POST & SCHELL PC
ATTORNEYS AT LAW

17 North Second Street
12th Floor
Harrisburg, PA 17101-1601
717-731-1970 Main
717-731-1985 Fax
www.postschell.com

Andrew S. Tubbs

atubbs@postschell.com
717-612-6057 Direct
717-731-1985 Fax
File #: 140069

November 15, 2011

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

RE: Final Annual Report for Year 2 of PPL Electric Utilities Corporation's Act 129 Plan
Docket No. M-2009-2093216

Dear Secretary Chiavetta:

Enclosed is PPL Electric Utilities Corporation's ("PPL Electric") Final Annual Report for Year 2 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 Submitted,

Andrew S. Tubbs

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

PY2 Final Annual Report to the Pennsylvania Public Utility Commission

For the period June 1, 2010 to May 31, 2011
Program Year 2

For Act 129 of 2008
Energy Efficiency and Conservation Program
PPL Electric Utilities

Prepared by PPL Electric and The Cadmus Group, Inc.
November 15, 2011 (Corrected)

Table of Contents

Abbreviations (see Appendix N: Glossary of Terms for definitions)

AHRI	Air-Conditioning, Heating, and Refrigeration Institute
ARP	Appliance Recycling Program
ASHP	Air-source heat pump
BPI	Building Performance Institute
C&I	Commercial and industrial
CAC	Central air conditioner
CBO	Community-based organization
CEC	California Energy Commission
CFL	Compact fluorescent lighting
CI	Capacity index
CMP	Custom measure protocol
COP	Coefficient of performance
CPITD	Cumulative program/portfolio inception-to-date
CSP	Conservation services provider
DCV	Demand control ventilation
DHP	Ductless heat pumps
ECM	Electronically commutated motor
EDC	Electric distribution company
EE&C	Energy efficiency and conservation
EEMIS	Energy Efficiency Management Information System
EER	Energy efficiency ratio
EFLH	Equivalent full load hours
EI	Efficiency index
EIC	Eic | Comfort Home
EM&V	Evaluation, measurement, and verification
EMS	Energy management system
EPS	E-Power Solutions
FDSI	Field Diagnostic Services, Inc.
GNI	Government, non-profit, institutional
GSHP	Ground-source heat pump
HOU	Hours-of-use
HPWH	Heat pump water heater
HSPF	Heating seasonal performance factor
IQ	Incremental quarter
ISR	In-service rate
JACO	JACO Environmental Inc.
KAMs	Key account managers
kW	Kilowatt
kWh	Kilowatt hour
M&V	Measurement and verification
MW	Megawatt
MWh	Megawatt-hour
NTG	Net-to-gross

ODC	Opinion Dynamics Corporation
OLS	Ordinary least squares
PUC	*Public Utility Commission*
PV	Photovoltaic
PYTD	Program/portfolio year-to-date
QA/QC	Quality assurance/quality control
RAP	Resource Action Program Inc.
RTF	Regional Technical Forum
RTS	Residential Thermal Storage
SEER	Seasonal energy efficiency ratio
SSEMVP	Site specific evaluation, measurement, and verification plan
SVG	Savings factor (typically used to estimate savings for lighting controls)
SWE	Statewide evaluator
TRC	Total Resource Cost
TRM	Technical Reference Manual
USP	Universal Services Program
VSD	Variable speed drive
WRAP	Winter Relief Assistance Program

1 Overview of Portfolio

Act 129, signed October 15, 2008, mandated energy savings and demand reduction goals for the largest electric distribution companies (EDCs) in Pennsylvania. Pursuant to those goals, energy efficiency and conservation (EE&C) plans were submitted by each EDC and approved by the Pennsylvania Public Utility Commission (PUC). This annual report documents the progress and effectiveness of the EE&C accomplishments for PPL Electric for Program Year 2.

The following outlines the compliance goal progress as of the end of the reporting period:[1]

Cumulative Portfolio Energy Impacts[2]

- The cumulative program/portfolio inception-to-date (CPITD) reported gross energy savings are 533,526 MWh/yr.
- Reported energy savings to date are approximately 140% of the May 31, 2011 compliance target (382,000 MWh/yr) and approximately 47% of the May 31, 2013 compliance target (1,146,000 MWh/yr).
- The CPITD verified energy savings are 509,361 MWh/yr.
- CPITD verified savings are 133% of the 382,000 MWh/yr May 31, 2011 energy savings compliance target.[2] **Therefore, PPL Electric achieved its 1% energy reduction compliance target.**
- CPITD verified savings are 44% of the 1,146,000 MWh/yr May 31, 2013 energy savings compliance target.[2]
- The CPITD reported participation is 221,557 participants[3] excluding the compact fluorescent lighting (CFL) Campaign, and approximately 869,143 participants[4] including the CFL Campaign.

Portfolio Demand Reduction

- The CPITD reported gross demand reduction is 69.46 MW, which is approximately 23% of the September 30, 2012 compliance target (297 MW).
- The CPITD verified demand reduction is 65.64 MW.[2]
- The CPITD verified demand reduction is 22% of the 297 MW May 31, 2013 compliance target.[2]

[1] The percentage of compliance target achieved was calculated using verified gross cumulative program/portfolio inception-to-date (CPITD) values (or, if not available, preliminary verified gross values) divided by the compliance target value.

[2] The CPITD is the most meaningful performance metric to compare to compliance targets.

[3] This is based on the number of transactions (rebate forms). Note that a customer transaction may include multiple measures. Also, a customer may submit multiple transactions and, by definition, could be counted as a participant more than once.

[4] See Table 1.3 for an estimate of CFL participants.

Low-Income Sector

- There are 102 measures offered to the low-income sector, comprising 50% of the total measures offered. **That percentage significantly exceeds the compliance requirement of 8.64%.**
- The CPITD reported gross energy savings for low-income sector programs (excluding low-income customer participation in non-low-income programs) is 7,962 MWh/yr.
- Including low-income customer participation in non-low-income programs, the CPITD reported gross energy savings for low-income sector programs is 32,042 MWh/yr.
- The CPITD verified energy savings for low-income sector programs (excluding low-income customer participation in non-low-income programs) is 8,310 MWh/yr.
- Including low-income customer participation in non-low-income programs, the CPITD verified energy savings for low-income sector programs is 32,562 MWh/yr.

Government, School, and Non-Profit Sector

- The CPITD reported energy savings to date for government, school, and non-profit sector programs are 46,252 MWh/yr, which is approximately 121% of the May 31, 2011 compliance target (38,200 MWh/yr) and approximately 40% of the May 31, 2013 compliance target (114,600 MWh/yr). The compliance targets are based on verified savings.
- The CPITD verified energy savings for government and non-profit sector programs are 41,461 MWh/yr.[2]
- CPITD verified savings are 109% of the 38,200 MWh/yr May 31, 2011 energy savings compliance target.[3] **Therefore, PPL Electric achieved its institutional (government, schools, and non-profits) compliance target for May 2011.**
- CPITD verified savings are 36% of the 114,600 MWh/yr May 31, 2013 energy savings compliance target.[2]
- CPITD verified savings are 32% of the 29.7 MW May 31, 2013 demand reduction compliance target.

Program year portfolio highlights as of the end of the reporting period are as follows:

- The program/portfolio year-to-date (PYTD) reported gross energy savings are 452,070 MWh/yr.
- The PYTD verified energy savings are 425,208 MWh/yr.[3]
- The PYTD reported gross demand reduction is 63.30 MW.
- The PYTD verified demand reduction is 58.32 MW.[3]
- The PYTD reported participation is 190,716 participants in all programs (excluding the CFL Campaign).

There are 14 programs in PPL Electric's portfolio that were approved in the EE&C Plan. All programs except the New Home Program have been launched. The PUC has determined that Time-of-Use (TOU) Program savings do not qualify for Act 129 EE&C because TOU is funded by Default Supply, not Act 129 EE&C. Ten programs claimed savings in PY2.

- The Appliance Recycling Program (ARP) offers customers incentives to turn in their outdated refrigerators, freezers, and air conditioners.
- The Efficient Equipment Incentive Program offers prescriptive rebates to residential and non-residential customers.
- The Custom Incentive Program offers custom incentives to non-residential customers per kilowatt hour (kWh) saved in the first year of participation.
- The CFL Campaign is an upstream program that offers incentives to manufacturers to buy down the cost of CFLs; manufacturers and retailers then lower the cost of CFLs to consumers.
- 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 Low-Income Winter Relief Assistance Program (WRAP) provides weatherization to low-income customers, with Act 129 funding expanding the existing low-income usage reduction program.
- E-Power Wise provides low-income customers with information about energy use, as well as with home-energy kits.
- The HVAC Tune-Up Program offer services to all commercial and small industrial customers with an existing split or packaged HVAC rooftop unit(s).
- The Home Assessment & Weatherization Program provides residential customers with information about their home's energy performance and gives recommendations on the most effective, highest priority actions they can take to save energy in their home.
- The Energy Efficiency Behavior & Education Program encourages customers to take energy-saving actions by sending periodic reports with energy saving tips and comparisons of their usage to other peer customers.

The Direct Load Control Program and Load Curtailment Program will only claim savings from June 1 to September 30, 2012, since that is the only period when peak load reductions apply. The Direct Load Control Program started to recruit participants during PY2 Q4.

Figure 1.1 shows the quarterly progress of PPL Electric's suite of energy efficiency programs. This figure provides a rough benchmark comparing *ex post* verified savings to targets.

Figure 1.1. CPITD *Ex post* Verified Energy Savings by Quarter, Relative to May 2011 and May 2013 Compliance Targets

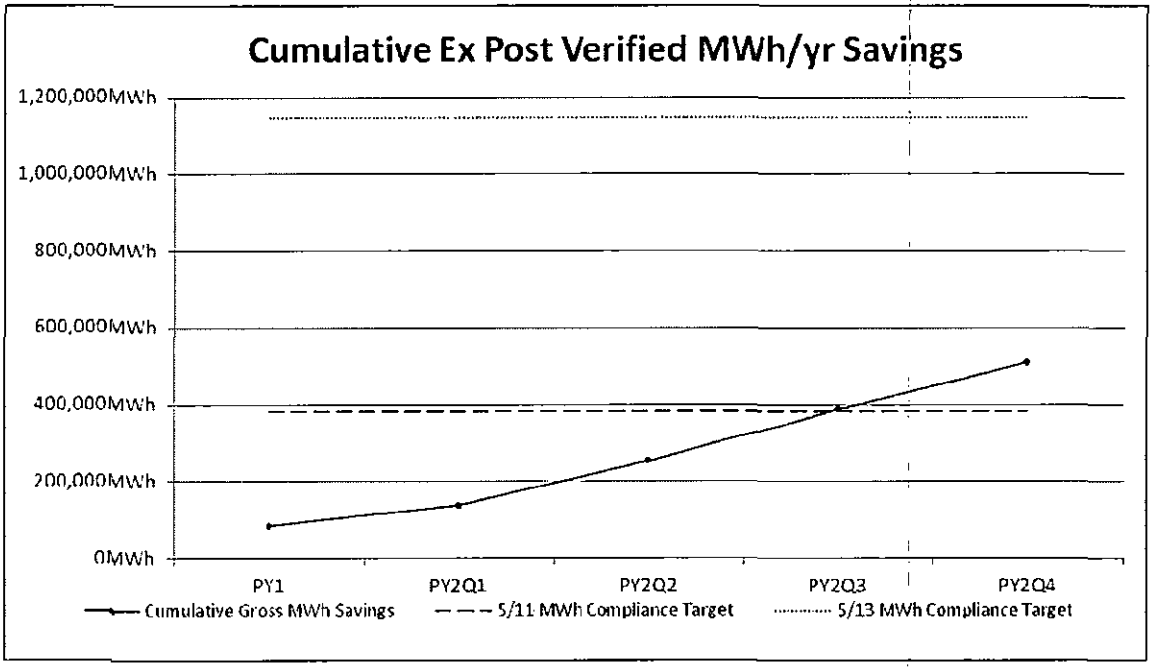
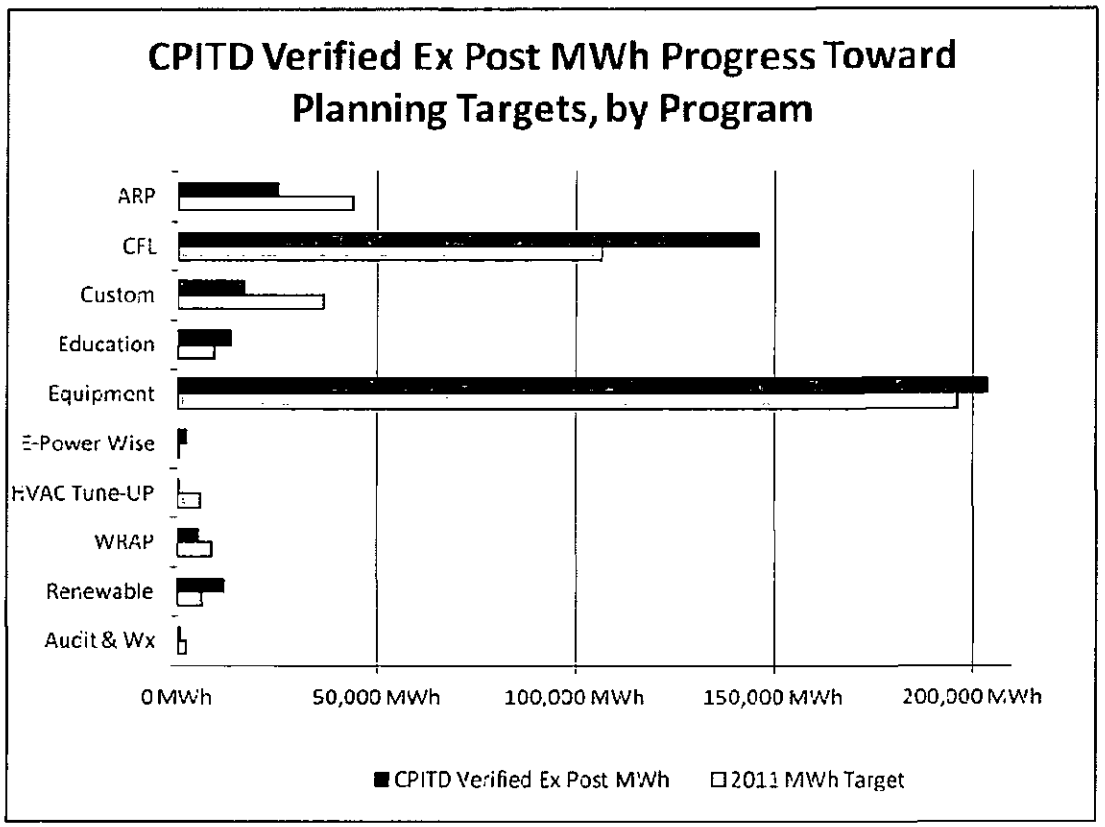


Figure 1.2 shows progress towards the May 2011 planning targets by program. Note that although the May 2011 energy savings goal is 382,000 MWh/yr, the PPL Electric EE&C Plan projected 419,907 MWh/yr in savings. The first two years of Act 129 demand-side management activity resulted in 509,361 MWh/yr in energy savings.

Figure 1.2. Progress Towards May 2011 Planning Targets by Program, Showing Verified *Ex post* Savings



1.1 Summary of Portfolio Impacts

A summary of the portfolio reported impacts is presented in Table 1.1. Reported gross impacts reflect savings reported in PPL Electric's tracking database[5]. Those reported *ex ante* savings from the tracking database have been adjusted, where necessary, to reflect differences between the methods used to determine savings in the tracking database and the methods in the Technical Reference Manual (TRM), or to reflect data capture errors. This adjustment is explained in more detail in the program chapters.

The *ex ante* adjusted savings were used to calculate verified savings. In this report, verified *ex post* savings include only the measures that meet the following criteria: (1) a TRM or custom measure protocol (CMP) was approved for the measure, and (2) *ex post* verification activities are complete.

[5] Because the peak load reduction was determined at the system or generation level, reported peak load reductions have been adjusted to reflect transmission and distribution losses.

Table 1.1: EDC Portfolio Impacts Through the End of the Reporting Period

Impact Type	Total Energy Savings (MWh/yr)	Total Demand Reduction (MW)
Reported Gross Impact: Incremental Quarterly	138,720	19.06
Reported Gross Impact: Program Year-to-Date	452,070	63.30
Reported Gross Impact: Cumulative Portfolio Inception-to-Date[a]	533,526	69.46
Adjusted *Ex ante* Impact: Incremental Quarterly[b]	129,455	16.50
Adjusted *Ex ante* Impact: Program Year-to-Date[b]	446,218	65.68
Adjusted *Ex ante* Impact: Cumulative Portfolio Inception-to-Date[a],[b]	530,381	72.99
PYTD Unverified *Ex post* Savings[c]	123	0.03
Estimated Impact: Projects in Progress[d]	11,789	2.84
Estimated Impact: PYTD Total Committed	463,859	66.14
PYTD Verified Impact[e]	425,208	58.32
CPITD Verified Impact[a]	509,361	65.64
PYTD Net Impact[f]	317,997	43.15
CPITD Net Impact[a]	379,096	48.01

NOTES:
[a] CPITD is the most meaningful performance metric to compare to compliance targets.
[b] Adjusted *ex ante* reflect savings adjustments that account for data errors (such as duplicate records); information about the systems installed through the program (tonnage, efficiency, and geographic location), or to reflect differences between the method used to determine savings *in* the tracking system and the method in the TRM.
[c] Unverified *ex post* savings are pending approval of a TRM Protocol or CMP by the Commission. In addition, unverified savings are those with an approved protocol but which have not yet been *verified*.
[d] Projects in progress are defined as projects where the measure has not *been* installed, the measure has been installed but is not yet operable, or the rebate check has not yet been issued. For purposes of this report, only projects under the Custom Incentive Program are included in this summary.
[e] This is the portfolio verified impact, which is calculated by aggregating PYTD verified impacts.
[f] This is the portfolio net impact, which is calculated by aggregating program net impacts. The evaluation, measurement, and verification (EM&V) conservation services provider (CSP) calculated program net impacts by multiplying PYTD verified impacts by program net-to-gross (NTG) ratios. The NTG information is only used to improve program design. NTG is not used for compliance purposes.

A summary of the portfolio cost-effectiveness evaluation (the Total Resource Cost (TRC) test) is presented in Table 1.2.

Table 1.2: Verified Preliminary Portfolio Total Evaluation Adjusted Impacts Through the End of the Reporting Period

TRC Category	IQ[a]	PYTD[a]	CPITD
TRC Benefits ($)	Not required	$370,636,979	$399,872,622
TRC Costs ($)	Not required	$214,671,053	$226,296,331
TRC Benefit-Cost Ratio		1.73	1.77

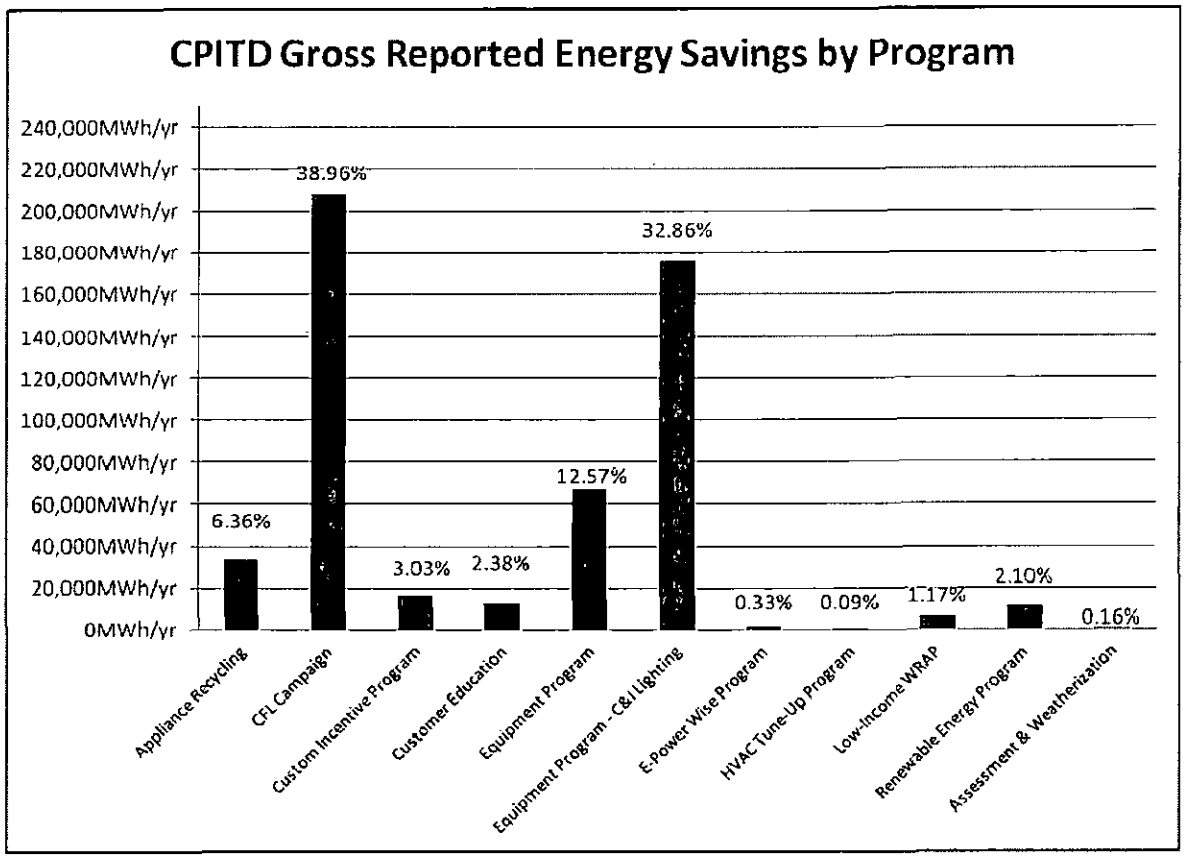
NOTES:
[a] Based on verified gross *ex post* savings.

A summary of portfolio finances is available in Section 1.5.

1.2 Summary of Energy Impacts by Program

A summary of the reported energy savings by program is presented in Figure 1.3.

Figure 1.3: CPITD Reported Gross Energy Savings by Program Through the End of the Reporting Period



A summary of the energy impacts by program through PY2 Q4 is presented in Table 1.3 and Table 1.4.

Table 1.3: EDC Reported Participation and Gross Energy Savings by Program Through the End of the Reporting Period

Program	Participants			Reported Gross Impact (MWh/yr)[a]		
	IQ	PYTD	CPITD	IQ	PYTD	CPITD
Appliance Recycling Program	4,657	13,083	17,823	8,678	24,867	33,936
Compact Fluorescent Lighting Campaign[b]	96,928	454,795	647,566	31,077	146,000	207,838
Custom Incentive Program	23	54	55	10,463	16,139	16,178
Energy Efficiency Behavior & Education Program	50,000	50,000	50,000	12,699	12,699	12,699
Efficient Equipment Incentive Program	46,255	113,747	138,834	32,383	58,968	67,042
Efficient Equipment Incentive Program (C&I Lighting)	529	1,996	1,996	38,126	175,329	175,329

Program	Participants			Reported Gross Impact (MWh/yr)[a]		
	IQ	PYTD	CPITD	IQ	PYTD	CPITD
E-Power Wise Program	797	4,050	4,050	342	1,737	1,737
Low-Income WRAP	1,126	4,455	5,104	1,435	5,469	6,224
Renewable Energy Program	107	1,329	1,713	2,698	9,537	11,219
HVAC Tune-Up Program	567	711	711	414	468	468
Home Assessment & Weatherization Program	639	1,291	1,291	406	857	857
TOTAL PORTFOLIO	201,628	645,511	869,143	138,720	452,070	533,526

NOTES:
[a] Reported gross impacts reflect savings directly from PPL Electric's Energy Efficiency Management Information System (EEMIS) reporting database.
[b] As an upstream program, exact participation in the Compact Fluorescent Lighting Campaign is not known. The EM&V CSP estimated the number of CFL participants by dividing the total number of bulbs discounted (651,357 in PY2 Q4; 889,668 in PY2 Q3; 988,915 in PY2 Q2; 526,296 in PY2 Q1; and 1,342,595 in PY1) by a CFL-per-participant value derived from the customer telephone survey data (6.7 bulbs in PY2 and 7.0 bulbs in PY1). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at give-away events.

Table 1.4: EDC Reported Gross Unverified Energy Savings and Projects in Progress by Program Through the End of the Reporting Period

Program	Unverified *Ex post* Savings (MWh/yr)[a]	Projects In Progress (MWh/yr)[b]	PYTD Total Committed (MWh/yr)[c]	EE&C Plan Estimate for Program Year (MWh/yr)	Estimate Committed (%)
Appliance Recycling Program	-	-	24,867	35,311	70%
Compact Fluorescent Lighting Campaign	-	-	*146,000*	92,742	157%
Custom Incentive Program	123	11,789	27,928	31,657	88%
Energy Efficiency Behavior & Education Program	-	-	12,699	4,525	281%
Efficient Equipment Incentive Program	-	-	58,968	160,784	146%
Efficient Equipment Incentive Program (C&I Lighting)	-	-	175,329		
E-Power Wise Program	-	-	1,737	353	493%
Low-Income WRAP	-	-	5,469	4,423	124%
Renewable Energy Program	-	-	9,537	4,624	206%
HVAC Tune-Up Program	-	-	468	5,042	9%
Home Assessment & Weatherization Program	-	-	857	1,721	50%
TOTAL PORTFOLIO	123	11,789	463,859	341,182	136%

Program	Unverified *Ex post* Savings (MWh/yr)[a]	Projects In Progress (MWh/yr)[b]	PYTD Total Committed (MWh/yr)[c]	EE&C Plan Estimate for Program Year (MWh/yr)	Estimate Committed (%)
NOTES:					
[a] Unverified *ex post* savings are pending approval of a TRM Protocol or CMP by the Commission. In addition, unverified savings are those with an approved protocol but which have not yet been verified. In this report, these include, for example, commercial lighting installations.					
[b] This column reflects energy efficiency projects currently being processed and tracked by PPL Electric, but that were not complete at the time of this report. A complete project is defined as a one in which: (1) the measure has been installed, (2) the measure is commercially operable, and (3) a rebate check has been issued. Not all projects that are in progress will be completed.					
[c] This reflect the estimated gross impacts, including reported impacts and in-progress impacts, beginning June 1, 2010 through the end of the program year.					

A summary of evaluation verified energy impacts by program is presented in Table 1.5 and Table 1.6.

Table 1.5: PYTD Energy Savings by Program Through the End of the Reporting Period

Program	PYTD Reported Gross Impact (MWh/yr)[a]	PYTD Adjusted *Ex ante* Impact (MWh/yr)[b]	PYTD Realization Rate[c]	PYTD Verified Impact (see note 2 in Section 1) (MWh/yr)	PYTD NTG Ratio	PYTD Net Impact (MWh/yr)
Appliance Recycling Program	24,867	24,934	100%	24,934	61%	15,144
Compact Fluorescent Lighting Campaign	146,000	146,000	100%	146,000	77%	112,420
Custom Incentive Program	16,139	16,139	104%	16,676	31%	5,170
Energy Efficiency Behavior & Education Program	12,699	12,699	105%	13,286	100%	13,286
Efficient Equipment Incentive Program	58,968	57,715	84%	48,294	55%	26,385
Efficient Equipment Incentive Program (C&I Lighting)	175,329	169,108	92%	155,515	85%	132,359
E-Power Wise Program	1,737	2,589	82%	2,123	100%	2,123
Low-Income WRAP	5,469	5,469	99%	5,432	100%	5,432
Renewable Energy Program	9,537	10,232	115%	11,788	38%	4,506
HVAC Tune-Up Program	468	468	100%	468	100%	469
Home Assessment & Weatherization Program	857	866	80%	693	102%	704
TOTAL PORTFOLIO	452,070	446,218	95%	425,208	75%	317,997
NOTES:						
[a] Reported gross impacts reflect savings directly from PPL Electric's EEMIS reporting database.						
[b] Adjusted *ex onte* reflect savings adjustments that account for data errors (such as duplicate records) or information about the systems installed through the program (tonnage, efficiency, and geographic location). Adjustments for systems account for differences between planning assumptions and installed equipment, and rely solely on information collected in the EEMIS tracking database.						
[c] The realization rate reported here includes both verified and unverified *ex post* savings.						

Table 1.6: CPITD Energy Savings by Program Through the End of the Reporting Period

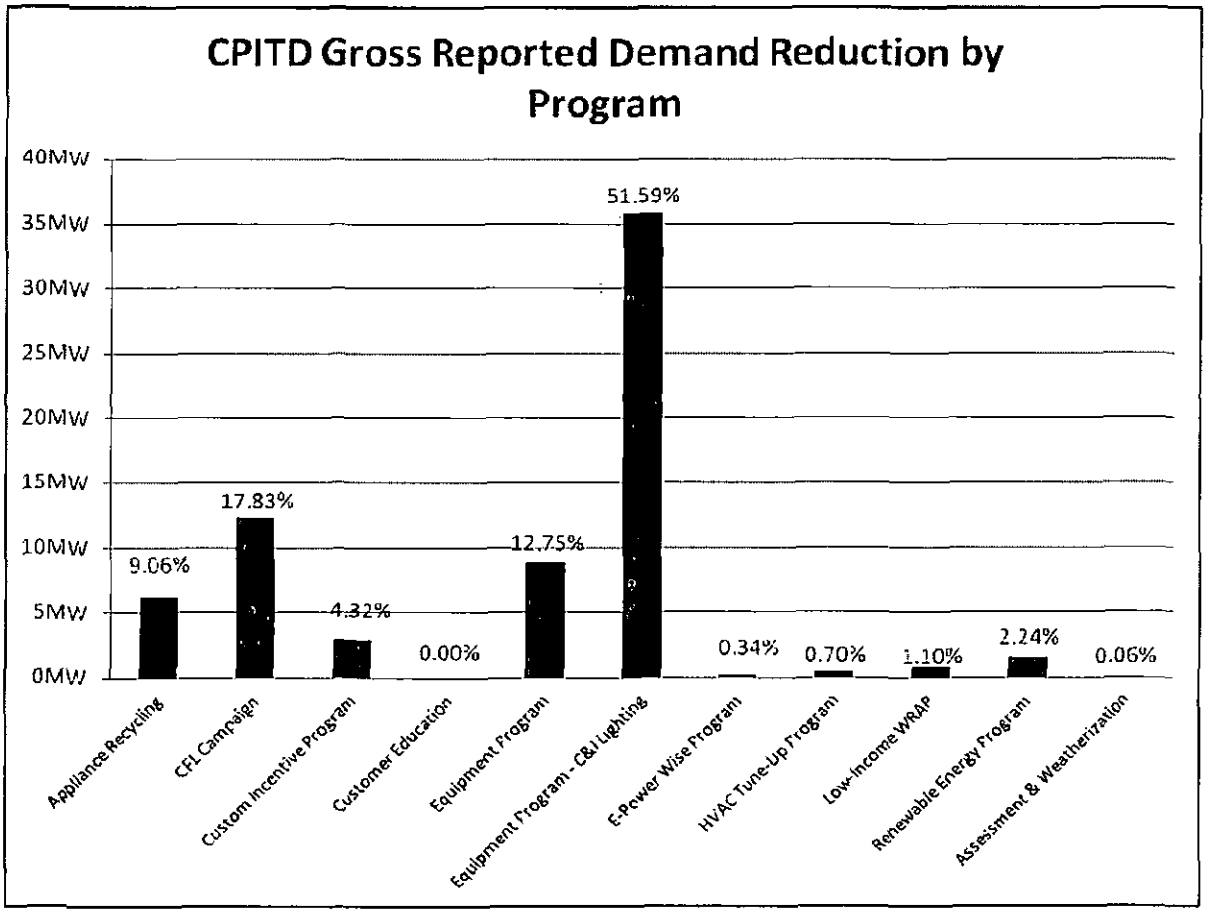
Program	CPITD Reported Gross Impact (MWh/yr)[a]	CPITD Adjusted *Ex ante* Impact (MWh/yr)[b]	CPITD Realization Rate[c]	CPITD Verified Impact(see note 2 in Section 1) (MWh/yr)	CPITD NTG Ratio	CPITD Net Impact (MWh/yr)
Appliance Recycling Program	33,936	34,171	100%	34,171	60%	20,409
Compact Fluorescent Lighting Campaign	207,838	207,838	100%	207,838	78%	161,890
Custom Incentive Program	16,178	16,178	104%	16,732	31%	5,187
Energy Efficiency Behavior & Education Program	12,699	12,699	105%	13,286	100%	13,286
Efficient Equipment Incentive Program	67,042	67,184	86%	57,771	54%	31,222
Efficient Equipment Incentive Program (C&I Lighting)	175,329	169,108	92%	155,515	85%	132,359
E-Power Wise Program	1,737	2,589	82%	2,123	100%	2,123
Low-Income WRAP	6,224	6,224	99%	6,187	100%	6,187
Renewable Energy Program	11,219	13,057	112%	14,578	36%	5,259
HVAC Tune-Up Program	468	468	100%	468	100%	469
Home Assessment & Weatherization Program	857	866	80%	693	102%	704
TOTAL PORTFOLIO	533,526	530,381	96%	509,361	74%	379,096

NOTES:
[a] Reported gross impacts reflect savings directly from PPL Electric's EEMIS reporting database.
[b] Adjusted *ex ante* reflect savings adjustments that account for data errors (such as duplicate records) or information about the systems installed through the program (tonnage, efficiency, and geographic location). Adjustments for systems account for differences between planning assumptions and installed equipment, and rely solely on information collected in the EEMIS tracking database.
[c] The realization rate reported here includes both verified and unverified *ex post* savings.

