. As indicated in the Act 129 Audit Plan prepared by the SWE, the reported realization rate is calculated as:

Ex post gross verified savings / Ex ante (adjusted reported gross) savings

Calculation of Ex Ante Adjusted Savings

Determination of *ex ante adjusted* savings involves adjusting the reported *ex ante* savings estimates for a number of factors, including:

 Revised parameters used in calculation of unit savings or corrections to open variables or assumptions about measure characteristics (e.g., geographic location, configuration). These are based on actual project application records. An adjustment can occur, for example, where the reporting database used one deemed value for a measure where the TRM has several deemed values that depend on configuration or location.

Calculation of Ex Post Savings

Determination of *ex post* savings involves adjusting the *ex ante* savings estimates for a number of factors that affect the calculation of savings, including:

- Corrections to data or calculation errors by the program implementers (CSPs) during the transfer of data to the tracking system, or errors within the tracking system.
- Actual installation rates.

- Possible failure rates.
- Changes in operating assumptions (e.g., business closures).

These adjustments are identified and, where applicable, reported for each program to provide a better perspective on the specific components of the savings realization rate for each program. **Figure A-1** illustrates the discussion above, progressing from *ex ante* to *ex post* evaluated savings.



Figure A-1: Ex Ante to Ex Post Savings Estimates

Measurement of Savings

Gross program savings are those savings expected to result from the program based on the as-installed performance of measures, as defined in the Audit Plan.

Sample-based surveys or site inspections are the main methods for verifying installations, as well as for verifying savings for measures in the TRM with fully deemed savings. For partially-deemed measures specified in the TRM, operating assumptions and other parameters will be validated using the procedures recommended in the Audit Plan and described in detail in program-specific EM&V plans.

Unique methods will be employed for verifying savings of measures offered under the Custom Incentive Program, which will be described in full for each project. Measures not included in the TRM will require custom methods for determining and verifying savings, called CMPs, which will be submitted to and approved by the SWE.

Methods for measuring savings for each program in the Plan are described in detail, according to the specifications of the Audit Plan and based on the IPMVP.

Figure A-2 shows the data sources and activity tracking for the PPL Electric Utilities Act 129 programs.



Figure A-2: Data Sources, Activity Tracking, and Evaluation Activities

Appendix B: PY3 Verification Sampling

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. Cadmus revised the sampling plans that were initially discussed in the individual program evaluation plans submitted to, and approved by, the SWE. This appendix reviews the updated sampling plans and verification activities for PPL Electric's ACT 129 programs. The revisions bring PPL Electric sampling plans into alignment with the SWE directives, and still exceed the SWE sampling guidelines.

SWE's sampling guidelines direct revisions to the existing sampling plans according to five primary instructions. These are:

- 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/Institutional 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 approved EE&C Plan. Of these, ten programs claimed savings in PY2 (the two demand response programs do not start claiming savings until the June 1, 2012 through September 30, 2012 summer demand response period is complete. The portfolio includes a number of programs that serve multiple sectors.

Participant Definitions

Participants are defined differently by program, as shown in **Table B-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 B-1**.

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 purchased, 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)	Yes	account number
Low Income 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
Low Income E-Power Wise	Household (unique account number): 1 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.	Yes	Project - Job number
Direct Load Control	Unique account number (Household or business).	No	Account number, CSP job number
Load Curtailment	Project.	No	Project - Job number

Table B-1: PY3 Participant Definition by Program

PY3 Evaluation Activities

Evaluation activities and measure verification include records review, participant surveys, site visits and metering. The records reviews also play a primary role in QA/QC. Where metering will be conducted, the sample will be nested within site visits. Site visits, by their nature, include records review. **Table B-2**

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shows the evaluation activities planned for each of the programs that will claim savings in PY3. Nonparticipant surveys will be conducted for select programs to collect information for the net savings adjustments.

Programs	Sectors	Records Review	Participant Surveys	Non-participant Surveys	Site Visits	Metering
Appliance Recycling	Residential	Census Quarterly	Planned Q4	NA	NA	NA
CFL Lighting Campaign	Residential	Census Quarterly	Planne	ed Q4	NA	NA
Consumer Behavior & Education	Residential	Census Quarterly	Planned Q4 Planned Q4		NA	NA
Efficient Equipment	Residential	Quarterly	Planned Q4	NA	NA	NA
Energy Assessment and Weatherization	Residential	Quarterly	Planned Q4	NA	NA	NA
Renewable Energy	Residential	Pro	ogram Closed to Resid	lential Sector PY3		
Low Income WRAP	Residential	Census to identify duplicates Quarterly, prorated by job type	NA	NA	NA	NA
Low Income E-Power Wise	Residential	Census database, Quarterly	Potential Q3	NA	NA	NA
Renewable Energy	Govt/Non- profit	Batched	Planned Q4	NA	Planned Q3, Q4	NA
Efficient Equipment non-lighting	Non-residential	Batched	Planned Q4	NA	Batched	NA
Efficient Equipment lighting	Non-residential	Quarterly	Planned Q4	NA	Quarterly	As needed
Efficient Equipment Direct Discount	Small commercial	Batched	Planned Q4	NA	Batched	As needed
HVAC Tune-Up	Small commercial	Batched	Contractors Customers	NA	Batched	Spot
Custom Incentive Program	Commercial & Industrial	Census large Sample small	Planned Q3, Q4	NA	As needed	As needed
Direct Load Control	Residential, Commercial	Planned Q3	Planned PY4	NA	NA	By CSP
Load Curtailment	Commercial & Industrial	Census	Planned PY4	Planned PY4	NA	By CSP

Table B-2: PY3 Planned Evaluation Activities

Sample Size Specifications

The PY3 sample targets shown in **Table B-3** are designed to meet 90% confidence and 10% precision by portfolio sector (residential and non-residential). Sampling targets are 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's Guidance Memo, each sector was considered first, and each program within the sector considered second.

Verification samples meet or exceed required rigor levels of 90/10 for the residential, non-residential, and low income segments. Generally, sample sizes meeting 90/10 are maximized at 68-70 sample points (using 0.5 CV).

Sample sizes by program meet or exceed 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 meet or are rounded up to meet or exceed this target. The government/non-profit/institutional sector meets or exceeds 85/15.

PY3 initial sample sizes were derived considering PY2 participation and verification realization rates. 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 will be revised (if needed) in PY3 Q4, considering participation in all measure groups.

	Conf &	PY2 Participation Population Used to determine PY3				
Programs	Precision	sample	Records Review	Participant Surveys	Site Visits	Notes
Appliance Recycling	85/15	13,083 (unique CSP job numbers)	Census (Quarterly Review)	70 participants (Planned Q4)	NA	Designed to meet minimum for 90/10 (68), prorated by appliance type. Prorate surveys among sectors in proportion to number of participants.
Residential Efficient Lighting (CFL Lighting Campaign)	90/10	All customers	Census (Quarterly Review)	300 (Planned Q4)	NA	Upstream program; participants unknown. Sample size 300, for a 90/10 precision target, including NTG adjustment.
Consumer Behavior & Education	90/5	50,000	Census (Planned Q4)	150 participants 40 drop-outs 150 non- participants (Planned Q4)	NA	Billing analysis includes census of participants Surveys examine program processes and measure adoption.
Efficient Equipment – residential	90/10	113,747	70 stratified	70 stratified (Planned Q4)	NA	Samples by stratum defined by technology (base on high, medium, low savings). See Table 8.
Efficient Equipment - Non- residential non-lighting (medium & small stratum)	85/15 in each of 2 strata	2,917	50 (12 Quarterly, batched)	50 (Planned Q4)	50 (Batched to occur in Q3 & Q4)	Samples by two strata (25 each) defined by measure groups. See Table 6.
Efficient Equipment - Non- residential Direct Discount	85/15	New delivery channel	25 (12 Quarterly, Batched Q3-Q4)	70 customers TBD contractors (Planned Q4)	25 (Batched to occur in Q3-Q4)	Measures primarily direct install lighting, some refrigeration. Contractors receive rebates and will be interviewed to discuss program process. Customers will be interviewed to verify measure installation. Site visit and survey samples are independent.

Table B-3: PY3 Annual Sampling Strategy by Program

Programs	Conf & Precision	PY2 Participation Population Used to determine PY3 sample	Records Review	Participant Surveys	Site Vicite	Notes
Efficient Equipment - Non- residential lighting (large stratum)	90/10	1,996 (unique CSP job numbers)	92 - same records as site visits (23 Quarterly)	70 (Planned Q4)	92 (23 Quarterly)	Large stratum included majority of ex ante savings; sample must approach 90/10; CV = .06(planned 23 site visits and records review per quarter). Sample size will meet GNI sector precision targets. Metering as needed (+/- 50% of TRM Appendix C EFLH). Prorate and target by sector (GNI, large, small commercial). 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	85/15	1,288	60	140 (Planned Q4)	NA	70 Surveys designed to meet minimum for 90/10 (68), sample points will be equally allocated by audit type (two program tracks). When records for participants installing recommended measures are uploaded, Cadmus will conduct a phone survey of 70 such participants. Records review sample size is designed to meet 85/15, with half of the sample points allocated to those receiving walk-through surveys and half of the sample points allocated to those receiving a comprehensive audit. Records review focus on QAQC; results are reported separately from surveys. Records review and surveys are independent samples.
Programs	Conf & Precision	PY2 Participation Population Used to determine PY3 sample	Records Review	Participant Surveys	Site Visits	Notes
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Renewable Energy, targets by sector (residential and GNI)	85/15	84 GNI 1,245 Res.	~5 GNI (Planned Q4)	~5 GNI (Planned Q4)	~5 GNI (Planned Q4)	Final sample depends on participation. Additional site visits and records needed to collect data required for analysis. There will likely be more than five, but the number will be based on actual enrollment.
Low Income WRAP		4,415	45-48 (10-12 Quarterly, prorated by job type)	NA	NA	85/15 prorated by job type. Designated low income programs meet 90/10 as a sector.
Low Income E-Power Wise	90/10	3,995	Census database 70 enrollment forms	70 (Planned Q4)	NA	70 participant surveys may be conducted with customers receiving the energy kit via direct mail delivery channel. Enrollment form review split between pilot direct mail and CBO delivery channel.
HVAC Tune-Up	85/15	300 serviced units	20 pre 20 post	10 contractors Customers TBD	20 pre 20 post	Midstream program; surveys with contractors. Contractor interviews focus on program processes and satisfaction. Spot measurements during site visits; 20 pre & 20 post. Possible surveys with customers if receive rebate.
Custom Incentive Program	90/10	54	All large Sample small	70 (Batched Q3-Q4; ~19 each quarter)	All large Sample small	Number of customer surveys proportionate with large and small projects (census of large if not many); allocate by sector proportionately. Metering and spot measurements as needed. Number of surveys depends on number of completed, paid, and verified projects each quarter. Surveys focus on customer satisfaction and the program processes.

Programs	Conf & Precision	PY2 Participation Population Used to determine PY3 sample	Records Review	Participant Surveys	Site Visits	Notes
Direct Load Control	85/15	New PY3 Test events PY3	50 (25 per sector) (Planned Q3)	(Planned PY4)	NA	Test events will be called in PY 3 (summer 2011). Demand reduction from events called in PY 4 (summer 2012) will be claimed. Surveys will be conducted in PY4.
Load Curtailment	85/15	New PY3 Test events PY3	Census (Planned PY4)	(Planned PY4)	NA	Review Forecasting methods & model performance. Demand reduction from events called in PY 4 (summer 2012) will be claimed. Surveys will be conducted in PY4.

The PY3 sampling strategy for each program 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 by government/non-profit/institutional (GNI) sector participants was monitored to determine whether it met 20% of the program's total program savings. Since the GNI sector did not reach 20% in PY3, GNI was not sampled as an independent sector in this program.

In PY2, there were over 400 measures rebated and 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. PY3 sampling plan is based on the participation in PY2, anticipating similar participation.

Non-residential Sector

The measure groups planned for the PY3 Efficient Equipment Program's non-residential participants are shown in **Table B-4**. The strata were determined from cumulative PY1 and PY2 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 PY3 medium stratum includes the ASD, VSD, compressors (including motors and refrigeration) measure groups. The PY3 non-residential small stratum includes HVAC measures, residential appliances, office equipment and miscellaneous measures. Program participants in the small strata sample selected for on-site verification are a subset of the medium strata. That is, sites selected for the medium strata include measures in the small strata. Coupling small strata measures with medium strata measures in the same site visit is an efficient use of resources. Also, in PY1, Cadmus, PPL, and the SWE agreed that less rigor is appropriate for the small strata. Most measures included in the small strata are residential and small appliances.

PY3 Efficient Equipment Non-residential Strata							
Stratum	Stratum Definition	PY2 Percent of Efficient Equipment verified savings	Measure Groups Included in Stratum	PY3 Sampling Rigor			
Large	Top measure	94%	Lighting	90/10, CV = .6			
Medium	Next 10%	5%	Compressors VSD Retrofit, ASD, Motors	85/15, CV = .5			
Small	Last 10%	1%	All others: HVAC, appliances, office equip, other	80/30, CV = .5			

Table B-4: PY3 Efficient Equipment Program Non-residential Stra

Since lighting measures included in the large stratum exhibited a large variability in the range of *ex ante* savings reported and verified savings in PY2, this stratum is again separated into large, medium, and small stratum. Each quarter the sample will be reexamined and the samples drawn according to the strategy shown in **Table B-5**: . That is, 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 PY3 sampling plan for verification activity for the non-residential lighting participants is shown in Table B-5: . Site visits, by their nature, include records review and verification. About 92 site visits are planned in PY3, (CV = .6), about 23 or 24 drawn from each quarter's participants (savings claimed in EEMIS). A sample of large stratum participants will be included in the telephone surveys.

PY3 Lighting Sample Strata					
Stratum	Quarterly PY3 Sample				
Large	Top 50%	12			
Medium	Next 30%	7			
Small	Last 20%	5			
	Total	24			

Table B-5: PY3 Efficient Equipment Non-residential Large Stratum: Lighting

Cumulatively, in PY1 and PY2, compressor VSD retrofits, ASD/VSD, and motors constituted 87% of all non-lighting measures in the non-residential sector. PY3 non-lighting strata are organized by measure group based on PY2 activity, as shown in **Table B-6**, along with the sample size for the independent verification activities, including records review, site visits, and surveys.

Table B-6: PY3 Efficient Equipment Non-residential Medium and Small Strata

PY3 Efficient Equipment Non-residential Medium and Small Strata						
Stratum Measure Groups Included PY3 Sampling Rigor Annual PY3 Sample						
Medium	Compressor VSD Retrofit, ASD/VSD, Motors	85/15, CV = .5	25 each: records review, survey, site visits			
Small	HVAC, appliances, office equip, other	85/15, CV = .5	25 each: records review, survey, site visits			

Non-residential Direct Discount Delivery Channel

In late PY2, PPL Electric introduced a new delivery channel for specific Efficient Equipment measures, targeting the small commercial sector. This delivery channel offers directly installed lighting and some refrigeration measures. Because this is a new delivery channel, both the delivery contractors (who receive the rebates) and the participating customers will be contacted for surveys. The verification sample size will be determined using the 85/15 rigor level, assuming a CV of 0.5. Based on anticipated participation of about 4,000 customers, a verification sample size of 23 to 25 participants will be targeted. This sample size will be used to draw independent samples for records review, surveys, and verification site visits. Contractor surveys will focus on program processes and collect data to assess the net-to-gross ratio.

Residential Sector

We based the PY3 sampling for residential sector participants in the Efficient Equipment program on the final PY1 and PY2 cumulative participation. The residential sector followed the same approach to define strata as that used in the large lighting strata. That is, the measure group with the top 50% of ex ante verified savings is included in the large stratum. Measure groups that made up close to the next 30% are included in the medium stratum. The remaining measures are included in the small stratum.

Table B-7 shows the PY2 and PY2 verification results in the Efficient Equipment program, residential sector, by stratum. These data were used to inform the sample plan for PY3.

PY3 Efficient Equipment Residential Strata						
Stratum	Stratum Definition	Percent of cumulative verified savings	PY1-PY2 Realization Rate and precision	Measure Groups		
Large	Top 50%	50%	84% RR; 13% precision	HVAC measures		
Medium	Next 30%	35%	99.8% RR; 0.5% precision	Appliances		
Small	Last 20%	15%	120% RR: 7.6% precision	HPWH RTS, refrigeration, office equipment, other		

Table B-7: Cumulative Efficient Equipment Program: Residential Strata

Table B-7 shows the measures included in each stratum in PY3. Because the cumulative realization rates and precision were very high for the small and medium strata, the majority of sample points in PY3 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 records reviews and surveys. By design, site visits were not used to verify measure installation.

Stratum	Stratum Definition	PY3 Measure Groups	PY3 Sample Size
Large	Top 50%	HVAC measures (CAC, ASHP, room AC, ductless mini-split)	46 (2/3 of total)
Medium	Next 30%	Appliances	12 (1/3 of total)
Small	Last 20%	HPWH, RTS, refrigeration, office equipment, other	12 (1/3 of total)

Table B-8: PY3 Efficient Equipment Program Residential Strata

Renewables Program

The Renewables Program offered two technologies during PY2, 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/institutioal sector in PY3. Installations were verified through records reviews, site visits and engineering analyses. The PY3 verification sample will meet rigor levels of 85% confidence and 15% precision. Verification activities will occur in Q4, to draw the sample from the largest population.

HVAC Tune-Up

Sampling procedures follow the HVAC Tune-up CMP approved by the SWE. The sample is based on individual serviced units, including all measures that apply to the serviced unit. The unit of sample is not a 'project' which could include multiple units at one location. Servicing can include multiple measures, depending on the outcome of the diagnostic test results. The unit sample size is based on the SWE's sampling guidelines, requiring sample sizes meeting an 85 percent confidence level with a 15% margin of error (precision). In PY2, 300 units were serviced. Using this population to estimate the sample for PY3, the sample size for 85/15 level of rigor is 22.

PY2 HVAC Tune-Up Sample						
Number of Sample Points (Units) by Verification Activity						
Surveys with Records Engir Technology Sector contractors Review Site Visits An						
HVAC Tune-Up	Non-residential	10	22	22	22	

Table	B-9:	PY2	HVAC	Tune-Up	Sample
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Custom Incentives 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). However, projects with savings below this threshold can also be included in the large stratum.

A sample of small projects will be selected from all projects completed and paid during PY3. 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.

Appliance Recycling

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 surveys will be fielded once, with a target sample of 70 respondents, meeting 90/10 criteria for confidence and precision. PY1 and PY2 non-participant survey data will be used in PY3; no new ARP non-participant surveys will be conducted in PY3. Non-participant surveys will be used to determine the net savings and part use factor. Sample sizes meet or exceed the SWE's requirements for sampling to meet 85/15 by program.

Residential Lighting

This CFL program is an upstream program, and participants 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 PY3, 300 customer surveys are targeted. The PY3 survey efforts are designed to target 90% confidence with 10% precision.

Consumer Behavior & Education

A survey of customers receiving Home Energy Reports will be conducted annually. In PY3, PPL Electric anticipates 10,000 customers will receive Home Energy Reports. Surveys will be conducted with 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 will be stratified by metropolitan area. The sample strata will be sufficiently large to estimate the program effect i.e., the difference between the two groups.

Energy Assessment and Weatherization

The EM&V CSP will draw a random sample to meet specifications of the SWE team's revised sampling requirements in Guidance Memo 003. Telephone surveys will be conducted with 70 randomly selected audit-only customers participating in PY3. The sample will be allocated equally between participation in the walk-through surveys and the comprehensive audit. An additional survey will be conducted of 70 randomly selected program participants who installed any of the major measures recommended in the walk-through survey or comprehensive audit.

An annual sample of 60 records (meeting 85/15 sampling criteria) will be selected and verified through a records review of the documentation. Records will be stratified by audit type: walk-through survey (EEMIS measure code PEU – 30 sample points), comprehensive audit of all electric items (measure code PEY1 – 15 sample points), and comprehensive audit of CAC only (measure code PEY2 – 15 sample points).

Low Income WRAP

The sample size for the two designated low income programs will meet sampling rigor of 90/10. In PY3, 45 - 48 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. Eight sample points per quarter will be randomly selected from sites where a field inspection was conducted; the remaining three sample points will be selected from sites which did not receive a field inspection. The sample points per quarter will be distributed as presented in **Table B-10**.

Stratum	Received a Field Inspection	Did Not Receive a Field Inspection	Total
Base Load	2	1	3
Low Cost	3	1	4
Full Cost	3	1	4
Total	8	3	11

Table B-10: PY3 Low Income WRAP Records Review Sample

Low Income E-PowerWise

Together with low income WRAP, the sampling exceeded requirements for 90/10 in the low income sector. Program's enrollment records will be reviewed to ensure that records were traceable from the implementation contractor's database to the PPL Electric EEMIS database, and to verify that the program counts only one kit per household. This review will capture duplications across program quarters. A QA/QC review of a random sample of 70 participant enrollment forms (35 pilot enrollment form and 35 CBO enrollment forms) will be conducted.