1.3 Summary of Demand Impacts by Program

A summary of the reported demand reduction by program is presented in Figure 1.4.

Figure 1.4: Reported Demand Reduction by Program Through the End of the Reporting Period



A summary of demand reduction impacts by program through PY2 Q4 is presented in Table 1.7 and Table 1.8.

Table 1.7: Participation and Reported Gross Demand Reduction by Program Through the End of the Reporting Period

Program	Participants			Reported Gross Impact (MW)[a]		
	IQ	PYTD	CPITD	IQ	PYTD	CPITD
Appliance Recycling Program	4,657	13,083	17,823	1.63	4.92	6.29
Compact Fluorescent Lighting Campaign[b]	96,928	454,795	647,566	1.85	8.71	12.39
Custom Incentive Program	23	54	55	1.20	3.00	3.00
Energy Efficiency Behavior & Education Program	50,000	50,000	50,000	-	-	-

Program	Participants			Reported Gross Impact (MW)[a]		
	IQ	PYTD	CPITD	IQ	PYTD	CPITD
Efficient Equipment Incentive Program	46,255	113,747	138,834	4.52	7.99	8.86
Efficient Equipment Incentive Program (C&I Lighting)	529	1,996	1,996	8.44	35.83	35.83
E-Power Wise Program	797	4,050	4,050	0.05	0.24	0.24
Low-Income WRAP	1,126	4,455	5,104	0.18	0.67	0.77
Renewable Energy Program	107	1,329	1,713	0.70	1.42	1.56
HVAC Tune-Up Program	567	711	711	0.48	0.48	0.48
Home Assessment & Weatherization Program	639	1,291	1,291	0.02	0.04	0.04
TOTAL PORTFOLIO	201,628	645,511	869,143	19.06	63.30	69.46

NOTES:
[a] Reported gross impacts reflect savings directly from PPL Electric's EEMIS reporting database, however, because the peak load reduction was determined at the system or generation level, reported peak load reductions have been adjusted to reflect transmission and distribution losses.
[b] As an upstream program, exact participation in the Compact Fluorescent Lighting Campaign is not known. The EM&V CSP estimated the number of CFL participants by dividing the total number of bulbs discounted (651,357 in PY2 Q4, 889,668 in PY2 Q3; 988,915 PY2 Q2; 526,296 in PY2 Q1; and 1,342,595 in PY1) by a CFL-per-participant value derived from the customer telephone survey data (6.7 bulbs in PY2 and 7.0 bulbs in PY1). The CFL count reflects the total number of program bulbs; including discounted bulbs sold at retail stores and bulbs distributed at give-away events.

Table 1.8: Reported Gross Demand Reduction by Program Through the End of the Reporting Period

Program	Unverified *Ex post* Savings (MW)[a], [b]	Projects in Progress (MW)[b]	PYTD Total Committed (MW)	EE&C Plan Estimate for Program Year (MW)	Estimate Committed (%)
Appliance Recycling Program	-	-	4.92	4.05	122%
Compact Fluorescent Lighting Campaign	-	-	8.71	14.49	60%
Custom Incentive Program	0.03	2.84	5.84	6.04	97%
Energy Efficiency Behavior & Education Program	-	-	-	0.51	0%
Efficient Equipment Incentive Program	-	-	7.99	28.67	153%
Efficient Equipment Incentive Program (C&I Lighting)	-	-	35.83		
E-Power Wise Program	-	-	0.24	0.05	487%
Low-Income WRAP	-	-	0.67	0.69	98%
Renewable Energy Program	-	-	1.42	0.50	283%
HVAC Tune-Up Program	-	-	0.48	2.61	18%
Home Assessment & Weatherization Program	-	-	0.04	0.17	25%
TOTAL PORTFOLIO	0.03	2.84	66.14	57.79	114%

Program	Unverified *Ex post* Savings (MW)[a], [b]	Projects in Progress (MW)[b]	PYTD Total Committed (MW)	EE&C Plan Estimate for Program Year (MW)	Estimate Committed (%)

NOTES:
[a] Unverified *ex post* savings are pending approval of a TRM Protocol or CMP by the Commission.
[b] Because the peak load reduction was determined at the system or generation level, reported peak load reductions reflect transmission and distribution losses.
[c] The PYTD total committed demand reduction is only sixty percent of the EE&C plan's estimated demand reduction due to differences in coincidence factors. Specifically, the PYTD total committed demand reduction is calculated using a coincidence factor of 0.476 from the TRM, whereas the EE&C plan demand reduction was calculated using a coincidence factor of 1.357.

A summary of evaluation adjusted demand impacts by program are presented in Table 1.9 and Table 1.10.

Table 1.9: Verified PYTD Demand Reduction by Program Through the End of the Reporting Period

Program	PYTD Reported Gross Impact (MW)[a]	PYTD Adjusted *Ex ante* Impact (MW)[b]	PYTD Realization Rate[c]	PYTD Verified Impact (see note 2 in Section 1) (MW)	PYTD NTG Ratio	PYTD Net Impact (MW)
Appliance Recycling Program	4.92	5.17	100%	5.17	61%	3.14
Compact Fluorescent Lighting Campaign	8.71	8.71	100%	8.71	77%	6.70
Custom Incentive Program	3.00	3.00	69%	2.03	31%	0.63
Energy Efficiency Behavior & Education Program	-	-	-	-	N/A	-
Efficient Equipment Incentive Program	7.99	9.90	82%	8.14	55%	4.45
Efficient Equipment Incentive Program (C&I Lighting)	35.83	34.96	87%	30.39	85%	25.86
E-Power Wise Program	0.24	0.24	74%	0.18	100%	0.18
Low-Income WRAP	0.67	0.67	99%	0.67	100%	0.67
Renewable Energy Program	1.42	2.44	100%	2.45	38%	0.94
HVAC Tune-Up Program	0.48	0.48	100%	0.48	100%	0.48
Home Assessment & Weatherization Program	0.04	0.11	90%	0.10	102%	0.10
TOTAL PORTFOLIO	63.30	65.68	89%	58.32	74%	43.15

NOTES:
[a] Reported gross impacts reflect savings directly from PPL Electric's EEMIS reporting database, however, because the peak load reduction was determined at the system or generation level, reported peak load reductions have been adjusted to reflect transmission and distribution losses.
[b] Adjusted *ex ante* reflect savings adjustments that account for data errors (such as duplicate records) or information about the systems installed through the program (tonnage, efficiency, and geographic location). Adjustments for systems account for differences between planning assumptions and installed equipment, and rely solely on information collected in the EEMIS tracking database.
[c] The realization rate reported here includes both verified and unverified *ex post* savings.

Table 1.10: Verified CPITD Demand Reduction by Program Through the End of the Reporting Period

Program	CPITD Reported Gross Impact (MW)[a]	*CPITD* Adjusted *Ex ante* Impact (MW)[b]	CPITD Realization Rate[c]	CPITD Verified Impact (see note 2 in Section 1) (MW)	CPITD NTG Ratio	*CPITD Net* Impact (MW)
Appliance Recycling Program	6.29	7.11	100%	7.11	60%	4.25
Compact Fluorescent Lighting Campaign	12.39	12.39	100%	12.39	78%	9.65
Custom Incentive Program	3.00	3.00	69%	2.04	31%	0.63
Energy Efficiency Behavior & Education Program	-	-	-	-	N/A	-
Efficient Equipment Incentive Program	8.86	11.04	84%	9.30	54%	5.04
Efficient Equipment Incentive Program (C&I Lighting)	35.83	34.96	87%	30.39	85%	25.86
E-Power Wise Program	0.24	0.24	74%	0.18	100%	0.18
Low-Income WRAP	0.77	0.77	99%	0.76	100%	0.76
Renewable Energy Program	1.56	2.90	100%	2.90	36%	1.06
HVAC Tune-Up Program	0.48	0.48	100%	0.48	100%	0.48
Home Assessment & Weatherization Program	0.04	0.11	90%	0.10	102%	0.10
TOTAL PORTFOLIO	69.46	72.99	90%	65.64	73%	48.01

NOTES:
[a] Reported gross impacts reflect savings directly from PPL Electric's EEMIS reporting database, however, because the peak load reduction was determined at the system or generation level, reported peak load reductions have been adjusted to reflect transmission and distribution losses.
[b] Adjusted *ex ante* reflect savings adjustments that account for data errors (such as duplicate records) or information about the systems installed through the program (tonnage, efficiency, and geographic location). Adjustments for systems account for differences between planning assumptions and installed equipment, and rely solely on information collected in the EEMIS tracking database.
[c] The realization rate reported here includes both verified and unverified *ex post* savings.

1.4 Summary of Evaluation

The evaluation, measurement, and verification (EM&V) conservation services provider (CSP) calculated realization rates. The realization rate is defined as the percentage of *ex ante* adjusted savings achieved, determined through the independent evaluation review. A realization rate of 1 (or 100%) indicates there is no difference between the *ex ante* adjusted savings and verified savings, as measured by independent evaluators. Realization rates were determined by certain attributes relative to one of three protocol types:

1. Fully deemed TRM measure realization rates are driven by differences in the number of installed measures.

2. Partially deemed TRM measure[6] realization rates are driven by: (1) differences in the number of installed measures, and (2) differences between the reported and actual values of the open variables.
3. Custom measure realization rates are driven by differences in the energy savings determined by approved protocols. The protocol type determines which data are sampled.

1.4.1 Impact Evaluation

The realization rates for each program are presented in Table 1.11. PYTD sample participants include the measures in the samples selected for verification activities, including records reviews, surveys, and site visits. The sample included participant measures that were included in one, two, or all three verification activities.

The Efficient Equipment Incentive Program participants reflect the number of measures installed. A total of 480 measures were verified through quality assurance/quality control (QA/QC) activities, which included documentation and records reviews, surveys, and site visits. Some of these measures were verified by more than one of these methods. Sampling is addressed in Appendix L.

Table 1.11: Summary of Realization Rates and Confidence Intervals for kWh/yr

Program	Realization Rate (kWh/yr)	Confidence and Precision (kWh/yr)	Realization Rate (kW)	Confidence and Precision (kW)
Appliance Recycling Program	100%	±2% precision with 90% confidence	100%	±2% precision with 90% confidence
Behavioral and Education Program	105%	±12 percent with 95% confidence	NA	NA
Compact Fluorescent Lighting Campaign	100%	NA	100%	NA
Custom Incentive Program	104%	±1 percent precision with 90% confidence	67%	±5 percent precision with 90% confidence
Efficient Equipment Incentive Program	73%	±7% precision with 85% confidence	82%	±7% precision with 85% confidence
Efficient Equipment Incentive Program (C&I Lighting)	90%	±10% precision with 90% confidence	87%	±7% precision with 90% confidence
E-Power Wise Program	82%	±6% precision with 85% confidence	74%	±1.4% precision with 90% confidence
Low-Income WRAP	99.3%	NA	99.3%	NA
Renewable Energy Program (GSHP)	118%	±5% precision with 85% confidence	93%	±4% precision with 85% confidence
Renewable Energy Program	109%	±1% precision with 85% confidence	109%	±1% precision with 85% confidence
Home Assessment & Weatherization Program	80%	±9% precision with 85% confidence	90%	±10.2% precision with 85% confidence
TOTAL PORTFOLIO	95%	±4 percent with 90% confidence	89%	±4 percent with 90% confidence

[6] TRM measures with stipulated values and variables.

1.4.2 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

1.5 Summary of Finances

The TRC test demonstrates the cost-effectiveness of a program by comparing its total economic benefits to its total cost. The breakdown of PPL Electric's finances and TRC analyses are presented in Table 1.12 through Table 1.14.

Table 1.12: Summary of Portfolio Finances: TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$9,627,238	$34,762,287	$38,629,713
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$9,627,238	$34,762,287	$38,629,713
B.1	Design & Development[a]	$673,571	$1,006,544	$2,690,305
B.2	Administration[b]	$984,067	$3,219,628	$5,344,768
B.3	Management[c]	$6,375,761	$18,432,880	$23,786,813
B.4	Marketing	$736,423	$4,837,394	$7,267,200
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$8,769,822	$27,496,446	$39,089,086
C	**EDC Evaluation Costs**	$1,061,407	$4,565,754	$4,492,976
D	**Statewide Evaluator (SWE) Audit Costs**	$0	$0	$1,041,879
	Total Utility TRC Costs	$19,458,468	$66,824,487	$83,253,653
E	**Participant Costs**	N/A	$182,608,853	$197,573,950
	Total TRC Costs (line items: B, C, D, & E)	$9,831,229	$214,671,053	$242,197,890
	Discounted Costs (TRC)	N/A	$214,671,053	$226,296,331
F.1	**Annualized Avoided Supply Costs – Residential**	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	**Lifetime Avoided Supply Costs**	N/A	$370,636,979	$427,327,213
	Total Lifetime Economic Benefits	N/A	$370,636,979	$427,327,213
	Discounted Lifetime Economic Benefits	N/A	$370,636,979	$399,872,622
	Portfolio Benefit-to-Cost Ratio	N/A	1.73	1.77

Category	IQ	PYTD	CPITD

NOTES:
Definitions for terms in this table are subject to TRC Order. Various cost and benefit categories are subject to change pending the outcome of TRC Technical Working Group discussions.
[a] CPITD includes EE&C Plan development charges from December 2008 and revisions to EE&C Plan.
[b] Includes Administrative CSP (application and rebate processing), PPL Electric's general administrative/clerical costs, and PPL Electric's tracking system.
[c] Includes direct program management costs and common costs associated with overall portfolio management.

Table 1.13: Summary of TRC by Program, PYTD Values

Program	TRC Benefits ($)	TRC Costs ($)	TRC Benefit-Cost Ratio
Appliance Recycling Program	$20,624,101	$1,758,796	11.73
Compact Fluorescent Lighting Campaign	$87,010,123	$12,492,362	6.97
Custom Incentive Program	$13,796,003	$7,677,903	1.80
Energy Efficiency Behavior & Education Program	$1,232,711	$815,014	1.51
Efficient Equipment Incentive Program	$58,872,238	$23,997,597	2.45
Efficient Equipment Incentive Program (C&I Lighting)	$163,926,261	$87,439,843	1.87
E-Power Wise	$1,298,803	$362,099	3.59
Low-Income WRAP	$7,548,444	$9,437,875	0.80
Renewable Energy Program	$15,594,479	$53,548,636	0.29
HVAC Tune-Up Program	$171,913	$622,265	0.28
Home Assessment & Weatherization Program	$561,903	$924,785	0.61
Common Costs	$0	$15,593,877	0.00
TOTAL PORTFOLIO	$370,636,979	$214,671,053	1.73
NOTES:			

Table 1.14: Summary of TRC by Program, CPITD Values

Program	TRC Benefits ($)	TRC Costs ($)	TRC Benefit-Cost Ratio
Appliance Recycling Program	$26,187,777	$2,414,802	10.84
Compact Fluorescent Lighting Campaign	$113,980,335	$17,116,215	6.66
Custom Incentive Program	$12,830,822	$7,210,377	1.78
Energy Efficiency Behavior & Education Program	$1,141,399	$896,710	1.27
Efficient Equipment Incentive Program	$65,957,676	$27,502,230	2.40
Efficient Equipment Incentive Program (C&I Lighting)	$151,783,575	$80,962,818	1.87
E-Power Wise	$1,202,596	$383,580	3.14
Low-Income WRAP	$7,984,799	$11,769,500	0.68

Program	TRC Benefits ($)	TRC Costs ($)	TRC Benefit-Cost Ratio
Renewable Energy Program	$18,124,184	$54,568,890	0.33
HVAC Tune-Up Program	$159,179	$613,981	0.26
Home Assessment & Weatherization Program	$520,280	$886,285	0.59
Common Costs	$0	$21,970,944	0.00
TOTAL PORTFOLIO	$399,872,622	$226,296,331	1.77
NOTES:			

2 Portfolio Results by Sector

The EE&C Implementation Order issued on January 15, 2009 states reporting requirements for specific sectors on page 11. In order to comply with these requirements, each program has been categorized into one of the following sectors:

1. Residential EE (excluding low-income)
2. Residential Low-Income EE
3. Small Commercial & Industrial EE
4. Large Commercial & Industrial EE
5. Government & Non-Profit EE

A summary of portfolio gross energy savings and gross demand reduction by sector is presented in Figure 2.1 and Figure 2.2. A summary of CPITD gross energy savings and gross demand reduction by sector is presented in Figure 2.3 and Figure 2.4, as well as in Table 2.1 and Table 2.2.

Figure 2.1: PYTD Reported Gross Energy Savings by Sector

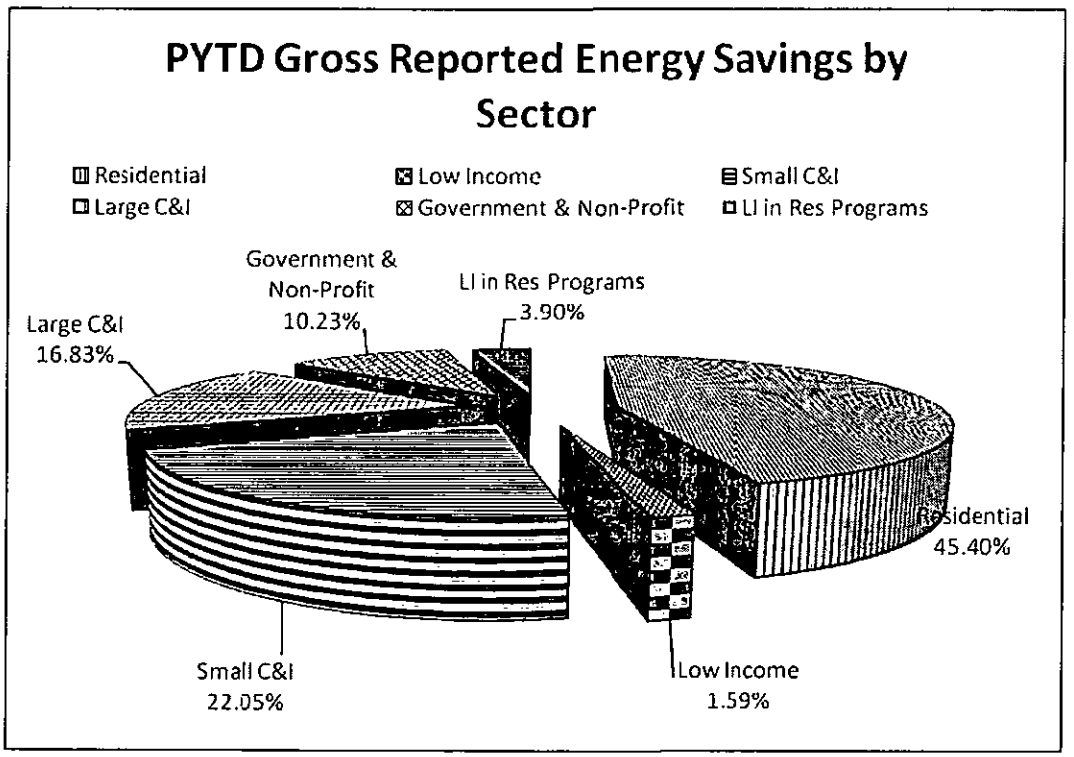


Figure 2.2: PYTD Reported Gross Demand Reduction by Sector

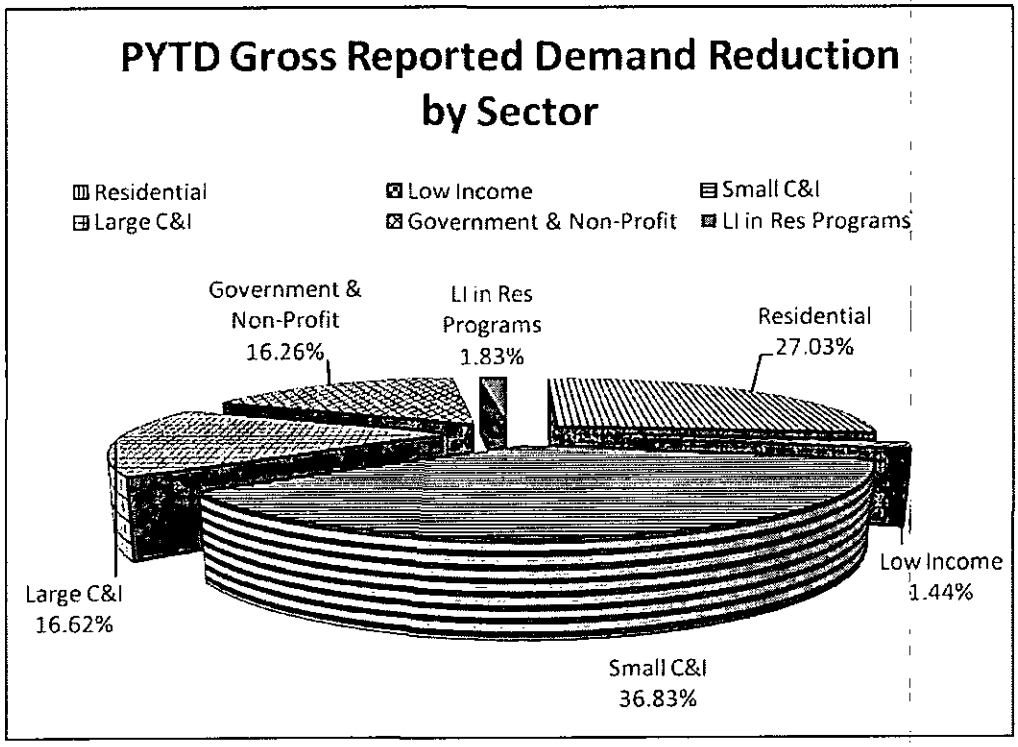


Figure 2.3: CPITD Reported Gross Energy Savings by Sector

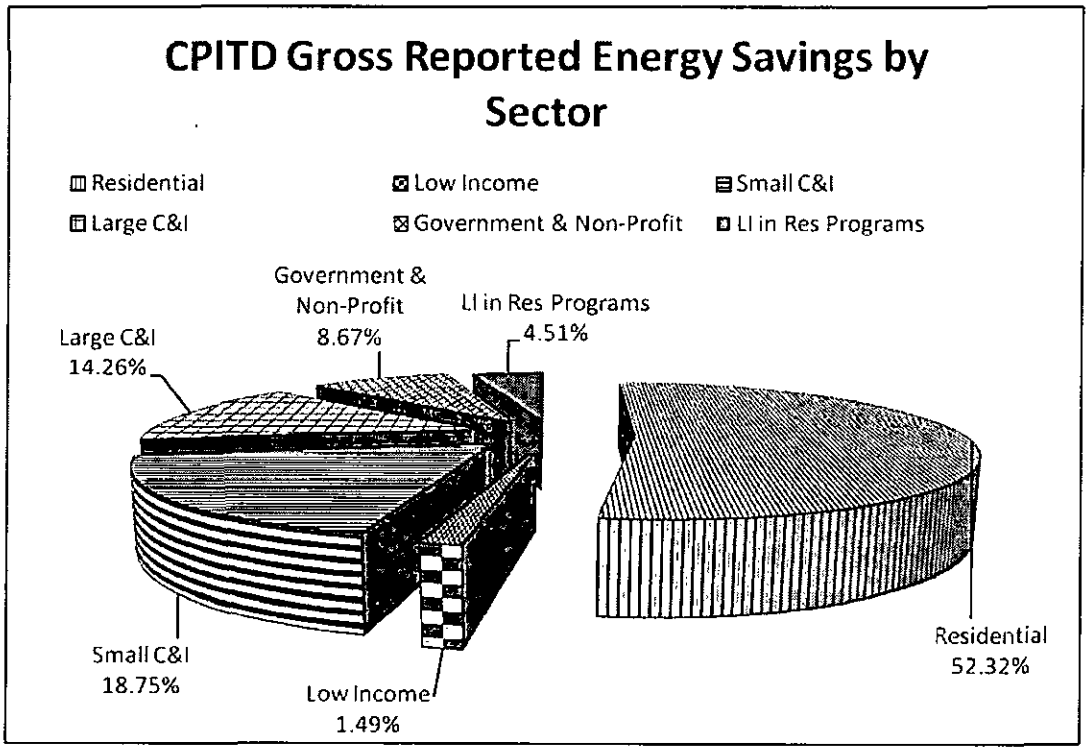


Figure 2.4: CPITD Reported Gross Demand Reduction by Sector

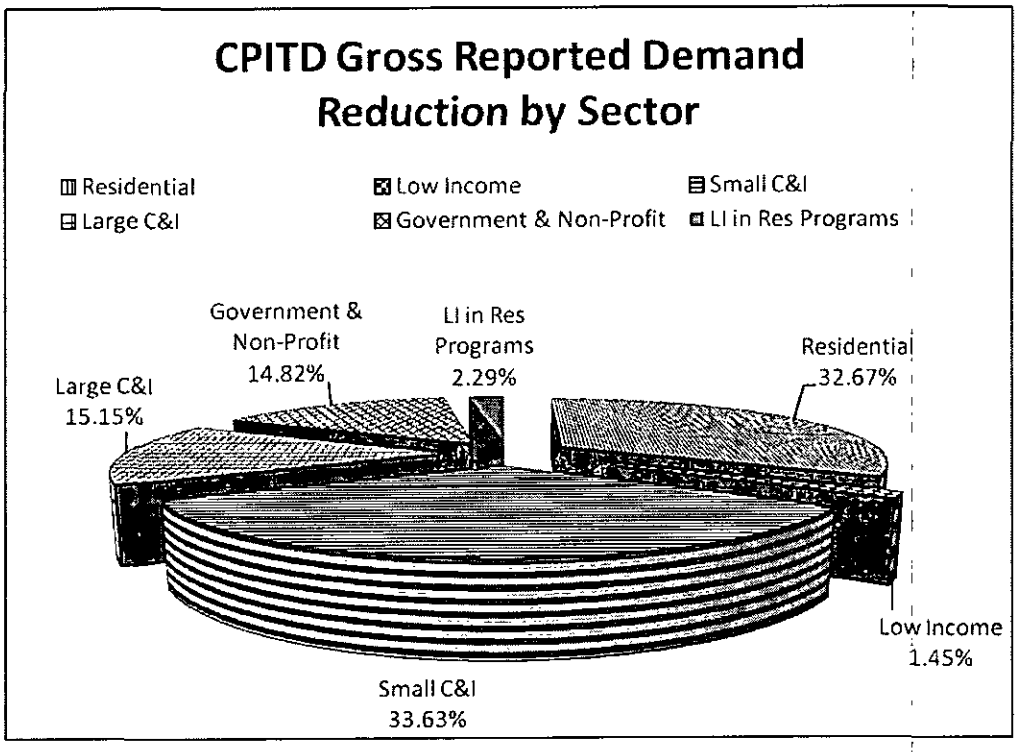


Table 2.1: Reported Gross Energy Savings by Sector Through the End of the Reporting Period

Market Sector	Reported Gross Impact (MWh/yr)			Projects in Progress (MWh/yr)	Total Committed (MWh/yr)[a]	PYTD Unverified *Ex post* Savings (MWh/yr)	Realization Rate (MWh/yr)
	IQ	PYTD	CPITD				
Residential EE	58,624	205,223	279,122	10,619	265,661	-	99%
Residential Low-Income EE	1,777	7,206	7,962	-	7,962	-	94%
Low-Income Participation in Non-Low-Income Programs	5,567	17,628	24,080	-	24,080	-	-
Small Commercial & Industrial EE	26,614	99,703	100,041	-	100,041	123	94%
Large Commercial & Industrial EE	23,743	76,068	76,068	368	76,437	-	86%
Government & Non-Profit EE	22,394	46,241	46,252	802	47,054	-	94%
TOTAL PORTFOLIO	138,720	452,070	533,526	11,789	545,315	123	95%

NOTES:
[a] Total committed uses CPITD gross impact values.

Table 2.2: Reported Gross Demand Reduction by Sector Through the End of the Reporting Period

Market Sector	Reported Gross Impact (MW)			Projects in Progress (MW)	Total Committed (MW)[a]	PYTD Unverified *Ex post* Savings (MW)	Realization Rate (MW)
	IQ	PYTD	CPITD				
Residential EE	4.63	17.11	22.69	2.68	23.78	-	98%
Residential Low-Income EE	0.22	0.91	1.00	-	1.00	-	93%
Low-Income Participation in Non-Low-Income Programs	0.29	1.16	1.59	-	1.59	-	-
Small Commercial & Industrial EE	5.61	23.32	23.36	-	23.36	0.03	83%
Large Commercial & Industrial EE	3.60	10.52	10.52	0.05	10.57	-	81%
Government & Non-Profit EE	4.71	10.29	10.29	0.11	10.40	-	89%
TOTAL PORTFOLIO	19.06	63.30	69.46	2.84	72.30	0.03	94%

NOTES:-
[a] Total committed uses CPITD gross impact values.

2.1 Residential EE Sector

The Residential EE sector target for annual energy savings in PY2 is 123,612 MWh/yr and the sector target for annual peak demand reduction is 17.44 MW. The Residential EE sector target for CPITD annual energy savings is 153,260 MWh/yr and the CPITD target for peak demand reduction is 21.39 MW. These "targets" are planning assumptions in the EE&C Plan.

A sector summary of results by program is presented in Table 2.3 and Table 2.4.

Table 2.3: Summary of Residential EE Sector Incremental Impacts by Program Through the End of the Reporting Period

Residential EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
Appliance Recycling Program	4,577	8,513	1.59
Compact Fluorescent Lighting Campaign[a]	96,928	31,077	1.85
Custom Incentive Program	1	18	0.00
Energy Efficiency Behavior & Education Program	50,000	12,699	-
Efficient Equipment Incentive Program	43,264	10,938	1.35
Efficient Equipment Incentive Program (C&I Lighting)	32	239	0.08
Renewable Energy Program	77	301	0.02
Home Assessment & Weatherization Program	639	406	0.02
Sector Total	195,518	64,191	4.92

Residential EE Sector	IQ Participants	IQ Reported Gross *Energy Savings* (MWh/yr)	IQ Reported Gross *Demand Reduction* (MW)
NOTES: [a] As an upstream program, exact participation in the Compact Fluorescent Lighting Campaign is not known. The EM&V CSP estimated the number of CFL participants by dividing the total number of bulbs discounted (651,357 in PY2 Q4, 889,668 in PY2 Q3; 988,915 PY2 Q2; 526,296 in PY2 Q1; and 1,342,595 in PY1) by a CFL-per-participant value derived from the customer telephone survey data (6.7 bulbs in PY2 and 7.0 bulbs in PY1). The bulb count reflects the total number of program bulbs, including discounted bulbs and the give-away component.			

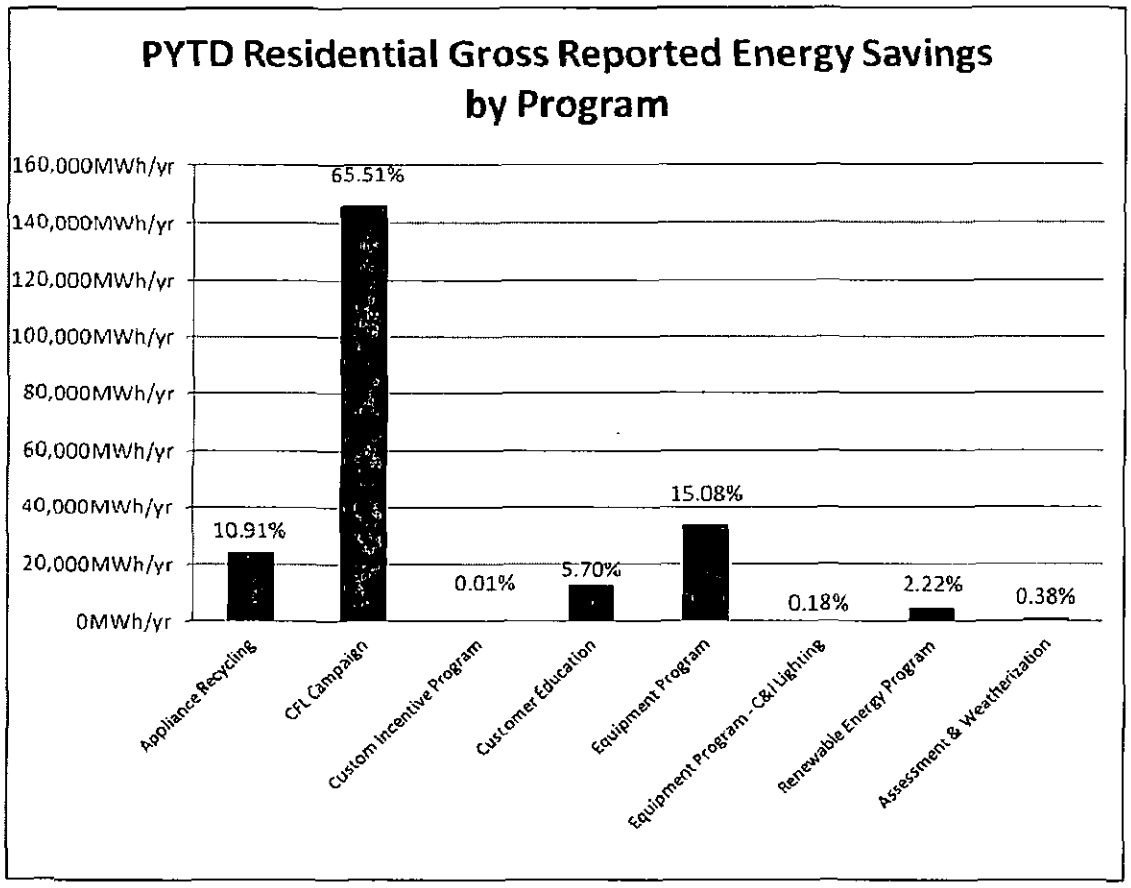
Table 2.4: Summary of Residential EE Sector PYTD Impacts by Program Through the End of the Reporting Period

Residential EE Sector	PYTD Participants	PYTD Reported Gross Energy Savings (MWh/yr)	PYTD Reported Gross Demand Reduction (MW)
Appliance Recycling Program	12,813	24,317	4.81
Compact Fluorescent Lighting Campaign[a]	454,795	146,000	8.71
Custom Incentive Program	1	18	0.00
Energy Efficiency Behavior & Education Program	50,000	12,699	-
Efficient Equipment Incentive Program	108,787	33,596	4.11
Efficient Equipment Incentive Program (C&I Lighting)	59	408	0.13
Renewable Energy Program	1,245	4,957	0.46
Home Assessment & Weatherization Program[b]	1,291	857	0.04
Sector Total	628,991	222,851	18.27

NOTES:
[a] As an upstream program, exact participation in the Compact Fluorescent Lighting Campaign is not known. The EM&V CSP estimated the number of CFL participants by dividing the total number of bulbs discounted (651,357 in PY2 Q4, 889,668 in PY2 Q3; 988,915 PY2 Q2; 526,296 in PY2 Q1; and 1,342,595 in PY1) by a CFL-per-participant value derived from the customer telephone survey data (6.7 bulbs in PY2 and 7.0 bulbs in PY1). The CFL count reflects the total number of program bulbs, including discounted bulbs sold at retail stores and bulbs distributed at give-away events.
[b] Home Assessment & Weatherization Program participation includes one record that was originally attributed to the Small C&I sector but was later reallocated to the Residential EE sector.

A summary of the sector energy savings by program is presented in Figure 2.5.

Figure 2.5: Summary of Residential EE Sector PYTD Reported Gross Energy Savings by Program



A summary of the sector demand reduction by program is presented in Figure 2.6. A summary of the sector CPITD gross energy savings and gross demand reduction by program is presented in Figure 2.7 and Figure 2.8.

Figure 2.6: Summary of Residential EE Sector PYTD Reported Demand Reduction by Program

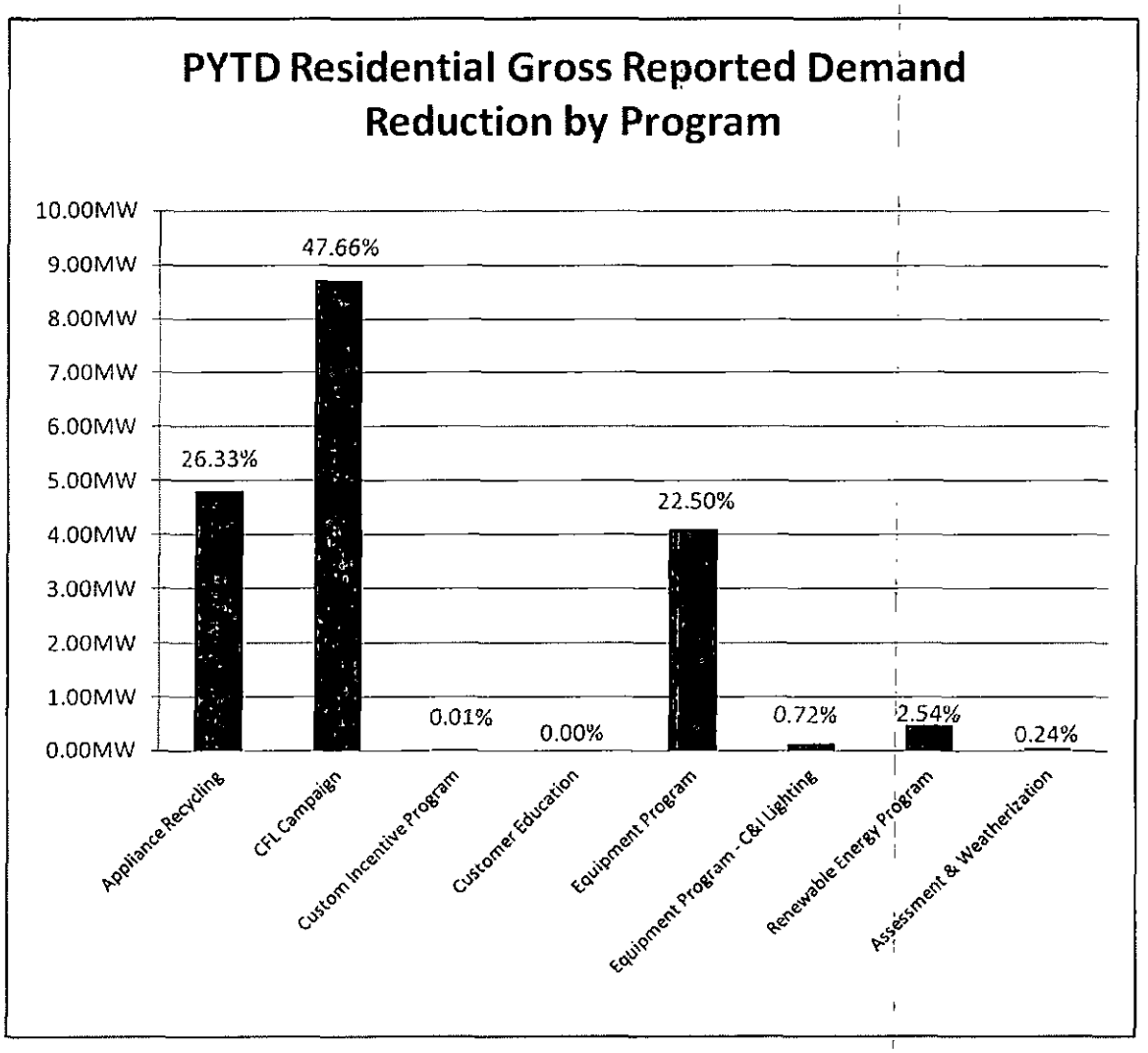


Figure 2.7: Summary of Residential EE Sector CPITD Reported Gross Energy Savings by Program

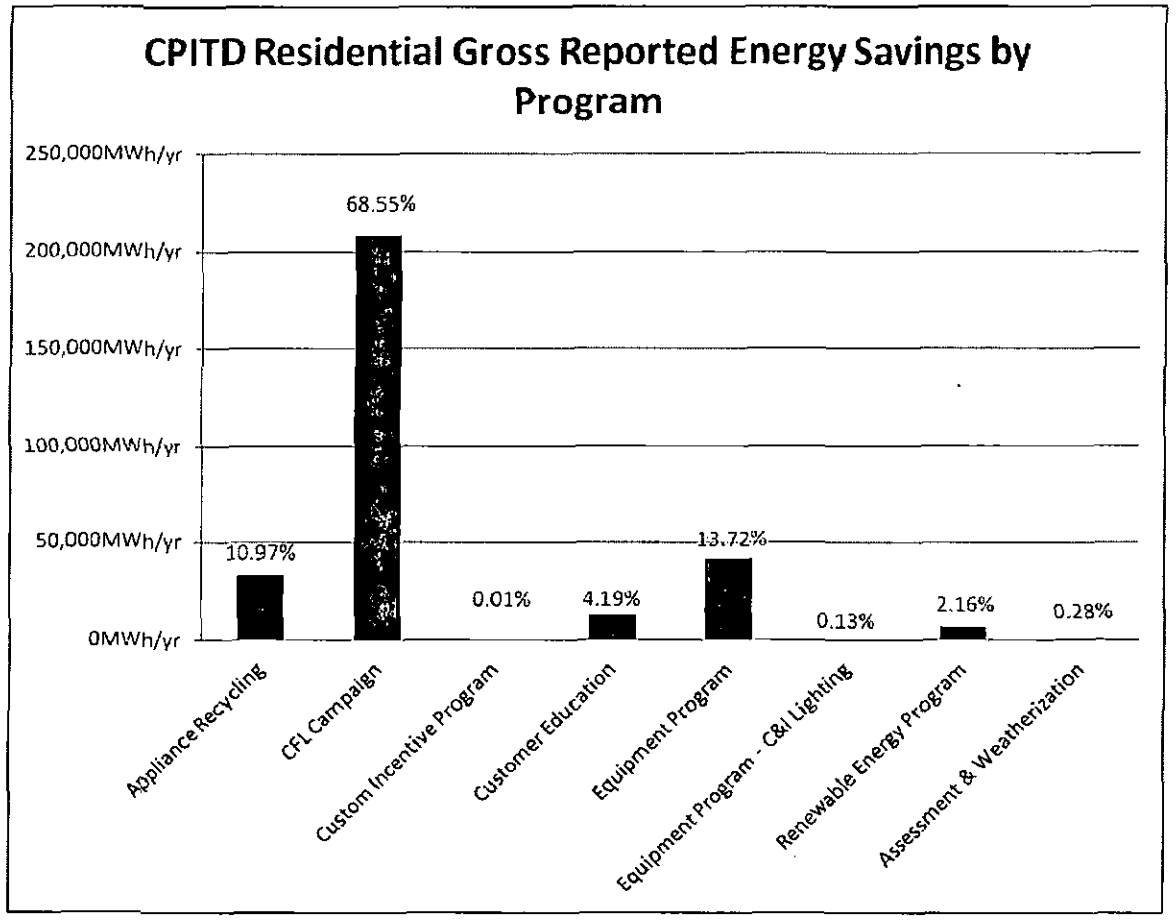
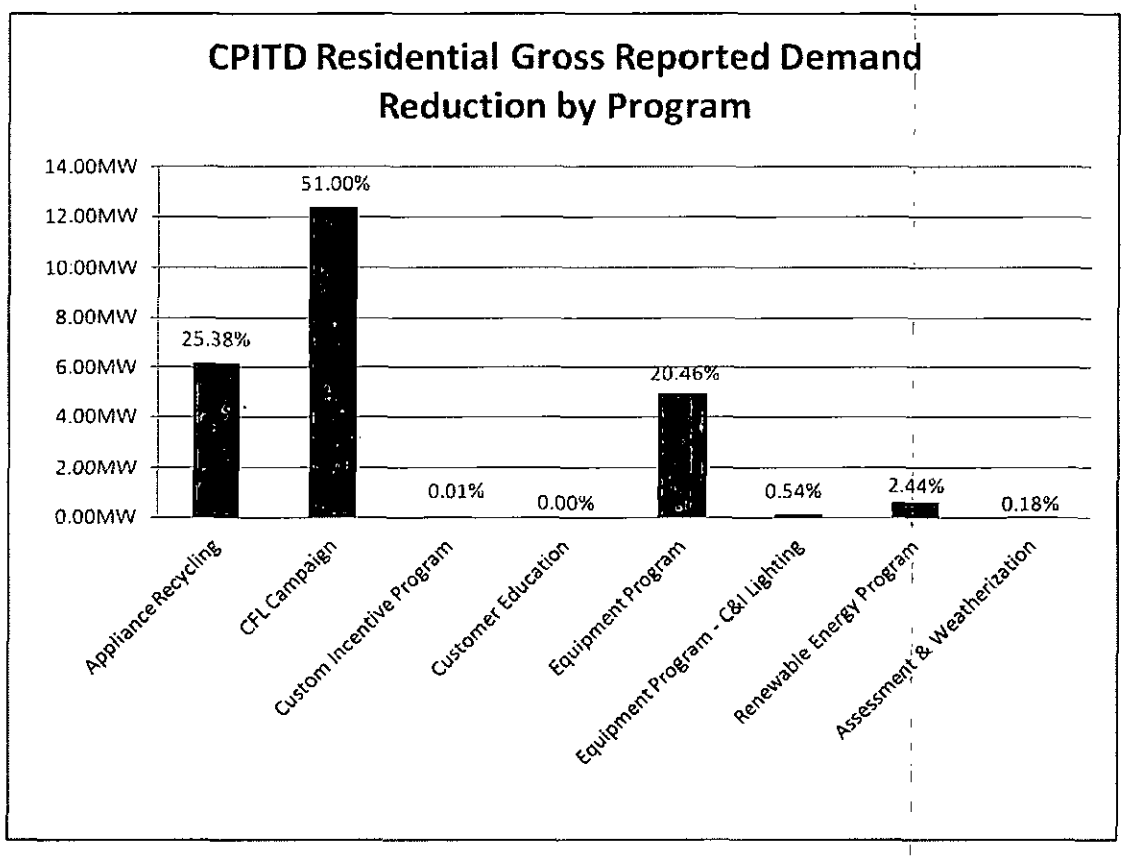


Figure 2.8: Summary of Residential EE Sector CPITD Reported Demand Reduction by Program



2.2 Residential Low-Income EE Sector

The Residential Low-Income EE sector target for annual energy savings in PY2 is 20,264 MWh/yr and the sector target for annual peak demand reduction is 3.13 MW. The Residential Low-Income EE sector target for CPITD annual energy savings is 26.642 MWh/yr and the CPITD target for peak demand reduction is 4.08 MW. These "targets" are planning assumptions in the EE&C Plan.

In keeping with the Commission's Order on May 5, 2011, directing PPL Electric Utilities to generate estimates of low-income participation across all relevant EE&C programs, the PA PUC representatives met with PPL Electric and their EM&V CSP during Q4. The group discussed ways to estimate low-income participation in non-low-income residential programs. The PA PUC approved using Act 129 survey data to determine if participants are low-income customers (defined as those who are at or below 150% of federal poverty level). Table 2.5 shows the estimated portion of residential savings attributable to low-income customers for each relevant program.

Table 2.5. Estimated Low-Income Participation in Residential Programs

Program	Percent of Residential Participation from Low-Income Sector	Estimated PYTD Gross Energy Savings from Low-Income Participation in Residential Programs (MWh/yr)	Estimated PYTD Gross Demand Reduction from Low-Income Participation in Residential Programs (MW)
Appliance Recycling Program	5.9%	1,430	0.28
Compact Fluorescent Lighting Campaign	9.4%	13,754	0.82
Energy Efficiency Behavior & Education Program	15.6%	1,984	-
Efficient Equipment Incentive Program	1.3%	425	0.05
Renewable Energy Program	0.0%	-	-
Home Assessment & Weatherization Program	4.0%	34	0.00
Sector Total	N/A	17,628	1.16
NOTES:			

A sector summary of results of the designated low-income programs is presented in Table 2.6 and Table 2.7.

Table 2.6: Summary of Residential Low-Income EE Sector Incremental Impacts by Program Through the End of the Reporting Period

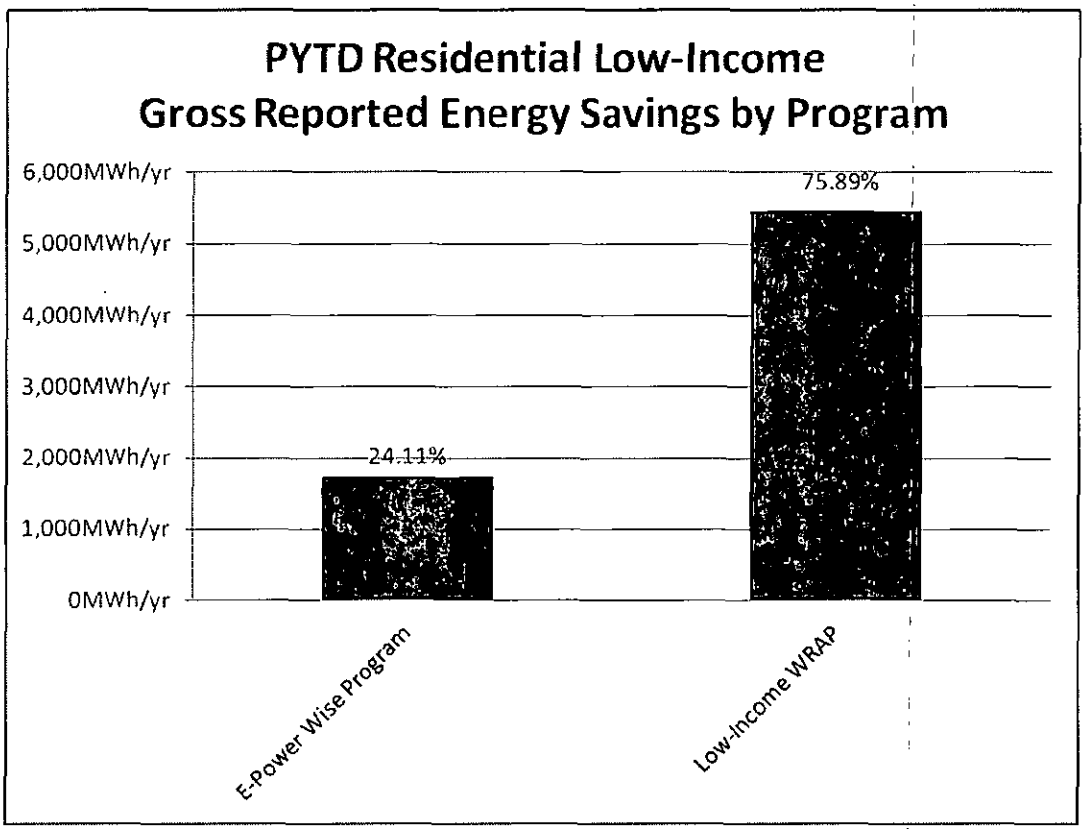
Residential Low-Income EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
E-Power Wise	797	342	0.05
Low-Income WRAP	1,126	1,435	0.18
Sector Total	1,923	1,777	0.22
NOTES:			

Table 2.7: Summary of Residential Low-Income EE Sector PYTD Impacts by Program Through the End of the Reporting Period

Residential Low-Income EE Sector	PYTD Participants	PYTD Reported Gross Energy Savings (MWh/yr)	PYTD Reported Gross Demand Reduction (MW)
E-Power Wise	4,050	1,737	0.24
Low-Income WRAP	4,455	5,469	0.67
Sector Total	8,505	7,206	0.91
NOTES:			

A summary of the sector energy savings by program is presented in Figure 2.9.

Figure 2.9: Summary of Residential Low-Income EE Sector PYTD Reported Gross Energy Savings by Program



A summary of the sector demand reduction by program is presented in Figure 2.10. A summary of the sector CPITD gross energy savings and gross demand reduction by program is presented in Figure 2.11 and Figure 2.12.

Figure 2.10: Summary of Residential Low-Income EE Sector PYTD Reported Demand Reduction by Program

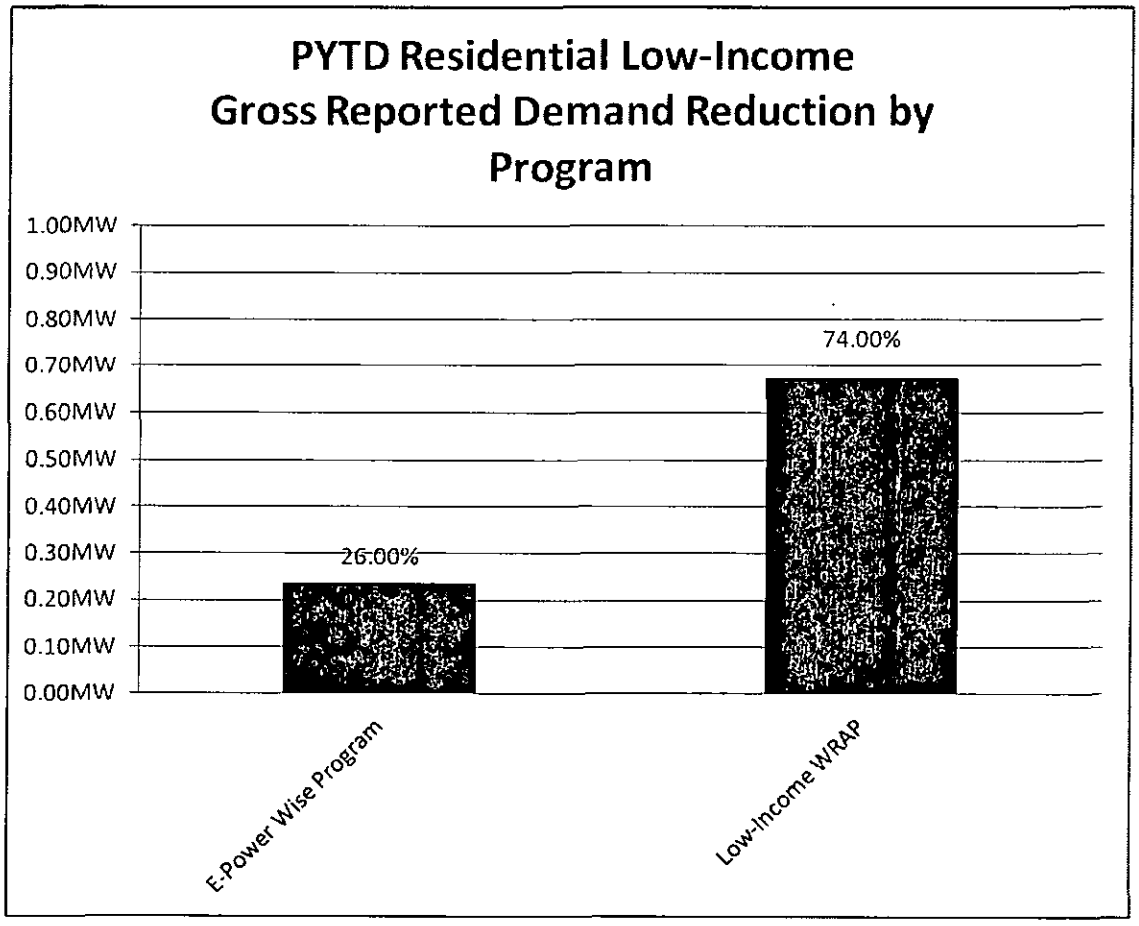


Figure 2.11: Summary of Residential Low-Income EE Sector *CPITD Reported Gross* Energy Savings by Program

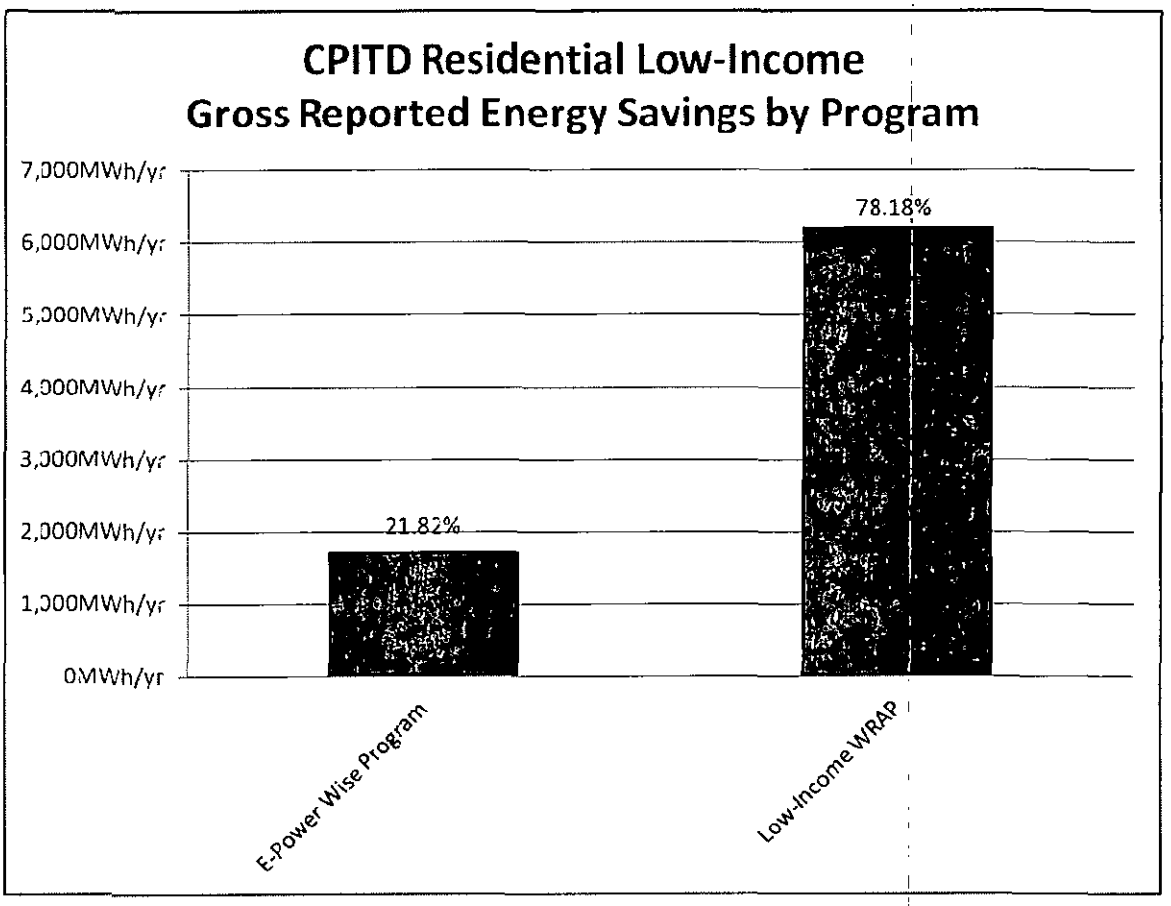
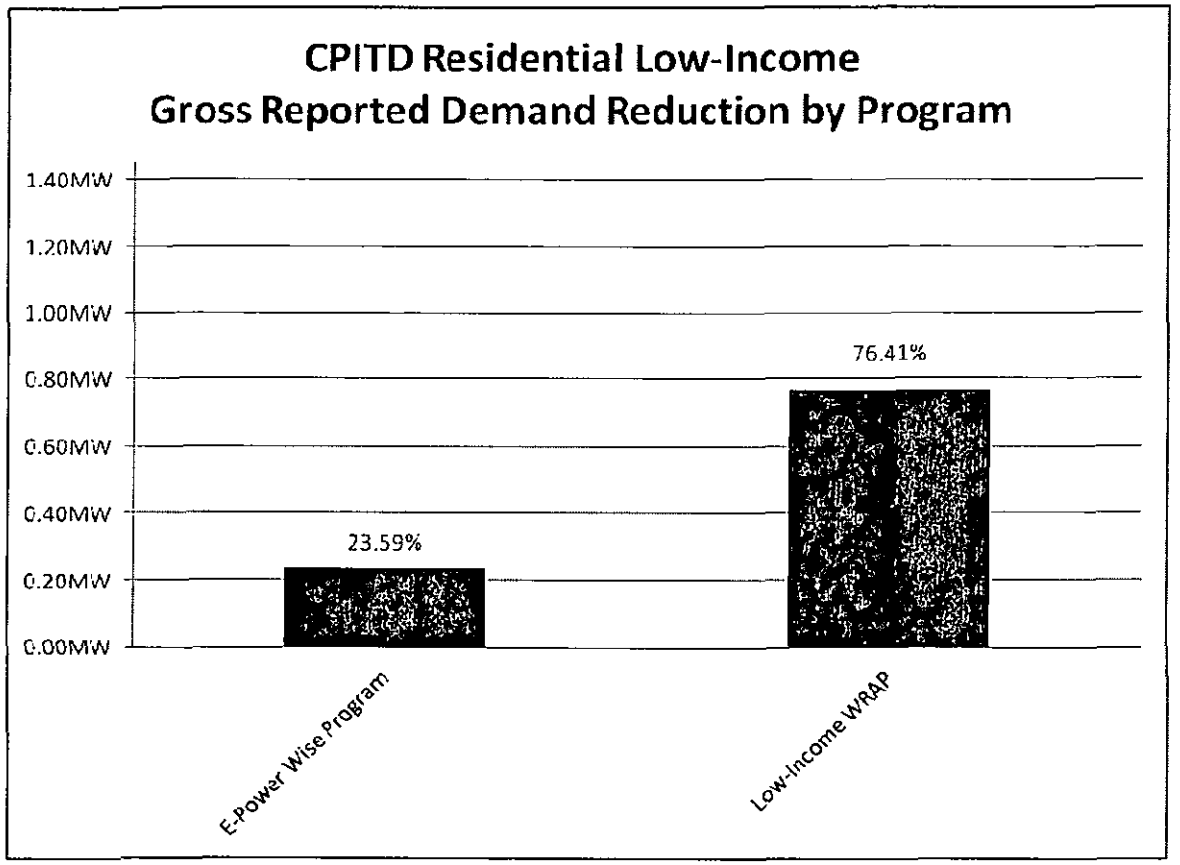


Figure 2.12: Summary of Residential Low-Income EE Sector CPITD Reported Demand Reduction by Program



2.3 Small Commercial & Industrial EE Sector

The Small Commercial & Industrial (C&I) EE sector target for annual energy savings in PY2 is 141,351 MWh/yr and the sector target for annual peak demand reduction is 27.39 MW. The Small C&I EE sector target for CPITD annual energy savings is 168,854 MWh/yr and the CPITD target for peak demand reduction is 32.72 MW. These "targets" are planning assumptions in the EE&C Plan.

A sector summary of results by program is presented in Table 2.8 and Table 2.9.

Table 2.8: Summary of Small C&I EE Sector Incremental Impacts by Program Through the End of the Reporting Period

Small C&I EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
Appliance Recycling Program	77	156	0.03
Custom Incentive Program	4	419	0.09
Efficient Equipment Incentive Program	1,428	9,998	1.38

Small C&I EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
Efficient Equipment Incentive Program (C&I Lighting)	297	15,630	3.63
HVAC Tune-Up Program	546	412	0.48
Renewable Energy Program[a]	-	-	-
Sector Total	2,352	26,614	5.61

NOTES:
[a] While only residential and government, non-profit, and institutional (GNI) customers are eligible for the Renewable Energy Program; in some cases a PV system was installed in a residential application on a small C&I rate schedule. This can happen if the account is a farm, a residential rental property, or a separately metered out-building, such as a workshop at a personal residence.