PPL Electric planned a pilot delivery channel, mailing the energy kits to customers. A telephone survey will be conducted with 70 direct mail participants to assess satisfaction and behavior changes associated with the program. The surveys included in the direct mail participant's kit will be included in the analysis.

No further surveys are planned for participants who receive the kit through their CBO.

Telephone Survey Sampling Procedures

Cadmus conducted telephone surveys in PY3, following a batch-wise sampling approach. Phone surveys were conducted for verification, to assess satisfaction and process-related issues, and to collect data needed to calculate the NTG ratio. The targets for completed phone surveys and the achieved completions are summarized in **Table B-11**. (Phone survey results are discussed by program in Appendix N: Process Evaluation.)

Program	Target Completes	Achieved Completes
Appliance Recycling	75	76
Residential Lighting	325	266
Energy Efficiency Behavior & Education: Participants and Drop-outs	190	191
Energy Efficiency Behavior & Education: Non-participants	150	150
Efficient Equipment Incentive: Residential Sector	70	72
Efficient Equipment Incentive: Fuel Switching	44	27
Efficient Equipment Incentive: Commercial Sector	120	120
Efficient Equipment Incentive: Direct Discount Participants	70	49
E-Power Wise: Direct Mail Kit Recipients	65	66
Renewable Energy	10	2
Home Energy Assessment & Weatherization: Weatherization Participants	70	71
Total	1,189	1,090

Table B-11: Summary of PY3 Survey Efforts

Cadmus developed two types of telephone survey sampling procedures for PPL Electric Utilities Act 129 programs. The first process, and most complex, 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, the Behavior & Education non-participant sample, and the non-participant spillover 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 informed various process evaluation metrics, verify measure installation, and collect data for the net-to-gross analysis. During PY3, the following methodology was used to select samples for telephone surveys with a sample of program participants.

- Appliance Recycling
- Efficient Equipment (Residential, Non-residential, Direct Discount)
- Renewable Energy
- Energy Assessment and Weatherization
- E-PowerWise

The sample for these surveys was selected using the same nine-step process used in PY2:

- 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. For each billing account, stratify according to the measure code with the largest deemed kWh savings value.
- 5. 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).
- 6. Remove any account with an invalid phone number (e.g., less than 10 digits, invalid area code, etc.).
- 7. Apply any additional exclusion to the pool of stratified accounts; this may include items like site visits or other phone verification activity.
- 8. 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.
- 9. For all selected names, append contact information and any program participation data needed to inform the read-ins for all survey questions.
- 10. 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. Two non-participant surveys were conducted in PY3.

- Residential Lighting
- Behavior and Education participants (program implemented by OPower)

The sample for these surveys will be drawn from PPL's customer information database or from the OPower participant database, as appropriate. A five-step process is used, 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.

Table B-12 summarizes the telephone survey activity for PY3 evaluation efforts.

Survey/Strata	Field Start Date	Field End Date	Target Completes	Achieved Completes	Average Call Time (minutes)
PPL Behavior and Education Participant and Drop Out			190	191	
Participants since PY2	A/0/2012	A /27 /2012	75	76	14:50
Participants since PY3	4/5/2012	4/2//2012	75	75	14.50
Opt-outs			40	40	
PPL Behavior and Education Non-participant	4/11/2012	4/21/2012	150	150	8:59
ARP Participant			75	76	
Refrigerator/Freezer Only	4/18/2012	2 4/23/2012	65	66	10:15
Refrigerator/Freezer + Room AC]		10	10	
Residential Lighting			325	266	
Recent CFL Purchasers who are Aware of Program			100	84	
Recent CFL Purchasers who are Not Aware of Program			75	76	
Non-recent CFL Purchasers who are Aware of Program	4/23/2012	5/9/2012		31	9:16
Non-recent CFL Purchasers who are Not Aware of Program	1		75	- 44	
Not Aware of CFLs	1		75	31	
Residential Efficient Equipment Participant	E /2 /2012	F/4/2012	70	72	
HVAC measures (CAC, ASHP, room AC, ductless mini-split)	5/2/2012	5/2/2012 5/4/2012	46	47	5.57

Table B-12: PY3 Final Telephone Survey Targets and Achievements and Fielding Statistics

Survey/Strata	Field Start Date	Field End Date	Target Completes	Achieved Completes	Average Call Time (minutes)
Appliances			12	12	
HPWH, RTS, refrigeration, office equipment, other		 	12	13	
Fuel Switch	7/17/2012	7/30/2012	44	27	10:11
Commercial Efficient Equipment Participant			120	120	
Lighting (large)			70	71	9:08
Compressors VSD Retrofit, ASD, Motors (medium)	4/30/2012	5/17/2012	25	5	
All Others: HVAC, appliances, office equipment, other (small)]		25	44	
Commercial Efficient Equipment - Direct Discount Participant	5/21/2012	6/5/2012	70	49	12.36
Home Energy Assessment & Weatherization – Audit Participant	7/25/2012	D /1 /2012	70	71	11.40
Walk-Through Home Survey	7/25/2012	8/1/2012	35	36	11:40
Comprehensive Energy Audit	1		35	35	
Home Energy Assessment & Weatherization – Weatherization Participant	7/30/2012	8/28/2012	43	43	11:31
Renewable Energy Participant	7/23/2012	8/3/2012	10	2	6:48
E-Power Wise Direct Mail Pilot Participant	8/6/2012	8/16/2012	65	66	12:09

Appendix C: Low-Income Measure List

This table shows the measures offered to all customers and to low income customers. Measures are listed alphabetically. The measures are grouped by measure type, following the TRM as a guide. For example, CFL listed below includes all CFLs that receive an upstream incentive. Likewise, the air conditioner measure includes all SEER offered. Each measure listed was rebated or installed at least one time in PY3. The EM&V CSP followed the SWE guidance to document and determine the percent of measures offered to low income customers. Measures are listed two times if they are offered to customers at no cost specifically through low income programs, and the measure is rebated through another program. There are 146 measure groups offered within PPL Electric's portfolio. There are 54 measure groups offered to low income customers. Altogether, 37% of the measures are offered to low income customers.

	Programs Where Measure is	ls measure offered to	Is measure targeted to low- income customers? (Specific low- income measure)	Residential programs with low costs of entry in which the low-income
Measure	Offered	(Y/N)?	(Y/N)?	population is likely to participate
Air conditioner	Efficient Equipment	Yes	No	This rebated measure is offered to general residential customers
Air conditioner	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Air Conditioner Cover	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Air conditioner recycling	Appliance Recycling	Yes	<u>No</u>	Yes
Air Filter	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Air sealing/ infiltration	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Air-Cooled Chiller	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Anti-Sweat Heater Controls	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Appliance / Air Conditioner Timer	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
ASD/VSD	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
ASHP	Efficient Equipment	Yes	No	Yes
Audit	Assessment & Weatherization	Yes	No	Yes
Baseboard Replacement Repair	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Basic Diagnostic Test (no economizer)	Commercial HVAC Tune-Up	Yes	No	No, this measure is typically a commercial application
CAC Control	Direct Load Control	Yes	No	Yes
Case Fans	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Ceiling Fan	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
CFL	Residential Lighting Campaign; Efficient Equipment - C&I Lighting; Assessment & Weatherization	Yes	No	Offered to general residential customers as upstream buydown
CFL	E-Power Wise; WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Changeout Appliance	WRAP	Yes	Yes	This measure is offered at no cost to low income customers

Table C-1: PY3 Measure Groups and Low Income Offerings

Measure	Programs Where Measure is Offered	ls measure offered to low-income (Y/N)?	ls measure targeted to low- income customers? (Specific low- income measure) (Y/N)?	Residential programs with low costs of entry, in which the low-income population is likely to participate
Clean Refrigerator Coils	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Clothes Washer	Efficient Equipment	Yes	No	Yes
Clothesline	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
CO2 Detector	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
CO2 Efficiency Test	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Cold Cathode Bulb	Efficient Equipment - C&I Lighting	Yes	No	Yes
Commercial Lighting	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Commercial Refrigerator	Efficient Equipment	Yes	No	Yes
Compressor	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Computer	Efficient Equipment	Yes	No	Yes
Consumer Energy Report	Customer Education and Behavior	Yes	No	Yes
Custom Incentive Program Projects	Custom Incentive Program	Yes	No	No, this measure is typically a commercial application
Daylighting Controls	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Dehumidifier	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
De-Lamp T5 or T8	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Dishwasher	Efficient Equipment	Yes	No	Yes
Display Cases	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Door	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Door Repair	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Dryer Vent	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Duct sealing	Assessment & Weatherization	Yes	No	Yes
Duct Work and Repair	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Ductless mini-split heat pump	Efficient Equipment	Yes	No	Yes

Measure	Programs Where Measure is _Offered	ls méasure offered to low-income (Y/N)?	ls measure targeted to low- income customers? (Specific low- income measure) (Y/N)?	Residential programs with low costs of entry, in which the low-income population is likely to participate
Economizer Adjustment	Commercial HVAC Tune-Up	Yes	No	No, this measure is typically a commercial application
Energy Education	E-Power Wise; WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Energy Star Copiers	Efficient Equipment	Yes	No	Yes
Energy Star Dehumidifier	Efficient Equipment	Yes	No	Yes
Energy Star Fax Machine	Efficient Equipment	Yes	No	Yes
Energy Star Ice Maker	Efficient Equipment	Yes	No	Yes
Energy Star LED Fixture	Efficient Equipment - C&I Lighting	Yes	No	Yes
Energy Star Light Fixtures	Efficient Equipment	Yes	No	This rebated measure is offered to general residential customers
Energy Star Light Fixtures	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Energy Star Monitor	Efficient Equipment	Yes	No	Yes
Energy Star Printer	Efficient Equipment	Yes	No	Yes
Energy Star Refrigerator	Efficient Equipment	Yes	No	Yes
Energy Star Scanner	Efficient Equipment	Yes	No	Yes
Energy Star Water Cooler	Efficient Equipment	Yes	No	Yes
Evaporator Fan Controller	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Evaporator Fans - Walk-ins	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Faucet Aerator	Assessment & Weatherization	Yes	No	This rebated measure is offered to general residential customers
Faucet Aerator	E-Power Wise; WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Faucet Repair	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Faucet Replacement	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Fishline Basement Ceiling	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Floating Head Pressure Control	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Fluorescent Circlite lamp, Preheat Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application

Measure	Programs Where Measure is Offered	ls measure offered to low-income (Y/N)?	ls measure targeted to low- income customers? (Specific low- income measure) (Y/N)?	Residential programs with low costs of entry, in which the low-income population is likely to participate
Fluorescent Circular lamp, RS Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent ES High Output Lamp	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent ES Lamp	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent ES Lamp Instant Start Magnetic Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent High Bay Fixtures	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent High Output lamp	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent High Output T5	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent High Output T8	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent STD lamp electronic ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent STD lamp instant start ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent Super T8 Instant Start Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T12	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T12 Electronic Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T12 Instant Start Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T5	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T8	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T8 Instant Start Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T8 Magnetic Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent T8 Rapid Start Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Fluorescent, U-Tube	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Gas Furnace	Efficient Equipment	Yes	No	Yes
GFX	WRAP	Yes	Yes	This measure is offered at no cost to low income customers

Measure	Programs Where Measure is Offered	ls measure offered to low-income (Y/N)?	ls measure targeted to low- income customers? (Specific low- income measure) (Y/N)?	Residential programs with low costs of entry, in which the low-income population is likely to participate
GSHP	Renewable Energy	Yes	No	No, this measure is typically a commercial application
Halogen Incandescent	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Heat Pump Water Heater	Efficient Equipment	Yes	No	Yes
High Pressure Sodium Lamp	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
HPT8 Replacement Fixture	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
HVAC Install	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
HVAC Tune-Up and Repair - Residential	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Incandescent	Efficient Equipment - C&I Lighting	Yes	No	Yes
Induction Fixture	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Infiltration	Assessment & Weatherization	Yes	No	Yes
Install Roof Cap	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Install Shelf in Attic Truss Braces	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Insulation	Efficient Equipment; Assessment & Weatherization	Yes	No	This rebated measure is offered to general residential customers
Insulation	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
LED	Residential Lighting Campaign; Efficient Equipment; Efficient Equipment - C&I Lighting	Yes	No	Yes
LED nightlight	E-Power Wise	Yes	Yes	This measure is offered at no cost to low income customers
Lighting Timers	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Load Curtailment	Load Curtailment	Yes	No	No, this measure is typically a commercial application
Low Flow Showerhead	E-Power Wise; WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Metal Halide Lamp	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Metal Halide Pulse Start	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application

		ls measure offered to	Is measure targeted to low- income customers? (Specific low- income	
Measure	Offered	(Y/N)?	(Y/N)?	Residential programs with low costs of entry, in which the low-income
Metal Halide Pulse Start w/ Linear			(
Reactor Ballast	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Metal Halide Pulse Start w/ Super				
Ballast	Ffficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Miscellaneous Efficiency	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Motors	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Mercury Vapor Lamp	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
New Construction	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Occupancy Sensor	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Occupancy Sensor with Daylighting Control	Efficient Equipment - C&I Lighting	Yes	No	No, this measure is typically a commercial application
Paneling	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Pressure Relief Valve	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Programmable Thermostat	Efficient Equipment	Yes	No	Yes
PV	Renewable Energy	Yes	No	No, this measure is typically a commercial application
Raise Attic Floor (1 pc Plywood)	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Refrigerant Cycle Improvement	Commercial HVAC Tune-Up	Yes	No	No, this measure is typically a commercial application
Refrigerator	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Refrigerator/Freezer Recycling (not replaced)	Appliance Recycling	Yes	No	Yes
Refrigerator/Freezer Recycling (replaced)	Appliance Recycling	Yes	No	Yes
Remove and Replace Drop Ceiling	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Repairs	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Smart Plug	WRAP	Yes	Yes	This measure is offered at no cost to low income customers

Measure	Programs Where Measure is Offered	ls measure offered to low-income _(Y/N)?	Is measure targeted to low- income customers? (Specific low- income measure) (Y/N)?	Residential programs with low costs of entry, in which the low-income population is likely to participate
SmartStrip	Assessment & Weatherization	Yes	No	Yes
Solar Water Heater	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Storm Door	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Storm Windows	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Thermostat (commercial)	Commercial HVAC Tune-Up	Yes	No	Yes
Thermostat (residential)	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Tinting	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
T-Max Panel for Skylite	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Tub Diverter	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Tyvek	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Water Element Test	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Water Heater	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Water Heater Jacket	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Waterbed retrofit	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Water-Cooled Chiller, Screw Chiller	Efficient Equipment	Yes	No	No, this measure is typically a commercial application
Window repair/insulation	WRAP	Yes	Yes	This measure is offered at no cost to low income customers
Windows	WRAP	Yes	Yes	This measure is offered at no cost to low income customers

Appendix D: Fuel Switching

Fuel Switching Reporting and Results

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 0.49% of rebated appliances in the Efficient Equipment Incentive Program involved fuel switching, the actual incidence is much lower.

Efficient Equipment Incentive Program

In PY3, PPL Electric has issued more than 39,000 rebates to residential customers. Of those, only 198 (0.50%) have been 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 D-1 summarizes the measures that, according to the customer rebate forms, replaced gas equipment. The table summarizes the number of customer-indicated gas replacement measures, total rebates issued for the measures, 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 CAC system, followed by heat pump water heater replacement. As an additional note, comparable gas equipment does not exist for some of the rebated measures. For instance, refrigerators, dishwashers, and clothes washers do not have gas equivalents, meaning some customer responses are clearly incorrect.

Measure Name	Rebate Forms Indicating Measure Replaced Gas Device	Total Rebates Issues	Percent of Total
ENERGY STAR Dehumidifier ^T	0	952	0.00%
Indoor ES Light Fixtures	0	473	0.00%
Clothes Washer (Tier 2 MEF) ¹	1	4,118	0.02%
Programmable Thermostat	1	4,276	0.02%
High-Efficiency Gas Furnace (RTS fuel switching)	1	29	3.45%
Room AC (1st unit) ¹	2	5,435	0.04%
Dishwasher ¹	4	2,864	0.14%
ENERGY STAR Refrigerator	8	15,362	0.05%
ASHP - SEER 15	17	1,066	1.59%
ASHP - SEER 16	24	1,331	1.80%
Ductless Heat Pump	28	1,278	2.19%
Heat Pump Water Heater	40	1,089	3.67%
CAC - SEER 16	72	937	7.68%
TOTAL	198	39,210	0.50%
NOTES: 1. Measures do not have a gas equivalent			

Table D-1: Summary	of	Rebate	Forms
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In PY3, the EM&V CSP fielded a survey of residential Efficient Equipment Incentive Program participants that included questions related to fuel switching. The survey was fielded to 160 fuel-switching customers and achieved 33 completes (See **Table D-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.

Disposition	Frequency
Completed	33
Refused	45
No answer/answering machine	59
Invalid number/number not in service	16
Employed/affiliated by PPL Electric or employed in Market Research	3
Partial complete	4
Total	160

Table D-2:	Fuel-Switching	Customer	Survev	Summary
Tuble D Li	r act owneeling	oustonia	•••••	- anna ,

Of the 33 respondents, 25 households (76%) confirmed that they had replaced a gas device. Six households did not replace a gas device and two did not know. Respondents reported a total of 27 replaced devices. The "Don't know" respondent shown in the table below stated he/she *did* replace a gas device, but could not recall the specific equipment device. See **Table D-3** below.

Gas Device	Number Replaced
Gas water heater	10
Gas furnace - space heating	14
Other ¹	3
Don't know	1
None	5
Total	33
NOTES:	
1. Includes clothes dryer, propane heat pump ar	nd cook top

Table D-3: Summary of Replaced Gas Devices

Of these 27 replaced devices, 17 (63%) were replaced because they were broken, did not work correctly, or were old and in need of replacement. Eight units were replaced because of the cost of operation or efficiency. See **Table D-4** below.

Reason	Count
Didn't work right or old and in need of replacement	11
Broken and/or failed	6
Wanted more efficient equipment	6
Other ¹	4
TOTAL	27
NOTES:	
 Smaller tank, switched to electric cook top, "decide furnace at same time" (CAC replacement), "part of air contents." 	d to do A/C and onditioner"

Table D-4: Summary of Reasons for Replacing Gas Devices

Figure D- and Figure D- show the response patterns for customers who replaced gas heating and gas water heating equipment, respectively. In Figure D-, 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 17³⁰ units replaced, 10 were replaced because of equipment issues, while four customers indicated they had concerns about the efficiency of the replaced unit or wanted to be more efficient.

The "Other" category includes one customer switching to an electric cooktop, another "[deciding] to do A/C and furnace at the same time," and a third replacing part of an AC unit.³¹ In none of those cases, however, did the customer indicate the equipment was replaced in order to receive a rebate.

The second column of responses ("Installed Replacement Equipment" in Figure D-) demonstrates that the majority of installed replacement equipment is gas furnaces.

The third column ("Rebate Received for Replaced Equipment" in Figure D-) shows that only one customer received a rebate for the replacement equipment. In this instance, the customer used the rebate to replace an ASHP that was in need of replacement. The equipment rebated to the respondents through the Efficient Equipment Incentive Program is summarized in the final column ("PPL Issued Rebates" in Figure D-).

³⁰ The 17 units include "Gas furnace-heating space" and "Other" categories

³¹ PPL Electric does not offer a rebate for electric stoves. This is an example of customer confusion: the rebate received by these customers was for a CAC.



Figure D-1: Responses for Customers Replacing Gas Heating Equipment and Other Gas Equipment

In Figure D-, as with the gas heating equipment, most respondents replaced their water heater because it was broken, operating poorly, or inefficient. One customer indicated that the replaced water heater was undersized ("Other" reason category). Of the 10 customers who reported replacing gas water heaters, two indicated that the rebate was an incentive for receiving more energy efficient equipment. In these two instances, the PPL Electric-issued rebate was for a heat pump water heater.



Figure D-2: Responses for Customers Replacing Gas Water Heating Equipment

Nine of the 33 respondents reported receiving a rebate for replaced equipment. As shown in **Table D**below, eight of the nine 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.

Scale	Count
1: Not at all Important	0
2	0
3	0
4	0
5	1
6	0
7	2
8	3
9	1
10: Very Important	2

In general, while 0.50% 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 much lower than reported.

In terms of air conditioning replacement, of the 14 households/respondents that confirmed they had replaced a gas furnace, 13 had air conditioning before the replacement. Only one respondent did not have air conditioning. See **Table D-6**. That one respondent that did not originally have air conditioning reported he/she did not switch from the oil or gas heating system in order to get AC.

Air Conditioning	Count		
Yes	13		
No	1		
TOTAL	14		

Table D-6: Households with air conditioning before replacing a gas device

Appendix E: Net-to-Gross Analysis

Introduction

On August 2, 2011, the PA PUC's issued the Total Resource Cost Test (TRC) Order, directing electric distribution companies (EDCs) to collect the data necessary to determine a net-to-gross ratio (NTGR) for each program and to apply that ratio to determine the cost-effectiveness of future modifications to existing program. The method for incorporating NTGR in cost-effectiveness calculation has been described in the *California Standard Practice Manual*³² but has not been defined in the Act 129 TRC Order.