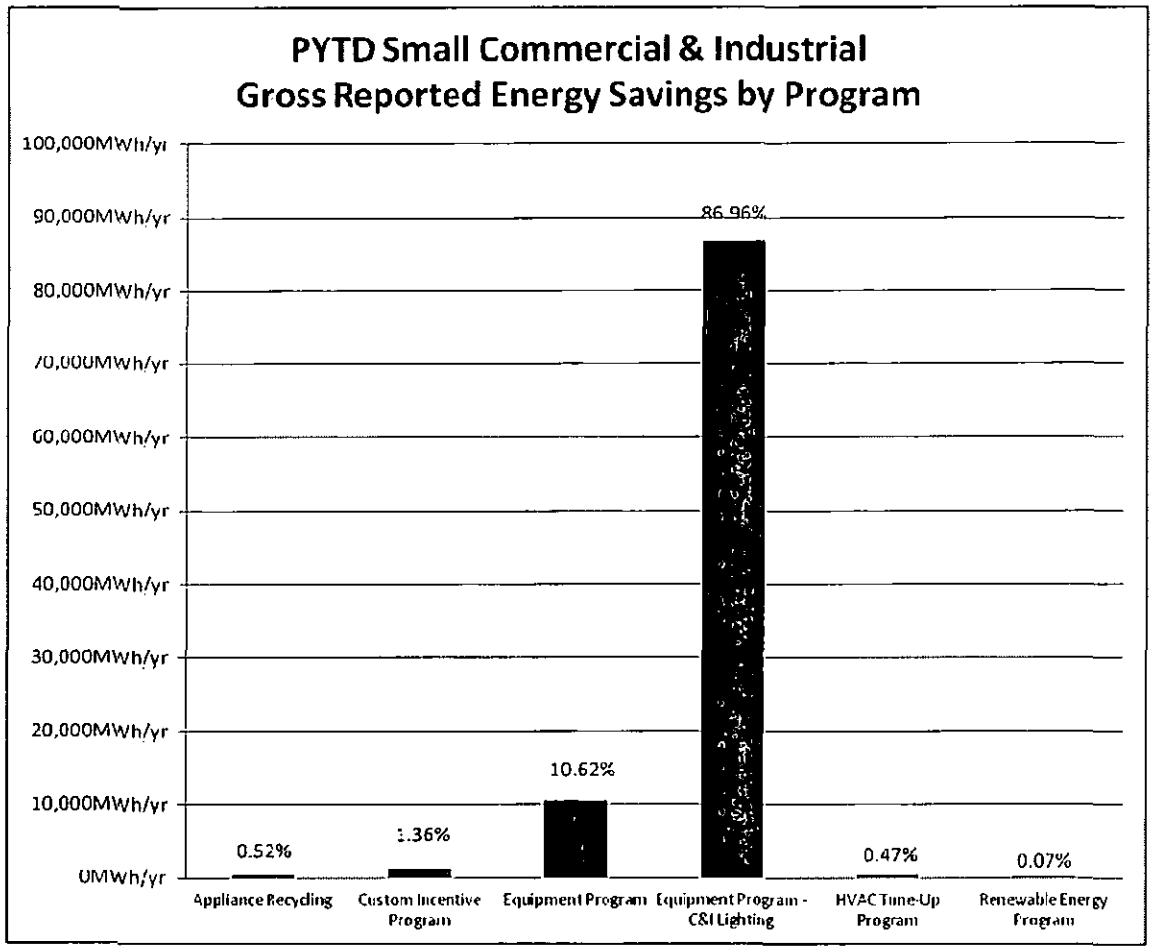
Table 2.9: Summary of Small C&I EE Sector PYTD Impacts by Program Through the End of the Reporting Period

Small C&I EE Sector	PYTD Participants	PYTD Reported Gross Energy Savings (MWh/yr)	PYTD Reported Gross Demand Reduction (MW)
Appliance Recycling Program	258	521	0.10
Custom Incentive Program	24	1,355	1.38
Efficient Equipment Incentive Program	2,611	10,593	1.49
Efficient Equipment Incentive Program (C&I Lighting)	1,270	86,703	19.85
HVAC Tune-Up Program	685	464	0.48
Renewable Energy Program[a]	6	68	0.01
Sector Total	4,854	99,703	23.32

NOTES:
[a] While only residential and GNI customers are eligible for the Renewable Energy Program, in some cases a PV system was installed in a residential application on a small C&I rate schedule. This can happen if the account is a farm, a residential rental property, or a separately metered out-building, such as a workshop at a personal residence.

A summary of the sector energy savings by program is presented in Figure 2.13:

Figure 2.13: Summary of Small C&I EE Sector PYTD Reported Gross Energy Savings by Program



A summary of the sector demand reduction by program is presented in Figure 2.14. A summary of the sector CPITD gross energy savings and gross demand reduction by program is presented in Figure 2.15 and Figure 2.16.

Figure 2.14: Summary of Small C&I EE Sector PYTD Reported Demand Reduction by Program

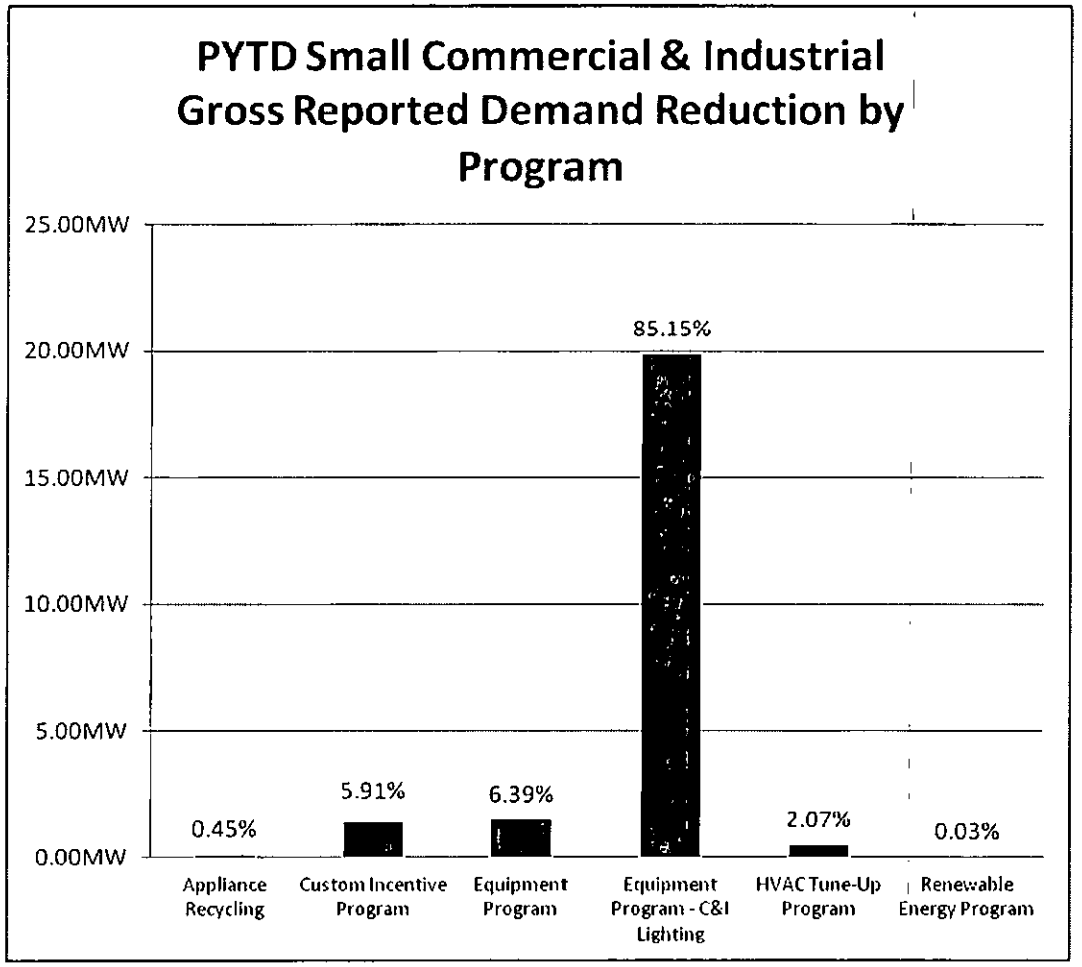


Figure 2.15: Summary of Small C&I EE Sector CPITD Reported Gross Energy Savings by Program

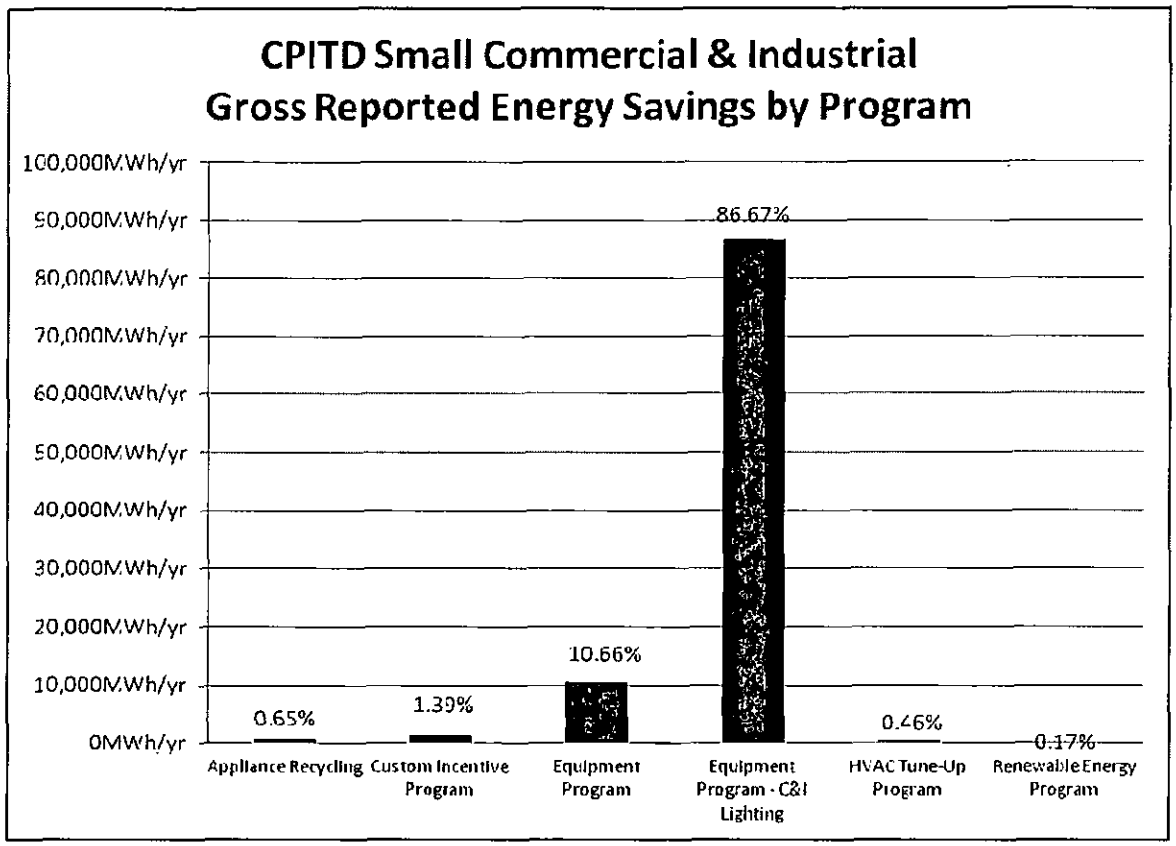
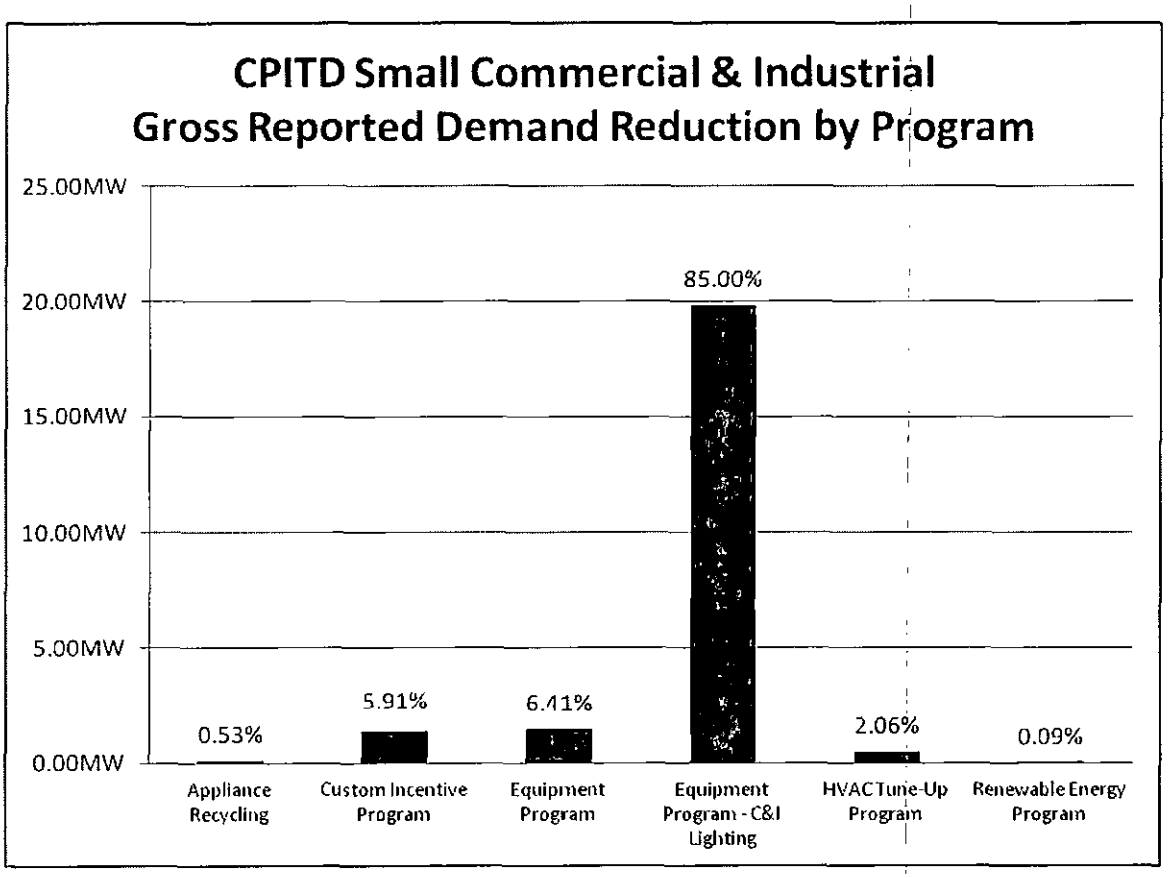


Figure 2.16: Summary of Small C&I EE Sector CPITD Reported Demand Reduction by Program



2.4 Large Commercial & Industrial EE Sector

The Large C&I EE sector target for annual energy savings in PY2 is 25,831 MWh/yr and the sector target for annual peak demand reduction is 4.46 MW. The Large C&I EE sector target for CPITD annual energy savings is 33,645 MWh/yr and the CPITD target for peak demand reduction is 5.45 MW. These "targets" are planning assumptions in the EE&C Plan.

A sector summary of results by program is presented in Table 2.10 and Table 2.11.

Table 2.10: Summary of Large C&I EE Sector Incremental Impacts by Program Through the End of the Reporting Period

Large C&I EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
Appliance Recycling Program	2	7	0.00
Custom Incentive Program	11	8,742	0.92
Efficient Equipment Incentive Program	39	7,755	1.09
Efficient Equipment Incentive Program (C&I	21	7,238	1.58

Large C&I EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
Lighting)			
HVAC Tune-Up Program	21	2	0.00
Sector Total	94	23,743	3.60
NOTES:			

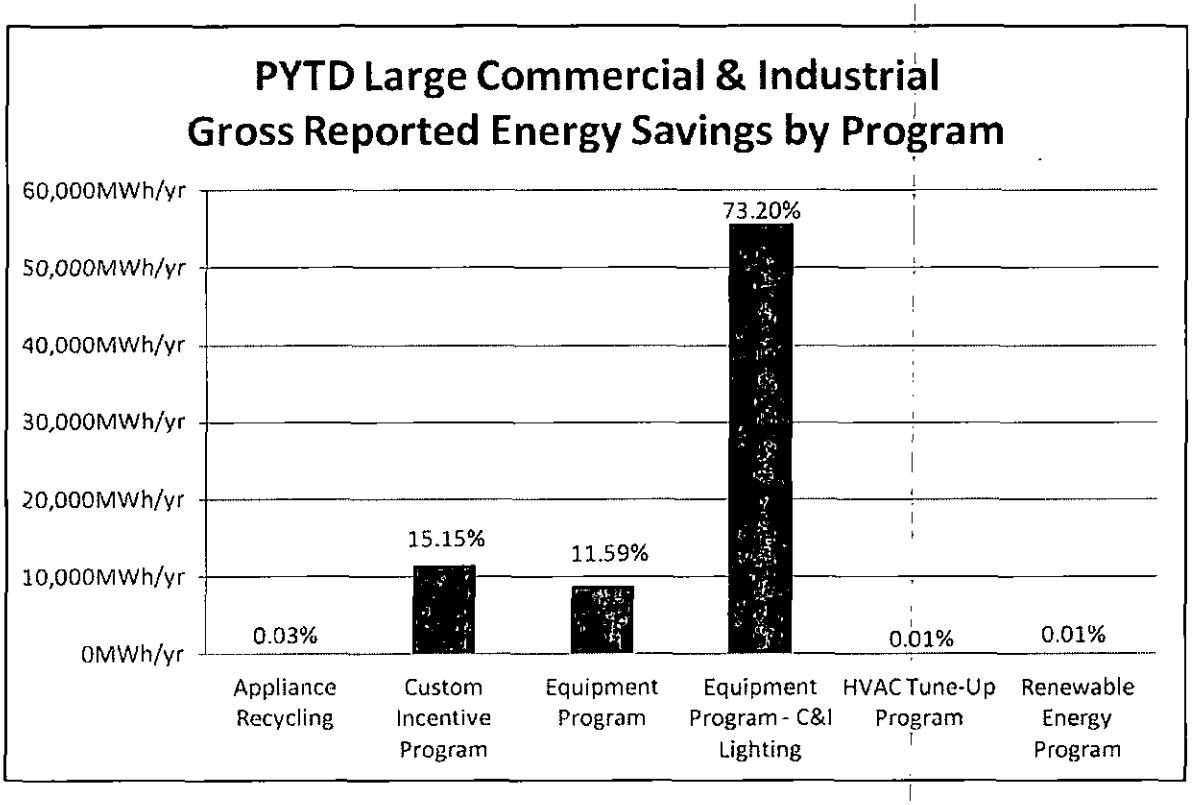
Table 2.11: Summary of Large C&I EE Sector PYTD Impacts by Program Through the End of the Reporting Period

Large C&I EE Sector	PYTD Participants	PYTD Reported Gross Energy Savings (MWh/yr)	PYTD Reported Gross Demand Reduction (MW)
Appliance Recycling Program	11	26	0.01
Custom Incentive Program	16	11,527	1.36
Efficient Equipment Incentive Program	96	8,817	1.18
Efficient Equipment Incentive Program (C&I Lighting)	157	55,684	7.98
HVAC Tune-Up Program	26	4	0.00
Renewable Energy Program[a]	1	11	0.00
Sector Total	307	76,068	10.52

NOTES:
[a] While only residential and GNI customers are eligible for the Renewable Energy Program, in some cases a PV system was installed in a residential application on a large C&I rate schedule. This can happen if the account is a farm, a residential rental property, or a separately metered out-building, such as a workshop at a personal residence.

A summary of the sector energy savings by program is presented in Figure 2.17.

Figure 2.17: Summary of Large C&I EE Sector PYTD Reported Gross Energy Savings by Program



A summary of the sector demand reduction by program is presented in Figure 2.18. A summary of the sector CPITD gross energy savings and gross demand reduction by program is presented in Figure 2.19 and Figure 2.20.

Figure 2.18: Summary of Large C&I EE Sector PYTD Reported Demand Reduction by Program

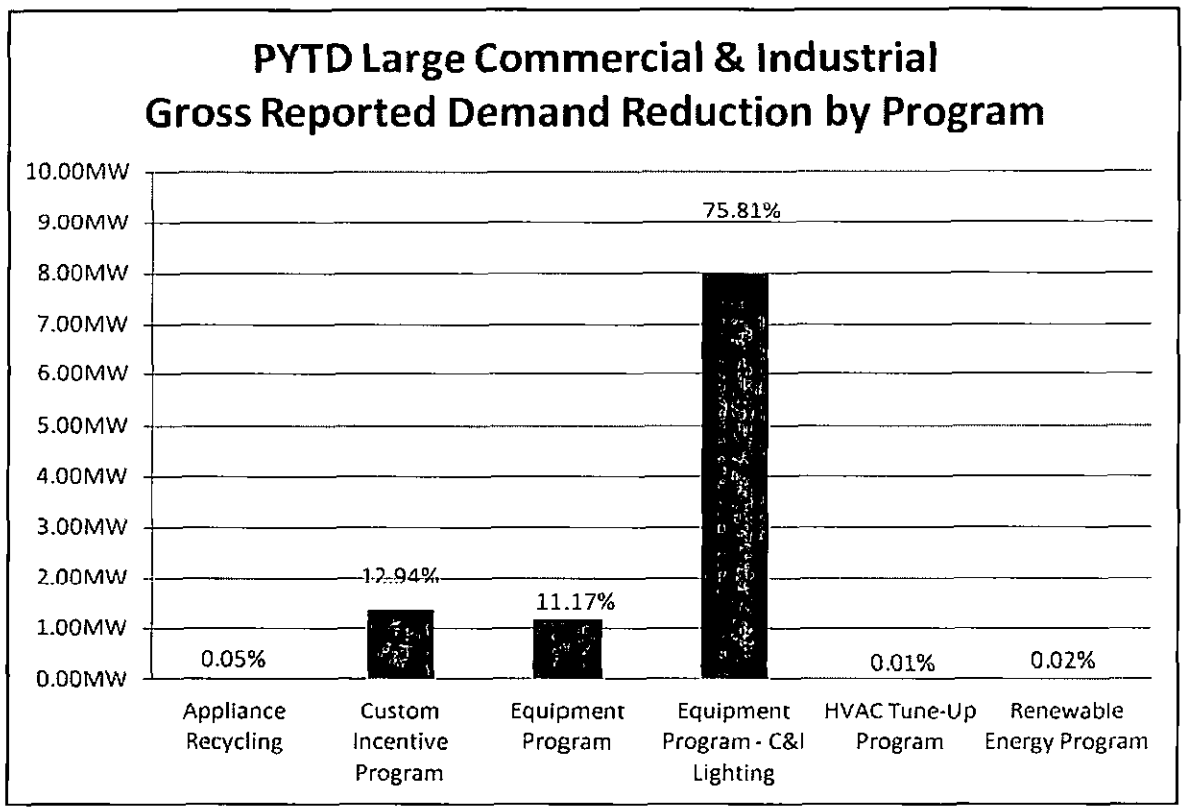


Figure 2.19: Summary of Large C&I EE Sector CPITD Reported Gross Energy Savings by Program

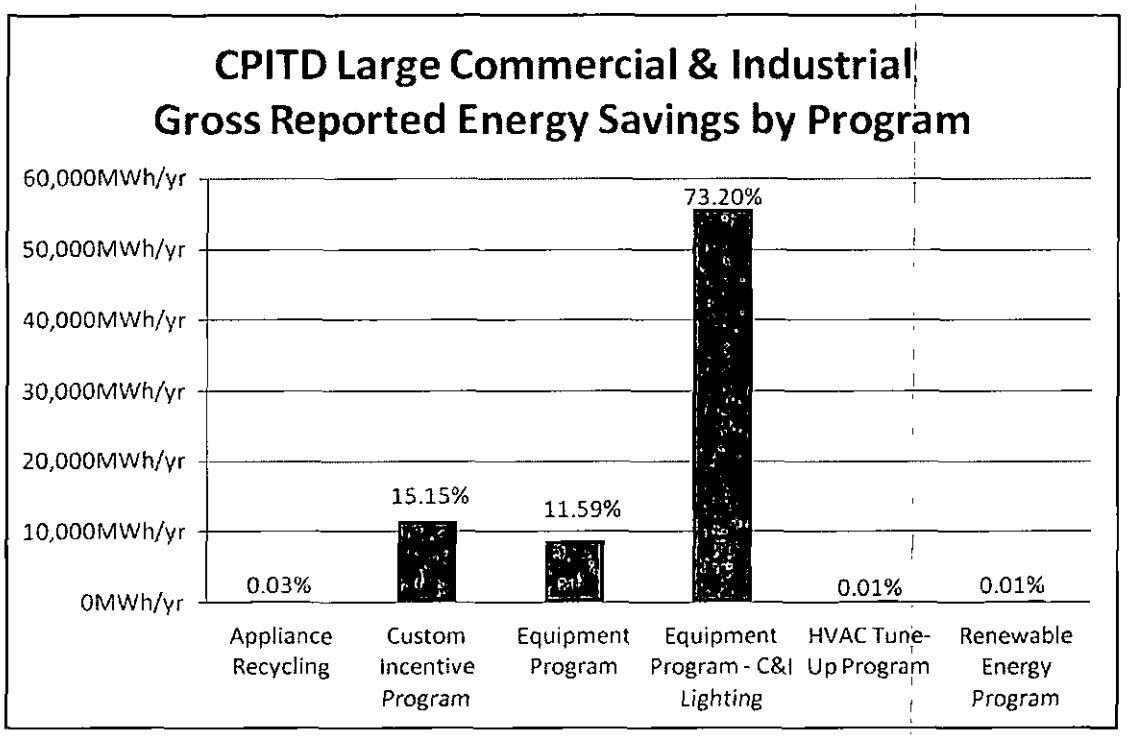
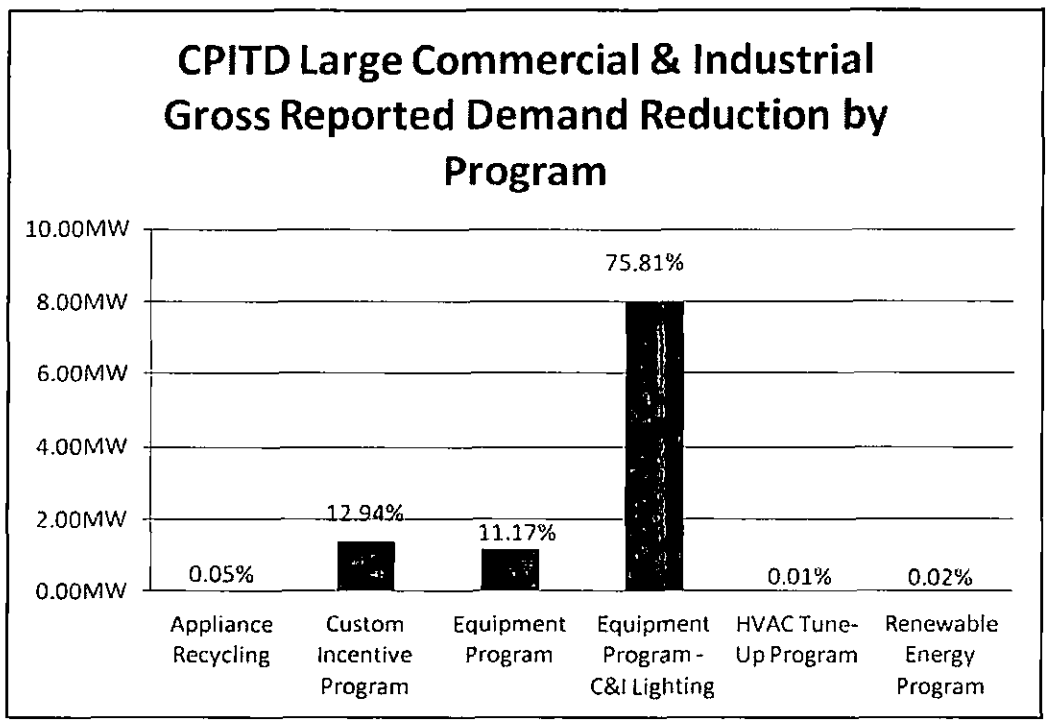


Figure 2.20: Summary of Large C&I EE Sector CPITD Reported Demand Reduction by Program



2.5 Government & Non-Profit EE Sector

The Government & Non-Profit EE sector target for annual energy savings in PY2 is 25,831 MWh/yr and the sector target for annual peak demand reduction is 4.46 MW. The Government & Non-Profit EE sector target for CPITD annual energy savings is 37,506 MWh/yr and the CPITD target for peak demand reduction is 6.53 MW. These "targets" are planning assumptions in the EE&C Plan.

A sector summary of results by program is presented in Table 2.12 and Table 2.13.

Table 2.12: Summary of Government & Non-Profit EE Sector Incremental Impacts by Program Through the End of the Reporting Period

Government & Non-Profit EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
Appliance Recycling Program	1	2	0.00
Custom Incentive Program	7	1,284	0.19
Efficient Equipment Incentive Program	1,524	3,692	0.71
Efficient Equipment Incentive Program (C&I Lighting)	179	15,019	3.14
Renewable Energy Program	30	2,397	0.68
Sector Total	1,741	22,394	4.71

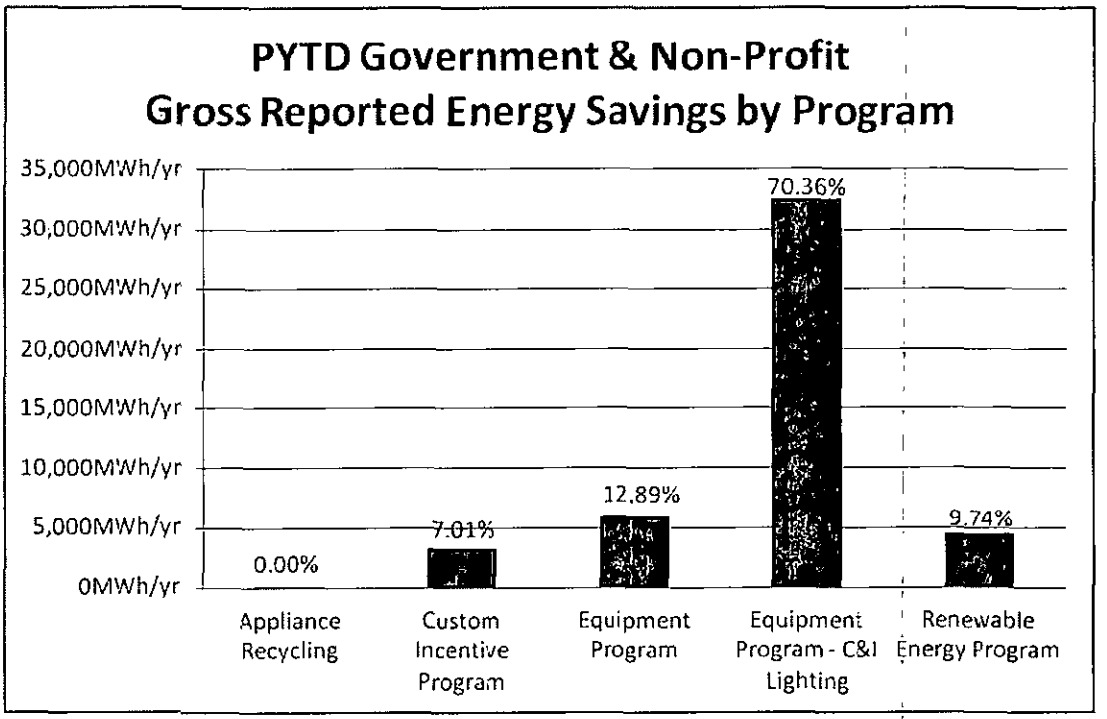
Government & Non-Profit EE Sector	IQ Participants	IQ Reported Gross Energy Savings (MWh/yr)	IQ Reported Gross Demand Reduction (MW)
NOTES:			

Table 2.13: Summary of Government & Non-Profit EE Sector PYTD Impacts by Program Through the End of the Reporting Period

Government & Non-Profit EE Sector	PYTD Participants	PYTD Reported Gross Energy Savings (MWh/yr)	PYTD Reported Gross Demand Reduction (MW)
Appliance Recycling Program	1	2	0.00
Custom Incentive Program	13	3,239	0.26
Efficient Equipment Incentive Program	2,253	5,962	1.22
Efficient Equipment Incentive Program (C&I Lighting)	510	32,536	7.87
Renewable Energy Program	77	4,502	0.94
Sector Total	2,854	46,241	10.29
NOTES:			

A summary of the sector energy savings by program is presented in Figure 2.21.

Figure 2.21: Summary of Government & Non-Profit EE Sector PYTD Reported Gross Energy Savings by Program



A summary of the sector demand reduction by program is presented in Figure 2.22. A summary of the sector CPITD gross energy savings and gross demand reduction by program is presented in Figure 2.23 and Figure 2.24.

Figure 2.22: Summary of Government & Non-Profit EE Sector PYTD Reported Demand Reduction by Program

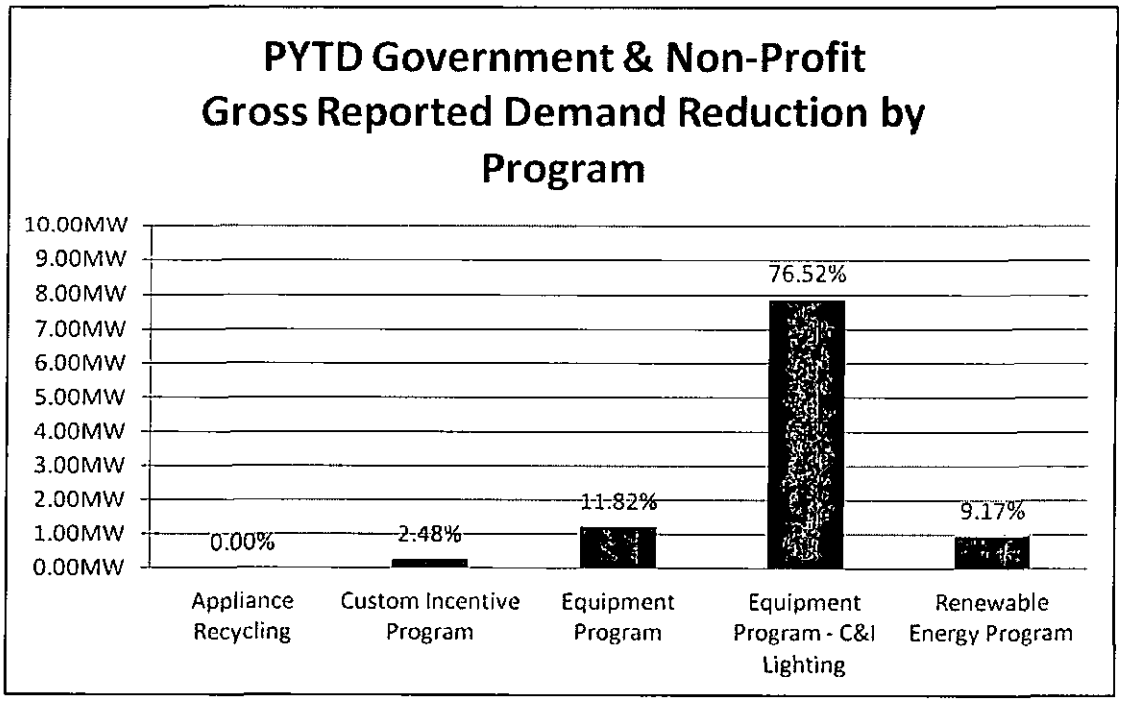


Figure 2.23: Summary of Government & Non-Profit EE Sector CPITD Reported Gross Energy Savings by Program

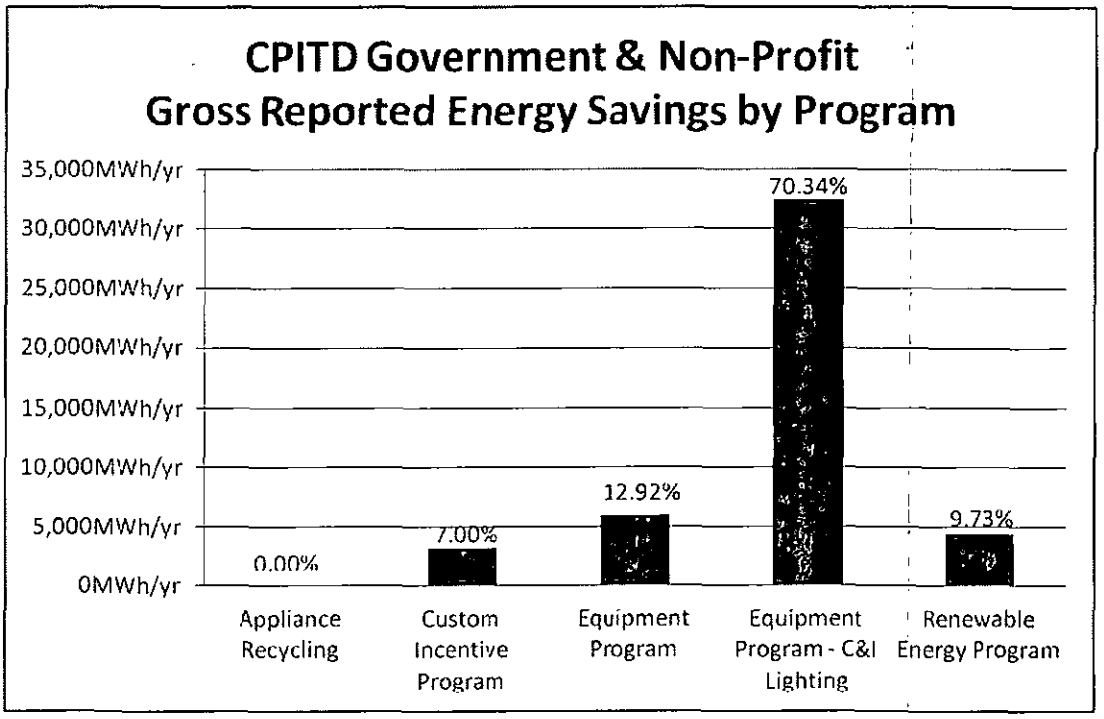
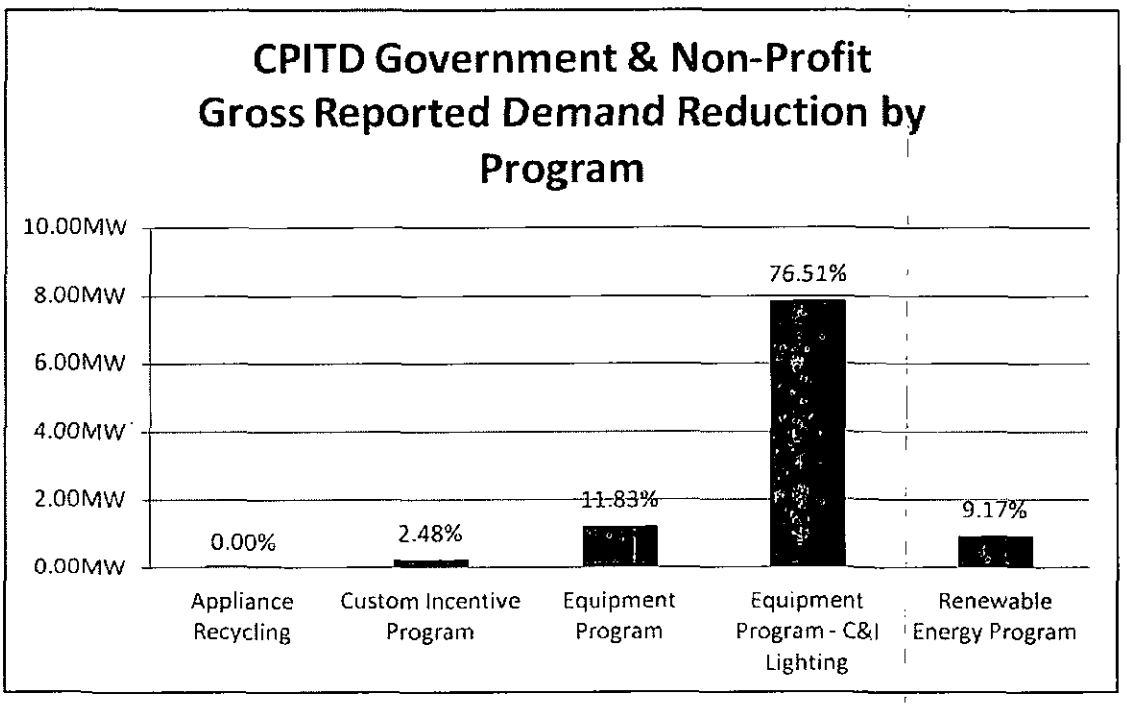


Figure 2.24: Summary of Government & Non-Profit EE Sector CPITD Reported Demand Reduction by Program



3 Portfolio Results by Program

3.1 Appliance Recycling Program

The ARP offers free pick up and recycling of operating but inefficient refrigerators, freezers, and room air conditioners. ARP's overarching goal is 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 appliances are disposed of in an environmentally responsible manner.
- On-site decommissioning to ensure appliances are not resold in a secondary market.
- Promoting other PPL Electric energy efficiency programs.
- Collecting and recycling no fewer than 69,600 appliances through 2013, with a total energy reduction of 114,760 MWh/yr and 13,150 kW.

3.1.1 Program Logic

The theory for ARP can be summarized as follows:

> By permanently retiring older, inefficient appliances, the program will remove them from PPL Electric's grid. As a result, the program helps consumers save on their utility bills and lessens baseload demand. Disposing of units in an environmentally sound manner reduces the likelihood of ozone-destroying chemicals entering the atmosphere, improving air quality and reducing greenhouse gas emissions. The participation experience helps residential customers learn more about the benefits of energy efficiency and allows PPL Electric to maintain an efficient appliance stock.

The program's logic model, shown in Figure 1.3-1 of the EM&V Plan, highlights the program's key features as understood by the EM&V CSP, indicating logical linkages between activities, outputs, and outcomes.

The logic model's elements are:

- **Program inputs:** The program inputs are PPL Electric customers with a working, residential-grade refrigerator, freezer, or air conditioner; PPL Electric staff (including management, coordination, and marketing); the appliance recycling CSP; vehicles for appliance transport; the recycling facility; applications and forms; incentive funding; and recycling expertise and technologies.
- **Program activities:** The program's primary activities include marketing and outreach (including cross-program referrals), processing applications, verifying customer eligibility, picking up and recycling inefficient appliances, and processing incentive payments.

- **Program outputs:** Outputs include marketing materials produced; applications processed; number of appliances scheduled, picked-up, and subsequently recycled; and incentives paid.
- **Short-term outcomes** (one year): Outcomes resulting from customers participating in the program are secondary and inefficient appliances being permanently retired from use and customer awareness of other PPL Electric EE&C programs.
- **Intermediate outcomes** (two to three years): Outcomes consist of increased participation due to customer familiarity with the program, the reduced number of operating secondary and inefficient appliances, and waste materials from recycled appliances being disposed of in an environmentally responsible manner.
- **Long-term outcomes** (four to seven years): Outcomes include fewer old and inefficient appliances in existence and achieved energy and demand savings targets of 114,760 MWh/yr and 13 MW.

3.1.2 Program Measurement and Verification Methodology

A complete discussion of the measurement and verification (M&V) methodology can be found in Chapters 3, 4, and 5 of the Appliance Recycling QA/QC and EM&V Plan.

***Ex ante* Adjustment Methodology**

No TRM *ex ante* adjustments were made for refrigerators. Adjustments were made to *ex ante* reported savings to make room air conditioner savings values[7] meet TRM specifications. The adjustment was based on the actual locations of participants, because PPL Electric's tracking system uses a single savings value for all cities. In July 2010, the Statewide Evaluator (SWE) issued new savings assumptions, deemed energy savings, and demand impact values for room air conditioner retirement.

***Ex ante* Adjustment Findings**

Based on the TRM *ex ante* adjustment, savings for recycled room air conditioners reflect the savings for the city in which the unit was removed. The updated savings for each location are shown in Table 3.1.

Table 3.1: Room Air Conditioner Retirement – Savings Assumptions and Participation by City

Measure	City	EFLH	Capacity	EER	Energy Impact (kWh/yr)	CF[a]	Demand Impact (kW)	Effective Useful Life	Frequency - PY2 Annual Participants (# of units)
Room Air Conditioner Retirement	Allentown	243	10,000	9.07	268	0.58	0.64	4	749
	Harrisburg	288	10,000	9.07	318	0.58	0.64	4	618
	Scranton	193	10,000	9.07	213	0.58	0.64	4	502
	Williamsport	204	10,000	9.07	225	0.58	0.64	4	360

NOTES:
[a] CF stands for coincidence factor.

[7] Savings assumptions for room air conditioners are based on 'Table 2: RAC Retirement Only EFLH and Energy Savings by City' of the Room AC TRM interim protocol approved by the SWE.

Savings Realization Rate Methodology

The EM&V CSP conducted telephone surveys to assess the accuracy of records for this program. A random sample of participants was selected for telephone survey verification to exceed 90% confidence and 10% precision for the program year. The quantity and type of units collected, as well as the operational condition of each unit, was verified with program participants.

In addition to the telephone surveys, the EM&V CSP inspected a census of PY2 annual participant records from the Energy Efficiency Management Information System (EEMIS) database. All data in EEMIS for this program were compared to the appliance recycling CSP records to verify whether all units reported as recycled were in fact recycled by the ARP CSP.

Savings Realization Rate Findings

There were three discrepancies between EEMIS and the ARP CSP tracking database that affected the savings realization rate. The JACO Environmental Inc. (JACO) database recorded two fewer refrigerators/freezers and one less room air conditioner than EEMIS. Therefore, the net change from the records review for this program was two fewer refrigerators/freezers, and one less room air conditioner. There was one instance from survey verification efforts where a customer explained their refrigerator did not turn on when plugged in (a program eligibility requirement), resulting in a net change of one less refrigerator.

The EM&V CSP estimated a 90% exact binomial confidence interval for measure groups in this program. Reported savings for refrigerators and freezers is 99.4% accurate, with a 90% confidence interval between 97.05% and 99.97%.[8] The EM&V CSP confirmed that all room air conditioner records were correct. Using an exact binomial confidence interval, at least 96% of the room air conditioner records are accurate with 90% confidence.

Because this is a sizable program that recycled thousands of appliances in PY2, this adjustment had a minimal effect on the savings realization rate. Based on these verification findings, the PY2 annual realization rate for this program is 100%.

Findings from the records review resulted in the realization rates shown in Table 3.2 for each measure type. These realization rates were calculated using the PY2 annual records review, and were applied to all reported savings for PY2.

Table 3.2: ARP Realization Rates and *Ex post* per Unit Savings by Measure Type

Measure Type	TRM Adjusted *Ex ante* Savings (kWh/yr)	TRM Adjusted *Ex ante* Savings (kW)	Realization Rate	*Ex post* kWh/yr Savings per Unit	*Ex post* kW Savings per Unit
Refrigerator/Freezer	1,728	0.24	100%	1,728	0.24
Room Air Conditioner	262	0.64	100%	262	0.64

[8] Binomial confidence intervals are not necessarily symmetric.

Measure Type	TRM Adjusted *Ex ante* Savings (kWh/yr)	TRM Adjusted *Ex ante* Savings (kW)	Realization Rate	*Ex post* kWh/yr Savings per Unit	*Ex post* kW Savings per Unit
NOTES:					

Net-to-Gross Ratio Methodology
The EM&V CSP used both participant and nonparticipant survey data to calculate net savings for this program.

Free-ridership Methodology
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 net-to-gross (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 or not 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 free-ridership: instances where the appliance would have been kept and stored unused (number 2 above) or discarded and destroyed (number 4). Both of those scenarios would have the same impact on energy consumption independent of program participation. The participant and nonparticipant surveys collected customer behavior data around these four scenarios to compute the NTG ratio.

In other evaluations, the EM&V CSP 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. The notion of appliance replacement within a

participating home has no bearing on the program's gross savings, although it may be important information for understanding the efficiency of the appliance stock in PPL Electric's service territory.

A more complete discussion of the NTG methodology can be found in Chapter 5 of the Appliance Recycling QA/QC and EM&V Plan.

Spillover Methodology
Participant spillover refers to the participant's 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.

Net-to-Gross Ratio Findings
Per the Audit Plan,[9] until a Commission order is issued, only gross savings will be reported and verified; gross savings will not be adjusted by the NTG ratio.

Free-ridership Findings
The free-ridership result was 0.43 for the ARP.

Spillover Findings
Some ARP survey respondents stated 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 3% spillover for ARP. The overall NTG ratio is 61%.

3.1.3 Program Sampling

The EM&V CSP conducted participant and nonparticipant surveys for QA/QC and for impact and process evaluations. The CSP selected a random sample of program participants who were recycling a room AC and a refrigerator or freezer. Participant survey instruments included questions affecting all evaluation activities, and the same sample population was used for QA/QC and process and impact evaluations. For PY2, the EM&V CSP completed a total of 142 participant surveys stratified by measure type, 49 of which included respondents that had recycled at least one room air conditioner in addition to at least one refrigerator or freezer (those that recycle a room air conditioner must also recycle either a refrigerator or a freezer to qualify as a participant in this program). The participant surveys exceeded 90% confidence and 10% precision.

[9] Statewide Evaluation Team. *Audit Plan and Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs*, December 2009.

The EM&V CSP conducted nonparticipant surveys with a random sample of PPL Electric customers. Screening questions identified customers who had not participated in PPL Electric's ARP, but who had discarded an eligible appliance within the last year. The EM&V CSP completed a total of 134 nonparticipant surveys stratified by measure type. The disposition of EM&V samples for this program is shown in the Appliance Recycling QA/QC and EM&V Plan and is included below.

The records review included a census of participants in the EEMIS database. Altogether, records were verified for 13,083 unique CSP Job Numbers (i.e., unique rebates).

Table 3.3: Appliance Recycling Program Sample Disposition – PY2

Sample Review Type	Target	Completes
Participant Surveys		
Refrigerator/Freezer	90	93
Room Air Conditioner	45	49
Nonparticipant Surveys	140	134
Participant Records Review	Census	Census
Total	**275**	**276**
NOTES:		

3.1.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.1.5 Program Partners and Trade Allies

PPL Electric's customer programs specialist provides general program management and oversight, monitors the program, provides program information to trade allies, approves invoices and program data, and resolves program issues. A single ARP implementation CSP, JACO, provides turnkey services to administer and manage the program's day-to-day operations. The ARP CSP's role includes marketing the program to customers; staffing a call center that performs customer intake, scheduling services, and responds to customer questions and concerns; processing applications and rebates; tracking program data; and providing customer and transaction information to PPL Electric. Other trade allies are appliance dealers in PPL Electric's service territory, such as Best Buy and Sears.

3.1.6 Program Finances

A summary of the project finances are presented in Table 3.4.

Table 3.4: Summary of Program Finances - TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$0	$0	$0
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$0	$0	$0
B.1	Design & Development[a]	$0	$0	$0
B.2	Administration[a]	$0	$0	$0
B.3	Management[b]	$343,049	$1,459,181	$2,120,108
B.4	Marketing[a]	$68,475	$299,615	$424,975
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$411,524	$1,758,796	$2,545,083
C	**EDC Evaluation Costs**[a]	$0	$0	$0
D	**SWE Audit Costs**[a]	$0	$0	$0
	Total Utility TRC Costs	$411,524	$1,758,796	$2,545,083
E	**Participant Costs**[c]	N/A	$0	$0
	Total TRC Costs	$411,524	$1,758,796	$2,545,083
	Discounted Costs (TRC)	N/A	$1,758,796	$2,414,802
F.1	**Annualized Avoided Supply Costs –Residential**[d]	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	**Lifetime Avoided Supply Costs**	N/A	$20,624,101	$27,715,489
	Total Lifetime Economic Benefits	N/A	$20,624,101	$27,715,489
	Discounted Lifetime Economic Benefits	N/A	$20,624,101	$26,187,777
	Program Benefit-to-Cost Ratio	N/A	11.73	10.84

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[b] Includes PPL Electric and the program CSP's implementation, management, and oversight of this program. Includes the CSP's cost to pick up, decommission, and recycle appliances. Includes incentives paid to participants which, per the TRC Order, are treated as a program cost because the payment is not reimbursement of a portion of the incremental cost.
[c] The participant costs reported are net incentives paid by PPL Electric. The incremental cost is equal to the sum of the incentives and the participant costs.
[d] The annualized avoided supply costs represent the average annual avoided costs for the sector in PY2.

3.2 Compact Fluorescent Lighting Campaign

The CFL Campaign has two components:

- An upstream retail lighting component provides incentives to CFL manufacturers. The upstream incentives then effectively buy down the retail price of ENERGY STAR® CFL bulbs. The majority of program-discounted CFLs are sold in retail brick-and-mortar stores, although PPL Electric also offers program-discounted CFLs through an online retail store.
- A give-away component provides customers with ENERGY STAR CFLs free-of-charge at events sponsored by PPL Electric.

The objectives of the CFL Campaign are to:

- Develop and execute strategies aimed at transforming the market for ENERGY STAR-qualified CFLs 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 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 energy efficiency and CFL use in various lighting applications.
- Promote consumer awareness and understanding of the ENERGY STAR label.
- Promote other PPL Electric EE&C programs to customers.

3.2.1 Program Logic

Logic models for upstream and give-away program components are shown in the Compact Fluorescent Lighting Campaign EM&V Plan, Figure 1.2-1 and Figure 1.2-2. The CFL Campaign theory is summarized as follows:

> By using various program delivery mechanisms, PPL Electric encourages its customers to purchase new ENERGY STAR-qualified CFLs and install them as replacements for inefficient incandescents, thereby producing energy and demand savings.

The CFL Campaign logic models highlight key program features and indicate logical linkages between activities, outputs, and outcomes. Both models' program inputs are PPL Electric's strategic direction, program management, and other support; PPL Electric's funding; and the CSP's program implementation expertise.

The logic models' elements include:

- **Program inputs:** Inputs to the program include PPL Electric staff and customers, the CFL technology, trade allies (CFL manufacturers, retailers, and community groups), incentive funding, and the CFL CSP.

- **Program activities:** Primary program activities include trade ally recruitment and coordination; bulk CFL pricing negotiations; marketing and outreach to customers; program material dissemination; and distribution of low- and no-cost CFLs to customers.
- **Program outputs:** Outputs include informed and active trade allies and community organizations; marketing materials; promotional campaigns and bulb give-away events; and program-discounted CFLs.
- **Short-term outcomes** (one year): Outcomes include promotional campaigns to educate customers about CFLs; increased CFL availability; increased customer demand for CFLs; and reduced retail prices for program-discounted CFLs. These outcomes lead to immediate energy and demand savings.
- **Intermediate outcomes** (two to three years): Outcomes include increased customer familiarity and comfort with CFLs, leading to more CFL installations and resulting in more energy and demand savings; increased program participation by a growing set of manufacturers, retailers, and other trade allies; reduced CFL manufacturing costs due to economies of scale and technological improvements; and more efficient and effective program implementation resulting from the continuous evaluation and QA/QC feedback loops.
- **Long-term outcomes** (four to seven years): Outcomes include customers thinking of CFLs as standard lighting equipment (i.e., transformation of the light bulb market) and substantial energy and demand savings, with a target of 292,100 MWh/yr and 45,630 kW planned through 2013.

3.2.2 Program Measurement and Verification Methodology

The energy and demand savings (*ex ante* reported gross savings) reported in EEMIS for the CFL Campaign included two types of adjustments:

1. First, EEMIS-reported savings, which were computed from the deemed savings equation given in the TRM, were adjusted to correct for a known error in the TRM demand savings algorithm. This resulted in the CFL Campaign's TRM adjusted *ex ante* demand savings values. Beginning in PY3, EEMIS will use the corrected kW value, adjusted for the 0.84 in-service rate (ISR).
2. Next, the realization rate was computed. For the CFL Campaign, the realization rate was based on the EM&V CSP's records review. The EM&V CSP applied the realization rate to the CFL Campaign's adjusted *ex ante* energy and demand savings to derive *ex post* verified energy and demand savings for the program.

The SWE requested that the EM&V CSP explore several parameters related to CFL savings estimation, but indicated that adjustments for these parameters need not be made to the program savings at this time. These parameters include CFL installation rates, hours-of-use (HOU), delta wattage, and NTG. The EM&V CSP assessed these parameters through customer surveys and trade ally interviews.

***Ex ante* Adjustment Methodology**

EEMIS computed energy and demand savings for the CFL Campaign using the deemed CFL savings algorithms given in the TRM. While the TRM's energy savings algorithm includes a factor for the ISR ($ISR_{CFL} = 0.84$), the demand savings algorithm does not. To accurately calculate demand savings, the

ISR_{CFL} should be included in the CFL demand savings algorithm. Thus, the *ex ante* demand savings were adjusted to incorporate the ISR_{CFL}.

***Ex ante* Adjustment Findings**
As no adjustment is needed to the CFL energy savings algorithm, the *ex ante* energy savings reported in EEMIS are equal to the *ex ante* adjusted energy savings. *Ex ante* demand savings, however, were adjusted for the ISR, as described above.

Savings Realization Rate Methodology
The EM&V CSP derived the realization rate for the CFL Campaign by reviewing program records. The CFL Campaign program CSP works directly with CFL 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 sales data on the approved program-discounted CFLs from participating retailers. The manufacturers then send their sales data to the program CSP, and the program CSP reformats these disparate data sets and uploads them to their own internal program database. Finally, the program CSP uploads the monthly (participation) sales data from its database to EEMIS. EEMIS also maintains a separate, mostly static measures table with descriptive details about discounted CFLs. Only data from the CFL Campaign CSP's database and from EEMIS are available for the EM&V CSP to review.

Due to the upstream nature of the CFL Campaign, PPL Electric and the program CSP do not know which PPL Electric customers purchased CFLs that were discounted through the program. For the CFL Campaign, EEMIS (and the program CSP's database) was therefore designed to capture information about the program-discounted CFLs themselves; no data is collected about participating CFL Campaign customers. Each record in EEMIS is a unique combination of:

- CFL SKU,
- Retailer name and store identifier where each CFL was sold, and
- Date each CFL was sold to retail customers.

Other variables captured in EEMIS for the CFL Campaign include CFL manufacturer, CFL wattage, wattage of an equivalent incandescent light bulb, and additional CFL characteristics.

Both EEMIS and the CFL CSP produce quarterly reports in standardized formats. The EM&V CSP used these standardized reports to develop a mostly automated system for conducting CFL Campaign record reviews and analyzing the associated realization rate. Using this system, the EM&V CSP completed a review of the census of PY2 CFL Campaign records from EEMIS for each quarter, rather than reviewing a sample of randomly selected records (as was described in the CFL Campaign EM&V and QA/QC Plan). The EM&V CSP then compared these to records in the program CSP's participation database, matching records by CFL SKU, retailer, store identifier, and date the CFL was sold. The EM&V CSP also compared the energy and demand savings calculated for each record in EEMIS to the energy and demand savings calculated in the program CSP's measures table.

Savings Realization Rate Findings

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) and demand (kW) savings values for 46,083 out of the total 47,130 PY2 records (i.e., values for variables matched in 99.5% of the records). Upon further investigation, the EM&V CSP found that the mismatches were due to differences in the incandescent equivalent wattages in a *text* field of one of the data sources. The EM&V CSP found that EEMIS did use the correct wattages to calculate energy and demand savings. The CFL Campaign's PY2 realization rate is therefore 100%.

Additional CFL Savings Parameters

The SWE requested that PPL Electric collect self-reported survey data on installation rates, HOU, and delta watts. These data are intended to meet SWE requirements, and are not used to adjust the TRM assumptions or *ex post* evaluated savings. To assess these parameters, the EM&V CSP fielded two customer surveys in PY2 in which survey respondents who purchased CFLs were asked about the number and location of CFLs installed in their homes and the number of CFLs in storage. Results from the PY2 customer surveys are used in this report.

Self Reported CFL Installation Rate Based on PY2 Survey Results

Seventy percent of the customers contacted for the PY2 self-report telephone surveys said that they had purchased CFLs within the past three months, and 9% said they had received CFLs for free within the past three months. These recent CFL purchasers and recipients were asked how many CFLs they had installed in their homes and how many were in storage.

The EM&V CSP calculated the installation rate as the number of CFLs installed divided by the total number installed and in storage, resulting in a survey-based installation rate of 82%. The survey was designed to produce results with 90% confidence and 10% precision, and the deemed installation rate of 84% falls within the 90% confidence interval.

Self Reported CFL HOU Based on PY2 Survey Results

PY2 survey respondents who said they had one or more CFLs installed in their home were asked how many CFLs were installed in specific rooms of their home. The EM&V CSP used respondents' survey answers, in combination with secondary research published by the Regional Technical Forum (RTF),[10] to develop an estimate of the average HOU per day per CFL for PPL Electric customers. As shown in Table 3.5, the estimated average HOU for the mix of CFL locations reported by PPL Electric respondents for PY2 was 2.56.[11] This approach provides a reasonable proxy for in-home CFL HOU in PPL Electric's service area. There are not sufficient data from other regions of the U.S. to assess whether the CFL HOU resulting from this approach (where survey respondents were asked specifically for the number of CFLs installed in each room of the house, rather than for an estimate of the total number of CFLs installed

[10] The RTF, an organization chartered by the Northwest Power and Conservation Council, researched the average lighting HOU per day by room. Refer to the Microsoft Excel® file *'EStarLighting_ExistingFY10v1_5.xls'* available online at http://www.nwcouncil.org/rtf/measures/Default.asp.

[11] This value is in the range of what the EM&V CSP has observed in other jurisdictions through lighting metering studies (observed CFL HOU between 1.9 and 3.0).

throughout the house) is statistically significantly different from the CFL HOU estimate that would result from in-home metering.

Table 3.5: CFL Estimated Hours-of-Use Analysis

Survey Question – Where are the CFLs Installed?	Bulbs per Room	Share of Total	HOU per Day	Weighted Average
Formal living room	523	15%	2.9	0.44
Formal dining room	198	6%	2.9	0.16
Family room	259	7%	2.9	0.22
Bedrooms	529	15%	1.3	0.20
Bathrooms	409	12%	1.8	0.21
Kitchen and dining area	510	15%	3.5	0.51
Laundry and utility rooms	141	4%	1.8	0.07
Entryway and hallways	187	5%	2.9	0.16
Closets	85	2%	1.3	0.03
Office/den	87	2%	2.9	0.07
Garage	159	5%	2.9	0.13
Outside locations	270	8%	3.3	0.26
Other rooms	129	4%	2.9	0.11
Total CFLs	**3,486**	**100%**	**Average HOU**	**2.56**
NOTES:				

Free-ridership, Spillover, and Net-to-Gross Ratio Methodology

Upstream energy efficiency programs, such as PPL Electric's CFL Campaign, present challenges in evaluating program net impacts for the following reasons:

- Light bulbs are generally inexpensive and are purchased on a fairly regular basis, so customers are only able to accurately recall details about buying light bulbs for a short time after the purchase takes place (e.g., how many individual light bulbs and how many packages were purchased, when the purchase occurred). This is true for CFLs as well as for incandescent bulbs, especially after customers become somewhat familiar with CFLs and no longer view them as novelty items.
- As described in Section 4.1 of the EM&V Plan, the upstream CFL Campaign is largely invisible to PPL Electric's customers. Many end-use customer participants are unaware they are taking part in the program. In fact, evaluations of upstream programs implemented elsewhere have found that the majority of customer participants are unaware of their participation status.
- The program's marketing and outreach components are expected to lead not only to sales of program-discounted CFLs, but potentially also to sales of large numbers of non-program CFLs (spillover). Non-program CFL sales can occur at participating retailers (i.e., sales of non-discounted CFLs during program promotions and CFL sales made outside of program promotional periods), as well as at nonparticipating retailers. Limiting the NTG analysis to only those few respondents who recalled purchasing a program-discounted CFL or receiving a CFL

free-of-charge from a PPL Electric–sponsored give-away event could significantly underestimate program impacts. In fact, studies conducted in Wisconsin, Massachusetts, and Vermont in 2005 and 2006 found NTG values exceeding 100% due to the influence these types of programs exerted on the overall CFL market.

With these challenges in mind, the EM&V CSP conducted a NTG analysis based on findings from customer telephone surveys conducted in PY2. The analysis incorporated all 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. Based on participant answers to a battery of free-ridership questions, the weighted mean free-ridership rate for CFLs purchased by respondents who were aware of the program was 47%, with an upper bound of 58% and a lower bound of 36%.