The TRC Order also required EDCs to submit a summary of their NTG study scope and methods, including estimated costs, for stakeholder comments and a prudency review. This document describes the approach that Cadmus, PPL Electric's EM&V CSP, used for determining NTG. PPL Electric reviewed its NTG method with stakeholders in October, 2011.

This discussion focuses on NTGR solely in the context of energy efficiency and conservation programs. There is no freeridership and spillover expected in targeted low-income programs (E-PowerWise and WRAP). In addition, no FR is expected in the demand response and direct load control programs, since, strictly speaking, these concepts do not apply to load curtailment programs.

Definition and Components of NTG

The 2011 Audit Plan defines net savings and the NTGR as follows:

- Net Savings: The total change in load that is attributable to an energy-efficiency program. This
 change in load may include, implicitly or explicitly, the effects of free drivers, free riders, energyefficiency standards, changes in the level of energy service, and other causes of change in energy
 consumption or demand.
- NTGR: A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts.³³

³² CPUC. California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects. 2001. Available at: http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

³³ While the definition in the Audit Plan glossary does not state that gross savings are evaluated savings, the definition implies these are adjusted gross savings, that is, *ex post* gross verified savings. Adjustments are made, for example, for installation rates, failure, and site specific conditions.

As noted in the Audit Plan, there are two primary factors that differentiate net savings from gross savings, free-ridership and spillover, defined below.

- Freeridership (FR): Participants' adoption of measures offered under the program that would have occurred in the absence of the program.
- Spillover (SO): Reductions in energy consumption and/or demand caused by the presence of the energy-efficiency program that are beyond the savings achieved by participants in the program. Spillover can be from participants and/or non-participants.
 - Participant spillover (SO_P): The adoption of measures by participants in addition to those incented by the program that are attributable to the program's presence.
 - Non-participant spillover (SO_{NP}): The adoption of measures by eligible customers who did not participate in the program.

Market effects can include changes in retail stocking practices. For example, a program can influence market practices such as the SEER level of stocked heat pumps, home building practices, and the availability of products without the consumer's knowledge. If utility programs are successful and influence market practices (transform the market), the NTGR naturally declines over time (get "worse") as market transformation increases. Therefore, in addition to non-participants who are aware of a program, SONP may also include savings from purchases of energy equipment by non-participants from retailers who stock the energy efficient measure due to a program's influence. These upstream market transformation impacts are generally difficult, if not impossible, to measure with any reasonable level of accuracy. And, a market effects study can be costly. For these reasons, a market effects study is not included in the NTG study discussed in this memo. These market effects are not measured and are not considered in adjustments to compliance targets. However, these impacts could be substantial and this should be acknowledged in policy decisions about the treatment of NTGR.



Figure E-1. Components of Net-to Gross Ratio

NTGR and its components are usually expressed as fractions. Algebraically, NTGR may be expressed as follows:

$$NTGR = (1 - FR) + SO_P + SO_{NP}$$

The NTGR is applied in TRC cost-effectiveness calculations to adjust both savings attributable to the program and the program's costs in order to derive an adjusted benefit-to-cost ratio. A method for incorporating NTGR in TRC calculations has not yet been specified.

Calculating NTGR for Act 129 Programs

Self-report methods rely on survey responses, which are used to estimate separate values for FR, SOP, and SONP, and then these are combined to derive the NTGR. For the purpose of NTGR calculations for Act 129-funded programs, PPL Electric proposes to use the self-report method described in Section 4.1.3 of the revised draft 2011 Audit Plan. PPL Electric's proposed approach for implementing this method is described below.

Implementation of the self-report method for each program involves conducting surveys of consumers who participated in the program as well as a representative sample of consumers who were eligible but did not participate. The proposed method for implementing these surveys and analyzing their results are described below.

Cadmus implemented large participant surveys in PY1, PY2, and in PY3. These surveys have served to verify measure installation, assess program process issues including customer satisfaction, and collects data to compute FR and SOP. Cadmus incorporated FR and SOP batteries in these surveys. Because no SONP were conducted in PY3, the NTGR reported for PY3 will only reflect FR and SOP. Cadmus will conduct SONP surveys with vendors in PY4. For PY3, Cadmus conducted secondary research, reported in a separate Appendix, but did not include an estimate in the NTGR calculations.

Sample Size

Participant Surveys

The 2011 Audit Plan does not stipulate sample size for determining FR, but states that the estimates must be "typically developed such that the statistical precision at the measure category level (lighting, HVAC, motors, etc.) is 90 percent confidence with a 20 percent precision range and at the program level is 90 percent confidence ±10 percent in precision" (Section 4.1.3.1).

EM&V verification sample sizes are stipulated in the SWE Sampling Resolution Memo (GM-003, dated February 18, 2011). (These minimum confidence and precision targets are repeated in Table 4-8 of the draft 2011 Audit Plan.) In GM-003, the SWE states the following minimum confidence and precision levels:

- 90/10 for the Residential Portfolio
- 90/10 for the Non-Residential Portfolio
- 85/15 for each program within each portfolio

Note that the Audit Plan suggests surveys be conducted (including FR and SO questions) with a sample size that meets 90% confidence and 10% precision at the program level and 90/20 at the measure category level for FR. Therefore, FR sampling rigor required per the Audit Plan will exceed verification requirements prescribed by GM-003 and the 2011 Audit Plan. Since the surveys include both verification and FR and SOP batteries, sample sizes will be increased from verification only (85/15 at the program level) to meet FR requirements (90/10 at the program level).

In PY1 and PY2, Cadmus' sampling plans for measure verification, including surveys, has exceeded the 85/15 requirement at the program level, and has met or exceeded the 90/10 requirement at the sector level. Where appropriate, Cadmus has determined sampling targets based on ex ante savings strata (small, medium, and large projects), which often include specific measure categories within one stratum.

In PY1 and PY2, sample sizes exceeded 90/10. In PY3, sample sizes by program were closer to 90/10. This sampling plan meets the Audit Plan requirements of 90/10 by program, which is about 70 surveys per program. The Efficient Equipment prescriptive rebate program included surveys for multiple sectors and

strata, including (1) residential sector rebates; (2) commercial non-lighting rebates; (3) commercial lighting rebates; (4) direct discount delivery channel participants.

		PY1 and	PY3	
		PY2	Target	PY3
	Program	Completed	Number of	Completed
Program Survey	Launch	Surveys	Surveys	Surveys
Appliance Recycling Participant	PY1	245	70	75
Appliance Recycling Non-participant		169	0	0
Residential Lighting (Formerly CFL Campaign)	PY1	633	325	266
E-Power Wise Direct Mail Pilot Participant (new delivery channel]]
in PY3)	PY3		65	66
Energy Efficiency Behavior & Education Participant				
(no freeridership, spillover only)	PY2	319	190	191
Residential Efficient Equipment Participant	PY1	304	70	72
Commercial Efficient Equipment Participant - non-lighting				
measures	PY1	128	50	49
Commercial Efficient Equipment Participant – lighting measures		82	70	71
Commercial Efficient Equipment Participant - Direct Discount				
delivery channel (new delivery channel in PY3)			70	49
Renewable Energy Program				
(program closed in PY3)		221	10	2
Residential Energy Assessment & Weatherization Participant-Audit				
Only (35 walk through survey and 35 comprehensive survey)		68	70	71
Residential Energy Assessment & Weatherization Participant-				· · · · · · · · · · · · · · · · · · ·
Installed Measures		0	43	43
Custom Incentive Participant		20	70	0

Table E-1: Participant Survey Sample Sizes — FR and SO

Surveys planned for the Custom Incentive Program were postponed until PY4, due to scheduling conflicts with other surveys conducted by PPL Electric.

Non-participant Surveys Proposed for PY3

The proposed sampling plan for the SONP surveys is designed to produce results that will meet SWE requirements. Non-participant surveys were planned for trade allies. However, due to PPL's surveys conducted with trade allies, the surveys were postponed until PY4 when they can be coordinated with PPL's surveys.

Freeidership Survey Design

The self-report surveys administered to program participants included separate FR and SOP batteries. Freerider survey questions determine whether the participant is a freerider, a partial freerider, or a full

freerider. To avoid response bias, we determine FR by eliciting information about the participants' decision to adopt program measures through a battery of indirect questions. Confirmatory questions are asked each respondent.

For residential programs where the homeowner is the decision-maker, the following FR questions are asked, but may be revised to tailor them to program specifics:

- 1. Already Ordered or Installed. When you first heard about the program/rebate from PPL Electric for the [MEASURE], had you already purchased the [MEASURE]?
- 2. **Planning to Purchase**. When you first heard about the program/rebate from PPL Electric, had you already been planning to purchase, or had you already begun collecting information about the [MEASURE]?
- 3. Would Have Installed Without Rebate. Without a rebate from PPL Electric, would you still have purchased the exact same [MEASURE] for your home?
- 4. Same Efficiency. Without the rebate, would you have still purchased a [MEASURE] that was just as energy efficient, more efficient, or less efficient?
- 5. **Planning to Install Soon**. Without the rebate, would you have bought the [MEASURE] sooner, at about the same time, later in the same year, in one to two years, in three to five years, or five or more years later?
- 6. **Purchased Same Measure Previously.** Before buying the [MEASURE] and receiving your rebate from PPL Electric, had you ever purchased the same [MEASURE] for your home/business?

The FR portion of the non-residential survey includes similar questions, but replaces the residential survey question about planning to purchase with a question asking whether the measure purchased had been included in their capital, operating, or maintenance plans or budgets. In addition, for certain measures quantity is a consideration and should be included. The following sequence of FR questions are asked the non-residential sector, but may be revised to tailor to program specifics:

- 7. Already Ordered or Installed. When you first heard about the rebate from PPL Electric for the [MEASURE], had you already purchased the [MEASURE]?
- 8. Already in Budget. Was buying the [MEASURE] included your most recent capital budget before you participated in the program?
- 9. **Purchased Same Measure Previously**. Before your organization participated in the PPL Electric program for the first time, had you ever purchased the same type of [MEASURE]?
- 10. Would Have Installed Without Rebate. Would you have purchased the [MEASURE] without the rebate?
- 11. Same Efficiency. Without the rebate, would you have still purchased a [MEASURE] that was just as energy efficient, more efficient, or less efficient?
- 12. Planning to Install Soon. Without the rebate, would you have bought the [MEASURE] sooner, at about the same time, later in the same year, in one to two years, in three to five years, or five or more years later?
- 13. Same Quantity. Without the rebate, would you have still purchased and installed the same number of [MEASURE]?

The survey asks whether the participant had heard about the measure before they heard about the program. If they had never heard of the measure or the technology before the program, they cannot be a FR.

Freeidership Scoring Model

Cadmus developed a simple model to score responses based on the FR questions. We then calculated the precision (standard error) for these scores based on the scores' distribution. This approach is cited in the NAPEE National Action Plan for Energy Efficiency Handbook on DSM Evaluation, 2007 edition, page 5-1, and offers several important features:

- Derives a partial FR score based on the likelihood of a respondent taking similar actions in the program's absence.
- Applies a consistent set of rules to individual respondents' answers when determining FR scores.
- Uses consistency checks and open-ended questions to ensure that quantitative scores match respondents' explanations of program attribution.
- Enables the ability to change weightings for sensitivity analysis, in order to test the robustness of the response set.

Our experience has shown that program participants do not fall neatly into FR and non-FR categories. For example, we assign partial FR scores 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. To account for this, our model incorporates the following inputs:

- Raw participant survey responses, along with the program categories and energy savings for the rebated measures.
- Tables converting the raw survey responses for each program category into matrix terminology.
- Custom FR scoring matrices for residential and non-residential programs.



Shown in Figure E-2, the model uses a simple interface, allowing users to produce a scoring analysis for any program category. It displays combinations of participants' responses and their corresponding FR scores, and then produces a summary table of the average score and precision estimates for that program category. The model uses the sample size and a two-tailed test at the 90 percent confidence interval to determine the average score's precision.

Spillover Survey Design

Participant Spillover Survey Questions

SO_P occurs slowly over time as the program matures and information about the program spreads. While the accuracy of the FR estimate depends on eliciting responses close to the time of the measure adoption decision, SO occurs in the longer term.

The purpose of the SO_P survey battery is to determine energy-efficient measures the participant installed outside of the program, without a rebate, that were influenced by the program. We designed the participant spillover survey to answer three primary questions:

- Since participating in the program being evaluated, has the participant installed additional energyefficient equipment or measures that were not rebated through a program?
- How influential was the program in the participant's decision to install additional energy-efficient measures?

How much or how many measures were installed?



Figure E-3: Participant Spillover

Savings from additional measures are considered SO if the program significantly influenced the decisions to purchase the measures. Therefore, the SO portion of the survey includes questions about the characteristics and quantity of measures installed, as well as how influential the program was in their decision to purchase and install the additional measures.

The survey asks respondents to only answer about products that are considered energy-efficient, such as ENERGY STAR-rated appliances, CFLs, and high-efficiency air conditioners.

The survey will also ask customers why they did not seek a rebate for qualifying equipment.

Spillover Scoring Matrix

Cadmus uses a top-down approach to calculate SO savings. We fill the sampling quota in each measure category with customers who state they installed a measure. Spillover savings are only attributed to customers who installed a measure, were aware of the rebate programs, and were influenced by the program.

Our approach involves reviewing the entire spillover survey data set and removing respondents who indicated that PPL Electric's programs had no or very little influence on their decision to purchase

additional measures. We will drop measures that are not in the TRM or where the quantity or additional specifics are unknown (e.g., insulation and windows) from our analysis.

We determine savings for the remaining measures by mapping them to measures offered by PPL Electric or listed in the TRM. For example, where respondents state they installed an incented air conditioner without a rebate because they were highly influenced by PPL Electric's program, we assign the verified savings value for air conditioners to the respondent.

Non-participant Spillover Survey Questions

 SO_{NP} can be large because it involves all eligible customers. In the case of a large utility such as PPL Electric Utilities, it could be a significant energy savings number. There are two commonly used approaches to computing non-participant spillover. These are both self-report survey efforts. One approach is to administer the survey to non-participant customers. This can be a large and expensive effort to determine the influence that the programs have on customers who purchase rebated measures without a rebate (shown as "method 1" in Figure E-4 below). The second approach is to survey the trade allies participating in the programs (shown as "method 2" in Figure E-4 below).

Cadmus will use the same approach for non-participant spillover as other PA EDC EM&V CSPs. That is, surveys will be administered to trade allies to assess the extent to which PPL's programs influenced standard practice. Where trade allies changed their practice to offer all their customers efficient equipment typically rebated through the program, it results in spillover. That is, customers purchase the efficient equipment without a rebate because that is the equipment commonly stocked by vendors. In this way, the PPL programs and the trade allies are transforming the market.


Figure E-4: Non-participant Spillover

PY3 NTGR Calculations

As explained above, NTGR is composed of three elements:

$$NTGR = (1 - FR) + SO_P + SO_{NP}$$

In PY3, no non-participant surveys were conducted, due to timing and coordination issues related to other surveys PPL was conducting with their trade allies. Secondary research was conducted and is summarized later in this appendix, but no adjustment was included in PY3 NTGR for non-participant spillover. Therefore, for PY3, the equation to compute the NTGR equation does not include non-participant spillover.

To calculate the NTGR, FR and SO (both participant and non-participant) must be expressed as a ratio of gross savings (ex post verified gross savings). This is done by estimating the total savings determined to be attributable to FR, and SOP, as follows:

NTGR = Gross Verified Savings - FR + SO Savings participant / Gross Verified Savings

In surveys, where FR is calculated directly as a fraction (p_{FR}) , total savings attributable to FR may be estimated using the following relationship:

kWhFR = P_{FR} * Gross Verified Program Savings

Average SO_P is estimated in surveys not as a ratio, but as kWh per participant respondent; that is, we add the savings all measures (i) in the sample that were purchased without a rebate and the purchase was highly influenced by participation in a rebate program.

The ratio of total spillover savings to total program savings is then computed for the sample. This spillover ratio (percent spillover savings) is then included in the final equation to compute the NTG ratio:

$$NTGR = (1-FR) + SO_P$$

PY3 NTG Results

In PY3, Cadmus completed 889 participant surveys, shown in **Table E-2**. Surveys included questions for freeridership and spillover, tailored to the program specifics (sector, measures, and delivery channel).

Program Survey	FR	so	Number of Times Survey Fielded	Number of PY3 Completed Surveys
Appliance Recycling Participant	X	x	1	76
Residential Lighting (upstream program; formerly called Compact Fluorescent Lighting Campaigne)	x	x	1	266
Energy Efficiency Behavior & Education Participant		x	1	191
Residential Efficient Equipment Incentive	х	x	1	72
Commercial Efficient Equipment Incentive	x	х	1	169
Renewable Energy Program	x	x	1	2
Energy Assessment & Weatherization Participant	x	x	1	43
Energy Assessment & Weatherization Participant-Audit Only		x	1	71
			Total	889

Table E-2: PY3 Surveys Inclu	ding NTG Questions
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For the Appliance Recycling Program, responses to the participant and non-participant surveys taken together determine what the customer would have done in the absence of the program, i.e., freeridership.

In the upstream residential lighting (CFL) program, participants are not known since the discount is offered the manufacturer, and customers may not know they purchased a discounted bulb. The survey is designed to catalog respondents as those who are recent CFL purchasers, and those who are aware and unaware of PPL EU's discounted CFL program. Respondents who are aware of CFLs were asked the freeridership questions.

The Behavior and Education Program sends letters to customers, offering them energy saving tips and information about their energy consumption. No incentives are paid to customers. Therefore, there is

no freeridership in this program. To assess spillover, surveys did ask respondents about participation in other rebate programs and installation of energy efficiency measures.

In programs with commercial participants freeridership scores were weighted by the verified savings before applying the freeridership score to the population. That is, once the freeridership scores were determined for each participant, a savings weighted score was computed. The individual score was multiplied times the participant's verified savings to determine a savings weighted score. In this way, scores for very large projects carry greater weight than scores for much smaller projects.

Spillover savings were not applied to lighting measures. In the residential sector, 11 survey respondents across all programs reported they purchased 138 CFLs. Since CFLs are discounted in the upstream program, it is possible that CFL purchases reported by respondents were PPL program bulbs. To avoid double counting savings, no spillover savings were included for reported CFLs.

Shown in **Table E-3**, participant spillover savings ranged from no spillover to 4% of program savings. Survey respondents from the Renewables Program, and non-residential Efficient Equipment non-lighting and direct install participants did not report any additional unrebated measures installed, i.e., they did not report spillover.

In PY3, freeridership ranged from 10% for non-residential Efficient Equipment participants installing lighting measures, to 67% among the Commercial Efficient Equipment non-lighting participants. Retroactive projects were allowed for projects completed and reported in PY2.

Program	Total Survey Responses	Total Unique Spillover Respondents	Survey Sample Spillover kWh	Survey Sample Program kWh	Participant Spillover %	Freeridership	NTG	NTG Precision
ARP	198	6	2,116	109,932	2%	39%	63%	4%
Audit Weatherization	39	3	304	46,444	1%	18%	83%	10%
Audit Only	71	2	1,680	43,159	4%	0%	104%	NA
Renewables	2	0	NA	NA	0%	0%	100%	NA
Residential Efficient Equipment	99	1	60	73,367	0%	35%	65%	5%
Comm EE – Non-Lighting	49	0	0	93,493	0%	67%	33%	7%
Comm EE - Lighting	71	2	1,706	9,335,996	0%	19%	81%	5%
Comm EE Direct Install - Lighting	49	0	0	1,560,554	0%	10%	90%	6%
Custom ¹	20	0	0	NA	0%	69%	31%	NA
Residential Lighting ²	69	NA	NA	NA	Range 48% - 56%	Range 44% - 52%	70%	9%

Table E-3: PY3 NTG Results

1 Custom Program: PY2 data used for PY3

2 See Appendix F for methodology used in Residential Lighting program

Non-participant Spillover Secondary Research

Cadmus conducted secondary research exploring non-participant spillover. Various studies reviewed for this research estimated free-ridership, participant "like" and "unlike" spillover, and non-participant "like" and "unlike" spillover. To estimate the range of non-participant spillover that might be expected from different measures, we cataloged the survey research, program and/or non-participant spillover reported as a percent of savings or total kWh savings. Most estimates were based on self-report methods that were tailored to the sponsoring utility, and the individual program or the measure of interest. Non-participant surveys were typically conducted with design professionals or equipment vendors involved in the installations.

To estimate non-participants spillover, a typical approach applied the percentage of spillover (determined through survey research) to the program savings tracked in a database. Spillover was calculated for each design professional or equipment vendor. The results were then extrapolated to the program's kWh savings recorded in the database which were not included in the survey sample.

Another author reported the baseline sales used to estimate spillover effects were gathered via 100 surveys of nonparticipating retailers. The program effects sales data were gathered from 5 program retailers accounting for 70% to 80% of program volume.

A number of report authors stated there was large uncertainty in their spillover estimates or that findings were not significant. These either did not include the spillover estimate in the final NTG analysis or recommended using a NTG value of 1.

Table E-4 summarizes the findings from several studies. Where a study reported savings both at the program and the measure level, the measure level savings are included in the table below. The table is sorted by sector and measure, to more easily see the range of results. **Table E-5** provides additional study details.

Study ID	Utility ^{1,2}	Location	Measure	Sample Size	Non- participant Spillover	Population Savings Impact (kWh) ³
Commerci	al Sector					
1	Massachusetts PAs	NE	Motors	24	46%	358,092
2	Connecticut Light & Power	NE	Motors	16	0%	0
3	NYSERDA	NE	Motors	116	15%	258 (GWh)
1	Massachusetts PAs	NE	HVAC	41	0%	0

Table E-4: Summary of Non-participant Spillover Secondary Research

Study ID	Utility ^{1,2}	Location	Measure	Sample Size	Non- participant Spillover	Population Savings Impact (kWh) ³
2	Connecticut Light & Power	NÉ	HVAC	60	4%	395,726
1	Massachusetts PAs	NE	VSD	63	13%	2,235,383
2	Connecticut Light & Power	NE	VSD	28	14%	344,868
1	Massachusetts PAs	NE	Lighting	134	0%	0
2	Connecticut Light & Power	NE	Lighting	151	3%	1,700,580
4	California IOUs	w	Lighting - High Bay (mainly T5HO fixtures)	729	23-27%	15.1 - 27.2 (GWh)
1	Massachusetts PAs	NE	Compressed Air	17	3%	100,809
2	Connecticut Light & Power	NE	Compressed Air	22	4%	162,132
1	Massachusetts PAs	NE	Refrigeration	4	0%	0
2	Connecticut Light & Power	NE	Refrigeration	6	0%	0
5	California IOUs	W	New Construction	109	22%	21,397,000
6	PG&E W		Split A/C Remote Condensing Unit Evaporative Coolers Water Chillers Evaporative Condensers Window Film Cooling Towers Package Terminal	1,337	13%	Avoided cost used as a proxy for impact
6	PG&E	w	T8 Fixtures HID CFLs LEDs Electronic Ballasts Fluorescents Occupancy Sensors	2,796	7%	Avoided cost used as a proxy for impact
7	National Grid NE		HVAC Programmable Thermostats VFDs Motors Lighting Compressed Air Process Cooling Refrigeration	233	9%	123,232

Study ID	Utility ^{1,2}	Location	Measure	Sample Size	Non- participant Spillover_	Population Savings Impact (kWh) ³
Residentia						
8	Focus on Energy	MW	Boiler Tune-Up	-	2%	932 (Therms)
8	Focus on Energy	MW	Hot water heating equipment	-	25%	21 (Therms)
8	Focus on Energy	MW	HVAC	-	1%	42 (Therms)
9	Northeast Utility	NE	Insulation	1,202	28%	-
9	Northeast Utility	NE	Air Sealing	1,202	28%	-

NOTES:

1. Massachusetts PAs included in the nonparticipant study cited here include: National Grid, NSTAR, WMECO, Unitil, and Cape Light.

2. Connecticut Light and Power was the recipient of a study which utilized nonparticipant spillover findings from National Grid, Unitil, and United Illuminating.

3. The savings extrapolated to the entire population takes the attributed non-participant spillover rate and applies it to the entire population gross savings. All values are in kWh unless otherwise stated.

Table E-5: Non-Participant Spillover Secondary Research - Study Details

Study ID	Study Author	Study Year	Study Name	Analytic Method
1	TetraTech	2011	2010 Commercial and Industrial Electric Programs Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
2	PA Consulting Group	2008	2007 Commercial and Industrial Programs Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
3	Quantec / Summit Blue	2007	2007 Commercial & Industrial Market Effects Evaluation	Self-report survey, engineering algorithms
4	KEMA / Itron	2010	2010 High Bay Lighting Market Effects Study Final Report	Baseline comparison, utility data review, surveys, in-depth interviews
5	RLW Analytics	2003	Final Report 1999-2001 Building Efficiency Assessment (BEA) Study	Self-report survey, DOE-2 engineering models, and on-site audits
6	Quantum Consulting	1999	Pacific Gas & Electric Company 1997 Commercial Energy Efficiency Incentives Program: Lighting Technologies	Self-report survey, on-site audit
7	PA Consulting Group	2002	National Grid 2001 Commercial and Industrial Free-ridership and Spillover Study	Design professionals / equipment vendors self-report survey
8	TetraTech	2010	CY10 Apartment and Condo Efficiency Services Market Effects	Baseline comparison, contractor survey
9	Cadmus	2012	Report is not publicly available	Self-report survey / discrete choice model

Appendix F: 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 CFL Campaign's PY3 freeridership, spillover, and NTG ratio. The survey began with a battery of questions to identify respondents who were aware of CFLs prior to the survey. Responses from the 160 customers who had purchased one or more CFLs in the past three months were used in the NTG analysis (out of 266 total respondents who completed the telephone survey).

Freeridership was analyzed on a per-CFL basis, rather than per-customer. The 160 respondents had collectively purchased 972 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 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 CFL Campaign and those who were not. Respondents in categories 3 and 4 were not included in the NTG analysis.

Freeridership, Spillover, and NTG Findings

PY3 survey respondents who were aware of the program reported purchasing a total of 589 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 52%, with an upper bound of 61% and a lower bound of 44%.

Respondents in category 2 (unaware of the program) reported they had collectively purchased 383 CFLs in the past three months. The EM&V CSP observed that some of these respondents were influenced by the program even though they were not aware of it, while others were not. 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 free-riders. The EM&V CSP reasoned that, at most, freeridership among recent purchasers who were unaware of the program was

52% (the average of those who were aware of the program). At the low end, freeridership for recent purchasers who were unaware of the program was 44% (the same lower bound as for recent purchasers who were aware of the program).

The EM&V CSP computed the CFL Campaign NTG using the above values and the following equations. The calculation is also shown graphically in **Figure F-1**.

(1) Net FR = ((CFL_{Aware} * FR_{Aware}) + (CFL_{Unaware} * Not-Influenced_{Unaware}) - (CFL_{Unaware} * Influenced_{Unaware})) / CFL_{Total}

Where:

- Net FR = Net freeridership, defined as freeridership minus spillover.
- CFL_{Aware} = Number of CFLs recently purchased by respondents who were aware of the program.
- FR_{Aware} ≈ Freeridership rate for respondents who were aware of the program (derived from the battery of freeridership questions on the customer survey).
- CFL_{Unaware} = Number of CFLs recently purchased by respondents who were *not* aware of the program.
- Not-Influenced_{Unaware} = Percent of CFLs purchased by respondents who were not aware of the program and were not influenced by it (considered free-riders).
- Influenced_{Unaware} = 1 Not-Influenced_{Unaware} = Percent of CFLs purchased by respondents who were not aware of the program but were influenced by it (considered spillover).
- CFL_{Total} = Total number of CFLs recently purchased by respondents.

For the mid-range freeridership case:

- (1) Net FR = ((306 * 52%) + (199 * 52%) (184 * 48%)) / 972 = 33%
- (2) NTG = 1 33% = 67%

For the high-range freeridership case:

- (1) Net FR = ((359 * 61%) + (199 * 52%) (184 * 48%)) /972 = 39%
- (2) NTG = 1 39% = 61%

And for the low-range freeridership case:

- (1) Net FR = ((259 * 44%) + (169 * 44%) (214 * 56%)) / 972 = 22%
- (2) NTG = 1 22 = 78%

Since it is highly unlikely that all recent CFL purchasers who were unaware of the CFL Campaign before they participated in the customer survey would have purchased the same quantity of CFLs without the program discount, the program's actual NTG ratio is likely somewhat higher than the 67% mid-point estimate. The EM&V CSP therefore estimates NTG for the CFL Campaign as 70%.



Figure F-1: CFL Campaign Net-to-Gross Calculation

Appendix G: Additional Energy Efficient Behavior & Education Program Impact Analysis

Data Development

The monthly billing data of treatment and control group homes for the legacy and expansion groups provided by the program implementation CSP to the EM&V CSP for billing analysis were relatively clean. However, the EM&V CSP performed some data cleaning and preparation tasks. First, the EM&V CSP dropped homes whose accounts became inactive, who were flagged, or who did not have a complete PY3 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 employee. Table G-1 shows the details on the data organization.

	Number of observations from billing data			
	Legacy Expansion			
Original billing data	3,896,488	2,253,968		
Availability of customer data	3,518,337	2,082,214		
Delete record with missing First Report Dates	3,518,337	2,079,189		
	Number of unique accounts			
Deleted accounts with multiple entry	86,390	72,224		
Final Recipient	43,261	49,651		
Control	43,129	22,573		

Table	G-1:	Data	Preparatio	n Summarv
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This resulted in a balanced panel of 43,261 homes in the legacy treatment group and 43,129 homes in the control group for the legacy group estimation sample. In the expansion group estimation sample, there were 49,651 treatment group homes and 22,573 control group homes.

The EM&V CSP calculated the heating degree days and cooling degree days (base of 65 degrees) for each customer bill and merged them with the billing data. In the billing analysis, 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.

Model Specification

To estimate the program energy savings, the EM&V CSP employed a non-parametric, difference-indifferences regression model of monthly energy consumption with customer home fixed effects. The average daily electricity (kWh) consumption (ADC) of home 'i' in month 't' is given by:

ADC_{it} =
$$\alpha_i + \beta_1 \text{ POST}_{it} + \beta_2 \text{ PROGRAM}_{it} \times \text{ POST}_{it} + \mu_{my} + \varepsilon_{it}$$
 Equation G-1

where:

α_{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 β_2).
PROGRAM	=	An indicator variable for program participation (= 1 if the home was in the treatment group; = 0 otherwise).
μ _{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 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.
E _{it}	=	Error term for home 'i' in month 't.'
β1	=	Coefficient representing the impact of factors affecting the

- 1 = Coefficient representing the impact of factors affecting the consumption of all homes between the pre-treatment and treatment periods.
- β₂ = 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 the membership of a customer to either the treatment or the control group is unrelated to his/her energy use after

conditioning/accounting for month-by-year(weather) and individual fixed effects. The experimental design of the program ensures that this assumption is satisfied. The EM&V CSP also tested the statistical equivalence of the treatment and control groups. The results of these tests are reported below.

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 would be 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:

 $ADC_{it} = \alpha_i + \Sigma_{\rho=1}{}^{\rho}\beta_{\rho} MONTH_{ipt} + \Sigma_{\rho=1}{}^{\rho}\beta_{\rho} PROGRAM_{it} \times MONTH_{ipt} + \varepsilon_{ipt} Equation G-2$ where:

p = Indexes the month number in the estimation period (p = 1, 2, ...).

In this framework, the average daily savings of the program on homes in month 'p' equals:

Average savings in month $p = \beta_p$, for p = 1 to P.

PY3 Behavior and Education Savings Estimates

Table G-2 shows estimates of the PY3 impacts for the legacy group from several specifications of **Equation G-1**. All of the models were estimated by ordinary least squares (OLS), and the standard errors were adjusted for correlation over time in a customer's consumption using Huber-White robust standard errors.³⁴

³⁴ 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.

	Model'1	Model 2	Model 3	Model 4
Post Year 2	3.107	11.427	-1.778	8.234
	0.034	0.051	0.034	1.874
Post Year 3	-0.746	-5.571	-1.984	-1.546
· · · · · · · · · · · · · · · · · · ·	0.043	0.048	0.043	0.051
Participant x Post Year 2	-0.665	-0.666	-0.666	-0.666
	0.048	0.062	0.048	0.048
Participant x Post Year 3	-0.941	-0.945	-0.942	-0.943
	0.062	0.029	0.062	0.062
Customer Fixed Effects	Yes	Yes	Yes	Yes
Month-by-year Fixed Effects	No	Yes	No	Yes
Weather Polynomials	No	No	Yes	Yes
R ²	0.0043	0.2199	0.1368	0.2333

Table G-2: Conditional Average Program Treatment Effects for Legacy PY3

Across the model specifications, the Behavior and Education Program effect on average daily consumption is precisely estimated and consistent. The PY2 impact was to reduce average daily consumption by approximately -0.66 kWh per home. The PY3 impact was to reduce average daily consumption by -0.94 kWh per home. Thus, the consumption impact increased by 41% between PY2 and PY3.

Figure G-1 shows the percent average daily savings with 95% confidence intervals in each month between June 2009 and May 2012 for the legacy group.³⁵ The monthly average treatment effects are 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 not any program savings before June 2010 and, as expected, the 95% confidence interval includes zero percent savings in this period.

³⁵ 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.



Figure G-1: Monthly Conditional Average Treatment Effects for Legacy Group Homes

In the first year of the program, the percent savings (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 fluctuate between 1.5% and 2% in PY3. There is no evidence of a decline in the percent savings in the second year of the legacy program. The absolute kWh impacts (not depicted) are higher in the winter and summer months when demand for heating and cooling is higher. Also the kWh savings in summer 2011 are higher than those in summer 2010. This was due to a ramping up of conservation behavior over the first and second years as the summers of 2010 and 2011 were equally warm.

Table G-3 reports regression-based estimates of the expansion group PY3 savings. The only difference between the legacy and expansion regression models is that the treatment period for the legacy group covers one year instead of two. The coefficient on *Participant x Post Year* in **Table G-3** is an estimate of the average daily savings in PY3. In Model 1, the program's effect on a home's average daily consumption was estimated to be -0.405 kWh. However, as models 2-4 show, the savings estimates are sensitive to the inclusion of controls for weather and month effects. Including the month-by-year and weather dummy variables increases the savings. Specifically, the inclusion of the weather polynomials or month-by-year fixed effects accounts for differences between years in weather and the weather-sensitivity of program savings.

	Model 1	Model 2	Model 3	Model 4
Post Year	-6.590	2.760	-0.720	-0.400
	0.067	0.170	0.065	0.175
Participant x Post Year	-0.405	-0.800	-0.950	-0.922
· · · · · · · · · · · · · · · · · · ·	0.080	0.080	0.080	0.080
Customer Fixed Effects	Yes	Yes	Yes	Yes
Month-by-year Fixed Effects	No	Yes	No	Yes
Weather Polynomials	No	No	Yes	Yes
R ²	0.0134	0.4422	0.4787	0.4806

Table G-3: Conditional Average Program Treatment Effects for Expansion PY3

Figure G-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. The savings trend rapidly upward after the program start and reach a steady state of 1.5% within approximately four months. The trend shows relatively little variability across months in PY3.



Figure G-2: Monthly Conditional Average Treatment Effects for Legacy Group Homes

Annual Net Program Savings

PY3 operated from June 1, 2011 to May 30, 2012. The EM&V CSP used estimates of the monthly kWh program effects to estimate the PY3 net savings. Specifically, the program savings were estimated as the weighted sum of the conditional average monthly treatment effects:

PY3 Savings =
$$\sum_{p'=1}^{12} -\beta_{2p'} * \text{Days}_{p'} * \text{TreatedHomes}_{p'}$$

Where:

p'	=	Indexes the months of PY3
β_{2p}	=	The conditional average daily kWh savings in month p' from Equation H2. The coefficient was obtained from the regression analysis.
Days _p ,	=	The number of days in month p'
Treated Homes,	,,= T	he number of homes receiving the treatment in that month or in a

previous month and whose account was still active.

The PY3 annual savings for the typical program home was estimated as follows:

PY3 Savings =
$$\sum_{p'=1}^{12} -\beta_{2p'} * Days_{p'}$$

Table G-4 shows the estimate of PY3 program and typical home savings and associated 95% confidence intervals.

Program Net Savings							
	Point Estimate (MWh)	95% lower Bound	95% Upper Bound				
Legacy	13,760	11,478	16,042				
Expansion	15,610	11,358	19,862				
Total Program	29,370	24,544	34,196				
	Typical Home	e Net Savings					
	Point Estimate (kWh)	95% lower Bound	95% Upper Bound				
Legacy	306	256	357				
Expansion	317	231	404				

Table G.A. DV3	Energy Efficiency	Bohavior &	Education F	Program Savings	Ectimator
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The Behavior & Education Program savings in the legacy group were estimated to be 13,760 MWh/yr, with a 95% confidence interval of 11,478 to 16,042 MWh. The program savings in the expansion group

were estimated to be 15,610 MWh/yr, with a 95% confidence interval of 11,358 to 19,862 MWh. The total PY3 program savings were estimated to be 29,370 MWh.

For the average treatment group home, annual savings were 306 kWh/yr or 1.7%, using legacy control group post-treatment annual consumption as a baseline. For the average expansion group home, annual savings were 317 kWh/yr or 1.2%.

Test of Statistical Equivalence of the Treatment and Control groups.

A key assumption of the EM&V CSP analysis was that the program's CSP randomly assigned homes to treatment and control groups. In the PY2 evaluation, the EM&V CSP tested this assumption for the legacy group and confirmed the assignment was random. In this report, the EM&V CSP also reports tests of equivalence of the treatment and control groups but for the expansion group.

The EM&V CSP conducted t-tests of the equality of annual consumption for the treatment and control groups in the pre-program period. Error! Reference source not found. shows the results of the test. The EM&V CSP cannot reject the hypothesis of equality, suggesting that assignment to treatment and control groups was random.

Program name	Program group	Total consumption in pre- treatment period	t-test	p_Value
	Control (22567)	25,843.40	0.45	0.65
Expansion	Recipient (49650)	25,812.60	U.+J	0.05

Table G-5: Test to show the statistical equivalence of annual consumption

The EM&V CSP also conducted a chi-squared test of statistical equivalence of the geographic distribution of treatment and control group customers using information about the home's ZIP code location. The EM&V CSP computed a chi-square value of 527 with a p-value of 0.34 and could not reject the hypothesis of statistical equivalence.

In addition, the EM&V CSP examined energy use for space cooling and heating in the pre-program period to see whether expansion group treatment and control group homes responded similarly to weather. The EM&V CSP expects that some program savings would derive from changes in weather-sensitive energy uses. To compare weather-sensitive energy use of treatment and control group homes in the pre-treatment period, the EM&V CSP estimated the following regression model:

$$ADC_{it} = \alpha_i + \mu_{my} + \beta_1 HDD_{it} + \beta_2 HDD_{it}^2 + \beta_3 HDD_{it}^3 + \beta_4 CDD_{it} + \beta_5 CDD_{it}^2 + \beta_6 CDD_{it}^3 + PROGRAM_{it}^*(\theta_1 HDD_{it} + \theta_2 HDD_{it}^2 + \theta_3 HDD_{it}^3 + \theta_4 CDD_{it} + \theta_5 CDD_{it}^2 + \theta_6 CDD_{it}^3) + \varepsilon_{it}$$

where

α_i	z	customer fixed effect
μ _{my}	=	month-by-year fixed effects
HDD _{it}	=	average daily heating degree days in month t
CDD _{it}	Ξ	average daily cooling degree days in month t
PROGRAM _{it}	=	an indicator variable for program participation (=1, if in treatment group; and =0, otherwise)

The coefficients θ measure any difference between treatment and control groups in energy use related to heating and cooling. If assignment to treatment and control groups was random, these coefficients should be statistically indistinguishable from zero.

The EM&V CSP estimated the above model for the expansion group. Table G-0-6 shows the estimated coefficients of the interaction terms. The θ coefficients on the interaction terms were statistically significant, suggesting there were differences between treatment and control groups in the sensitivity of their energy use to weather in the pre-period. A joint test of significance of the four interaction terms gave an F-value of 3.69 with p-value of 0.0052.

Parameter	Estimate	Standard Error	t Value	Pr > t
HDD	0.5302301	0.04291351	12.36	<.0001
HDD2	0.0714833	0.00200475	35.66	<.0001
HDD3	-0.0008286	0.00003076	-26.94	<.0001
CDD	3.9265162	0.11783802	33.32	<.0001
CDD2	-0.2637066	0.01666185	-15.83	<.0001
CDD3	0.0114412	0.00079655	14.36	<.0001
Program X HDD	0.1750875	0.05168847	3.39	0.0007
Program X HDD2	-0.0073402	0.00241209	-3.04	0.0023
Program X HDD3	0.0000999	0.00003699	2.7	0.0069
Program X CDD	0.4957941	0.14300768	3.47	0.0005
Program X CDD2	-0.0592421	0.02037628	-2.91	0.0036
Program X CDD3	0.0024707	0.00097854	2.52	0.0116

Table G-0-6: Estimated Regression Coefficients

Figure G-3 shows the predicted difference in average daily electricity consumption from heating and cooling between the expansion treatment and control groups during PY3. The difference assumes that treatment group homes did not receive Home Energy Reports in PY3 and was generated using average daily HDDs and CDDs and the coefficients on the interaction terms between *Program* and degree days in **Table G-6**. The figure also displays the average daily heating and cooling degrees in each month.

Figure G-3 shows that treatment group homes would have consumed more energy during the heating and cooling seasons than control group homes on average. For example, in the cooling season, the difference would have been approximately 1.5 kWh/day. In the winter months, the difference was approximately 1.3 kWh/day. Thus, in the expansion group, the energy use of treatment group homes appears to be more sensitive to weather than the energy use of control group homes.