The EM&V CSP then observed that some of the recent PY2 CFL purchasers who were unaware of the CFL Campaign 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, free-ridership among recent program CFL purchasers who were unaware of the program was 47% (the average of those who were aware of the program). At the low end, free-ridership for recent purchasers who were unaware of the program was 36% (the same lower bound as for recent purchasers who were aware of the program).

The EM&V CSP combined free-ridership and spillover rates for recent purchasers who were and who were not aware of the program to derive an overall NTG ratio. The CFL Campaign's NTG result was then corroborated with the results from recently published upstream CFL program evaluations conducted in other areas of the country.

The CFL Campaign's free-ridership, spillover, and NTG methodologies and findings are discussed in more detail in Appendix C.

Free-ridership, Spillover, and NTG Findings

Based on the free-ridership estimates derived from the PY2 customer surveys, the CFL Campaign's NTG ratio ranges between 71% and 94%. 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 at the higher end of the 71% to 94% range. The EM&V CSP therefore estimates NTG for the CFL Campaign as 85% in PY2.

Recent evaluations have shown that other relatively new upstream lighting programs have similar NTG ratios. As shown in Table 3.6, NTG ratios for these other utilities ranged from 62% to 96%.

Table 3.6: NTG Values from Other Recent Upstream CFL Evaluations

	Program Year			
Program	2007	2008	2009	2010
Ameren Illinois Utilities				83%

Program	Program Year			
	2007	2008	2009	2010
Ameren Missouri				96%
APS	78%			
Rocky Mountain Power, Utah	82%	87%		
Rocky Mountain Power, Washington	89%	81%		
Southwestern Public Service Company			81%	
<Unnamed> Mid-Atlantic Utility				80%
<Unnamed> Southwest Utility			75%	79%
Wisconsin Focus on Energy	75%		67%	62%
Xcel Energy				
NOTES:				

Although the NTG ratio was computed for the CFL Campaign, no NTG adjustments were applied to the program's gross savings. Going forward, NTG adjustments will not be applied to the program's savings until required by the Commission and specified in the TRM.

3.2.3 Program Sampling

As described above, the EM&V CSP reviewed a census of records submitted to PPL Electric by the CFL Campaign CSP.

The EM&V CSP fielded customer telephone surveys in PY2 Q1 and PY2 Q3. The telephone survey sample frame was developed from PPL Electric's customer database. To ensure that the telephone survey would provide useful results for both participants and nonparticipants while staying within a reasonable budget, the survey was conducted using the maximum and minimum target numbers for completed interviews.

For the PY2 customer surveys, the EM&V CSP completed surveys with a total of 284 respondents (106 respondents in PY2 Q1 and 178 respondents in PY2 Q3) out of the 1.2 million total PPL Electric residential customers. The PY2 survey efforts achieved 90/5 levels of confidence/precision.

3.2.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.2.5 Program Partners and Trade Allies

PPL Electric's customer programs specialist provides general program management and oversight, monitors the program, approves invoices and program data, and resolves program issues. A third-party implementation CFL CSP, Ecos, works on both the upstream and give-away CFL Campaign components.

For the program's upstream component, the CFL CSP recruits manufacturer and retailer participants; negotiates memorandum of understanding agreements with participant manufacturers; coordinates CFL shipment and transportation logistics; coordinates CFL marketing and outreach with participating retailers; tracks program data; and provides program reports to PPL Electric. The CFL CSP uses a broad range of retailers, including chain stores (e.g., national big box and mass merchandise retailers) and smaller local and independent stores throughout PPL Electric's service territory. The CFL CSP is also responsible for establishing convenient drop-off locations for CFL recycling in PPL Electric's service territory.

For the give-away program component, the CFL CSP and PPL Electric recruit community-based organizations (CBOs), retailers, home show coordinators, and other local organizations to participate in CFL give-away events. These events are used as a forum for education and outreach to increase customer awareness of (1) CFL benefits, (2) appropriate CFL use and installation, (3) CFL safe handling and recycling, and (4) the range of EE&C programs that PPL Electric offers. The CFL CSP negotiates with CFL manufacturers to distribute CFLs at these events, and provides point-of-purchase displays and educational materials for use at the events.

The CFL CSP maintains a call center to respond to all end-use customer questions about the CFL Campaign. While the CFL CSP handles the majority of marketing for the program, the marketing CSP oversees the general branding of the program marketing materials. Retailer trade allies sell qualifying CFLs to end-use customers.

Typical delivery processes for the upstream buy-down and give-away components of the CFL Campaign are shown in Appendix C of the EM&V Plan. Trade allies include participating and nonparticipating manufacturers and retailers. Participating manufacturers and retailers were identified through the CFL CSP's monthly reports. Non-participating trade allies include manufacturers and retailers who were approached by the CFL CSP and declined to participate, or who participated for a time and then dropped out of the program. Additional non-participating trade allies were identified through secondary research.

3.2.6 Program Finances

A summary of the program finances are presented in Table 3.7.

Table 3.7: Summary of Program Finances: TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$842,611	$3,495,765	$4,625,175
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$842,611	$3,495,765	$4,625,175
B.1	Design & Development[a]	$0	$0	$0
B.2	Administration[a]	$0	$0	$0
B.3	Management[b]	$473,702	$1,503,004	$2,123,973

	Category	IQ	PYTD	CPITD
B.4	Marketing[a]	$6,472	$31,479	$145,960
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$480,174	$1,534,483	$2,269,933
C	**EDC Evaluation Costs**[a]	$0	$0	$0
D	**SWE Audit Costs**[a]	$0	$0	$0
	Total Utility TRC Costs	$1,322,785	$5,030,248	$6,895,108
E	**Participant Costs**[c]	N/A	$10,957,879	$15,771,642
	Total TRC Costs	$480,174	$12,492,362	$18,041,575
	Discounted Costs (TRC)	N/A	$12,492,362	$17,116,215
F.1	**Annualized Avoided Supply Costs –Residential**[d]	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	**Lifetime Avoided Supply Costs**	N/A	$87,010,123	$120,425,530
	Total Lifetime Economic Benefits	N/A	$87,010,123	$120,425,530
	Discounted Lifetime Economic Benefits	N/A	$87,010,123	$113,980,335
	Program Benefit-to-Cost Ratio	N/A	6.97	6.66

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[b] Includes PPL Electric and the program CSP's implementation, management, and oversight of this program.
[c] The participant costs reported are net incentives paid by PPL Electric. The incremental cost is equal to the sum of the incentives and the participant costs.
[d] The annualized avoided supply costs represent the average annual avoided cost for the sector in PY2.

3.3 Custom Incentive Program

The Custom Incentive Program includes the following features:

- Incentives for individual equipment measures or systems not covered by other PPL Electric programs.
- Incentives based on avoided or reduced kWh/yr for implemented, cost-effective measures. Incentives are limited to 50% of project costs.
- PPL Electric will reimburse customers for up to 50% of the cost for a technical study of measures eligible for Custom Incentive Program incentives, and may provide additional study cost reimbursement following the successful implementation of a cost-effective project.

The objectives of the Custom Incentive Program include:

- Providing customers with opportunities and the flexibility to reduce their energy costs and increase their energy efficiency by implementing cost-effective measures that are not included in other programs.
- Encouraging customers to install high-efficiency HVAC, compressed air, and other measures or processes.
- Promoting strategies that encourage and support market transformation for energy efficient products and services in the nonresidential sectors.
- Identifying new measures or technologies that should be added to the Efficient Equipment Incentive Program or other programs and that no longer need to be treated as custom.
- Promoting other PPL Electric EE&C programs.
- Achieving energy savings of 140,459 MWh/yr and demand savings of 27 MW of peak demand impacts with roughly 400 custom projects (anticipated to include over 1,500 measures) over the initial four year term of the program.
- Reducing the first-cost barrier and making high-efficiency equipment a more viable option for customers through incentives that serve to partially offset the difference in costs between high-efficiency equipment and standard (baseline) equipment. The incentives offered for technical assessments reduce the cost of energy audits, thus expanding their use and leading to the identification of cost-effective energy efficiency projects.

3.3.1 Program Logic

The Custom Incentive Program theory can be summarized as follows:

> By providing rebates for high-efficiency equipment not included in other PPL Electric programs, the Custom Incentive Program will increase 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, leading to additional energy and demand savings.

The program logic model is shown in Table 1.4.1 of the Custom Incentive EM&V Plan. The elements of the logic model are as follows:

- **Program inputs**: The program inputs include the targeted customers, support from PPL Electric staff and from the CSP's, rebates for technical studies and energy efficiency measures, support from the trade allies, the QA/QC CSP, the efficient equipment, applications and forms, and expertise.
- **Program activities**: The primary program activities include the management and strategic direction, the trade allies' support, marketing, rebate form submission and processing, eligibility verification and application processing, project development through trade allies, technical and cost benefit analysis, evaluation of technical reports by CSP's, installation of the equipment by the customer or by a contractor, field verification of completed projects, and the adjustment of energy savings estimates.

- **Program outputs**: Outputs include the marketing materials distributed, the marketing channels utilized, referrals to other EE&C programs, customer applications processed, projects developed, technical reports approved and qualified by CSP's, projects completed, projects field verified, and rebates processed.
- **Short-term outcomes** (one year): Outcomes include more energy efficiency assessments occurring than would have happened in the absence of the program, installations of high-efficiency equipment, repairs, and optimization or process changes that reduce electricity consumption and peak demand in higher numbers than would have occurred without the program.
- **Intermediate outcomes** (two to three years): Outcomes include participating structures using less energy than nonparticipating structures.
- **Long-term outcomes** (four to seven years): Outcomes include PPL Electric meeting a goal of reducing energy consumption by 140,460 MWh/yr and reducing peak demand by 27 MW by 2013 through this program.

3.3.2 Program Measurement and Verification Methodology

A complete discussion of the M&V methodology can be found in Chapters 3, 4, and 5 of the Custom Incentive QA/QC and EM&V Plan.

Savings Realization Rate Methodology
Each custom project was defined as being large or small. Large projects are 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, some projects with savings below this threshold were included in the large stratum. The entire population of projects in this stratum will be verified and the results will not be extrapolated to other sites through a realization rate.

A sample of small projects was selected at the close of each program quarter. Savings for this sample were verified and a realization rate was determined. The realization rate was applied to the population of the projects in the small project stratum.

Incentives were paid for 54 projects in the Custom Incentive Program in PY2. Of these projects, 42 were included in the large stratum and have been (or will be) verified. There were a total of 12 small projects in PY2, from which a sample of six were selected for verification

Verified savings for all projects in the large stratum and a sample of projects in the small stratum were determined by following site specific evaluation, measurement, and verification plans (SSEMVPs). In some cases, PPL Electric delays full or partial 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.

Savings Realization Rate Findings
A summary of each project and its specific verification process is available in Appendix D. Table 3.8 shows the total reported and verified savings for projects in the large strata.

Table 3.8: Custom Incentive Program Reported and Verified Savings for Large Projects

Period	Number of Projects	Reported kWh/yr Savings	Reported kW Savings	Projects Verified	Verified kWh/yr Savings	Verified kW Savings
PY2	42	15,261,789	2,630	36	15,683,422	1,809
CPITD	43	15,300,430	2,633	37	15,739,153	1,813
NOTES:						

Of the reported large project savings, six unverified projects account for 122,622 kWh/yr of reported savings. Those projects will be verified using billing analysis once 12 months of post-installation data is available.

There have been 12 small strata projects reported for the Custom Incentive Program in PY2. The total reported savings for those small projects is 877,538 kWh/yr and 186 kW. A sample has been selected and verification of these projects has been completed. Realization rates of 111% and 77% were found for kWh/yr and kW savings, respectively. These realization rates were applied to the unverified small projects. Using this approach, the verified savings for the small strata projects is 992,605 kWh/yr and 119 kW. Table 3.9 shows the total reported and verified savings for the Custom Incentive Program.

Table 3.9: PPL Electric Reported and Verified Savings for all Custom Incentive Program Projects

Period	Number of Projects	Reported kWh/yr Savings	Reported kW Savings	Verified Quantity	Verified kWh/yr Savings	Verified kW Savings
PYTD	54	16,139,327	2,818	42	16,676,027	1,928
CPITD	55	16,177,968	2,820	43	16,731,758	1,932
NOTES:						

Table 3.10 shows the savings and realization rates for projects in the Custom Incentive Program.

Table 3.10: Custom Incentive Program Average Savings and Realization Rates

Period	Reported kWh/yr Savings	Reported kW Savings	*Ex post* kWh/yr Savings[a]	*Ex post* kW Savings[a]	Realization Rate (kWh/yr)	Realization Rate (kW)
Paid PY2 Q1	53,359	3	150,071	37	281%	1,279%
Paid PY2 Q3	246,181	30	260,139	33	106%	109%
Paid PY2 Q3	5,377,136	1,638	5,796,242	614	108%	37%
Paid PY2 Q4	10,462,651	1,146	10,592,197	1,272	101%	111%
PYTD	16,139,327	2,818	16,798,649	1,957	104%	69%
CPITD	16,177,968	2,820	16,854,380	1,961	104%	70%
NOTES: [a] These numbers reflect verified savings only.						

Net-to-Gross Ratio Methodology
The EM&V CSP developed PY2 NTG ratios based on self-reported data from participants, but no adjustments will be applied to savings until required by the SWE. More detail regarding NTG methodology and calculations can be found in Appendix B.

Free-Ridership Methodology
The NTG ratio was determined through self-report participant surveys with a sample of participants. The survey included spillover and free-ridership questions. The free-ridership battery of survey questions were tailored to participants of the Custom Incentive Program. These questions were used to develop a free-ridership score through a scoring matrix. More details about the free-ridership analysis and the scoring matrix are included in Appendix B. No adjustments for the NTG ratio were applied to savings, as specified by the PUC. Information obtained by computing the NTG ratio will be used only to refine and improve program delivery.

Spillover Methodology
Participant spillover refers to the participant's installation of measures in addition to those incented by the program, and for which the program influenced the participant to install the additional measures.

Participant survey respondents were asked if they installed any other measures without receiving a rebate. They were also asked if their program participation influenced their decision to install the additional measures. Spillover findings are presented in the next section of this report. More details about the spillover analysis are included in Appendix B.

Net-to-Gross Ratio Findings

Free-ridership Findings
Surveys were conducted with 19 participants who completed projects in PY2. Respondents were asked about the projects they completed, *including* whether they would have installed the same measures without the Custom Incentive Program. Once the free-ridership 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 free-ridership score was 69% for this program. Since there were no spillover savings, the NTG ratio for the program was 31%.

Spillover Findings
Custom Incentive participants did not report installing any additional measures without receiving a rebate. Therefore, there is no participant spillover attributable to this program.

3.3.3 Program Sampling

As discussed above, the EM&V CSP defined each custom project as either large or small. Large projects are currently defined as having reserved (*ex ante*) savings greater than 500,000 kWh/yr, and were all included in the impact evaluation sample. A random sample of small projects was selected for savings verification at the close of each program quarter.

Incentives were paid for 54 projects in the Custom Incentive Program in PY2. Of these, 42 were placed in the large stratum and were (or will be) verified. The remaining projects were defined as small projects. There were a total of 12 small projects in PY2 from which a sample was selected (one from Q3 and 11 from Q4).

The EM&V CSP will conduct EM&V reviews of all large projects. The small projects may be divided into two strata, one populated with projects that have anticipated savings less than or equal to 500,000 kWh/year but greater than 250,000 kWh/year (stratum one), and one populated with projects that have anticipated savings equal to or less than 250,000 kWh/year (stratum two). This approach further weights the EM&V research towards the larger projects. Additional detail can be found in the Custom Incentive Program Evaluation Plan. Savings thresholds will be periodically re-evaluated based on the distribution of projects.

3.3.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The process evaluation has been updated and is filed concurrently with this report.

3.3.5 Program Partners and Trade Allies

For the Custom Incentive Program, key staff members include the PPL Electric EE&C programs director and staff, the EM&V program manager and staff, and the PPL Electric staff and CSP developing the EEMIS system (CGI). In January 2011, PPL Electric hired a new third-party implementer to act as the C&I CSP, KEMA (referred to as E-Power Solutions or EPS), who work with customers in this program. PPL Electric staff and the C&I CSP will provide the participant and nonparticipant customer information to the EM&V CSP, including name, address, telephone number, and account number.

Trade allies are entities that provide services for Custom Incentive Program participants. Trade allies include, for example, HVAC contractors installing qualifying equipment, lighting contractors installing qualifying lighting, contractors selling qualifying motors to customers, and contractors conducting various audits or otherwise assisting with the program. Trade allies can be identified through customer rebate applications and from records kept by the PPL Electric Custom Incentive Program managers, the QA/QC CSP, or the Key Account Managers (KAMs).

3.3.6 Program Finances

A summary of the project finances are presented in Table 3.11.

Table 3.11: Summary of Program Finances - TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$992,703	$1,392,314	$1,413,914
A.2	EDC Incentives to Trade Allies	$0	$0	$0

	Category	IQ	PYTD	CPITD
A	**Subtotal EDC Incentive Costs**	$992,703	$1,392,314	$1,413,914
B.1	Design & Development[a]	$0	$0	$0
B.2	Administration[a]	$0	$0	$0
B.3	Management[b]	$355,321	$454,085	$553,123
B.4	Marketing[a]	$0	$0	$0
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$355,321	$454,085	$553,123
C	**EDC Evaluation Costs**[a]	$0	$0	$0
D	**SWE Audit Costs**[a]	$0	$0	$0
	Total Utility TRC Costs	$1,348,025	$1,846,399	$1,967,037
E	**Participant Costs**[c]	N/A	$7,223,818	$7,225,989
	Total TRC Costs	$355,321	$7,677,903	$7,779,112
	Discounted Costs (TRC)	N/A	$7,677,903	$7,210,377
F.1	**Annualized Avoided Supply Costs –Residential**[d]	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	**Lifetime Avoided Supply Costs**	N/A	$13,796,003	$13,852,748
	Total Lifetime Economic Benefits	N/A	$13,796,003	$13,852,748
	Discounted Lifetime Economic Benefits	N/A	$13,796,003	$12,830,822
	Program Benefit-to-Cost Ratio	N/A	1.80	1.78

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[b] Includes PPL Electric's implementation, management, and oversight of this program.
[c] The participant costs reported are net incentives paid by PPL Electric. The incremental cost is equal to the sum of the incentives and the participant costs.
[d] The annualized avoided supply costs represent the average annual avoided cost for the sector in PY2.

3.4 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. The program 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.

3.4.1 Program Logic

The Efficient Equipment Incentive Program theory can be summarized as follows:

> By providing a rebate for high-efficiency/ENERGY STAR-rated equipment (such as HVAC measures, motors, appliances, and lighting), the program will increase market saturation and acceptance of high-efficiency equipment. Customers will learn about the energy benefits and achieve energy and demand savings by installing qualifying equipment. Increased market penetration of high-efficiency/ENERGY STAR-rated equipment will further increase sales, leading to additional energy and demand savings.

The program logic model is shown in Table 1.4.1 of the Efficient Equipment EM&V Plan.

The elements of the logic model are as follows:

- **Program inputs**: The program inputs include the targeted customers; support from PPL Electric staff, the CSP's, and trade allies; and the efficient equipment.
- **Program activities**: The primary program activities include management and strategic direction, the trade allies' support, marketing, rebate form submission, eligibility verification, education, equipment installation by the customer or by a contractor, and rebate processing and payment.
- **Program outputs**: Outputs include marketing materials distributed, customers submitting rebate forms, customers verified as eligible, measures installed, and rebates paid.
- **Short-term outcomes** (one year): Outcomes include increased program awareness, increased customer and trade ally awareness of energy efficient equipment, and increased installations of energy efficient equipment. Rebated equipment is installed, leading to immediate energy and demand savings. Program effectiveness is confirmed through EM&V and QA/QC.
- **Intermediate outcomes** (two to three years): Outcomes include a reduction in annual energy consumption and peak load, and lower electric bills for program participants.
- **Long-term outcomes** (four to seven years): Outcomes include PPL Electric meeting their goal of reducing energy consumption by 716 GWh and reducing peak demand by 127 MW by 2013.

3.4.2 Program Measurement and Verification Methodology

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 nonresidential measures was also verified through site visits.

The energy and demand *ex ante* gross savings 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.
2. 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 systems information (efficiency, tonnage, and features), installation rates, and equipment qualifications collected through surveys, site visits, and records review.

Non-Lighting Measures

***Ex ante* Adjustments Methodology**

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 code (for location adjustments), manufacturer and model information, or capacity.

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

Table 3.12 outlines the factors adjusted using EEMIS reported information in calculating TRM-adjusted *ex ante* savings.

Table 3.12: Summary of *Ex ante* Adjustments to Reported Savings

Measure	Factors
Room Air Conditioners	Location (EFLH)

Measure	Factors
Central Air Conditioning	Location (EFLH), Capacity, SEER, EER
Air Source Heat Pump	Location (EFLH), Capacity, SEER, EER
(DX) Packaged AC	Location (EFLH), Capacity, EER
Programmable Thermostats	Location (EFLH)
ENERGY STAR Refrigerators	Configuration
ENERGY STAR Clothes Washers	Water heating fuel
ENERGY STAR Light Fixtures	Fixture type
ENERGY STAR Dishwashers	Water heating fuel
ENERGY STAR Dehumidifier	Pints per day
Heat Pump Hot Water Heaters	Energy Factor
ENERGY STAR Copiers	Images Per Minute
ENERGY STAR Scanners	Images Per Minute
ENERGY STAR Printers	Images Per Minute
ENERGY STAR Ice Makers	Ice and compressor types
NOTES:	

Systematic reporting issues were also corrected in the TRM-adjusted *ex ante* savings. This only occurred with commercial reach-in refrigerators where quantities were incorrectly recorded, which is described in more detail below.

Ex ante Adjustments Findings

Appliances

As described above, TRM adjustments capture recorded information from the EEMIS extract, correct for planning assumptions, and generally correct any differences between recorded savings and TRM savings. In the case of refrigerators, savings are recorded in EEMIS as 80 kWh/yr per unit; the savings associated with an ENERGY STAR-rated refrigerator with a top-mounted freezer and no door ice. TRM-adjusted *ex ante* savings are calculated using reported manufacturer and model number and the ENERGY STAR qualification list. The EM&V CSP found that the average savings for rebated refrigerators is 87 kWh/yr.

Similarly, reported manufacturer and model number information provided configuration information that increased the overall savings for dehumidifiers. The savings for dehumidifiers varies by pints per day, and the EM&V CSP found that the typical rebated dehumidifier has savings of 281 kWh/yr compared to the reported 213 kWh/yr.

In the case of dishwashers and clothes washers, customer reported water heating fuel information resulted in a slight increase to the TRM-adjusted *ex ante* savings. The rebate applications indicate that the proportion of savings achieved by gas water heating customers is slightly lower than the proportion assumed in EEMIS.

HVAC

The primary adjustment to programmable thermostats, room air conditioners (RAC), CACs, and air source heat pumps (ASHP) was to use equivalent full load hours (EFLH) based on the location of the installed unit. Where appropriate, adjusted TRM *ex ante* savings also account for reported seasonal energy efficiency ratio (SEER), energy efficiency ratio (EER), capacity, and heating seasonal performance factor (HSPF) information. This group of measures was found to have higher TRM-adjusted *ex ante* savings compared to *ex ante* reported savings.

Because there is no TRM protocol for commercial thermostats, no savings are claimed for thermostats installed in commercial settings. Residential thermostats were adjusted to EFLH assumptions in the TRM that are specific to the city where the unit was installed.

Commercial Refrigeration

Commercial reach-in refrigerators were adjusted, as mentioned above, to correct for a data entry issue with reported quantity. When a customer in PY2 applied for more than one reach-in refrigerator rebate, the quantity was overstated. For example, one customer submitted a rebate for 80 units. EEMIS reflects 80 records, but each record has a recorded quantity of 80. Similarly, an application for 14 rebates was entered into EEMIS as 14 records, each with a quantity of 14. The adjusted *ex ante* savings reflect the corrected quantities.

Savings for ice makers differ based on ice and compressor types. The EM&V CSP used reported manufacturer and model information and the ENERGY STAR equipment list to update the reported savings. In general, the TRM-adjusted *ex ante* savings for ice makers were much higher than the reported savings.

The remainder of commercial refrigeration measures required records review, site visits, or surveys in order to calculate updated savings. For those measures, there are no TRM-adjustments to *ex ante* savings.

Office Equipment

Office equipment rebated through this program includes ENERGY STAR fax machines, copiers, computers, and monitors. The *ex ante* adjustments for these measures reflect updates to the TRM and images-per-minute specific for copiers, fax machines, and printers. Overall, these adjustments increased savings. Savings for computers and monitors decreased slightly from reported savings, while copier and fax machine savings increased after incorporating reported images-per-minute in the savings calculations.

Other

This group of measures includes LED traffic signals, faucet aerators, high-efficiency gas furnaces for Residential Thermal Storage (RTS) customers, and ENERGY STAR light fixtures. ENERGY STAR light fixture TRM-adjusted *ex ante* savings account for differing fixtures types as determined through manufacturer and model information, which resulted in a slight increase in savings. LED traffic signals also slightly increased as a result of updating the savings to reflect TRM-deemed values.

There were no TRM-adjustments for high-efficiency gas furnaces. Savings for the gas furnaces were evaluated through a billing analysis, described in the savings realization rate section.

While reported heat pump hot water heater (HPWH) savings reflect planning assumptions, TRM-adjusted *ex ante* savings were calculated using the TRM and EEMIS-reported energy factor (EF) information, resulting in a slight decrease in savings.

Table 3.13 and Table 3.14 show the TRM-adjusted *ex ante* savings for each measure category.

Table 3.13: Summary of Reported and TRM-Adjusted *Ex ante* kWh/yr Savings

Measure Category	*Ex ante* Savings (kWh/yr) (per unit)	*TRM*-adjusted *Ex ante* Savings (kWh/yr) (per unit)	*Ex ante* Savings (kWh/yr) (total)	*TRM*-adjusted *Ex ante* Savings (kWh/yr) (total)
Commercial Refrigerators	1,701	830	16,401,521	8,000,372
Faucet Aerators	61	61	216,855	216,855
Motors	196,579	196,579	5,700,785	5,700,785
Chiller Pipe Insulation	4	4	68,582	68,582
Commercial HVAC	4,558	4,558	118,505	118,505
LED Traffic Signals	365	372	929,481	948,823
ENERGY STAR Dehumidifiers	213	281	799,602	1,053,497
Room AC	59	73	284,380	351,298
ENERGY STAR Refrigerators	80	87	2,464,480	2,670,265
ENERGY STAR Dishwashers	105	108	1,905,750	1,952,708
ENERGY STAR Clothes Washers	135	146	4,298,670	4,663,976
ENERGY STAR Light Fixtures	44	52	29,128	34,544
Programmable Thermostat	754	1,377	7,251,218	13,242,774
Central Air Conditioners	301	791	890,267	2,340,201
Air Source Heat Pumps	1,649	1,738	11,007,212	11,601,405
Heat Pump Hot Water Heaters	2,312	2,151	3,588,576	3,338,403
High-efficiency Gas Furnace	10,000	10,000	980,000	980,000
ENERGY STAR Computer	151	133	340,123	300,181
ENERGY STAR Copier	112	143	20,109	25,668
ENERGY STAR Scanner	253	253	7,590	7,590
ENERGY STAR All-in-One	253	253	38,709	38,709
ENERGY STAR Water Cooler	361	0	2,166	0
ENERGY STAR Fax	14	78	294	1,638
ENERGY STAR Printer	156	156	39,312	39,312
ENERGY STAR Monitor	155	15	730,746	70,686
Programmable Thermostat (nonresidential)	754	0	853,528	0
NOTES:				

Table 3.14: Summary of Reported and TRM-Adjusted *Ex ante* kW Savings

Measure Category	*Ex ante* Savings (kW/yr) (per unit)	*TRM*-adjusted *Ex ante* Savings (kW/yr) (per unit)	*Ex ante* Savings (kW/yr) (total)	*TRM*-adjusted *Ex ante* Savings (kW/yr) (total)
Commercial Refrigerators	0.23	0.11	2,210	1,105
Faucet Aerators	0.01	0.01	43	43
Motors	29.19	29.19	846	846
Chiller Pipe Insulation	0	0	2	2
Commercial HVAC	1.65	1.65	43	43
LED Traffic Signals	0.11	0.11	279	269
ENERGY STAR Dehumidifiers	0.04	0.01	132	41
Room Air Conditioners	0.05	0.06	251	275
ENERGY STAR Refrigerators	0.01	0.01	368	383
ENERGY STAR Dishwashers	0.02	0.02	373	392
ENERGY STAR Clothes Washers	0.01	0.01	475	471
ENERGY STAR Light Fixtures	0.01	0	4	2
Programmable Thermostat	0.05	-	523	-
Central Air Conditioners	0.17	0.74	511	2,189
Air Source Heat Pumps	0.12	0.41	794	2,767
Heat Pump Hot Water Heaters	0.22	0.2	344	310
High-efficiency Gas Furnace	0.04	0.04	4	4
ENERGY STAR Computer	0.02	0.02	46	41
ENERGY STAR Copier	0.02	0.02	3	3
ENERGY STAR Scanner	0.03	0.03	1	1
ENERGY STAR All-in-One	0.03	0.03	5	5
ENERGY STAR Water Cooler	0.05	0.05	0.3	0
ENERGY STAR Fax	0	0.01	0.05	0
ENERGY STAR Printer	0.02	0.02	5	5
ENERGY STAR Monitor	0.02	0	98	9
Programmable Thermostat (nonresidential)	0.05	0	62	0
NOTES:				

Savings Realization Rate Methodology for 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 review, surveys, and site visits.

The records review involved verifying information from EEMIS using rebate application forms, customer-submitted supporting documentation, CSP recorded information, and databases from ENERGY STAR or

the Air-Conditioning, Heating, and Refrigeration Institute (AHRI). The EM&V CSP reviewed the installation addresses and quantities of each measure for all equipment. Records review also verified 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, there were instances of CACs and ASHPs categorized as heat pump water heaters (HPWHs) in EEMIS, and thermostats were found under various other HVAC equipment. The realization rate corrects for 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. This avoids interpolating TRM-adjusted *ex ante* savings, which would result in a misleading lower reported precision of the results. For those measures where no *ex ante* adjustments were made, realization rates reflect the difference between reported and verified savings.

Over the course of PY2, the EM&V CSP conducted site visits of nonresidential customers for verification purposes. These site visits, along with records review, confirmed open variables necessary for calculating savings. Telephone surveys verified the number of units installed and the addresses where the units were installed for both residential and nonresidential customers. For selected measures, information about open variables was collected through surveys.

In order 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. More detail about that billing analysis is provided below.

Table 3.15 shows a summary of elements verified or validated for each measure as part of records verification, in addition to installation and qualification rates.

Table 3.15: Summary of Verification Elements

Measure	Record Verified Elements	Survey Verified Elements	Site Visit Verified Elements
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 Lighting	ENERGY STAR qualified, fixture type, Watts	Fixture type	
ENERGY STAR Dehumidifiers	ENERGY STAR qualified, pints per day		Pints per day
ENERGY STAR Clothes Washers	ENERGY STAR qualified, hot water fuel type	Hot water fuel type	Hot water fuel type
ENERGY STAR Dishwashers	ENERGY STAR qualified, hot water fuel type	Hot water fuel type	Hot water fuel type
Programmable Thermostats	Heating fuel	End-uses controlled, heating fuel	End-uses controlled, heating fuel
ENERGY STAR Refrigerators	ENERGY STAR qualified, configuration		Configuration

Measure	Record Verified Elements	Survey Verified Elements	Site Visit Verified Elements
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)		
Commercial HVAC		Full-load and part-load efficiency, building type	
Ductless Heat Pumps	SEER, capacity (tons)	SEER, capacity (tons), indoor and outdoor unit information	SEER, capacity (tons), indoor and outdoor unit information
Faucet Aerators	GPM		GPM
NOTES:			

Realization Rate Findings for Non-lighting Measures

Ex post savings were calculated for each measure based on the findings of the records review, site visits, and telephone surveys. For verification activity sampling, measures were assigned to one of three strata for the residential and non-residential sectors: large, medium, and small. In the non-residential sector, commercial lighting defined the largest stratum, and those results are described in a subsequent section. The strata definitions for non-lighting are defined in Table 3.16.

Table 3.16: Strata Definitions

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

The findings for each measure group are described below and realization rates for each stratum are outlined in the tables below.

Appliances

Verification of appliances primarily consisted of a records review to validate the quantity, verify qualification, and determine the configuration of the appliance, in the case of refrigerators and dehumidifiers. Surveys were used to determine water heating fuel type for dishwashers and clothes

washers, while also verifying the quantity and installation rate. In general, these adjustments had a minor impact on the realized savings.

Verified savings for residential refrigerators reflect units that did not qualify for ENERGY STAR ratings, of which there were two, and records verified configuration information. Savings for three units were updated for configuration findings. For clothes washers, records review, surveys, and site visits verified the EEMIS reported fuel type. The adjustment to dishwashers was primarily due to non-qualifying units that were included in EEMIS. One dishwasher was reported in EEMIS as having gas water heat, but a phone survey determined that the customer has electric water heating. Verified savings for dehumidifiers reflect configuration findings.

HVAC

ASHP and CAC realization rates reflect the impact of verified SEER, capacity, and HSPF adjustments. Units installed in commercial settings were updated to reflect the commercial HVAC TRM methodology. Verified savings for units in commercial buildings were calculated using the commercial building type determined through records review, site visits, or surveys.

Through records review, it was determined that ductless heat pumps (DHP) had been mistakenly rebated. Of the verified ASHP, a total of eight units were DHP. Using manufacturer and model information, the EM&V CSP identified DHPs in the EEMIS data and analyzed those records using interim TRM protocols. Because calculating savings for DHPs requires collecting information regarding the location and number of indoor units and the types of heating/cooling systems replaced by the installed DHPs, verification of DHPs relied on survey and site visit data collected in PY2 Q4. This allowed for determining baseline heating and cooling systems, number of indoor and outdoor units, and the location of indoor units. Site visits were completed for three commercial locations and surveys targeted a census of residential customers who received rebates for DHP units. A total of six customers provided responses to the DHP survey questions.

For thermostats in residential settings, phone surveys were used to determine the controlled and heating fuel used by participating end-use customers. Records review was used to verify the quantity of thermostats installed.

Commercial Refrigeration

Commercial reach-in refrigerators had a low realization rate due to data entry issues. The majority of rebates issued for this measure went to customers who installed residential-sized refrigerators. The difference in reported savings for these measures are significant: the estimated savings used for reporting purposes are 1,197 kWh/yr for commercial reach-in refrigerators and 80 kWh/yr for residential refrigerators. While the administrative CSP issued the correct rebate for residential refrigerators, the higher savings value of 1,197 kWh/yr was reported instead of the appropriate 80 kWh savings value. In some cases the residential-sized units did not qualify for ENERGY STAR ratings and, in other cases, were apartment-sized. The realized savings corrected for all of these issues.

Savings for refrigeration compressor VFDs followed the interim protocols in verifying savings. Site visits and records review were used to determine compressor HP and refrigeration tonnage.

Only one customer received a rebate for chiller pipe insulation. The site visit verified the tonnage and efficiency of the chillers, and a site specific EM&V plan was developed and submitted to the SWE. The verified savings for that project are 12.4 MWh/yr compared to the reported 68.6 MWh/yr.

Records review, site visits, and surveys were used to verify quantity and open variables for display cases, evaporator fans, and anti-sweat heater controls. EEMIS reported values reflect per-project planning assumptions that pre-date TRM algorithms. In those cases, there is no direct correlation between reported and verified savings. Verified savings were calculated using the 2010 TRM and data collected through verification activities.

Motors

The verified savings for efficient motors were lower than reported in early PY2 applications due to double-counting of VFD savings. The rebate inventory form for efficient motors included savings for VFDs installed on the motor. When a customer who received a motor rebate separately applied for a VFD for the same motor, those VFD savings were captured twice. This issue has been corrected in the current inventory form.

Similarly, issues with the inventory form caused VFD energy savings to be higher than reported. While the 2010 TRM calls for using the baseline efficiency to calculate savings, correct savings are calculated using the nominal efficiency of the motor, consistent with SWE's analysis of VFDs. Verified demand savings were also lower due to a missing demand savings factor (SVG) adjustment in the reported savings calculation. This issue has been resolved in the current inventory form.

Because TRM protocol applies to motors with HP greater than or equal to 1.0, verified savings for motors under 1.0 HP are zero.

Office Equipment

The overall realization rate for office equipment is below 1.0 because equipment failed to qualify for an ENERGY STAR rating or the incorrect quantity was recorded. Records verification also validated model information such as images per minute.

Because there is no TRM protocol and assumed savings are low, no savings are claimed for water coolers. PPL Electric will no longer offer rebates for this measure.

Other

In order to estimate gross energy impacts of fuel switching for residential thermal storage customers, the EM&V CSP conducted a billing analysis for a census of participants. Through this billing analysis, weather-normalized annual consumption was estimated, controlling for weather, individual fixed-effects, and participation in other energy efficiency programs. The analysis determined that the average participating site saved 12,508 kWh annually. This analysis shows that the per-unit *ex ante* savings value of 10,000 kWh/yr was a conservative estimate of program performance.

ENERGY STAR light fixtures had lower realized savings due to differences in reported quantities.

The sole adjustment to the realization rate for HPWHs was for a record that was a DHP. Reported quantity and energy factor were all verified.

The following tables summarize TRM-adjusted *ex ante* and verified (*ex post)* savings for each defined stratum in the Efficient Equipment Incentive Program, excluding commercial lighting which is addressed below. The realization rate for each stratum is also shown. The first table addresses energy savings and is followed by a summary of demand savings.

Table 3.17: Summary of TRM-Adjusted *Ex ante* and *Ex post* kWh/yr Savings

Sector	Stratum	Measure Groups	TRM-adjusted *Ex ante* Savings (kWh/yr total)	*Ex post* Savings (kWh/yr total)	Realization Rate
Non-residential	Medium	Commercial refrigeration and motors	13,699,034	8,698,338	63%
	Small	HVAC, appliances, office equipment, other	2,078,467	1,656,218	80%
Residential	Large	HVAC (ASHP, CAC, RAC, programmable thermostats)	27,295,488	23,026,235	84%
	Medium	Appliances, HPWH	13,426,101	13,403,307	100%
	Small	RTS, commercial refrigeration, office equipment, other	1,216,002	1,510,193	124%
NOTES:					

Table 3.18: Summary of TRM-Adjusted *Ex ante* and *Ex post* kW Savings

Sector	Stratum	Measure Groups	*TRM*-adjusted *Ex ante* Savings (kW/yr total)	*Ex post* Savings (kW/yr total)	Realization Rate
Non-residential	Medium	Commercial refrigeration and motors	1,940	924	48%
	Small	HVAC, appliances, office equipment, other	503	668	133%
Residential	Large	HVAC (ASHP, CAC, RAC, programmable thermostats)	5,126	4,240	83%
	Medium	Appliances, HPWH	1,566	1,564	100%
	Small	RTS, commercial refrigeration, office equipment, other	44	133	303%
NOTES:					

Lighting Measures (non-residential)

In PY2, nonresidential lighting measures accounted for over two-thirds of the Efficient Equipment Incentive Program *ex ante* savings. Because of this large contribution to the program and portfolio savings, M&V for lighting measures was conducted independently from that for all other program measures. Following are summaries of the separate M&V methodologies used for both lighting and other measure categories.

A stratified sampling approach was used to determine the realized or *ex post* kWh/year and kW savings for lighting measures in the Efficient Equipment Incentive Program. The EM&V CSP conducted file and site reviews for the sampled projects, and collected HOU data for a subset of projects. Verified savings were developed for each sampled project, and the results were applied to the population of all completed projects to report the program *ex post* savings.

Ex ante savings adjustments were made to EEMIS to correct for systematic discrepancies between the TRM and EEMIS regarding savings values and assumptions, and to correct for known data entry errors such as double counting. Adjusted *ex ante* savings quantities show what EEMIS would have reported if it conformed to the TRM and it had not made repetitive errors.

Ex post savings are determined by the EM&V CSP; they include *ex ante* adjustments and sample-based adjustments. For the Efficient Equipment Incentive Program lighting measures, the realization rate is the ratio of EM&V CSP determined *ex post* savings to the EEMIS *ex ante* savings.

***Ex ante* Adjustment Methodology for Lighting Measures**

Two types of *ex ante* adjustments were made as part of the EM&V review; one type for Q1 records and the other for Q2 – Q4 records.

The Q1 EEMIS records had three types of systematic errors:

- Double counting of savings for application packages that included both an Appendix C inventory form and a rebate application.
- Zero savings for application packages without Appendix C inventories that had measures for which no baseline was defined in EEMIS.
- Zero savings for controls-only projects without an Appendix C inventory.

The EM&V CSP developed Q1 adjusted *ex ante* savings as follows:

- Removed the second record of each double-counted project found in EEMIS.
- Developed kWh/yr and kW savings for common retrofit fixture/lamp types and multiplied those savings by the count of rebated fixtures/lamps to populate zero savings records. Fixture/lamp savings were derived from an analysis of Q2 projects, which were required to include an Appendix C inventory. Savings were developed for six fixture/lamp types that accounted for approximately 99% of all installations. No savings were developed for seven additional fixture/lamp types due to a lack of data in Q2.
- Developed average kWh/yr and kW savings for controls-only projects and multiplied those savings by the count of rebated controls to populate zero savings records. The average savings per control was derived from an analysis of Q2 projects.

Table 3.19 summarizes the effects of the *ex ante* adjustments made in Q1.

Table 3.19: Q1 *Ex ante* Adjustments, Lighting

Unit of Savings	*Ex ante* Savings	TRM-adjusted *Ex ante*			
		Adjustment 1: Remove Double Counted Savings	Adjustment 2: Backfill Savings for Fixture Types	Adjustment 3: Backfill Savings for Controls	TRM *ex ante* Adjusted
kWh/yr	22,169,131	-9,892,584	2,418,149	1,253,211	15,947,907
kW	3,526	-1,392	432	135	2,701
NOTES:					

Out of a population of 1,886 applications in Q2, Q3, and Q4, 58 had zero *ex ante* kWh/yr savings and 20 with negative *ex ante* kWh/yr savings. The EM&V CSP assumed that these records represented systematic error(s). The 78 projects were removed before sampling and were evaluated separately from the sample. Thus the *ex ante* adjustments in Q2-Q4 consist of *removing* savings. Table 3.20 summarizes the *ex ante* adjustments.

Table 3.20: Q2 - Q4 *Ex ante* Adjusted Savings, Lighting

Ex ante (kWh/yr)	TRM-adjusted *Ex ante* (kW)
153,160,169	152,954,432
29,851	30,166
NOTES:	

Savings Realization Rate Methodology for Lighting Measures

The general approach to verify gross savings impacts for lighting measures is to draw a random sample of completed projects, determine the actual savings for each project in the sample based on as-built conditions observed during site visits, and to then multiply the ratio (the realization rate) of actual (*ex post*) to reported (*ex ante*) savings for the sample to the population of all completed projects. The result is the *ex post* savings for the program.

The sampling strategy for lighting measures is to weight the selection towards the largest contributors to savings. Specifically, 50% of the sample is drawn from the largest projects that account for 50% of program kWh/yr savings, 30% of the sample is drawn from the remaining largest projects that account for the next 30% of savings, and finally 20% of the sample is drawn from the remaining 20%. The net effect is that nearly one in three projects that account for 50% of the program *ex ante* savings was included in the PY2 review sample. Table 3.21 summarizes the stratification and sample distribution for Q2 – Q4.

Table 3.21: Sampling Summary, Q2-Q4

Stratum (percent of *ex ante* kWh/yr)	Number of Projects	Sample Size (number of projects)	Percentage of Projects Reviewed
50%	96	30	31%

Stratum (percent of *ex ante* kWh/yr)	Number of Projects	Sample Size (number of projects)	Percentage of Projects Reviewed
30%	269	18	7%
20%	1,443	12	1%
Total	1,808	60	3%
NOTES:			

The sample was designed to report savings with a 10% precision at the 90% confidence level, assuming a 0.50 coefficient of variation.

The sampling approach described above was modified for Q1 due to the need to:

- Address the double-counting and zero savings data issues that required *ex ante* adjustments.
- Comply with a SWE directive (since rescinded) to review each lighting project with savings greater than 50 kW plus a sample of smaller projects.

In Q1, the EM&V CSP conducted 37 site visits and 29 telephone verification interviews for a total of 56 project reviews out of the population of 104 completed projects.

The tasks involved in conducting an EM&V review of projects in a sample include:

- Reviewing application files for data accuracy and compliance with TRM requirements.
- Conducting on-site reviews at customer facilities of a sample of the lighting equipment contributing to the application savings in order to determine the as-built condition for the project.
- Conducting light logger studies or interval data analysis at selected facilities to determine actual lighting operating hours.
- Conducting interviews with customers to determine baseline and retrofit fixtures and to estimate operating hours.
- Based on the findings from the previous steps, revising the Appendix C inventory to re-calculate the application savings; this is the *ex post* savings for the sampled projects.

Table 3.22 summarizes the number of site visits, record reviews, and telephone surveys conducted in PY2. All projects selected for a site visit were also subject to a file review; telephone interviews were conducted primarily to develop the data needed for *ex ante* and *ex post* adjustments.

Table 3.22: Summary Counts of Site Visits, Record Reviews and Telephone Surveys

Qtr	Site Visit	Record Review	Telephone Survey
Q1	37	69	29
Q2	20	59	32
Q3	19	43	24
Q4	20	41	21

Qtr	Site Visit	Record Review	Telephone Survey
Total	100	179	74
NOTES:			

The EM&V CSP also conducted an HOU study for retrofitted fixtures installed in Q2 – Q4. The study was commissioned because site reviewers were reporting significant discrepancies between their estimates of actual hours and TRM-stipulated values for warehouse and manufacturing at light industrial facilities. Actual HOU was determined through light logger studies and/or analysis of 15 minute utility meter data obtained from PPL Electric. Projects were enrolled in the study if: 1) the site reviewer estimated that the actual HOU differed from TRM values by ± 50%, and 2) the project was in the large or medium sampling stratum. Twenty of the 60 projects in the Q2 – Q4 sample met the selection criteria. For these 20 projects, *ex post* kWh/yr savings are based on actual HOU. In all cases the actual HOU was greater than the TRM values.

The ratio of the EM&V CSP savings to the EEMIS reported savings (*ex post* to *ex ante*) is the realization rate for the sample. Program *ex post* savings are obtained by multiplying the PY2 *ex ante* savings by the realization rate as shown in Equation 3-1.

Equation 3-1

$$\frac{kWh}{yr}_{ex-post} = (Realization\ Rate) \times \left(\frac{kWh}{yr}_{ex-ante}\right)$$

***Ex post* Adjustments for Lighting Measures (non-residential)**

In parallel with the development of realization rates, the EM&V CSP conducted a separate review of the 58 zero *ex ante* savings and 20 negative *ex ante* savings projects enrolled in Q2 – Q4. The objective was to determine:

- Verified savings for projects that had received incentives but reported zero savings.
- Whether negative savings values were correct.

Reviewers conducted 33 customer telephone interviews and file reviews, and reconstructed appendix inventories for each project in the sample. The savings for the reviewed projects were normalized to incentive dollars (known with certainty from EEMIS) to create median kWh/$ and kW/$ factors for both zero and negative savings projects. The factors were multiplied by the incentive dollars for each zero and negative savings project to determine the total savings for each quarter for the population. The result was added to the *ex post* savings calculated in the sampling methodology shown in Equation 3-1.

Nearly all zero savings projects were a result of incomplete applications that did not include an Appendix C lighting inventory form. Negative savings projects were nearly all due to replacing standard T-12 lamp/ballast fixtures with high output ballasts fixtures and/or an increased number of lamps.

Table 3.23 summarizes the adjustments for zero and negative savings projects

Table 3.23: Summary Zero and Negative Savings Projects and Adjustments

	Ex ante			*Ex post*	
Report Period	Projects	kWh/yr	kW	kWh/yr	kW
Q2	51	-1,634	315.50	2,147,089	450.67
Q3	21	-186,274	-14.08	-210,602	-36.92
Q4	6	-17,828	13.40	461,370	88.89
PY2	78	-205,737	315	2,397,857	503
NOTES:					

Realization Rate Findings for Lighting Measures

PY2 *ex post* savings for lighting projects are reported in this section at the 90% confidence level and with 10% and 7% precision for kWh/yr and kW, respectively. The coefficient of variation for the PY2 kWh/yr savings is 0.55, and this value will be used in determining sample sizes in PY3.

Table 3.24 summarizes kWh/yr *ex-ante* and *ex-post* savings by quarter for PY2, while Table 3.25 summarizes the kW impacts. shows the savings by sector.

Table 3.24: PY2 Savings Summary by Quarter, kWh/yr

Period	*Ex ante* Reported (EEMIS, kWh/yr)	*Ex ante* Adjusted (kWh/yr)	*Ex post* Verified (kWh/yr)	Realization Rate
Q1	22,169,130	15,947,907	11,699,245	53%
Q2	66,116,346	66,114,712	58,291,162	88%
Q3	48,918,056	48,731,782	43,505,784	89%
Q4	38,125,766	38,107,938	44,227,760	116%
PY2	175,329,299		157,723,952	90%
NOTES:				

Table 3.25: PY2 Savings Summary by Quarter, kW

Period	*Ex ante* Reported (EEMIS, kW)	*Ex ante* Adjusted (kW)	*Ex post* Verified (kW)	Realization Rate
Q1	3,526	2,701	2,564	73%
Q2	13,046	13,362	10,838	83%
Q3	8,958	8,944	8,795	98%
Q4	7,846	7,860	6,847	87%
PY2	33,377		29,043	87%
NOTES:				

Table 3.26: PY2 Savings Summary by Sector

Sector	*Ex ante* Reported (EEMIS, kWh/yr)	% of Total	*Ex ante* Reported (EEMIS, kW)	Realization Rate (kWh/yr)	Realization Rate (kW)	*Ex post* Verified (kWh/yr)	*Ex post* Verified (kW)
Gov't/Non-Profit	32,535,521	19%	7,269	90%	87%	29,268,530	6,325
Large C&I	55,683,548	32%	7,660	90%	87%	50,092,194	6,665
Residential	407,598	0%	121	90%	87%	366,670	105
Small C&I	86,702,632	49%	18,327	90%	87%	77,996,558	15,947
Total	175,329,299	100%	33,377	90%	87%	157,723,952	29,043
NOTES:							

Net-to-Gross Ratio Methodology

Free-ridership Methodology

The NTG ratio was determined through self-report participant surveys with a sample of participants. The survey included spillover and free-ridership questions. The free-ridership 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 free-ridership score through a scoring matrix. More detail about the free-ridership analysis and the scoring matrix is included in Appendix B. No adjustments for the NTG ratio were applied to savings, as specified by the PUC. Information obtained by computing the NTG ratio will be used only to refine and improve program delivery.

Spillover Methodology

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

Participant 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. Spillover findings are presented in the next section. More detail about the spillover analysis is included in Appendix B.

Net-to-Gross Ratio Findings

Free-Ridership Findings

Table 3.27 shows the results of a free-ridership analysis of three participant groups for the Efficient Equipment Incentive Program. Residential survey responses were used for an overall program-sector estimate, while nonresidential customers were analyzed in two separate groups. The first group

comprises customers who received incentives for commercial lighting projects. The second group is all other nonresidential participants.

Table 3.27: Summary of Free-ridership Scores

Participant Group	Respondents	Free-ridership Score
Residential	224	52%
Nonresidential (lighting)	99	47%
Nonresidential (non-lighting)	42	15%
NOTES:		

Spillover Findings

Of residential survey respondents, 27% (60 of 224), and 24% of commercial sector respondents (34 of 141), stated they made energy efficiency improvements without receiving a rebate. Of these respondents, 28 of residential sector respondents and six nonresidential respondents stated that the Efficient Equipment Incentive Program was highly influential to their decision to install efficiency measures, and it was unlikely they would have installed measures had they not been influenced by the program.

Over half of residential respondents (56%) who installed additional equipment stated they relied on the efficiency rating or ENERGY STAR label to determine that the measure was energy efficient. The remaining relied on dealers or some other means to determine if the measures were energy efficient. Of the 12 nonresidential sector respondents, six relied on the efficiency rating or labeling to determine that the measure was energy efficient. The remainder relied on dealer information, rebate requirements, or third party reports.

Residential respondents who were highly influenced by the program in their decision to install additional equipment reported installing 188 CFLs, in addition to six refrigerators, four clothes washers, a heat pump hot water heater, two room air conditioners, and two heat pumps. Nonresidential customers primarily reported installing lighting, with only one customer indicating installing a heat pump.

The analysis of responses yielded an overall score of 6% for residential spillover and 4% for nonresidential spillover. The summary of NTG results is presented in Table 3.28. The residential and nonresidential (non-lighting) analyses were calculated at the 90% confidence level.

Table 3.28: Summary of NTG for Efficient Equipment Incentive Program

Participant Group	Respondents	Free-ridership Score	Participant Spillover	NTG	NTG Precision
Residential	224	52%	6%	54%	±7%
Nonresidential (non-lighting)	99	47%	4%	57%	6%
Nonresidential (lighting)	42	15%	0%	85%	7%
NOTES:					

Details of the free-ridership and spillover analyses are presented in Appendix B.

3.4.3 Program Sampling

In March 2011, the SWE team issued a sampling Guidance Memo, updating discussions held in November 2010. The EM&V CSP revised the sampling plan according to the SWE's November instructions. Subsequent conversations with the SWE team and the release of the Guidance Memo provide direction to change the sampling plans once more. The updated sampling plan will be used for the final PY2 samples. The revised plan will be submitted to the SWE, and sampling plan updates will be added to the Appendix of the program's Evaluation Plan.

Table 3.29 shows the PY2 records verification compared to the target sample. The EM&V CSP anticipated that rebate forms for multiple quantities of the same measure would require a single records review. However, in most cases, Helgeson Enterprises, PPL Electric's administrative CSP, and consequently EEMIS, tracked each rebated measure separately with no identifier to associate all rebates included on the same rebate application form. To account for this, the EM&V CSP requested all records (identified by the CSP Job Number) for customers selected in sampling (identified by their PPL Electric account number).

Table 3.29: Records Verification Sample for Efficient Equipment Incentive Program for PY2

Measure Group	Record Verification Goal	Records Verified
HVAC[a]	10	300
Motors	40	13
Appliances	10	225
Refrigeration	10	42
Office Equipment	10	80
Lighting	48	179
All Measures	128	839

NOTES:
[a] Counts are based on unique CSP Job Numbers. Some sites installed multiple systems, and therefore have more than one CSP Job Number.

3.4.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.4.5 Program Partners and Trade Allies

PPL Electric does not currently employ a customer programs specialist to oversee implementation of the Efficient Equipment Incentive Program for the residential sector. The exception is for residential appliances installed in commercial applications. Rebates for these measures continue to be processed by the administrative CSP (Helgeson).

In January 2011, PPL Electric hired a third-party implementer to act as the C&I CSP, KEMA (referred to as EPS). EPS began working with commercial customers in this program in PY2 Q4. EPS reviews C&I customer's project applications and assists as needed. EPS reviews rebates for all C&I customers except those with residential-sized appliances (clothes washers, room air conditioners, etc.), and works closely with trade allies and assisted in the re-design of rebate applications in preparation for PY3.

PPL Electric's KAMs promote the program and provide program support to PPL Electric's large C&I customers. PPL Electric's implementation staff manage, oversee, and monitor program performance; ensure program information is available on PPL Electric's ePower Website; provide trade ally outreach; and train and manage the marketing and administrative CSPs.

U Marketing serves as the marketing CSP for the residential and small C&I sectors. In this role, they develop marketing and communication plans and materials, inform trade allies about the program through direct mailings, and inform customers about the program through direct mailings and mass media. Trade allies also promote the program by explaining the program benefits to their customers and incorporating rebate values and program materials into their equipment sales approach. Trade allies also install program-eligible equipment and support customers in submitting program documentation.

Helgeson Enterprises, the administrative CSP, responds to customer questions through its call center and is also responsible for processing residential rebates for this program, entering all program data into internal tracking systems, and uploading program data to EEMIS. Helgeson has transferred responsibilities for working with nonresidential customers to EPS. The call center phone number will remain the same, but calls from nonresidential customers will be transferred to EPS.

Trade allies are entities that provide services for participants of the Efficient Equipment Incentive Program. Trade allies include HVAC and lighting contractors installing qualifying equipment and contractors selling qualifying motors to customers. Trade allies are identified through the customer applications and from records kept by the PPL Electric Efficient Equipment Incentive Program managers.

Customer rebate forms include contractor information, as appropriate for the technology. The administrative CSP records the contractor information in their database. These data are uploaded to EEMIS.

3.4.6 Program Finances

A summary of PPL Electric's project finances are presented in Table 3.30.

Table 3.30: Summary of Program Finances: TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$6,921,862	$25,938,902	$28,655,318
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$6,921,862	$25,938,902	$28,655,318
B.1	Design & Development[a]	$0	$0	$0
B.2	Administration[a]	$0	$0	$0
B.3	Management[b]	$642,224	$788,508	$839,153
B.4	Marketing[a]	$24,050	$30,111	$30,111
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$666,274	$818,618	$869,264
C	**EDC Evaluation Costs**[a]	$0	$0	$0
D	**SWE Audit Costs**[a]	$0	$0	$0
	Total Utility TRC Costs	$7,588,136	$26,757,520	$29,524,582
E	**Participant Costs**	N/A	$110,618,822	$115,850,409
	Total TRC Costs	$666,274	$111,437,440	$116,719,673
	Discounted Costs (TRC)	N/A	$111,437,440	$108,465,048
F.1	**Annualized Avoided Supply Costs –Residential**	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	**Lifetime Avoided Supply Costs**	N/A	$222,798,499	$234,244,843
	Total Lifetime Economic Benefits	N/A	$222,798,499	$234,244,843
	Discounted Lifetime Economic Benefits	N/A	$222,798,499	$217,741,251
	Program Benefit-to-Cost Ratio	N/A	2.00	2.01

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[b] Includes PPL Electric's implementation, management, and oversight of this program.

Fuel Switching Methodology

The EM&V CSP surveyed customers who indicated on rebate forms that they had replaced a gas device. The analysis of those results is presented in Appendix E.

3.5 E-Power Wise Program

The E-Power Wise Program serves PPL Electric customers with incomes at or below 150% of the federal poverty level. The program is available to customers in single family housing and in multifamily housing where 50% or more of the tenants qualify as being low-income. 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 CSP (Resource Action Program Inc., or RAP) trains CBO staff and/or others identified by the CSP 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 (participant returned 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, so they can make informed choices about their energy use.
- 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 kits, including CFLs, electroluminescent nightlights, showerheads, and faucet aerators.
- Obtain participation of no fewer than 7,200 customers through 2013 with a total reduction of 1,080 MWh/yr and 150 kW.

3.5.1 Program Logic

The E-Power Wise Program theory can be summarized as follows:

> Providing low-income customers with information about the steps they can take to reduce their power consumption will enable them to make wiser choices about their power usage. Providing customers with a sample of low-cost, energy efficiency tools increases their familiarity with those tools, promotes acceptance of energy efficient technologies, and encourages low-income customers to seek out similar technologies themselves. As a result, the program helps low-income consumers save on their utility bills, reduces the energy burden on low-income households, and lessens the utility's baseload demand.

The program logic examines key program features and describes linkages between inputs, activities, outputs, and outcomes. The program logic elements are as follows:

- **Program inputs:** Program inputs include the target customers, PPL Electric staff support, program applications and forms, and market actor support and expertise.

- **Program outputs:** Outputs include free energy savings kits produced and disseminated to customers, workshops conducted, trainers trained, and low-income consumers educated. Quality control and measurement and evaluation procedures are activated.
- **Short-term outcomes** (one year): Outcomes include training/workshops and free energy efficiency measures (kits) that educate low-income customers about energy efficiency and help them reduce their energy consumption and energy costs.
- **Intermediate outcomes** (two to three years): Outcome is a more knowledgeable low-income customer base. As this occurs, low-income customers will continue to make informed and effective decisions about their energy use. This will result in additional energy savings, customer satisfaction, environmental benefits, and PPL Electric's customer base becoming more sensitive to energy efficiency.
- **Long-term outcomes** (four to seven years): Outcomes include low-income customer participation in energy efficiency and cost savings, helping to improve their quality of life. Low-income customers will continue to seek out energy saving improvements.

The E-Power Wise Program logic model can be found in Section 1 of the E-Power Wise Evaluation Plan.

3.5.2 Program Measurement and Verification Methodology

A complete discussion of the M&V methodology can be found in Sections 3, 4, and 5 of the E-Power Wise QA/QC and EM&V Plan. As described there, two savings adjustments are necessary to calculate the E-Power Wise realization rate. The first, which adjusts the savings from the program's plan to the savings specified in the TRM, results in *ex ante* savings. The second adjustment, the savings realization rate adjustment, incorporates the results of the program's QA/QC records review and the measure installation rate and behavioral change findings from the customer telephone survey. Both methodologies, *ex ante* adjustment and savings realization rate adjustment, are explained in more detail below; results from each adjustment are reported separately.

***Ex ante* Adjustment Methodology**

This 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 are the adjusted *ex ante* savings.

***Ex ante* Adjustment Findings**

Table 3.31 shows the results of the TRM-adjusted *ex ante* calculations for the eight measures included in each kit.

Table 3.31: Reported and Adjusted *Ex ante* Savings per Technology and per Unit

Sector	Measure	Reported *Ex ante* Savings (kWh/yr)	*Adjusted Ex ante* Savings (kWh/yr)	Reported *Ex ante* Savings (kW)	Adjusted *Ex ante* Savings (kW)	Factors
Low-Income	Energy Education	181	181	0.02	0.020	Behavior-based CMP approved by the SWE. No savings included in EE&C Plan for behavioral changes.
	Faucet Aerator - Bath	45	61	0.01	0.006	Interim TRM adjusted value (1.5 gpm)[a]
	Faucet Aerator - Kitchen	45	61	0.01	0.006	Interim TRM adjusted value (1.5 gpm)[a]
	Low-flow Showerhead	47	231	0.01	0.021	Interim TRM adjusted value (2 gpm)[b]
	CFL 15W	41	40	0.002	0.002	TRM adjusted value (15W CFL)
	CFL 20W	50	49	0.002	0.002	TRM adjusted value (20W CFL)
	Electroluminescent Nightlight	20	26	0	0	Interim TRM value of 26 kWh/unit

NOTES:
[a] The kitchen and bath aerators have rated gpms (kitchen = 2.0 gpm, bath = 1.0 gpm) that differ from the gpm provided in the TRM. To maintain consistency with the TRM and reduce confusion between the aerator types, savings will be based on the rated gpm provided in the TRM (1.5 gpm).
[b] An adjustment was made to the 'GPMlow' variable of the calculation provided in the TRM for calculating low-flow showerhead energy savings. The TRM assumed a GPMlow value of 1.5, whereas the gpm of the low-flow showerhead included in the E-Power Wise Program kit was rated at 2.0. The calculation for savings attributed to this measure in the E-Power Wise Program kit used 2.0 gpm.

Savings Realization Rate Methodology

The adjustment for a savings realization rate is derived from two components: the QA/QC records review and the participant surveys. The methodologies for these components are discussed in detail below. Note that while QA/QC records reviews are conducted on a quarterly basis, participant phone surveys were conducted one time, in Q3. Participant surveys are also completed throughout the year in the form of paper surveys, which are distributed to the participants in the program kits and mailed back to the CSP.

QA/QC Records Review

The EM&V CSP derived the QA/QC final PY2 realization rate from a review of all of the program enrollment records for PY2. Participants' PPL Electric account numbers, E-Power Wise Program kit numbers, kit distribution dates, customer identification information, and other data stored in EEMIS were compared with enrollment data stored in the 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. This review was conducted on all PY2 records in order to capture duplications that may have taken place between program quarters. Once the number of kits attributable to the program was verified, the EM&V CSP multiplied the *ex ante* measure-level savings (shown in Table 3.31) by the total number of kits distributed to program participants, and then multiplied that total by the QA/QC realization rate to derive program-level QA/QC adjusted (but unverified) savings.