Figure G-3: Predicted Difference in Weather-Sensitive Energy Use Between Expansion Treatment and Control Group Homes

The difference in heating and cooling demand may help to explain why the expansion group program treatment effect in **Table G-6** is sensitive to the inclusion or omission of variables for weather. Not controlling for weather tended to depress the program savings (models 2-4).

Appendix H: 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 in the Energy Efficiency Behavior & Education Program and in the rebate programs: thus being double counted. This section discusses the estimation of the amount of Energy Efficiency Behavior & Education Program savings that were counted in other PPL Electric rebate programs.

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 Δn_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 PY2 energy efficiency program participation data in EEMIS. Next, the difference between treatment and control group customers in PY3 rebated savings were calculated and the difference was divided by the number of treatment group customers in the estimation sample. The result was an estimate of average Energy Efficiency Behavior & Education Program participant savings that were counted in other PPL Electric programs. Finally, the participant savings were multiplied by the number of PY3 Energy Efficiency Behavior & Education Program participants to estimate Energy Efficiency Behavior & Education Program savings counted in PPL Electric downstream rebate programs.

Table H-1 and Table H-2 show the Energy Efficiency Behavior & Education Program savings counted in each PPL Electric rebate program and the total for all rebate programs. Treatment and control group customers participated in six downstream rebate programs in PY3. The Appliance Recycling, Efficient Equipment, and Home Assessment & Weatherization programs accounted for most of the savings. For

example, the Energy Efficiency Behavior & Education Program resulted in approximately 3 kWh of annual savings per legacy group home from measures rebated through the Appliance Recycling Program.

	<u> </u>	·	[Diffe	rence		РҮЗ
	Treatme	nt Group	Contro	Control Group		(Treatment-Control)			
				r —		·	, 		Overlap
Program	Savings	Per Home Ex post	Ex post Savings	Per Home	<i>Ex post</i> Savings	Per Home Ex	Net	Per Home	Net Savings
	(MWh/yr)	Savings (kWh/yr)	(MWĥ/yr)	Savings (kWh/yr)	(MWh/yr)	<i>post</i> Savings (kWh/yr)	Savings (MWh/yr)	Net Savings (kWh/yr)	(MWh/yr)
Appliance Recycling	670.8	15.51	441.83	10.24	228.97	5.26	145.62	3.35	155.61
Efficient									
Equipment	012 10	10 0	645 20	14.00	167 99	2.04	116.01	2 65	172 /7
Incentive Program -	012.19	10.0	043.29	14.90	101.03	3.04	110.01	2.05	123.42
Residential									
Efficient Equipment Incentive Program – C&I Lighting	1.76	0.04	1.47	0.03	0.29	0.01	0.23	0.01	0.38
E-Power Wise	754	0.17	10.25	0.24	-2.71	-0.06	-7 71	-0.05	-2 70
Program	7.54	0.17	10.25	0.24	-2.71	-0.00	-2.71	-0.00	-2.75
Low Income WRAP	173.61	4.01	155.82	3.61	17.79	0.4	0.40	0.40	18.61
Residential Energy									
Assessment &	115.34	2.67	55.62	1.29	59.72	1.38	51.36	1.19	55.20
Weatherization									·
Total	1,782.22	41.2	1,310.28	30.38	471.94	10.82	310.9	7.5	350.4
NOTES	. ="								

Table H-1: Behavioral and Education Program Savings for Legacy Group Counted in Downstream Rebate Programs

Ex post savings are PY3 verified gross savings from EEMIS in treatment and control group homes. Net savings are ex post savings multiplied by program NTG. PY3 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.

	Treatme	nt Group	Contro	l Group	Difference (Treatment-Control)				PY3 Savings Overlap
Program	Ex post Savings (MWh/yr)	Per Home Ex post Savings (kWh/yr)	Ex post Savings (MWh/yr)	Per Home <i>Ex post</i> Savings (kWh/yr)	Ex post Savings (MWh/yr)	Per Home Ex post Savings (kWh/yr)	Net Savings (MWh/yr)	Per Home Net Savings (kWh/yr)	Net Savings (MWh/yr)
Appliance Recycling	737.6	14.86	281.99	12.49	455.61	2.36	289.77	1.50	69.82
Efficient Equipment Incentive Program - Residential	1162.13	23.41	492.29	21.81	669.84	1.6	462.86	1.11	51.43
Efficient Equipment Incentive Program – C&I Lighting	3.67	0.07	0.0	0.0	3.67	0.07	2.97	0.06	2.64
E-Power Wise Program	15.42	0.31	7.02	0.31	8.4	0	8.40	0.00	0.00
Low Income WRAP	354.02	7.13	198.7	8.8	155.33	-1.67	-1.67	-1.67	-77.68
Residential Energy Assessment & Weatherization	415.74	8.37	150.51	6.67	265.22	1.71	228.09	1.47	68.40
Total	2,688.58	54.15	1,130.51	50.08	1,558.07	4.07	990.4	2.5	114.6
NOTES:									

Table H-2: Behavioral and Education Program Savings for Expansion Group Counted in Downstream Rebate Programs

Ex post savings are PY3 verified gross savings from EEMIS in treatment and control group homes. Net savings are *ex post* savings multiplied by program NTG. PY3 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.

The legacy group program energy savings counted in other PPL Electric downstream rebate programs was 350 MWh/yr. or 2.5% of legacy group program savings. The expansion group program energy savings counted in other PPL Electric downstream rebate programs was 115 MWh/yr. or 0.7% of expansion group program savings. The total program savings counted in other downstream rebate programs was 465 MWh/yr. or 1.6% of PY3 savings.

Upstream Rebate Programs (CFLs)

The Residential Lighting program (formerly CFL Campaigne) does not track participation at the customer level, so it was not possible to estimate the overlap of Energy Efficiency Behavior & Education Program savings and the Residential Lighting savings by matching treatment and control group customers to lighting measures in EEMIS.

Appendix I: Custom Measure Protocol Measuring Impacts of Behaviorally Based Activities in Low-Income Energy Education/Energy Kit Programs

Background

This CMP was written for PPL Electric's Low Income EPowerWise Program, which delivers a one-time energy education class along with kit of low cost energy efficiency measures. As presented in PPL Electric's approved EE&C Plan, program savings for E-PowerWise are targeted to account for <0.1 percent of the total portfolio, and do not include savings from the behavioral measures. Savings anticipated for this program included energy efficiency measures provided in the kit. Savings for these measures are verified according to the TRM, which are deemed or partially deemed savings. This CMP examines only those savings resulting from behaviorally based activities.

The low expected savings from behavioral measures, combined with the complexity and expense involved in properly sampling and conducting a billing analysis, make billing analysis a less attractive option than engineering analysis and surveys. A billing analysis for programs providing kits with low cost measures is less than ideal for the following reasons:

- Low-income households have higher rates of mobility than the rest of the population, consistently reducing the size of the available study population for pre- and post-billing analyses.
- Changes in household demographics affect energy usage both positively and negatively on a greater scale than do energy education and energy-efficiency measures.
- The cost of conducting a billing analysis to identify these savings is disproportionate to the amount of savings expected from these measures, and, small savings attributed specifically to behavioral activities are difficult to discern in a whole house billing analysis.

For these reasons, the CMP was developed to utilize a combination of engineering estimates and surveys to assign savings based on actual steps taken by program participants. Numerous kit-based, low income programs containing behavior components have been conducted, utilizing survey-based evaluation methodologies, which incorporated customer responses into engineering algorithms for determining program savings.³⁶

³⁶ Drakos, J., M. Khawaja, et al. *Impact of Flipping the Switch: Evaluating the Effectiveness of Low-Income Residential Energy Education Programs*. 2007 Energy Program Evaluation Conference, Chicago, Illinois. August 2007.

Measure Description

Energy education programs are often designed to provide customers with information about the steps they can take to reduce their energy consumption in order to enable them to make wiser choices about their energy usage. Customers may also be provided a sample of low-cost energy-efficiency tools to increase their familiarity with those tools, and to promote acceptance of energy-efficient technologies. As a result, the programs help low-income consumers save on their utility bills directly through the use of the low-cost energy-efficiency measures, as well as indirectly through implementation of energy-efficient behaviors.

A collection (kit) of low-cost measures typically includes measures such as:³⁷

- CFL lamps
- LED nightlight
- Showerhead
- Aerators

Behavior prompts that may also be provided in the kit are designed to promote reductions in energy consumption by supporting energy-efficient behaviors learned through behaviorally based programs. The behavior prompts that may be distributed with the kits³⁸ include:

- Behavior prompts
 - "Wash in Cold Water" magnet for washing machine
 - o "Turn Your Computer Off" sticker for computer
 - o "Thermostat Sticker" for thermostat
 - o "Turn Off Light" sticker for light switch
 - o "PPL Electric Utilities Light Cover Sticker" for light switches
 - o Digital thermometer to measure temperatures

This custom measure M&V protocol (CMP) provides guidelines for calculating savings attributable to five energy-efficient actions³⁹ frequently promoted through behaviorally based programs. These actions

³⁷ Savings from the measures themselves will be evaluated according to the TRM requirements.

³⁸ These are included in kits distributed for PPL's E-PowerWise program.

result in energy savings from water heating and appliances by removing unnecessary equipment and modifying the temperature set-points. The energy-efficiency actions are:

- Reducing the water heater temperature
- Washing clothes in cold water
- Unplugging the refrigerator/freezer
- Decreasing the thermostat setting for heating
- Increasing the thermostat setting for cooling

Additional energy saving behaviors are encouraged through the program, although no savings will be evaluated due to the relative unreliability of measuring the savings from these behaviors. Should savings be determined at a later date, through other M&V activities, the evaluated savings will be assigned to these actions. These are:

- Adjustments to refrigerator and freezer temperatures
- Reductions in computer hours of use
- Reduction in overhead lighting hours of use

M&V Methodology

These guidelines are based on Option A (Partially Measured Retrofit Isolation) of the IPMVP. Option A was selected for this savings type due to the relatively small percent of savings expected at the portfolio level. For PPL Electric, expected portfolio savings are <0.1% and at the participant level (3-4%). A limited number of participants are expected (7,200 through 2013). This CMP was developed to utilize a combination of engineering estimates and surveys for the purpose of assigning savings resulting from activities, based on the actual steps taken by the program participants.

M&V Activities

In many programs, participants will receive a paper survey along with the kit of measures. Participants who return the surveys (respondents) may be eligible to receive a monetary incentive from the program CSP. In such cases, the EM&V CSP's M&V activities will rely in part on data collected through the paper

³⁹ Currently the TRM contains procedures for calculating the energy savings resulting from installation of CFLs included in the kit. Procedures for calculating the energy savings for showerheads and aerators have been submitted to the SWE. This CMP is concerned with calculating savings from activities only, and not calculating savings from measure installation.

survey, though additional information may be gathered through post-participation phone surveys, which may include:⁴⁰

- Respondent phone surveys
- Non-respondent phone surveys (participants who did not return the paper survey)

Measure installation rates reported by the written survey respondents are verified through the phone surveys. Measure installation rates and participant characteristics of the non-respondents to the written survey will be ascertained via the telephone survey and compared with the installation rates and participant characteristics reported by respondents who did return the written survey and utilized to estimate overall participant characteristics and measure adoption rates for the non-respondent group.

Both of these surveys are of similar or identical design so that the results can be easily aggregated, and are used to collect the data necessary to conduct savings calculations associated with behavioral changes by determining the following:⁴¹

- Reduction of water heater temperature setting calculation is based on yes/no response to account for the likelihood that participants will be unable to report the degree reduction accurately
- Location of clothes washing equipment (on-site in the home or off-site at commercial or community locations)
- Percent of clothes (washing loads) washed in cold water before and after participation in the program
- Number of refrigerators and freezers in the home
- Number of months per year refrigerators/freezers were turned off before and after participation in the program⁴²
- Reduction in space heating temperature setting calculation is based on yes/no response to account for the likelihood that participants will be unable to report the degree reduction accurately

⁴⁰ For PPL Electric's EPowerWise program, the EM&V CSP will conduct a phone survey in PY2 with a random sample of 70 respondent participants and 70 non-respondent participants. Installation rates will be determined by responses for these two participant groups.

⁴¹ Note that the survey also asks questions about measures with deemed savings, not related to behavioral changes. These questions are not discussed here.

⁴² This is not a refrigerator turn-in or replacement activity. This activity relates only to unplugging existing refrigerators or freezers.

 Increase in space cooling temperature setting – calculation is based on yes/no response to account for the likelihood that participants will be unable to report the degree reduction accurately

The results of the surveys will be used to determine the "In-Service Rate", the rate at which the energyefficient behaviors are implemented, for behaviors that utilize complete deemed savings values. The surveys will also be used to determine baseline conditions for measures that require established baselines from which to calculate savings; these are generally behaviors for which deemed savings estimates require certain baseline conditions. Examples of specific questions that have been designed to establish savings values will be presented in the Calculations and Adjustments section, alongside the calculations to be used for determining savings.

In addition, the surveys will be utilized to determine key participant characteristics that define baseline consumption, including but limited to the fuel source for water and space heating equipment, number and age of household occupants, and pre-installation usage factors. This data will be used in the calculation of deemed savings in order to achieve a more granular estimate of the impacts of adopting energy-efficient behaviors.

Because of the relatively small impact of the program in relation to the overall consumption of the participant group, no metering planned for this analysis. As this plan describes, savings are calculated through use of engineering calculations.

Measurement and Verification Plan

The M&V Plan for behaviorally based energy education programs is designed to incorporate the results of surveys conducted with a sample of participants with engineering calculations. The steps to collect the data used to calculate savings are presented in this section.

The process for the evaluation of behaviorally based measures is shown in Figure I-1 below.

	Custom Measure Process					
	Program Design PUC Pre Approval	CSP Distributes "Kits"	CSP Collects Written Surveys Compiles Data	EDC Evaluation Ex Post	SWE Ex Post	NOTES
M&V Protocol	SWE Reviews Generic Protocol					
M&V Plan	SWE Reviews Generic M&V Plan Provides OK					

Figure I-1: Custom Measure Evaluation Process

Program M&V	CBO Provides Kit of Measures and Energy Information to Participants	Participants Return Written Surveys and Data is sent to EDC Evaluator			
EDC EMV			EDC Evaluator Samples Participants and Conducts Phone Surveys, Verifies Baseline and Installations	SWE Participates in EDC Evaluation	Surveys with Non-Respondent Participants used to Adjust Respondent Survey Results
SWE-EMV				SWE Collaboration w/EDC Evaluator	

The E-PowerWise CSP will provide the following information in the participant tracking databases:

- Customer name, address, and account number
- CBO delivering training
- Energy kits and low-cost measures disseminated
- Self report survey data of measures installed, participant characteristics, and behavioral actions taken following the workshop and receipt of the kit

The EDC Evaluator will verify installation of the measures and collect data necessary to conduct savings calculations through use of participant surveys. There are no commissioning or metering activities included in this plan. The process by which survey data is input into the engineering calculations is described in Appendix J: E-Power Wise Program and Behavior Savings Calculations.

Sampling

A random sample of 70 responding participants (people who returned the written survey) and 70 nonresponding participants will be employed for the phone surveys. This number of participants results in a confidence level of 90% with precision of $\pm 10\%$ for each group.

Calculations and Adjustments

Energy savings for the energy-efficient actions identified above will be calculated by applying survey results to savings assumptions, as detailed for each of the actions below. In addition to the adoption of energy-efficiency behaviors, the surveys will also collect data pertaining to key participant characteristics, such as water and space heating equipment, number of household occupants in

predefined age brackets, and pre-installation usage factors. This data will be used to determine baseline conditions and assess the savings impacts of energy-efficiency actions.

Water Heater Energy Savings

Water heater energy savings is potentially twofold for participants who may elect to reduce the temperature of their water heater as well reduce the temperature of their washing machines. This may be represented as:

Electricity Impact (kWh) = Water Heater Setting Savings (kWh_{wh}) + Washing Machine Savings (kWh_{wm}) Where:

kWh_{wh} –Energy savings of water heater

kWhwm-Energy savings of washing machine

Water Heater Energy Savings Survey Questions

Prior to asking respondents the survey questions designed to establish savings for these behaviors, respondents would first be asked a screening question to determine whether or not they have a clothes washer on site. Following is an example question that could be asked prior to continuing with the survey, along with the possible responses and associated coding:

Do you wash your clothes in a clothes washer located on the premises?

- 1) Yes (CW=1)
- 2) No (CW=0)

Water Heater Setting Savings

The first component of this equation is the energy savings achieved as a result of a reduction in the temperature setting of the water heater. This is a deemed value calculated for aerator equipment if the participant indicates that a reduction has been made, as well as for clothes washing equipment if the participant also indicates the presence of on-site clothes washing equipment. Showerhead savings are not claimed through this energy-efficient action because it is expected that participants will use more of the hottest water setting to arrive at the same temperature they had been accustomed to using prior to the adjustment to the water heater.

Table I-2: kWh 🗄	Savings Equations -	- Water Heater	Setting Savings	(kWh _{wb})
				x

Scenario	kWh Savings Equation
water heater temperature reduction	(kWh _f + (kWh _{cw} X CW)) X ISR _{wh} X ISR _{ewb}

Where:

 kWh_f = Energy impact of water heater temperature reduction on faucet hot water use – deemed value

kWh_{cw} = Energy impact of water heater temperature reduction on clothes washer use – deemed value

CW = Verified clothes washing equipment on-site (Yes=1, No=0) - determined through survey

 ISR_{wh} = In-service rate per water heater temperature reduction (Yes=1, No=0) – determined through survey

 ISR_{ewh} = In-service rate per electric water heater versus other fuel water heater (Electric water heater=1, Other fuel=0) – determined through survey

Water Heater Setting Savings Survey Questions

Because the savings for this behavior utilizes deemed values based on documented research, the survey question is designed simply to determine whether or not the water heater settings had been reduced for the purpose of establishing the ISR. Following is an example question that could be asked to determine whether this change has been made, along with the possible responses and associated coding:

- ISR Assessment Since participating in the program, did you reduce the temperature setting of your water heater?
 - 1) Yes (ISR_{wh} =1)
 - 2) No(ISR_{wh}=0)

Washing Machine Setting Savings

The second component of the water heater energy savings is washing machine savings. These savings are achieved when participants choose to adjust the temperature settings of their washing machine by washing their clothing in cold water. However, washing machine energy savings contain the potential for interactive effects which must be accounted for in the calculation. This is accomplished by applying one of two calculations, depending on if the participant had previously indicated that a reduction to the water heating equipment temperature had been made (ISR_{wh} \approx 1) or had not been made (ISR_{wh} \approx 0).

If the participant had not reduced the temperature of their water heater, no interaction between the behaviors exists, and the resulting calculation applies a deemed savings value that assumes a higher water heater temperature. This value is then applied to the increased percent of loads washed in cold water.

If the participant indicates having reduced the temperature of their water heater, the deemed energy impact of washing in cold water is reduced, and the energy impact of the water heater temperature reduction on clothes washer use is removed from the calculation.

Scenario	kWh Savings Equation
washing machine temperature reduction, without water	
heater temperature adjustment - (ISR _{wh} =0)	ISR _{wm} X ((CW% _{post} - CW% _{pre}) X kWh _{cw2})) X ISR _{ewh}
washing machine temperature reduction, with water heater	
temperature adjustment - (ISR _{wh} =1)	ISR _{wm} X ((CW% _{post} - CW% _{pre}) X kWh _{trcw}) – kWh _{cw}) X ISR _{ewh}

Table I-3: kWh Savings Equations - Washing Machine Setting Savings (kWh_{wh})

Where:

 ISR_{wh} = In-service rate per water heater temperature reduction (Yes=1, No=0) – determined through survey

 ISR_{wm} = In-service rate per water heater temperature reduction (Yes=1, No=0) – determined through survey

 $CW\%_{post}$ = Percent of clothes washing loads washed in cold water post-participation – determined through survey

 $CW\%_{pre}$ = Percent of clothes washing loads washed in cold water pre-participation – determined through survey

 kWh_{cw2} = Energy impact of laundering in cold water without reduction in water heater setting – deemed value⁴³

 kWh_{trcw} = Energy impact of laundering in cold water after reducing water heater setting – deemed value43

 kWh_{cw} = Energy impact of water heater temperature reduction on clothes washer use – deemed value

 $ISR_{ewh} \approx In$ -service rate per electric water heater versus other fuel water heater (Electric water heater=1, Other fuel=0) – determined through survey

The resulting savings will be applied to the population as a whole, accounting for saturation of electric water heaters.

⁴³ The SWE recommends that data be collected on the number of relative age of occupants in the household, and that this data be utilized to determine the most appropriate deemed values based on these parameters. This type of information has been collected in similar studies and, if incorporated into the calculations of energy savings, would improve the accuracy of savings estimates (see *Assessment of Washington Energy Education in Schools – 2008-2009 Program Year* Cadmus Group memorandum written by Jamie Drakos and Meghan Lee; dated 10/8/2009.

Water Heater Setting Savings Survey Questions

The savings for this energy efficient behavior depends upon the individual participants baseline behavior in addition to the resulting behavior change related to program participation. Following is an example question that could be asked to determine the baseline condition associated with the participant prior to participation in the program, along with the possible responses and associated coding:

Baseline Condition Assessment – Before participating in the program, what percent of your laundry loads were washed in cold water only?

- 1) 0-20% (= CW%pre)
- 2) 21-40% (= CW%pre)
- 3) 41-60% (= CW%pre)
- 4) 61-80% (= CW%pre)
- 5) 81-100% (= CW%pre)

Following is an example question that could be asked to determine the savings associated with the energy efficient behavior resulting from program participation, along with the possible responses and associated coding:

Savings Assessment - After participating in the program, what percent of your laundry loads were washed in cold water only?

- 1) 0-20% (= CW%post)
- 2) 21-40% (= CW%post)
- 3) 41-60% (= CW%post)
- 4) .61-80% (= CW%post)
- 5) 81-100% (= CW%post)

Unplug Refrigerator and Freezer

Participants are encouraged to unplug their refrigerators and freezers if they are not necessary. Surveys will ask participants how many months this equipment was unplugged prior to participating in the program, as well as how many months this equipment was unplugged after participating in program; deemed values will then be applied to the difference.

Table I-4: kWh Savings Equations – Unplug Refrigerator and Freezer Savings

Scenario	kWh Savings Equation
Months refrigerator and freezer unplugged post-program	
participation	$R_{kWh} X (R_{Post} - R_{Pre}) + F_{kWh} X (F_{Post} - F_{Pre})$

Where:

R_{kwh} = kWh for refrigerator – deemed savings

R_{Post} = Sum of months per year refrigerator(s) was/were turned off post participation in program – determined through survey

 R_{Pre} = Sum of months per year refrigerator(s) was/were turned off pre participation in program – determined through survey

F_{kwh} = kWh for freezer – deemed savings

 F_{Post} = Sum of months per year freezer(s) was/were turned off post participation in program – determined through survey

 F_{Pre} = Sum of months per year freezer(s) was/were turned off pre participation in program – determined through survey

Unplug Refrigerator and Freezer Savings Survey Questions

The savings for this energy efficient behavior depends upon the individual participant baseline, in addition to the resulting behavior change related to program participation. Prior to asking the baseline and savings assessment survey questions, participants could be asked the following example screening questions:

Do you have more than one refrigerator in the home?

- 1) Yes
 - a) How many? [Record #]
- 2) No[Participant will not be asked refrigerator baseline and savings questions]

Do you have one or more stand-alone freezer in the home?

1) Yes

a) How many? [Record #]

2) No[Participant will not be asked freezer baseline and savings questions]

Following are example questions that could be asked to determine the baseline conditions associated with the participant prior to participation in the program, along with the possible responses and associated coding:

Baseline Condition Assessment – Refrigerator: Before participating in the program, did you ever turn off your refrigerator(s)?

- 1) No(R_{Pre}=0)
- 2) Yes
 - a) For each refrigerator, how many months would you leave your refrigerator turned off?
 i) [Record Refrigerator 1] (= R_{Pre1})

- ii) [Record Refrigerator 2] (= R_{Pre2})
- iii) [Record Refrigerator ...] (= $R_{Pre...}$)

Baseline Condition Assessment – Freezer: Before participating in the program, did you ever turn off your freezer(s)?

- 1) $No(F_{Pre}=0)$
- 2) Yes
 - a) For each freezer, how many months would you leave your freezer turned off?
 - i) [Record Freezer 1] (= F_{Pre1})
 - ii) [Record Freezer 2] (= F_{Pre2})
 - iii) [Record Freezer ...] (= F_{Pre...})

Following is an example question that could be asked to determine the savings associated with the energy efficient behavior resulting from program participation, along with the possible responses and associated coding:

Savings Assessment – Refrigerator: After participating in the program, did you ever turn off your refrigerator(s)?

- 1) No(R_{Post}=0)
- 2) Yes
 - a) For each refrigerator, how many months do you now leave your refrigerator turned off?
 - i) [Record Refrigerator 1] (= R_{Post1})
 - *ii)* [Record Refrigerator 2] (= R_{Post2})
 - iii) [Record Refrigerator ...] (= R_{Post...})

Savings Assessment – Freezer: After participating in the program, did you ever turn off your freezer(s)?

- 1) No(F_{Post}=0)
- 2) Yes
 - a) For each freezer, how many months do you now leave your freezer turned off?
 - i) [Record Freezer 1] (= F_{Post1})
 - ii) [Record Freezer 2] (= F_{Post2})
 - iii) [Record Freezer ...] (= F_{Post...})

Adjust Home Temperature Settings

Participants are encouraged to reduce the heating temperature and increase the cooling temperature in their homes. Surveys will be used to determine whether or not these changes were made, based on a yes/no response to account for the likelihood that participants will be unable to report the degree of change accurately.

Energy savings achieved as a result of participants reducing their heating temperature settings and raising their air-conditioning temperature settings will be calculated using the algorithm below.

Table I-5: kWh Savings Equations – Adjusted Home Ter	mperature Settings Savings
--	----------------------------

Scenario	kWh Savings Equation
Adjustments made to heating and cooling settings	HT _{kwh} X ISR _{HT} + AC _{kwh} X ISR _{AC}

Where:

HT_{kwh} = kWh for heating temperature reduced – deemed value

 $ISR_{HT} = In$ -service rate per heating temperature reduction (Yes=1, No=0) – determined through survey

AC_{kwh} = kWh for cooling temperature increased – deemed value

 $ISR_{AC} = In$ -service rate per cooling temperature increased (Yes=1, No=0) – determined through surveys⁴⁴

Adjust Home Temperature Savings Survey Questions

Because the savings for this behavior utilizes deemed values based on documented research, the survey questions are designed simply to determine whether or not the heating and cooling temperature settings had been adjusted for the purpose of establishing the ISR. Following is an example question that could be asked to determine whether a reduction in heating temperature had been made, along with the possible responses and associated coding:

ISR Assessment - Since participating in the program, did you reduce the heating temperature in your home?

Yes (ISR_{HT} =1)
 No(ISR_{HT}=0)

Following is an example question that could be asked to determine whether an increase in cooling temperature had been made, along with the possible responses and associated coding:

ISR Assessment - Since participating in the program, did you increase the cooling temperature in your home?

⁴⁴ The SWE recommends that the survey collect more granular information on temperature set point adjustments, and that such information should be integrated into this calculation.
1) Yes (ISR_{AC} =1)

2) No(ISR_{AC}=0)

Additionally, the EM&V CSP will include survey questions to collect temperature set point adjustments made by participants who report making this change. Since respondents may have difficulty remembering set points, survey responses will be analyzed, and the data will be integrated into the savings calculation if the results are determined to be reasonable and reliable.

Values and References

The following tables present the sources, values, and data types for each of the variables that were included in the Calculations and Adjustments section.

Component	Type	Value	Sources
kWhr	Fixed	119 kWh	1
kWh _{cw}	Fixed	84 kWh	1
CW	Variable	1 or 0	Survey Results
ISR _{wh}	Variable	1 or 0	Survey Results
ISR _{wm}	Variable	1 or 0	Survey Results
CW%post	Variable	Variable	Survey Results
CW%pre	Variable	Variable	Survey Results
kWh _{trew}	Fixed	393 kWh	1
kWh _{cw2}	Fixed	478 kWh	1

Table I-6: Water Heater Energy Savings

Sources:

1. Connecticut Light and Power Company, "CL&P and UI Program Savings Documentation for 2008 Program Year", September 2007, p. 193.

Unplug Refrigerator and Freezer Savings

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Component	Type	Value	Sources				
R _{kWh}	Fixed	144 kWh	2				
R _{Post}	Variable	Variable	Survey Results				
R _{Pre}	Variable	Variable	Survey Results				
F _{kWh}	Fixed	144 kWh	2.				
F _{Post}	Variable	Variable	Survey Results				
F _{Pre}	Variable	Variable	Survey Results				

Table I-7: Unplug Refrigerator and Freezer

Sources:

- 2. Pennsylvania Public Utility Commission, June 2010. Technical Reference Manual for Pennsylvania Act 129 Energy Efficiency and Conservation Program and Act 213 Alternative Energy Portfolio Standards - The average power consumption of units retired under similar recent programs:
 - a. Fort Collins Utilities, February 2005. Refrigerator and Freezer Recycling Program 2004 Evaluation Report.
 - b. Midwest Energy Efficiency Alliance, 2005. 2005 Missouri Energy Star Refrigerator Rebate and Recycling Program Final Report
 - c. Pacific Gas and Electric, 2007. PGE ARP 2006-2008 Climate Change Impacts Model (spreadsheet)
 - d. Quantec, Aug 2005. Evaluation of the Utah Refrigerator and Freezer Recycling Program (Draft Final Report).
 - e. CPUC DEER website, http://eega.cpuc.ca.gov/deer/measure.asp?s=1&c=2&sc=7&m=389059
 - f. Snohomish PUD, February 2007. 2006 Refrigerator/Freezer Recycling Program Evaluation.
 - g. Ontario Energy Board, 2006. Total Resource Cost Guide.

Component	Туре	Value	Sources
HT _{kWb}	Fixed	16 kWh	3
ISR _{HT}	Variable	Variable	Survey Results
AC _{kwh}	Variable	Variable	Survey Results
ISR _{AC}	Fixed	16 kWh	3

Table I-8: Adjust Home Temperature Settings

Sources:

3. The Cadmus Group, Iowa 2009 Energy Wise Program Final Report. June 2010.

Appendix J: E-Power Wise Program and Behavior Savings Calculations

This appendix provides the inputs and calculations used to determine energy savings for the E-Power Wise Program. Note, there were no demand savings planned for this program.

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 Flow Flow Flow Aerator" algorithm provided in the TRM, as follows:

$\Delta kWh = ISR \times [(F_B - F_P) \times T_{Person-Day} \times N_{Persons} \times 365 \times \Delta T_L \times U_H \times U_E \times Eff^{1}] / (F/home)$

The assumptions for variables used in these equations are provided in Table J-1.

Parameter	Description	Type	Value	Source	
		- Tined	2.2	2011 TDM	
г _в	Average Baseline Flow Rate of Aerator (GPIVI)	Fixed	2.2	2011 TRIVI	
Fρ	Average Post-measure Flow Rate of Sprayer (GPM)	Fixed	1.5	2011 TRM	
T _{Person-Day}	Average Time of Hot Water Usage per Person per Day (minutes)	Fixed	4.95	2011 TRM	
NPer	Average Number of People per Household	Fixed	2.48	2011 TRM	
ΔΤ	Average Temperature Differential Between Hot and Cold Water (°F)	Fixed	25	2011 TRM	
U _H	Unit Conversion: 8.33 BTU/Gallons,°F	Fixed	8.33	2011 TRM	
UE	Unit Conversion: 1 kWh/3,413 BTU	Fixed	1/3413	2011 TRM	
Eff	Efficiency of Electric Water Heater	Fixed	0.90	2011 TRM	
F/home	Average Number of Faucets per Household	Fixed	3.5	2011 TRM	
ISR ^[a]	In-Service Rate	Variable	Variable	Participant Kit Surveys	
NOTES:					
(a) Used interchangeably with installation rate.					

Table J-1: Low-Flow Faucet Aerator Calculation Assumptions

Low-Flow Showerhead Savings

The energy savings for the low-flow showerheads distributed through 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:

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 J-2**.

4				
Parameter	Description	Туре	Value	Source
GPM _{base}	Baseline Showerhead GPM	Fixed	2.5	2011 TRM
GPM _{low}	Low-flow Showerhead GPM	Variable	2	Participant Kit Surveys
people	Average Number of People per Household	Fixed	2.48	2011 TRM
gals/day	Average Gallons of Hot Water Used by Shower per Day	Fixed	11.6	2011 TRM
days/year	Number of Days per Year	Fixed	365	2011 TRM
showers	Average Number of Showers in Household	Fixed	1.6	2011 TRM
lbs/gal	Pounds per Gallon	Fixed	8.3	2011 TRM
Temp _{it}	Assumed Temperature of Water Used by Faucet	Fixed	120	2011 TRM
Temp _{in}	Assumed Temperature of Water Entering House	Fixed	55	2011 TRM
EF	Recovery Efficiency of Electric Hot Water Heater	Fixed	0.9	2011 TRM
conversion	Constant to Converts MMBtu to kWh	Fixed	0.003412	Participant Kit Surveys
ISR ^[a]	In-Service Rate	Variable	Variable	Participant Kit Surveys
NOTES: [a] Used interc	hangeably with installation rate.			

Table J-2: Low-flow Showerhead Calculation Assumptions

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:

∆kWh = ((CFL_{watts} X (CFL_{hours} X 365))/1000) X ISR_{CFL}

The assumptions for variables used in these equations are provided in Table J-3.

Parameter	Description	Туре	Value	Source
CFLhours	Average Hours of Use per Day per CFL	Fixed	2.9	2011 TRM
ISRcfl	In-Service Rate per CFL	Fixed	84%	2011 TRM
CFLwatts Delta	Average Delta Watts per Purchased ENERGY STAR CFL	Variable	Calculated	TRM and Participant Kit Surveys
ISR ^(a)	In-Service Rate	Variable	Variable	Participant Kit Surveys
NOTES: [a] Used intercha	angeably with installation rate.			

Table J-3: CFL Savings Calculation Assumptions

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:

$$\Delta kWh = ((W_{inc} * h_{inc}) - (WNL * h_{NL})) * 365 / 1000 * ISR_{NL}$$

The assumptions for variables used in this equation are provided in Table J-4.

	Tuble 1-4. Electronaminescent rughtinght savings car			
Parameter	Description	Туре	Value	Source
W _{NL}	Watts per Electroluminescent Nightlight	Fixed	0.03	2011 TRM
Winc	Watts per Incandescent Nightlight	Fixed	7	2011 TRM
h _{NL}	Average Hours-of-use per Day per Electroluminescent Nightlight	Fixed	24	2011 TRM
h _{inc}	Average Hours-of-use per Day per Incandescent Nightlight	Fixed	12	2011 TRM
ISR _{NL}	In-Service Rate per Electroluminescent Nightlight, to be Revised Through Surveys	Variable	Variable	Participant Kit Surveys
NOTES:				

Table J-4: Electroluminescent Nightlight Savings Calculation Assumptions

In PY3, the kWh savings for the Electroluminescent Nightlights were calculated by applying the ISR determined through participant surveys, to the deemed savings value for this measure.

Behavior Savings Methodology

Electric impacts associated with behavior changes made as a result of participation in the program are estimated based on calculations developed for the program's CMP. The CMP was designed to utilize a combination of engineering estimates and surveys for the purpose of assigning savings resulting from activities, based on the actual steps taken by the program participants.

The engineering algorithms for each of the behaviors for which the program is claiming electric energy savings are provided below. The results of the surveys conducted in PY3 are used to determine the ISR for the direct-mail delivery channel—the rate at which the energy efficient behaviors are implemented—for behaviors that utilize complete deemed savings values. The surveys are also used to determine baseline conditions for behaviors that require established baselines from which to calculate savings; these are generally behaviors for which deemed savings estimates require certain baseline conditions.

The following behavior savings were calculated based on behaviors reported by the PY3 direct-mail participants:

- Water Heater Energy Savings: Savings achieved by customers who reduced the temperature set point of their water heater and/or increased the number of clothes washer loads using cold water.
- Home Temperature Settings Savings: Savings achieved by customers who lowered their heating temperature set point and/or raised their cooling temperature set point.

The engineering algorithms for each of the behaviors for which the program is claiming electric energy savings are provided below, along with a description of the interactions that take place between some of the behaviors. Note, demand savings were not anticipated for this program. Final behavior savings attributed to E-Power Wise is calculated using a weighted average which accounts for participants who entered the program through the agency-based delivery channel. The behavior savings for the agency-based delivery channel.

Water Heater Energy Savings

Water heater energy savings is potentially twofold for participants who may elect to reduce the temperature of their water heater as well as reduce the temperature of their clothes washing machine. The overall calculation of water heater energy savings is represented as:

Electricity Impact (kWh) = kWh_{wh} + kWh_{wm}

Where:

kWh_{wh} = Energy savings of water heater

kWhwm = Energy savings of washing machine

The first component of this equation (kWh_{wh}) is the energy savings achieved as a result of a reduction in the temperature setting of the water heater. This is a deemed value calculated for aerator equipment if the participant indicates that a reduction has been made, as well as for clothes washing equipment if the participant also indicates the presence of on-site clothes washing equipment. Showerhead savings are not claimed through this energy efficient action, because it is expected that participants will use more of the hottest water setting to arrive at the same temperature they had been accustomed to using prior to making the water heater adjustment.

The energy savings for the reduction in the temperature setting of the electric water heater component of the water heater energy savings is calculated by inputting the ISR determined by the participant kit surveys into the "Water Heater Setting Savings" algorithm provided in the CMP, as follows:

Water Heater Setting Savings (ΔkWh_{wh}) = (kWh_f + ($kWh_{cw} X CW$)) X ISR_{wh} X ISR_{ewh}

The assumptions for variables used in this equation are provided in Table J-5.

Parameter	Description	Туре	Value	Source
kWh _r	Energy Impact of Water Heater Temperature Reduction on Faucet Hot Water Use	Fixed	119	СМР
kWh _{cw}	Energy Impact of Water Heater Temperature Reduction on Clothes Washer Use	 Fixed	84	СМР
cw	Verified Clothes Washing Equipment On-site	Variable	Variable	Phone Surveys
ISR _{wh}	In-Service Rate per Water Heater Temperature Reduction	Variable	Variable	Phone Surveys
ISR _{ewh}	In-Service Rate per Electric Water Heater Versus Other Fuel Water Heater	Variable	Variable	Phone Surveys

Table J-5: Water Heater Setting Savings (kWh_{wh}) Calculation Assumptions

The second component of the water heater energy savings is washing machine savings. These savings are achieved when participants choose to adjust the temperature settings of their washing machine by washing their clothing in cold water. However, washing machine energy savings contain the potential for interactive effects, which must be accounted for in the calculation. This is accomplished by applying one of two calculations, depending on whether the participant had previously indicated making a reduction to the water heating equipment temperature.

• If the participant had not reduced the temperature of their water heater, no interaction between the behaviors exists, and the resulting calculation applies a deemed savings value that assumes a higher water heater temperature. This value is then applied to the increased percent of loads washed in cold water.

• If the participant indicates having reduced the temperature of their water heater, the deemed energy impact of washing in cold water is reduced, and the energy impact of the water heater temperature reduction on clothes washer use is removed from the calculation.

The energy savings for the washing machine setting component of the water heater energy savings is calculated by inputting the ISR determined by the participant kit surveys into one of two "Water Heater Setting Savings" algorithms provided in the CMP, as follows:

Washing Machine Setting Savings, Without Water Heater Temperature Adjustment (LIkWhwm) = ISR_{wm} X ((CW%_{post} - CW%_{pre}) X kWh_{cw2})) X ISR_{ewh}

Washing Machine Setting Savings, With Water Heater Temperature Adjustment (∠IkWh_{wm}) = ISR_{wm} X ((CW%_{post} - CW%_{pre}) X kWh_{trcw}) – kWh_{cw}) X ISR_{ewh}

The assumptions for variables used in this equation are provided in Table J-6.

Parameter	Description	Туре	Value	Source
·			Variable	
ISR _{wm}	In-Service Rate per Water Heater Temperature Reduction	Variable		Phone Surveys
	Percent of Clothes Washing Loads Washed in Cold Water	-	Variable	
CW%post	Post-participation	Variable		Phone Surveys
	Percent of Clothes Washing Loads Washed in Cold Water		Variable	
CW%pre	Pre-participation	Variable		Phone Surveys
	Energy Impact of Laundering in Cold Water Without		Variable	
kWh _{cw2}	Reducing Water Heater Setting	Variable		Phone Surveys
	Energy Impact of Laundering in Cold Water After Reducing	-	393	
kWh _{trow}	Water Heater Setting	Fixed		CMP
	Energy Impact of Water Heater Temperature Reduction on		478	
kWh _{sw}	Clothes Washer Use	Fixed		CMP
	In-Service Rate per Electric Water Heater Versus Other Fuel		Variable	
ISR _{ewh}	Water Heater	Variable		Phone Surveys
NOTES:				

Table J-6: Washing Machine Setting Calculation Assumptions (kWh_{wm})

The resulting savings will be applied to the population as a whole, accounting for saturation of electric water heaters.

Adjust Home Temperature Settings

Participants are encouraged to reduce the heating temperature and increase the cooling temperature in their homes. Surveys are used to determine whether these changes were made based on a yes/no

response, which accounts for the likelihood that participants will be unable to report the degree of change accurately.

Energy savings achieved as a result of participants reducing their heating temperature settings and raising their air-conditioning temperature settings are calculated using the following algorithm:

Home Temperature Setpoint Savings (kWh_{temp}) = HT_{kWh} X ISR_{HT} + AC_{kWh} X ISR_{AC}

The assumptions for variables used in this equation are provided in Table J-7.

				·
Parameter	Description	Туре	Value	Source
HT _{kwb}	kWh of Heating Temperature Reduced	Fixed	16	СМР
ISR _{HT}	In-Service Rate per Heating Temperature Reduction	Variable	Variable	Phone Surveys
ACkwh	kWh of Cooling Temperature Increased	Fixed	16	СМР
ISR _{AC}	In-Service Rate per Cooling Temperature Increased	Variable	Variable	Phone Surveys
NOTES:				

Table J-7: Adjust Home Temperature Settings Savings (kWh_{temp}) Calculation Assumptions

Behavior Saving Inputs and Calculations

This section provides the inputs and calculations used to determine energy savings for the behavior change component of the E-Power Wise Program.

Water Heater Energy Savings

As described in the methodology, water heater energy savings are potentially twofold for participants who may elect to reduce the temperature of their water heater as well reduce the temperature used by their washing machine. In order to calculate savings associated with water heater setting changes and washing machine setting changes, participants were asked questions to:

- Verify the type of water heater: electric or other
- Verify whether clothes washing equipment is located on-site
- Determine if each participant lowered the temperature setting on their water heater
- Verify whether clothes are laundered in cold water
- Determine the percent increase in clothes laundered in cold water

Table J-8 presents data that was collected to complete the calculations designed to estimate energy savings for this behavior change. Note that while 66 total participants were surveyed, the percentages are based on the total number of participants who responded to each question, as shown in the table.

Baseline or Behavior Verified	Number of Respondents	Installation Rate (ISR)	Assigned Variable in CMP
Electric Water Heater on Site	63	63%	ISR _{ewh}
Washing Machine in Home/Unit	66	79%	cw
Lowered Water Heater Temperature	51	49%	ISR _{wh}
Confirmed Increase in Laundry Loads Washed in Cold Water	66	20%	ISR _{wm}
Increased Percentage of Laundry Loads Washed in Cold Water	51	44%	CW% _{post} -CW% _{pre}

Table J-8: Water	Heater	Energy	Savings	Variables	from	Survey
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Water Heater Setting Savings Calculation Results

The energy savings for the reduction in the temperature setting of the electric water heater component of the water heater energy savings was calculated using the fixed variables and variables determined by the participant kit surveys into the "Water Heater Setting Savings" algorithm provided in the CMP, as follows:

 $CMP (\Delta kWh_{wh}) = (kWh_{f} + (kWh_{cw} X CW)) X ISR_{wh} X ISR_{ewh}$

Verified $(\Delta kWh_{wh}) = (119 + (84 \times 79\%)) \times 49\% \times 63\%$

Total Water Heater Setting Savings (kWhwh) = 57 kWh

Washing Machine Setting Savings Calculation Results

The energy savings for the washing machine settings component of the water heater energy savings was calculated by inputting the fixed variables and variables determined by the participant kit surveys into the "Washing Machine Setting Savings" algorithm provided in the CMP, as follows:

CMP (AkWhwm)

Without Water Heater Temperature Adjustment = ISR_{wm} X ((CW%_{post} - CW%_{pre}) X kWh_{cw2})) X ISR_{ewh}

With Water Heater Temperature Adjustment = ISR_{wm} X ((CW%_{post} - CW%_{pre}) X kWh_{trcw}) - kWh_{cw}) X ISR_{ewh}

Verified (AkWhwm)

Without Water Heater Temperature Adjustment = 20% X ((44%) X 478)) X 63%

With Water Heater Temperature Adjustment = 20% X ((44%) X 393) - 84) X 63%

Washing Machine Setting Savings (kWhwm)

Without Water Heater Temperature Adjustment = 26

With Water Heater Temperature Adjustment = 11

Total Washing Machine Setting Savings (kWhwm) = 37

The total water heater energy savings for this program is presented below.

Electricity Impact (kWh) = $kWh_{wh} + kWh_{wm}$

95 kWh = 57 kWh + 37 kWh

Adjust Home Temperature Settings

As described in the methodology, surveys were used to determine whether program participants reduced the heating temperature and increased the cooling temperature in their homes. In order to calculate savings associated with adjustments to home temperature settings, participants were asked to:

- Verify whether they lowered their heating temperature
- Verify whether they raised their cooling temperature

Participants were also asked to indicate the daytime and nighttime settings for this equipment, both before and after participating in the program. This data was reviewed for potential inclusion in the savings calculation; however, it had an inconsistent quality.

Table J-9 presents data that was collected to complete the calculations for estimating energy savings for this behavior change. Note that while 66 total participants were surveyed, the percentages are based on the total number of participants who responded to each question, as shown in the table.

Baseline or Behavior Verified	Number of Respondents	Installation Rate (ISR)	Assigned Variable in CMP
Turned Down Heating Thermostat	63	57%	ISR _{HT}
Air Conditioner in Home/Unit	66	91%	ISR _{EAC}
Turned Up Cooling Thermostat	55	58%	ISR _{AC}

Table J-9: Adjust Home Temperature Energy Savings Variables from Survey

Energy savings achieved as a result of participants reducing their heating temperature settings and raising their air conditioning temperature settings were calculated using the algorithm presented in the CMP. However, a modification was made to account for the saturation of air conditioners among survey respondents. This variable is included as ISR_{EAC} in the CMP algorithm, as follows:

 $CMP (kWh_{temp}) = HT_{kWh} X ISR_{HT} + AC_{kWh} X ISR_{AC} X ISR_{EAC}$ $Verified (kWh_{temp}) = 16 X 57\% + 16 X 58\% X 91\%$ $Total Home Temperature Savings (kWh_{temp}) = 18 kWh$

Appendix K: TRC Incremental Costs

Program	Measure	Incremental Cost	Incremental Cöst Source
Efficient Equipment Incentive Program	Anti-Sweat Heater Controls	\$85.00/control	Utility Program 2004 Focus on Energy
Efficient Equipment Incentive Program	LED Traffic Signals 8" Red	\$382.30	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	HVAC Motors - Premium-Efficiency	\$313.91	EERE http://www1.eere.energy.gov/industry/bestpractices/market_assessment_glimps e.html and http://www1.eere.energy.gov/industry/bestpractices/pdfs/mc- 2463.pdf, A.O. Smith Motors and Baldor Motors
Efficient Equipment Incentive Program	ASD/VSD	\$248.88/hp	Engineering Calculation
Efficient Equipment Incentive Program	LED Traffic Signals12" Red	\$749.44	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	LED Traffic Signals 8" Green	\$668.73	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	LED Traffic Signals12" Green	\$1,078.23	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	LED Traffic Signals 8" Yellow	\$861.00	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	LED Traffic Signals Pedestrian 8 or 12"	\$1,632.00	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	LED Traffic Signals Yellow Arrow	\$205.89	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	LED Traffic Signals Green Arrow	\$284.50	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	LED Traffic Signals 12" Yellow	\$1,158.09	Retailers: Dialight, Atlanta Light Bulbs, and Duro Test
Efficient Equipment Incentive Program	Energy Star Dehumidifier	\$24.00	Energy Star
Efficient Equipment Incentive Program	Room AC	\$30.00	Energy Star
Efficient Equipment Incentive Program	Dishwasher	\$30.00	Energy Star
Efficient Equipment Incentive Program	Energy Star Clothes Washer	\$300.00	Energy Star

Program	Measure	Incremental Cost	Incremental Cost Source
Efficient Equipment Incentive Program	Indoor Energy Star Light Fixtures	\$20.00	Energy Star
Efficient Equipment Incentive Program	Commercial CAC - SEER 15	\$550.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	Commercial CAC - SEER 16	\$850.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	ASHP - SEER 14.5	\$350.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	ASHP - SEER 15	\$700.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	ASHP - SEER 16	\$1,050.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	Heat Pump Hot Water Heater	\$1,079.04	RTF and Cadmus research
Efficient Equipment Incentive Program	ice Maker - Energy Star	\$358.00	CEE : http://www.cee1.org/com/com-ref/ice-faq.php3#14
Efficient Equipment Incentive Program	Commercial Reach-In Refrigerator	\$180.00	Energy Star, FTSC 2004
Efficient Equipment Incentive Program	Energy Star Copiers	\$156.76	2005 DEER database
Efficient Equipment Incentive Program	Energy Star All-In-One	\$1.00	Energy Star
Efficient Equipment Incentive Program	Compressor VSD Retrofit Rebate	\$171.92/hp	Nexant Project Experience and LBNL
Efficient Equipment Incentive Program	High-Efficiency Case Fans	\$73.02/fan	DEER 2005 and SCE
Efficient Equipment Incentive Program	DX Packaged ASAC New Construction 11.5 EER	\$11,369.56	DEER 2005, CEC, and ACEEE
Efficient Equipment Incentive Program	DX Packaged ASAC New Construction 12.0 EER	\$13,779.69	DEER 2005, CEC, and ACEEE
Efficient Equipment Incentive Program	(DX) Packaged Air Conditioner System 12.5 EER	\$16,189.83	DEER 2005 and , CEC, and ACEEE
Efficient Equipment Incentive Program	Heat Pump - Air Source EER=11.0, COP=3.5	\$5,627.99	DEER 2005
Efficient Equipment Incentive Program	Heat Pump - Air Source EER=11.8, COP=3.8	\$12,050.51	DEER 2005, engineering calculation, and Appliance Standards Awareness Project
Efficient Equipment Incentive Program	High-Efficiency Compressor	\$132.88/hp	DEER 2005 / 1995 DOE
Efficient Equipment Incentive Program	Air-Cooled Chiller	\$11,270.03	DEER

Program	Measure	Incremental Cost	Incremental Cost Source
Efficient Equipment Incentive Program	Computer	\$1.00	Energy Star
Efficient Equipment Incentive Program	CAC - SEER 15	\$495.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	Energy Star Printers	\$25.00	Retailer: Best Buy
Efficient Equipment Incentive Program	Display Cases	\$132.03/case	DEER 2005 scaled with DOE data
Efficient Equipment Incentive Program	High-Efficiency Evaporator Fans - Walk-ins	\$249.58/fan	DEER 2005 and SCE
Efficient Equipment Incentive Program	Faucet Aerators	\$161.59	Engineering calculation
Efficient Equipment Incentive Program	Energy Star Fax	\$1.00	2005 DEER database
Efficient Equipment Incentive Program	High-efficiency Gas Furnace (RTS fuel switching)	\$4,000.00	Engineering calculation
Efficient Equipment Incentive Program	Energy Star Monitors	\$10.00	Energy Star
Efficient Equipment Incentive Program	Floating Head Pressure Control	\$2,409.99	DEER 2005 / CALMAC Report - September 2000 / GSD
Renewable Energy Program	PV – Residential	\$47,031.00	http://www.californiasolarstatistics.ca.gov/reports/cost_vs_system_size/
Renewable Energy Program	PV – Nonresidential	\$2,963,985.00	http://www.californiasolarstatistics.ca.gov/reports/cost_vs_system_size/
Renewable Energy Program	GSHP – Nonresidential	\$2,832.00/ton	Various vendors and studies
Efficient Equipment Incentive Program	Energy Star Refrigerator	\$30.00	Energy Star
Efficient Equipment Incentive Program	Programmable Thermostat – Nonresidential	\$172.36	DEER, RSMeans
Efficient Equipment Incentive Program	Programmable Thermostat – Residential	\$25.56	DEER
Efficient Equipment Incentive Program	Energy Star Scanners	\$1.00	Energy Star
Efficient Equipment Incentive Program	Energy Star Water Cooler	\$1.00	Energy Star
Efficient Equipment Incentive Program	Thermostat Replacement	\$272.00	DEER

Program	Measure	Incremental Cost	Incremental Cost Source		
Efficient Equipment Incentive Program	Water-Cooled Centrifugal Chiller	\$169.04/ton	DEER 2008		
Efficient Equipment Incentive Program	Ductless mini-split heat pumps	\$3,407.11	RTF and Cadmus research		
Efficient Equipment Incentive Program	Ceiling Insulation - CAC	\$8,413.36	RSMeans		
Efficient Equipment Incentive Program	Ceiling Insulation - Heat Pump	\$6,717.14	RSMeans		
Efficient Equipment Incentive Program	Wall Insulation - CAC	\$4,630.23	RSMeans		
Efficient Equipment Incentive Program	Wall Insulation-Heat Pump	\$3,032.66	RSMeans		
Efficient Equipment Incentive Program	Evaporator Fan Controller	\$139.82	RTF and Cadmus research		
Efficient Equipment Incentive Program	PTAC - New Construction 7,000 -10,000 Btu/h (>=.583 and < .833 Tons)	\$44.00/ton	DEER 2008		
Efficient Equipment Incentive Program	PTAC - New Construction >=14,000 Btu/h (>=1.167 Tons)	\$143.00/ton	DEER 2008		
Efficient Equipment Incentive Program	PTHP - New Construction 7,000 -10,000 Btu/h (>=.583 and < .833 Tons)	\$135.00/ton	DEER 2008		
Efficient Equipment Incentive Program	PTHP - New Construction 10,000 - 14,000 Btu/h (>=.833 and < 1.167 Tons)	\$353.00/ton	DEER 2008		
Residential Energy Assessment & Weatherization	CFL	\$3.59	Engineering Calculation		
Residential Energy Assessment & Weatherization	Faucet Aerator-Bath	\$0.50	Engineering Calculation		
Residential Energy Assessment & Weatherization	Faucet Aerator - kitchen	\$0.50	Engineering Calculation		
Residential Energy Assessment & Weatherization	Hot Water Pipe Insulation	\$16.94	DMME, RSMeans		

Program	Measure	Incremental Cost	Incremental Cost Source
Residential Energy Assessment & Weatherization	Infiltration	\$70.00	Engineering Calculation
Residential Energy Assessment & Weatherization	Duct Sealing	\$68.00	Engineering Calculation
Residential Energy Assessment & Weatherization	Wall Insulation (R-11)	\$2,168.00	Participant cost data
Residential Energy Assessment & Weatherization	Ceiling Insulation (R-38)	\$1,582.00	Participant cost data

Appendix L: Glossary of Terms

This Glossary of Terms was provided by the SWE.

- A -

Administration Costs: As defined by the TRC Technical Working Group.

Avoided Cost: In the context of energy efficiency, these are the costs that are avoided by the implementation of an energy efficiency measure, program, or practice. Such costs are used in benefit-cost analyses of energy efficiency measures and programs as defined by the Pennsylvania PUC in the TRC Test Order.⁴⁵ Any additions to this definition will be discussed by the TRC Technical Working Group.

- B -

- **Baseline**: Conditions that would have occurred without implementation of the subject measure or project. Baseline conditions are sometimes referred to as 'business-as-usual' conditions and are used to calculate program related efficiency or emissions savings. Baselines can be defined as either project specific baselines or performance standard baselines (e.g., building codes). For the purposes of Act 129, baselines are defined in the Pennsylvania TRM, in approved custom protocols, and in TRM interim approved protocols.
- **Baseline Data**: The information representing the systems being upgraded before the energy efficiency activity takes place.
- **Benefit-Cost Ratio**: The mathematical relationship between the benefits and costs associated with the implementation of energy efficiency measures, programs, or practices. The benefits and costs are typically expressed in dollars. This is the ratio of the discounted total benefits of the program to the discounted total costs over the expected useful life of the energy efficiency measure. The explicit formula for use in Pennsylvania is set forth in the Appendix to the TRC Order.⁴⁶ Also see *Benefit-Cost Test.*

⁴⁵ Pennsylvania Public Utility Commission. *Implementation of Act 129 of 2009 – Total Resource Cost Test (TRC) Order*. Docket No. M-2009-2108601. Issued June 18, 2009.

⁴⁶ Ibid.

- **Benefit-Cost Test**: Also called *Cost-Effectiveness Test*, defined as the methodology used to compare the benefits of an investment to the costs. For programs evaluated under Act 129, the TRC Test is the required benefit-cost test as issued in the TRC Order.⁴⁷
- **Bias:** The extent to which a measurement, sampling, or analytic method systematically underestimates or overestimates a value. Some examples of types of bias include engineering model bias; meter bias; sensor bias; an inadequate or inappropriate estimate of what would have happened absent a program or measure installation; a sample that is unrepresentative of a population; and selection of other variables in an analysis that are too correlated with the savings variable (or each other) in explaining the dependent variable (such as consumption).

– C –

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

- **Coincident Demand**: The demand of a device, circuit, or building that occurs at the same time as the peak demand of a utility's system load or at the same time as some other peak of interest, such as a building or facility peak demand. The peak or interest should be specified (e.g., 'demand coincident with the utility system peak').
- **Coincidence Factor**: The ratio, expressed as a numerical value or as a percentage of connected load, of the coincident demand of an electrical appliance or facility type with the utility system peak.
- **Confidence**: An indication of the probability that an estimate is within a specified range of the true value of the quantity in question. Confidence is the likelihood that the evaluation has captured the true value of a variable within a certain estimated range. Also see *Precision*.
- **Correlation**: For a set of observations, such as for participants in an energy efficiency program, the extent to which values for one variable are associated with values of another variable for the same participant. For example, facility size and energy consumption usually have a high positive correlation.

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

Cost-Effectiveness: An indicator of the relative performance or economic attractiveness of an investment or practice. In the energy efficiency field, the present value of the estimated benefits

47 Ibid.

produced by an energy efficiency program is compared to the estimated total costs to determine if the proposed investment or measure is desirable from a variety of perspectives (e.g., whether the estimated benefits exceed the estimated costs from a societal perspective). See *Benefit-Cost Test*.

Cost-Effectiveness Test: See Benefit-Cost Test.

- **Cumulative Energy Savings**: The summation of energy savings associated with multiple projects or programs over a specified period of time.
- **Cumulative-to-Date**: Beginning June 1, 2009 through the end of the current quarterly reporting period (February 28/29, May 31, August 31, or November 30).
- **Cumulative Portfolio/Program Inception-to-Date:** Beginning June 1, 2009 through the end of the current quarterly reporting period (February 28/29, May 31, August 31, or November 30).
- **Custom Program**: An energy efficiency program intended to provide efficiency solutions to unique situations not amenable to common or prescriptive solutions addressed by the PA TRM. Each custom project is examined for its individual characteristics, savings opportunities, efficiency solutions, and often, customer incentives. Under Act 129, these programs fall outside of the jurisdiction of the Pennsylvania TRM, and thus the M&V protocols for each should be approved by the SWE.

– D –

- **Deemed Savings:** An estimate of energy or demand savings for a single unit of an installed energy efficiency measure that: (1) has been developed from data sources and analytical methods that are widely considered acceptable for the measure and purpose, and (2) is applicable to the situation being evaluated. Individual parameters or calculation methods can also be deemed. Deemed savings for measures implemented under Act 129 are stipulated in the PA TRM, which undergoes an annual review and update process, as well as in the Interim TRM Measures, which are subject to interim approval by the SWE.
- Defensibility: The ability of evaluation results to stand up to scientific scrutiny. Defensibility is based on assessments by experts of the evaluation's validity, reliability, and accuracy. Under Act 129, it is the role of the SWE to determine the defensibility of the verified savings estimates reported by each of the EDCs.
- **Delta Watts**: The difference in the connected load (wattage) between existing or baseline equipment and the energy efficient replacement equipment, expressed in Watts or kilowatts.

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

Demand Reduction: See Demand Savings.

- **Demand Response:** The reduction of customer energy usage at times of peak usage in order to help system reliability, to reflect market conditions and pricing, or to support infrastructure optimization or deferral of additional infrastructure. Demand response programs may include contractually obligated or voluntary curtailment, direct load control, and pricing strategies.
- **Demand Savings**: The reduction in electric demand from the demand associated with a baseline system to the demand associated with the higher-efficiency equipment or installation. For the purposes of Act 129, demand savings resulting from demand response programs must occur during the 100 peak hours as defined in Act 129. Demand savings associated with energy efficiency measures implemented under Act 129 are calculated according to the approved calculation methods stipulated in the TRM or subsequently approved through alternative methods (e.g., interim measures, custom protocols).
- Demand-side Management: Strategies used to manage energy demand including energy efficiency, load management, fuel substitution, and load building.

– E ⊷

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

- **EE&C Plan Estimate for Program Year:** An estimate of the energy savings or demand reduction for the current program year as filed in the EDC EE&C plans.
- Effective useful life: An estimate of the median number of years that efficiency measures installed under a program are still in place and operable. For measures implemented under Act 129, it is required that the effective useful life or 15 years, whichever is less, be used to determine measure assessments.
- Electric Distribution Company (EDC): In reference to Act 129, there are seven EDCs with at least 100,000 customers that are required to adopt a plan to reduce energy and demand consumption within their service territory in accordance with 66 Pa. C.S. § 2608. The seven EDCs include: Allegheny Power, Duquesne Light, Metropolitan Edison Company, Pennsylvania Electric Company, Pennsylvania Power Company, PECO Energy Company, and PPL Electric Utilities.

- **Electric Distribution Company (EDC) Evaluation Costs:** Expenses incurred by the EDC pertaining to EM&V activities. This includes expenses for contractors, metering equipment, evaluation software, etc.
- **Electric Distribution Company (EDC) Implementation Costs:** Expenses incurred by the EDC pertaining to the implementation of Act 129 programs approved in their respective EE&C Plans. This includes expenses for payments to conservation service providers, marketing expenses, rebates, etc.
- **Electric Distribution Company (EDC) Incentive Costs:** Payments by the EDC to a customer participating in an EE&C program approved by the Commission. This may include rebates for the purchase of energy efficiency qualifying equipment, cash payments for participation in programs, etc.

End Use: An appliance that uses energy.

- **Energy Conservation**: Using less of a service in order to save energy. The term is often unintentionally used instead of energy efficiency.
- **Energy Efficiency**: The use of less energy to provide the same or an improved level of service to the energy consumer; or the use of less energy to perform the same function.
- **Energy Efficiency Measure:** An installed piece of equipment or a system, modification of equipment systems, or modified operations in customer facilities that reduce the total amount of electrical or gas energy and the capacity that would otherwise have been needed to deliver an equivalent or improved level of comfort or energy service.

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

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

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

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

— F —

- Free Driver: A program non-participant who adopted a particular efficiency measure or practice as a result of the evaluated program. Also see *Spillover*.
- Free-rider: A program participant who would have implemented the program measure or practice in the absence of the program. Free-riders can be: 1) total, in which the participant's activity would have completely replicated the program measure; 2) partial, in which the participant's activity would have partially replicated the program measure; or 3) deferred, in which the participant's activity would have completely replicated the program measure; or 3) deferred, in which the participant's activity would have completely replicated the program measure; but after the program's timeframe.

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

– G –

Gross Impact: See Gross Savings.

- Gross Savings: The change in energy consumption and/or demand that results directly from programrelated actions taken by participants in an efficiency program, regardless of why they participated.
- **Gross kW**: Expected demand reduction based on a comparison of standard or replaced equipment with equipment installed through an energy efficiency program.
- **Gross kWh**: Expected kWh reduction based on a comparison of standard or replaced equipment with equipment installed through an energy efficiency program.

-H-

- Impact Evaluation: An evaluation of the program-specific, directly induced quantitative changes (kWh, kW, and therms) attributable to an energy efficiency program.
- **Incremental Cost**: The difference between the cost of an existing or baseline equipment or service and the cost of an alternative energy efficient equipment or service.
- **Incremental Energy Savings**: The difference between the amount of energy savings associated with a project or a program in one period and the amount of energy savings associated with that project or program in a prior period.
- **Incremental Quarter:** The time period of one reporting quarter; typically used to reference the additional results accrued during the reporting quarter.

- **Incremental Quarterly Participants:** The difference between the cumulative number of program participants acquired in a program in one period and the cumulative number of participants acquired by that program in a prior period.
- Incremental Quarterly Reported Gross Impact: The difference between the amount of reported gross impacts of a program in one period and the amount of reported gross impacts of that program in a prior period.

-1-

- Kilowatt (kW): A measure of the rate of power used during a pre-set time period (e.g., minutes, hours, days, months) equal to 1,000 Watts.
- **Kilowatt-Hour (kWh)**: A common unit of electric energy; one kilowatt-hour is numerically equal to 1,000 Watts used for one hour.

- L -

- Lifetime kW: The expected demand savings over the lifetime of an installed measure, equal to the annual peak kW reduction associated with a measure multiplied by the expected lifetime of that measure. It is expressed in units of kW-years.
- Lifetime MWh: The expected electrical energy savings over the lifetime of an installed measure, calculated by multiplying the annual MWh reduction associated with a measure by the expected lifetime of that measure.
- Lifetime Supply Costs: The net present value of avoided supply costs associated with savings, net of changes in energy use that would have happened in the absence of the program over the life of the energy efficiency measure, factoring in persistence of savings. See Avoided Cost.⁴⁸
- Load Factor: A percentage indicating the ratio of electricity or natural gas used during a given timeframe to the amount that would have been used if the usage had stayed at the highest demand the whole time. The term is also used to indicate the percentage of capacity of an energy facility, such as a power plant or gas pipeline that is utilized for a given period of time.

48 Ibid.

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

– M –

Management Costs: To be defined by the TRC Technical Working Group.

- Market Assessment: An analysis that provides an assessment of how and how well a specific market or market segment is functioning with respect to the definition of well-functioning markets or with respect to other specific policy objectives. Generally includes a characterization or description of the specific market or market segments, including a description of the types and number of buyers and sellers in the market, the key actors that influence the market, the type and number of transactions that occur on an annual basis, and the extent to which market participants consider energy efficiency as an important part of these transactions. This analysis may also include an assessment of whether a market has been sufficiently transformed to justify a reduction or elimination of specific program interventions. Market assessments can be blended with strategic planning analysis to produce recommended program designs or budgets. One particular kind of market assessment effort is a baseline study, or the characterization of a market before the commencement of a specific intervention in the market, for the purpose of guiding the intervention and/or assessing its effectiveness later.
- Measurement and Verification (M&V): A subset of program impact evaluations that are associated with the documentation of energy savings at individual sites or projects using one or more methods that can involve measurements, engineering calculations, statistical analyses, and/or computer simulation modeling.
- **Measurement Error**: In the evaluation context, a reflection of the extent to which the observations conducted in the study deviate from the true value of the variable being observed. The error can be random (equal around the mean) or systematic (indicating bias).
- Megawatt (MW): A unit for measuring electricity equal to 1,000 kilowatts or one million Watts.
- Megawatt-Hour (MWh): A unit of electric energy numerically equal to 1,000,000 Watts used for one hour.

- Metered Data: Data collected over time through a meter for a specific end use, energy-using system (e.g., lighting, HVAC), or location (e.g., floors of a building, a whole premise). Metered data may be collected over a variety of time intervals. Usually refers to electricity or gas data.
- Metering: The collection of energy consumption data over time through the use of meters. These meters may collect information about an end-use, a circuit, a piece of equipment, or a whole building (or facility). Short-term metering generally refers to data collection for no more than a few weeks. End-use metering refers specifically to separate data collection for one or more end-uses in a facility, such as lighting, air conditioning, or refrigeration. Spot metering is an instantaneous measurement (rather than over time) to determine equipment size or power draw.
- **Monitoring**: The collection of relevant measurement data over time at a facility, including but not limited to energy consumption or emissions data (e.g., energy and water consumption, temperature, humidity, volume of emissions, hours of operation) for the purpose of conducting a savings analysis or to evaluate equipment or system performance.

– N –

Net Impact: See Net Savings.

- Net Present Value: The discounted value of the net benefits or costs over a specified period of time (e.g., the expected useful life of the energy efficiency measure).⁴⁹
- Net Savings: The total change in load that is attributable to an energy efficiency program. This change in load may include, implicitly or explicitly, the effects of free drivers, free-riders, energy efficiency standards, changes in the level of energy service, and other causes of changes in energy consumption or demand. Net savings are calculated by multiplying verified savings by a NTG ratio.
- Net-to-Gross (NTG) Ratio: A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts.
- **Non-participant**: Any consumer who was eligible but did not participate in the subject efficiency program in a given program year.

49 Ibid.

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

- P -

- Participant: A utility customer partaking in an energy efficiency program, defined as one transaction or one rebate payment in a program. For example, a customer receiving one payment for two measures within one program counts as one participant. A customer receiving two payments in two programs counts as two participants. A customer partaking in one program at two different times receiving two separate payments counts as two participants.
- Participant Costs: Costs incurred by a customer participating in an energy efficiency program. Typically, these costs are represented as incremental costs (i.e., the costs incurred for the purchase, installation, and maintenance of energy efficiency equipment over standard or existing equipment).
- **Peak Demand:** The maximum level of metered demand during a specified period, such as a billing month or a peak demand period. For Act 129, peak period is defined by the TRC Order as the peak 100 hours.
- **Peak Load:** The highest electrical demand within a particular period of time. Daily electric peaks on weekdays typically occur in the late afternoon and early evening. Annual peaks typically occur on hot summer days.
- **Percent of Estimate Committed**: The program year-to-date total committed savings as a percent of the savings targets established in each EDC EE&C Plan, calculated by dividing the PYTD total committed by the EE&C Plan program year estimate.
- Portfolio: Can be defined as: (1) a collection of programs addressing the same market (e.g., a portfolio of residential programs), technology (e.g., motor efficiency programs), or mechanisms (e.g., loan programs); or (2) the set of all programs conducted by one or more organizations, such as a utility or program administrator, and which could include programs that cover multiple markets, technologies, etc.

- **Precision:** An indication of the closeness of agreement among repeated measurements of the same physical quantity. It is also used to represent the degree to which an estimated result in social science (e.g., energy savings) would be replicated with repeated studies.
- Preliminary Program Year-to-Date (PYTD) Net Impact: Net impacts reported in quarterly reports. These net impacts are preliminary in that they are based on preliminary realization rates.
- Preliminary Program Year-to-Date (PYTD) Verified Impact: Verified impacts reported in quarterly reports. These verified impacts are preliminary in that they are based on preliminary realization rates.
- Preliminary Realization Rate: Realization rates reported in quarterly reports based on the results of M&V activities conducted on the sample to date. These results are preliminary because the sample-to-date is likely to have not met the required levels of confidence and precision.
- **Prescriptive Program**: An energy efficiency program focused on measures that are one-for-one replacements of the existing equipment and for which fixed customer incentives can be developed based on the anticipated similar savings that will accrue from their installation.
- **Process Evaluation**: A systematic assessment of an energy efficiency program for the purposes of documenting program operations at the time of the examination and identifying and recommending improvements to increase the program's efficiency or effectiveness for acquiring energy resources, while maintaining high levels of participant satisfaction.
- **Program Administrator:** Those entities that oversee the implementation of energy efficiency programs. This generally includes regulated utilities, other organizations chosen to implement such programs, and state energy offices.
- Program Year Energy Savings Target: Energy target established for the given program year as approved in each EDC EE&C Plan.
- Program Year Sample Participant Target: Estimated sample size for evaluation activities in the given program year.
- **Program Incentive:** An incentive, generally monetary, that is offered to a customer through an energy efficiency program to encourage their participation. The incentive is intended to overcome one or more barriers that keep the customer from taking the energy efficiency action on their own.
- Program Participant: A consumer that received a service offered through an efficiency program in a given program year. The term "service" can be one or more of a wide variety of services,

including financial rebates, technical assistance, product installations, training, energy efficiency information, or other services, items, or conditions.

- **Program Year-to-Date (PYTD)**: Beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).
- Program Year-to-Date (PYTD) Net Impact: The total change in load that is attributable to an energy efficiency program from June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).
- **Program Year-to-Date (PYTD) Participants**: The number of utility customers partaking in an energy efficiency program beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).
- Program Year-to-Date (PYTD) Reported Gross Impact: The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated, beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30). This value is unverified by an independent third-party evaluator.
- **Program Year-to-Date (PYTD) Sample Participants**: Total participant sample beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30).
- Program Year-to-Date (PYTD) Total Committed: The estimated gross impacts, including reported impacts and in-progress impacts, beginning June 1 of the current program year through the end of the current quarter (February 28/29, May 31, August 31, or November 30), calculated by adding PYTD reported gross impacts for projects in progress.
- **Project**: An activity or course of action involving one or multiple energy efficiency measures at a single facility or site.
- **Projects in Progress:** Energy efficiency and demand response projects currently being processed and tracked by the EDC, but that are not yet complete at the time of the report. A complete project is defined as a project in which the energy conservation measure has been installed and is commercially operable, and for which a rebate check has been issued.

- Q -

- Realization Rate: The term is used in several contexts in the development of reported program savings. The primary applications include the ratio of project tracking system savings data (e.g., initial estimates of project savings) to savings that: 1) are adjusted for data errors, and 2) incorporate the evaluated or verified results of the tracked savings.
- **Rebate Program:** An energy efficiency program in which the program administrator offers a financial incentive for the installation of energy efficient equipment.
- **Rebound Effect:** Also called 'snap back,' defined as a change in energy-using behavior that yields an increased level of service that is accompanied by an increase in energy use and occurs as a result of taking an energy efficiency action. The result of this effect is that the savings associated with the direct energy efficiency action is reduced by the resulting behavioral change.
- **Regression Analysis:** Analysis of the relationship between a dependent variable (response variable) to specified independent variables (explanatory variables). The mathematical model of their relationship is the regression equation.
- **Regression Model**: A mathematical model based on statistical analysis where the dependent variable is quantified based on its relationship to the independent variables which are believed to determine its value. In so doing, the relationship between the variables is estimated statistically from the data used.
- **Reliability:** The quality of a measurement process that would produce similar results on: (1) repeated observations of the same condition or event, or (2) multiple observations of the same condition or event by different observers.
- Renewable Energy: Energy derived from resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.
- **Reported Gross Impact:** The change in energy consumption and/or demand that results directly from program-related actions taken by participants in an efficiency program, regardless of why they participated. This value is unverified by an independent third-party evaluator.
- **Reporting Period**: The time following implementation of an energy efficiency activity during which results are to be determined.
- **Representative Sample**: A sample that has approximately the same distribution of characteristics as the population from which it was drawn.

Rigor: The level of effort expended to minimize uncertainty due to factors such as sampling error and bias. The higher the level of rigor, the more confidence there is that the results of the evaluation are accurate and precise.

- S –

Sample: In program evaluation, a portion of the population selected to represent the whole. Differing evaluation approaches rely on simple or stratified samples (based on some characteristic of the population).

Sample Design: The approach used to select the sample units.

- Sampling Error: The error in estimating a parameter caused by the fact that all of the disturbances in the sample are not zero.
- Savings Factor (SVG): The percent of time the lights are off due to lighting controls relative to the baseline controls system (typically a manual switch). Also referred to as the lighting controls savings factor.
- **Simple Random Sample**: A method for drawing a sample from a population such that all samples of a given size have an equal probability of being drawn.
- Snap Back: See Rebound Effect.
- Simulation Model: An assembly of algorithms that calculate energy use based on engineering equations and user-defined parameters.
- Spillover: Reductions in energy consumption and/or demand caused by the presence of an energy efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program. There can be participant and/or non-participant spillover. Participant spillover is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy saving practices after having participated in the efficiency program as a result of the program's influence. Non-participant spillover refers to energy savings that occur when a program installs energy efficiency measures or applies are a result of a program installs energy efficiency measures or applies energy savings practices as a result of a program's influence.
- **Spillover Rate**: An estimate of energy savings attributable to spillover effects expressed as a percent of savings installed by participants through an energy efficiency program.

- **Standard Error**: A measure of the variability in a data sample indicating how far a typical data point is from the mean of a sample. In a large sample, approximately two-thirds of observations lie within one standard error of the mean, and 95% of observations lie within two standard errors.
- **Statistically Adjusted Engineering Models:** A category of statistical analysis models that incorporate the engineering estimate of savings as a dependent variable. The regression coefficient in these models is the percentage of the engineering estimate of savings observed in changes in energy usage. For example, if the coefficient on the statistically adjusted engineering term is 0.8, the customers are, on average, realizing 80% of the savings from their engineering estimates.

Stipulated Values: See Deemed Savings.

- Stratified Random Sampling: The population is divided into subpopulations, called strata, that are nonoverlapping and together comprise the entire population. A simple random sample of each stratum is taken to create a sample based on stratified random sampling.
- **Stratified Ratio Estimation**: A sampling method that combines a stratified sample design with a ratio estimator to reduce the coefficient of variation by using the correlation of a known measure for the unit (e.g., expected energy savings) to stratify the population and allocate a sample from the strata for optimal sampling.

- T -

Takeback Effect: See Rebound Effect.

- **Total Resource Cost (TRC) Test**: A cost-effectiveness test that measures the net direct economic impact to the utility service territory, state, or region. The TRC Order⁵⁰ details the method and assumptions to be used when calculating the TRC test for EE&C portfolios implemented under Act 129. The results of the TRC test are to be expressed as both a net present value and a benefit-cost ratio.
- **Total Resource Cost (TRC) Test Benefits**: Benefits calculated in the TRC test that include the avoided supply costs, such as the reduction in transmission, distribution, generation, and capacity costs, valued at a marginal cost for the periods when there is a consumption reduction. The PA TRC benefits will consider avoided supply costs, such as the reduction in forecasted zonal wholesale electric generation prices, ancillary services, losses, generation capacity, transmission capacity,

⁵⁰ Ibid.

and distribution capacity. The avoided supply costs will be calculated using net program savings, defined as the savings net of changes in energy use that would have happened in the absence of the program. The persistence of savings over time will also be considered in the net savings.⁵¹

Total Resource Cost (TRC) Test Costs: The costs calculated in the TRC test will include the costs of the various programs paid for by an EDC (or by a default service provider) and the participating customers, and costs that reflect any net change in supply costs for the periods in which consumption is increased in the event of load shifting. Note that the TRC test should utilize the incremental costs of services and equipment. Thus, for example, this would include costs for equipment, installation, operation and maintenance, removal (less salvage value), and administrative tasks, regardless of who pays for them.⁵²

– U –

- **Uncertainty**: The range or interval of doubt surrounding a measured or calculated value within which the true value is expected to fall with some degree of confidence.
- **Upstream Program**: A program that provides information and/or financial assistance to entities in the delivery chain of high-efficiency products at the retail, wholesale, or manufacturing level. Such a program is intended to yield lower retail prices for the products.

- V -

- Verification: An independent assessment of the reliability (considering completeness and accuracy) of claimed energy savings or an emissions source inventory.
- Verified Gross Impact: Calculated by applying the realization rate to reported gross impacts.

– W –

Watt: A unit of measure of electric power at a point in time as capacity or demand. One Watt of power maintained over time is equal to one Joule per second. The Watt is named after Scottish inventor James Watt, and is shortened to W and used with other abbreviations, as in kWh (kilowatt-hours).

⁵¹ Ibid.

⁵² Ibid.

Watt-Hour: One Watt of power expended for one hour. One-thousandth of a kilowatt-hour.

- Whole-building Calibrated Simulation Approach: A savings measurement approach (defined in the International Performance Measurement and Verification Protocol Option D and in the American Society of Heating, Refrigerating and Air-Conditioning Engineers Guideline 14) that involves the use of an approved computer simulation program to develop a physical model of the building in order to determine energy and demand savings. The simulation program is used to model the energy used by the facility before and after the retrofit. The pre- or post-retrofit models are developed by calibration with measured energy use, demand data, and weather data.
- Whole-building Metered Approach: A savings measurement approach (defined in the International Performance Measurement and Verification Protocol Option C and in the American Society of Heating, Refrigerating and Air-Conditioning Engineers Guideline 14) that determines energy and demand savings through the use of whole-facility energy (end use) data, which may be measured by utility meters or data loggers. This approach may involve the use of monthly utility billing data or data gathered more frequently from a main meter.

- X --- Y --- Z --

<u>References</u>

- Pennsylvania Public Utility Commission. Implementation of Act 129 of 2009 Total Resource Cost Test (TRC) Order. Docket No. M-2009-2108601. Issued June 18, 2009.
- PAH Associations, prepared by Paul Horowitz. Facilitated by the Northeast Energy Efficiency Partnership. Glossary of Terms Version 1.0. A project of the Regional Evaluation, Measurement and Verification Forum. March 2009.

Appendix M: 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 PY3, approximately 13% of participants in non-low income programs were below 150% of the Federal Poverty Level (FPL), with associated savings of 27,156 MWh/year (see Table M-1). 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 M-2 for the percentage of respondents who answered these questions. The residential lighting program includes only recent purchasers.

Below 150% of the FPL											
						PY2			РҮ1		
Program	Total Survey Respondents	Number of Respondents Meeting FPL Guidelines	Percent	PYTD Verified Gross Savings (MWh/yr)	Savings Associated with 150% FPL Population	Total Survey Respondents	Number Meeting FPL Guidelines	Percent	Total Survey Respondents	Number Meeting FPL Guidelines	Percent
ARP	52	4	8%	18,893	1,453	102	6	6%	61	3	5%
Audit Wx	76	19	25%	2,144	536	50	2	4%	-	-	-
Behavior & Ed	252	26	10%	29,370	3,030	224	35	16%	-	-	-
Renewables	0	0	-	-	-	77	0	0%	49	0	0%
Res Eff. Equip	67	5	7%	15,281	997	158	2	1%	57	4	7%
Residential Lighting	133	22	17%	127,802	21,140	138	13	9%	52	7	13%
Overail Totals	580	76	13%	193,490	27,156	749	58	8%	219	14	6%

Table M-1: Low Income Participation in Non-Low Income Programs
Program	Total PY3 Survey Completes	Total Responding*	Percent Responding to Income/Household Questions and Completing Full Survey	Percent of Respondents Refusing to Answer Income/Household Questions or Not Completing Full Survey
ARP	75	52	69%	31%
Audit Wx	114	76	67%	33%
Beh & Ed	341	252	74%	26%
Res EE	99	67	68%	32%
CFL	160	133	83%	17%
Overali Totals	789	580	73%	27%
NOTES:				

Table M-2: Percentage of Respondents Answering Income and Household Questions¹

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.

PPL Electric | Page 243

Appendix N: Process Evaluation

The Process Evaluation will be submitted as a stand alone appendix.

PPL Electric | Page 244