Participant Surveys Methodology

Because of the relatively small impact of the program in relation to the overall consumption of the participant group, savings for energy saving measure installations and behaviors were estimated using engineering calculations. Customer survey results are used to calculate *ex post* per unit savings for each of the measures contained in the kit, as well as the savings associated with behavior changes. For measure savings, installation rates were input into the calculations included in the TRM. Energy savings attributed to behavior changes are calculated using the engineering algorithms for custom measure savings calculations. These calculations are presented in the Measure Savings Calculations and Behavior Savings Calculations sections of this report.

Multiple surveys were conducted in order to gather the data necessary to complete the engineering calculations. These included:

- Participant kit surveys (written surveys): sent home with the participants as part of the kit and returned to the CSP throughout the year.
- Participant phone surveys: conducted by phone with participants who returned a participant kit survey to the CSP (respondents) and those who did not return the participant kit survey (referred to as nonrespondents). These surveys were conducted in PY2 Q3.

Participant Kit Surveys
Each kit distributed through the program includes the participant survey reviewed and approved by PPL Electric. Participants who return the survey are entered into a drawing with an opportunity to win a gift card. In addition to questions designed to gauge satisfaction with the E-Power Wise Program, surveys are used to collect the necessary data for calculating installation rates and actions taken as a result of the program, and are ultimately used to determine the measure-level realization rate of the program. Participant self-reported data collected through the surveys is used to verify measure installation; however, the participant kit surveys did not contain many of the questions needed to collect the data necessary for the behavior energy savings calculations.

Participant Phone Surveys
The phone survey was tailored to the participant kit survey in order to enable the results to be more easily aggregated and compared between the surveys. However,.the phone survey diverged from the written surveys in order to gather the specific data necessary to conduct savings calculations associated with behavioral changes. Specifically, the phone survey was used 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 (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 refrigerator/freezer was turned off before and after participation in the program.[12]
- 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.

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

Sample Sizes

All of the kit surveys returned by the participants were included in the evaluation of the program. A sample of 70 participants who completed and returned a written survey and a sample of 70 participants who did not complete and return a written survey were randomly selected, meeting a confidence level of 90% with precision of ±10% for each group. These samples were achieved by providing the survey firm with a randomized list of participants to call from each group. Table 3.32 presents the delivery method, sample size, and functions of each of the surveys used in this evaluation.

Table 3.32: Survey Data Collection for E-Power Wise

Survey	Delivery Method	Frequency	Sample Size	Process Evaluation	Impact Evaluation	
					Measure Installation Energy Savings	Behavior Change Energy Savings
Participant Kit	Included in kit	All quarters	851 (all)	Yes	Yes	No
Respondent	Phone	PY2 Q3	70	Yes	If necessary	Yes
Nonrespondent	Phone	PY2 Q3	70	Yes	If necessary	Yes
NOTES:						

Program Savings Methodology

The EM&V CSP calculated both measure savings and the impacts of changing household behaviors that produce energy savings. Engineering algorithms and deemed savings calculations were combined with data gathered through participant surveys to determine the characteristics of the average household participating in the program and average energy savings. The algorithms and variables that are used to calculate measure savings and behavioral savings are provided in Appendix G.

Measure Savings

Electric impacts associated with measures installed through the program are estimated based on partially deemed savings values included in the TRM.

[12] This is not a refrigerator turn-in or replacement activity. This activity relates only to unplugging existing refrigerators or freezers.

The engineering algorithms for each of the measures for which the program is claiming electric energy savings are provided in Appendix G. Participant survey data regarding measure installation rates and secondary data on measure characteristics are used in the algorithms to calculate verified savings for each measure.

Savings Realization Rate Findings
The savings realization rate adjustment is derived from two components, the QA/QC records review and the participant surveys. The findings for these components are discussed in detail below.

QA/QC Records Review
A total of 4,050 participants were found in EEMIS prior to the QA/QC records review. The QA/QC records review found that 110 PPL Electric residential accounts had received more than one E-Power Wise Program kit. Of those 110 records:

- Eighteen were duplicate records; the account number and kit number were repeated twice in the database. These records were adjusted to reflect nine participants.
- Three were triplicate records; the account number and kit number were repeated three times in the database. These records were adjusted to reflect one participant to meet the program requirement of one kit per household.
- Eighty-six were participants who received two kits. These records were adjusted to reflect 43 participants to meet the program requirement of one kit per household.
- Three records contained a combination of duplicate records and duplicate kits. These records were adjusted to reflect two participants.

Additionally, one PPL Electric account number found in EEMIS was not found in the enrollment data stored in the CSP's electronic database. This account number was removed from the analysis.

As a result of the QA/QC records review findings, the total number of participants in the program was reduced to 3,995. This represents a 99% QA/QC realization rate for the program.

Table 3.33 shows the QA/QC realization rates for each kit measure from the PY2 analysis. Because the QA/QC realization rate is applied at the kit level, each of the eight measures distributed in the kit have the same QA/QC realization rate. This adjustment correctly calculates the number of kits that should be claimed.

Table 3.33: QA/QC Realization Rate for PY2

Sector	Measure	Kits in EEMIS	QA/QC Realization Rate	Kits Counted for Savings
Low-Income	Energy Education	4,050	99%	3,995
	Faucet Aerator – Bath	4,050	99%	3,995
	Faucet Aerator – Kitchen	4,050	99%	3,995
	Low-flow Showerhead	4,050	99%	3,995

Sector	Measure	Kits in EEMIS	QA/QC Realization Rate	Kits Counted for Savings
	CFL 15W	4,050	99%	3,995
	CFL 20W	4,050	99%	3,995
	Electroluminescent Nightlight	4,050	99%	3,995
	Kit Total	4,050	99%	3,995
NOTES:				

Participant Surveys
In total, 851 participant kit surveys were returned by the participants and included in the evaluation of this program. In addition, phone surveys were conducted with 73 respondent and 70 nonrespondent participants.

The results of the participant kit surveys and respondent and nonrespondent phone surveys were compared to determine the degree to which the overall installation rates differed. Due to the relatively high sample of participant kit surveys, combined with the relatively small difference in reported installation rates between the survey types, it was determined that the participant kit survey installation rates would be used to estimate overall measure savings across the population of participants.

The behavior savings resulting from participation in the program was determined through analysis of the phone survey results, as planned. However, participant response of behavior in the case of savings from unplugging refrigerators and freezers was inadequate to estimate savings.

Survey findings for each of the measure and behavior changes attributable to the program are provided below.

Measure Savings
In total, 851 participant kit surveys were returned by program participants. Table 3.34 presents the resulting installation rates for each of the energy saving kit items, as determined by the surveys. Note that installation rates and ISRs are presented in terms of the number of participants who answered the question, as opposed to the total number of people surveyed.

Table 3.34: Installation Rates for Kit Measures Distributed *Through* Program

Measure Installed	Number of People who Answered Question	Installation (ISR)
Bathroom Aerator	782	86%
Kitchen Aerator	782	72%
Showerhead	829	86%
20W CFL	812	94%[a]
15W CFL	819	96%
Nightlight	832	95%

Measure Installed	Number of People who Answered Question	Installation (ISR)
NOTES: [a] 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.		

The evaluation CSP was able to determine relative per-unit savings for each of the items included in the kits using installation rates determined through the participant phone surveys and TRM algorithms. Table 3.35 shows the savings attributable to each of the measures.

Table 3.35: E-Power Wise Program Measure Savings Per Unit

Measure Installed	Per-unit Savings (kWh/yr)	Per-unit Savings (kW)
Bathroom Aerator	44	0.003
Kitchen Aerator	52	0.004
Showerhead	199	0.016
20W CFL	54	0.003
15W CFL	46	0.002
Nightlight	25	0.0
NOTES:		

Behavior Savings

As described in the methodology section, participant phone surveys were designed to capture the data necessary to complete the algorithms developed for the CMP for this program. Results between the respondent and nonrespondents were compared in order to determine whether there was a difference between the groups. However, the results were similar and survey results were combined, resulting in a total sample of 143 surveys in the final analysis. Because there are multiple variables for each of the behaviors for which the program is claiming savings, the results of the phone surveys are presented individually in Appendix G, with overall savings for the behavior changes presented along with the measure savings in Table 3.36.

Participant Survey Derived Program Savings Results

The resulting savings per unit and per behavior change were used to calculate *ex post* savings. 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 to derive program-level *ex post* savings, as shown in Table 3.36. The total program energy realization rate is also provided.

Table 3.36: PY2 Summary of Savings and Realization Rates for E-Power Wise Measures

Sector	Measure	Kits in EEMIS	QA/QC Realization Rate	Survey Verified Savings Per Unit (kWh/yr)	Survey Verified Savings Per Unit (kW)	Energy Realization Rate (%)	Demand Realization Rate (%)
Low-Income	Energy Education	4,050	99%	146[a]	0.02	81%	100%
	Faucet Aerator - Bath	4,050	99%	52	0.004	80%	68%
	Faucet Aerator – Kitchen	4,050	99%	44	0.003	68%	49%
	Low-flow Showerhead	4,050	99%	199	0.016	74%	64%
	CFL 15W	4,050	99%	40	0.002	110%	110%
	CFL 20W	4,050	99%	49	0.003	105%	105%
	Electroluminescent Nightlight	4,050	99%	25	NA	90%	NA

NOTES:
[a] 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 which applies to the program-wide TRM-adjusted *ex ante* total. Since this approach employs a single realization rate, rather than a collection of inter-dependent realization rates, standard variance calculations yield valid program-wide precision estimates. The results from this analysis are in Table 3.37.

Table 3.37: PY2 Summary of Savings and Realization Rates for E-Power Wise Kits

	Total Kits	Total *Ex ante* Reported Savings	Total TRM-adjusted *Ex ante* Savings	Total *Ex post* Savings	Realization Rate	Precision (with 85% confidence)
kWh/yr	4,050	1,737,450	2,588,846	2,112,415	82%	5.6%
kW/yr		219	226	167	74%	1.4%

NOTES:

Table 3.37 contains precision calculations that are valid at the program level and used for calculating final verified program savings. The measure-level calculations in Table 3.36 are also valid, and may be used to inform discussions which do not critically rely on precision estimates for program-wide savings. More detail was provided in section 1 of this report.

Net-to-Gross Ratio Methodology
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.

3.5.3 Program Sampling

The EM&V CSP conducted a QA/QC review of a random sample of 70 participant enrollment forms in PY2 Q1 and another 70 participant enrollment forms in PY2 Q3 (with 90% confidence and 10% precision). The EM&V CSP also conducted quarterly records reviews comparing the CSP's electronic database with EEMIS, as described in the program EM&V methodology.

To verify measure installations and behavior changes associated with the program, the EM&V CSP conducted telephone surveys with a stratified random sample of 73 participants who returned the written survey distributed with the kits and 70 participants who did not return the written survey. Additionally, the census of participant kit surveys (851 total) that were returned by participants were included in the analysis.

3.5.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.5.5 Program Partners and Trade Allies

PPL Electric's customer program specialist oversees the program implementation. The customer program specialist reviews and approves all program marketing, educational materials, kit contents, and reports; manages the program CSP; monitors program progress; and reviews all program data and reports.

PPL Electric's CSP, Resource Action Programs (RAP), manages the program operation. Their responsibilities include training CBO staff, designing and delivering the energy efficiency kits, providing marketing and outreach support, maintaining and operating the customer service call center, and collecting participation data and survey responses.

CBOs recruit customers for workshops and one-on-one training, verify customer eligibility, deliver energy efficiency training, and report to the program CSP on workshop attendance and kits delivered. Participating CBOs receive an incentive for each kit they distribute.

3.5.6 Program Finances

A summary of PPL Electric's project finances are presented in Table 3.38.

Table 3.38: Summary of Program Finances - TRC Test

	Category	IQ	PYTD	CPITD
A.1	*EDC Incentives to Participants*	$0	$0	$0
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$0	$0	$0
B.1	Design & Development[a]	$0	$0	$0
B.2	Administration[a]	$0	$0	$0
B.3	Management[b]	$44,010	$362,099	$410,401
B.4	Marketing[a]	$0	$0	$0
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$44,010	$362,099	$410,401
C	**EDC Evaluation Costs**[a]	$0	$0	$0
D	**SWE Audit Costs**[a]	$0	$0	$0
	Total Utility TRC Costs	$44,010	$362,099	$410,401
E	**Participant Costs**	N/A	$0	$0
	Total TRC Costs	$44,010	$362,099	$410,401
	Discounted Costs (TRC)	N/A	$362,099	$383,580
F.1	**Annualized Avoided Supply Costs –Residential**	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	***Lifetime* Avoided Supply Costs**	N/A	$1,298,803	$1,298,803
	Total Lifetime Economic Benefits	N/A	$1,298,803	$1,298,803
	Discounted Lifetime Economic Benefits	N/A	$1,298,803	$1,202,596
	Program Benefit-to-Cost Ratio	N/A	3.59	3.14

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[b] Includes PPL Electric's implementation, management, and oversight of this program.

3.6 Low-Income WRAP

The PPL Electric Universal Services Program (USP) Low-Income WRAP 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 WRAP to encourage customers to conserve energy.

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. The 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.

A more detailed description of the WRAP objectives and theory are provided in the program's QA/QC and EM&V Plan.

3.6.1 Program Logic

The program theory for Low-income WRAP can be summarized as follows:

> Assisting low-income households that lack the resources to invest in energy efficient equipment will reduce their household energy use, energy bills, and energy burden in order to help the household stabilize bill payment and provide a more comfortable and energy efficient home.

The program logic model highlights the key program features, as understood by the EM&V CSP, indicating logical linkages between activities, outputs, and outcomes.

The elements of the program's logic model are:

- **Program inputs**: Program inputs include the targeted low-income population; the staff members who implement various aspects of the program; energy audit and other technical equipment necessary for program implementation; computer systems; energy education materials; and applications, forms, and any other paperwork used in implementation activities.
- **Program activities**: Program activities include qualifying participants' eligibility, conducting energy audits and measuring eligibility assessments, installing energy efficient measures, energy education, and referrals to other organizations.
- **Program outputs**: Program outputs include all of the immediate results from the program activities, such as participant enrollment, income qualification of participants, audits completed, repairs completed, energy saving measures installed, and customers served. Typically, items that do not require verification or are not cost-effective to verify are included in the logic model as outputs, but are not addressed separately in the Evaluation Plan.
- **Short-term outcomes** (one year): Outcomes include establishing participant eligibility for individual measures, improving the safety and health of participant homes, increasing the energy efficiency of equipment in participant homes, and increasing participant knowledge.

- **Intermediate outcomes** (two to three years): The outcome is installation of selected cost-effective measures, thereby reducing the energy use of participant households through efficient equipment and conservation. Client energy usage stability also improves, resulting in more energy conservation and better bill paying behaviors.
- **Long-term outcomes** (four to seven years): The outcomes are the desired final program impacts, including energy savings resulting from energy efficient equipment upgrades and conservation behaviors in the participating low-income population. Customer energy usage and payment behavior stability also improves.

3.6.2 Program Measurement and Verification Methodology

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 PY1 and PY2 savings are reported using evaluated savings, deemed by job type, as reported in the *WRAP 2008 Annual Report* submitted to and approved by the PA PUC. This method is consistent with recent 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).These values will be updated with analytic methods that include a billing analysis, described in the CMP that PPL Electric submitted to the SWE, which the SWE subsequently approved.

The revised Evaluation Plan incorporates decisions from the low-income working group and extensive discussion between the EDCs, the SWE, and PPL Electric. Analytic methods for future program years are described in the Evaluation Plan and the CMP.

***Ex ante* Adjustments Methodology**
As savings are deemed by job type, no adjustments were made to the *ex ante* reported savings.

Savings Realization Rate Methodology
PY2 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 PY2, the EM&V CSP selected a random sample of records from PY2 participants. Discussed in more detail in the sampling section below, the sample was stratified by job type and to prioritize homes with the largest numbers of measures installed (highest savings). 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 summary reports. The EM&V CSP compared information within the supporting documents to values recorded in the EEMIS tracking database.

The EM&V CSP reviewed the job type and measures installed to determine that the correct job type was recorded. The CSP also identified duplicate entries, where the same customer had work completed in more than one quarter. Savings were adjusted to remove double counting.

Savings Realization Rate Findings

In the PY2 tracking data, there were 40 accounts with more than one set of records. Eight accounts had more than one set of records in a single quarter, and 32 accounts had entries in the tracking data for more than one quarter.

Accounts with multiple sets of records do not occur often (less than 1% of PY2 records) and occur for different reasons, such as:

- Delay in procurement of a seasonal measure, such as an air conditioner.
- Upgrade of a job from baseload to low-cost or full-cost.

Because Act 129 deems savings by type of job, it is important to ensure the program is getting full credit for the complete package of upgrades made to a home. Therefore, PPL Electric and the EM&V CSP determined:

- PPL Electric will keep each seasonal job open until the measure is installed so that the account is only entered into the tracking system once.
- If a job is upgraded, both entries will be recorded as Act 129 jobs in EEMIS. PPL Electric will send a report to the EM&V CSP each quarter identifying these accounts. The EM&V CSP will correct for the double counting in the realization rate adjustment and attribute the adjustment to the job upgrade.

The claimed program savings were adjusted in PY2 to remove double counting of savings and updates by job type (Table 3.39).

Table 3.39: Act 129 WRAP Program Savings and Realization Rates

Sector	PY2 *Ex ante* kWh/yr Savings	PY2 *Ex ante* kW Savings	PY2 *Ex post* kWh/yr Savings	PY2 *Ex post* kW Savings	PY2 Realization Rate – kWh/yr	PY2 Realization Rate - kW
Low-Income	5,468,854	674	5,431,724	670	99.3%	99.3%
NOTES:						

The PY2 *ex ante* and *ex post* savings are based on the following three job types and associated savings. The number of jobs listed below is based on verified job numbers:

- Baseload jobs = 1,042 kWh/yr * 2,000 jobs = 2,084,000 kWh/yr
- Low-cost jobs = 1,588 kWh/yr * 687 jobs = 1,090,956 kWh/yr
- Full-cost jobs = 1,306 kWh/yr * 1,728 jobs = 2,256,768 kWh/yr

Net-to-Gross Ratio Methodology

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

3.6.3 Program Sampling

No participant surveys were conducted for the evaluation.

For the PY2 records review, jobs were stratified by job type (i.e., baseload, low-cost, and full-cost) and sorted by the number of measures installed within each stratum. The sample points per quarter were distributed evenly across the three case type strata, with the extra sample point assigned to the full-cost stratum. For each case type, the record with the greatest number of measures was selected for verification through a desk review, and the remaining sample points were selected via a simple random sample (Table 3.40).

Table 3.40: Act 19 WRAP Desk Review Sample Points by Quarter

Stratum	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Program Year 2
Baseload	4	3	3	4	14
Low Cost	3	3	4	4	14
Full Cost	4	4	4	5	17
Total	11	10	11	13	45
NOTES:					

The final sample size of 45 exceeds the sampling specification in the SWE's Guidance Memo 003. The memo specifies 85/15 confidence and precision per program (which would require approximately 25 sample points).

3.6.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.6.5 Program Partners and Trade Allies

The PPL Electric customer relations specialist for the USP Low-Income WRAP Program oversees Act 129 WRAP activities. The Act 129 WRAP uses the same delivery and tracking system as the USP WRAP program. The WRAP customer relations specialist oversees the development of the WRAP V data tracking system that captures Act 129 WRAP data. The WRAP specialist is responsible for ensuring that WRAP data are extracted and uploaded to EEMIS.

PPL Electric funds, administers, monitors, and recruits customers to participate in WRAP. The program is delivered by CBOs and private contractors, which provide the energy audits and direct installation measures. CBOs also coordinate, under the direction of PPL Electric, the installation of larger equipment measures (weatherization, heating system equipment, appliances, etc.), as well as conduct minor repairs and health and safety measures. PPL Electric also uses contractors to conduct third-party inspections. CBOs that currently deliver the company's WRAP will continue to provide these services under Act 129.

CBOs are encouraged to combine Act 129 funding with federal, state, or other human services funding to provide a whole-house energy efficiency solution.

3.6.6 Program Finances

A summary of the project finances are presented in Table 3.41.

Table 3.41: Summary of Program Finances - TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants[a]	$0	$0	$0
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$0	$0	$0
B.1	Design & Development[b]	$0	$0	$0
B.2	Administration[b]	$0	$0	$0
B.3	Management[c]	$2,444,061	$9,437,875	$12,468,603
B.4	Marketing[b]	$0	$0	$0
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$2,444,061	$9,437,875	$12,468,603
C	**EDC Evaluation Costs**[b]	$0	$0	$0
D	**SWE Audit Costs**[b]	$0	$0	$0
	Total Utility TRC Costs	$2,444,061	$9,437,875	$12,468,603
E	**Participant Costs**[d]	N/A	$0	$0
	Total TRC Costs	$2,444,061	$9,437,875	$12,468,603
	Discounted Costs (TRC)	N/A	$9,437,875	$11,769,500
F.1	**Annualized Avoided Supply Costs –Residential**[e]	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	**Lifetime Avoided Supply Costs**	N/A	$7,548,444	$8,543,943
	Total Lifetime Economic Benefits	N/A	$7,548,444	$8;543,943
	Discounted Lifetime Economic Benefits	N/A	$7,548,444	$7,984,799
	Program Benefit-to-Cost Ratio	N/A	0.80	0.68

	Category	IQ	PYTD	CPITD

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] 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.
[b] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[c] Includes PPL Electric's implementation, management, and oversight of this program.
[d] The participant costs reported are net incentives paid by PPL Electric. The incremental cost is equal to the sum of the incentives and the participant costs.
[e] The annualized avoided supply costs represent the average annual avoided cost for the sector in PY2.

3.7 Renewable Energy Program

The Renewable Energy Program encourages PPL Electric customers to install a solar PV array or GSHP at their home or institutional building. This program offers a financial incentive in the form of a rebate that reduces upfront system costs. Customers are also encouraged to reduce their load by installing applicable energy efficiency measures prior to installing a renewable energy system.

The program is available to residential and institutional customers (government, non-profit, and schools). For each of these customer segments, the program uses a consistent delivery and administrative strategy; however, budgets, savings, and impacts are tracked and reported separately.

The objectives of the Renewable Energy Program include:

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

3.7.1 Program Logic

The Renewable Energy Program theory can be summarized as follows:

> By providing an incentive for the installation of renewable energy systems, systems will be installed that would not have been installed in the absence of the program. Customers will learn of the energy benefits and achieve energy and demand savings. Contractors/installers gain experience designing and installing this equipment, which will increase the knowledge base and further sales, leading to additional energy and demand savings.

The program logic examines key program features and describes linkages between inputs, activities, outputs, and outcomes. The program logic elements are as follows:

- **Program inputs:** Program inputs include the target customers, PPL Electric staff support, program applications and forms, and market actor support and expertise.

- **Program activities**: The primary program activities include marketing, providing educational materials about renewable technologies, providing a list of trade allies, and providing up-front rebates to customers who install renewable technologies.
- **Program outputs**: Outputs include the number and types of marketing activities conducted, the number of trade allies participating in the program, the number of program participants, the number and size of PV and GSHP systems installed, the quality of the installations, and the total amount of incentive money paid out.
- **Short-term outcomes** (one year): Outcomes include increased program awareness, increased customer interest in renewable technologies, increased customer knowledge of renewable technologies, and increased installations of renewable technologies.
- **Intermediate outcomes** (two to three years): Outcomes include a reduction in peak energy demand, a reduction in annual energy consumption, and a decrease in participant electric bills.
- **Long-term outcomes** (four to seven years): Outcomes include a smoother and easier to manage demand curve, long-term reductions in peak energy demand and annual energy consumption, and aiding in market transformation toward cleaner energy sources.

The Renewable Energy Program logic model can be found in Section 1 of the Renewable Energy Evaluation Plan.

3.7.2 Program Measurement and Verification Methodology

A complete discussion of the EM&V methodology can be found in Sections 3, 4, and 5 of the Renewable QA/QC and EM&V Plan.

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

***Ex ante* Adjustments Methodology**
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.

In some cases, a PV or GSHP system was installed in a residential application that was on a C&I rate schedule. This can happen if the account is a farm, a residential rental property, or a separately metered out-building, such as a workshop at a personal residence. In these cases, customers were coded as large or small C&I in EEMIS. The sector was corrected to government/non-profit or residential based on the measure code, and a correction was made to the TRM adjusted *ex ante* savings.

For GSHPs, energy savings vary according to the EFLH cooling and heating assumptions for each city represented in the TRM reference tables. 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.

The tonnage, average EER, and coefficient of performance (COP) of installed units also impacted the savings realization rate. The EM&V CSP verified capacities, EER values, and COP values using the AHRI database[13] for approximately 82% of the systems installed in PY2. Where the EM&V CSP was unable to verify the efficiency due to missing data about the configuration of the system, missing or incorrect model numbers, or models that could not be found in any of the databases, results were extrapolated from the sample verified. In addition to reflecting information about installed measures, the adjusted *ex ante* savings reflect changes to the TRM made between the EE&C Plan approval and the PY2 evaluation.

For PV, the energy savings recorded in EEMIS were based on the EE&C Plan, where assumptions had been made about system location, capacity, orientation, and other characteristics. In reality, energy savings vary according to the location where the system was installed, system capacity, tilt, azimuth, shading, inverter efficiency, and module derate factor. The adjusted *ex ante* savings used information from EEMIS, rebate forms, and the interconnect forms to adjust the reported savings to reflect the characteristics of actual installed systems.

The EM&V CSP verified inverter efficiencies using the California Energy Commission (CEC) list of approved inverters.[14] Module derate factors were calculated by taking a ratio of the module rating reported on the CEC list of approved modules[15] to the manufacturer module rating. Because shading data was not collected on the rebate form or interconnect form, it was assumed there was no shading in the adjusted *ex ante* savings calculations.

PVWatts version 1[16] 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.

***Ex ante* Adjustment Findings**

The EM&V CSP calculated adjusted *ex ante* savings for residential, commercial, and institutional systems, shown in Table 3.42.

[13] http://www.ahridirectory.org/ahridirectory/pages/wbahp/defaultSearch.aspx

[14] CEC List of Eligible Inverters per SB1 Guidelines: http://www.gosolarcalifornia.ca.gov/equipment/inverters.php

[15] CEC List of Eligible SB1 Guidelines Compliant Photovoltaic Modules: http://www.gosolarcalifornia.ca.gov/equipment/pv_modules.php

[16] United States National Renewable Energy Laboratory, PV Watts version 1: http://rredc.nrel.gov/solar/calculators/PVWATTS/version1/

Table 3.42: Reported and Adjusted *Ex ante* Savings per Technology and Sector for PY2

Sector	Measure	*Ex ante* Savings (kWh/yr)	*Ex ante* Adjusted Savings (kWh/yr)	*Ex ante* Savings (kW)	*Ex ante* Adjusted Savings (kW)	Factors
Residential	GSHP	4,502,257	6,022,882	331	797	Location (for EFLH), Capacity, EER, COP, TRM change
	PV	454,784	885,824	98	224	Location, Capacity, Tilt, Azimuth, Inverter efficiency, Module derate factor
	Total	4,957,041	6,908,706	429	1,021	
Commercial and Industrial[a]	GSHP	64,479	0	7	0	Sector, Location (for EFLH), Capacity, EER, COP, TRM change
	PV	24,871	0	5	0	Sector, Location, Capacity, Tilt, Azimuth, Inverter efficiency, Module derate factor
	Total	89,350	0	12	0	
Institutional	GSHP	3,780,212	1,031,287	762	653	Location (for EFLH), Capacity, EER, COP, TRM change
	PV	710,869	2,292,170	107	582	Location, Capacity, Tilt, Azimuth, Inverter efficiency, Module derate factor
	Total	4,491,081	3,323,457	869	1,235	
Total		9,537,472	10,232,163	1,310	2,256	

NOTES:
[a] Adjusted *ex ante* savings for the C&I sector were reallocated to either the residential or institutional sector, based on the measure code.

GSHP system capacity and efficiency values are not currently recorded in EEMIS and savings are based on assumptions made for the EE&C Plan. The EM&V CSP determined the capacity and efficiency values using the AHRI database and based on manufacturer and model number information in EEMIS, and used these values in the TRM savings equations.

The assumed characteristics for residential GSHP systems were 3 tons, 14.1 EER, and 3.3 COP. The average reported GSHP installed was 4.0 tons, 18.1 EER, and 4.0 COP. The assumed characteristics for nonresidential systems were 145.9 tons, 20.0 EER, and 4.0 COP, and the average reported installed was 104.2 tons, 16.1 EER, and 3.6 COP. The EFLH for heating and cooling was adjusted based on the actual installation locations. Also, the savings equations in the protocol for nonresidential systems were used to calculate the system savings, which is a revised methodology from that used in the EE&C Plan. All of these adjustments account for the differences between the EEMIS reported savings and the adjusted *ex ante* savings for GSHPs.

PV system capacity is not currently recorded in EEMIS, and *ex ante* savings are based on assumptions made for the EE&C Plan. The EM&V CSP obtained the system capacity information through PPL Electric's interconnect form data and through record reviews. The increase from the claimed *ex ante* savings to the adjusted *ex ante* savings is largely due to customers installing more capacity than anticipated. The EE&C Plan assumed that residential customers would install 3 kW systems, but the average reported capacity installed in PY2 was over twice that assumed, at 6.1 kW. The EE&C Plan assumed that nonresidential systems would be 9 kW, but the average reported capacity was 329.9 kW.

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. The records review verified data for a sample of measures, and revealed that one nonresidential PV system and two nonresidential GSHP systems were actually residential installations. The EM&V CSP adjusted for this in the *ex post* evaluated savings, and savings were assigned to the verified sector.

For a sample of measures, site visits verified that the reported equipment type and quantity were installed. During GSHP site visits, the presence of a desuperheater was recorded, and the savings for desuperheaters at residential sites were incorporated into the *ex post* evaluated savings. 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 all the 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* and evaluated *ex post* savings.

The realization rates reported for PY2 Q4 use the PY2 Q3 realization rates. In PY2 Q3, both types of adjustments were made to the *ex post* evaluated savings. Therefore, PY2 Q4 includes both adjustments within the *ex post* evaluated savings. The adjusted *ex ante* savings (aligning with the TRM) are reported separately from the claimed *ex ante* savings (those reported in EEMIS).

In PY2 Q3, it was noted that the residential TRM equations for GSHP savings were used to calculate savings for the institutional systems. Since the PY2 Q3 report, a TRM protocol was proposed for calculating savings from nonresidential GSHP systems, and the savings in this report reflect that proposed change in methodology. There were two major changes to the methodology which impacted savings:

- The default baseline system was changed from a geothermal system meeting code requirements to an ASHP meeting code requirements. This resulted in an increase in energy and demand savings.
- The water-loop or ground-loop pump energy is now taken into account, resulting in a decrease in energy and demand savings.

Savings Realization Rate Findings

Ex post (realized) savings and realization rates for residential and nonresidential systems are shown in Table 3.43.

Table 3.43: Verified Savings per Technology and Sector for PY2

Sector	Measure	*Ex ante* Adjusted Savings (kWh/yr)	Verified *Ex post* Savings (kWh/yr)	*Ex ante* Adjusted Savings (kW)	Verified *Ex post* Savings (kW)
Residential	GSHP	6,022,882	7,448,231	797	1,120
	PV	885,824	904,018	224	229
	Total	6,908,706	8,352,249	1,021	1,348

Sector	Measure	*Ex ante* Adjusted Savings (kWh/yr)	Verified *Ex post* Savings (kWh/yr)	*Ex ante* Adjusted Savings (kW)	Verified *Ex post* Savings (kW)
Commercial and Industrial[a]	GSHP	0	1,003	0	1
	PV	0	0	0	0
	Total	0	1,003	0	1
Institutional	GSHP	1,031,287	877,023	653	260
	PV	2,292,170	2,557,274	582	649
	Total	3,323,457	3,434,298	1,235	910
Total		10,232,163	11,787,550	2,256	2,259

NOTES:
[a] Adjusted *ex ante* savings for the C&I sector were reallocated to either the residential or institutional sector, based on the measure code. One project, however, was confirmed to be C&I.

For residential GSHP PY2 projects, the realization rate was 124% ± 5% for energy savings and 141% ± 3% for peak demand savings, both with 95% confidence intervals. For nonresidential GSHP PY2 projects, the realization rate was 85% ± 3% for energy savings and 40% ± 12% for peak demand savings, with 95% confidence. The residential savings increased due to incorporating the desuperheater savings. The nonresidential outcome was mainly due to the decrease in savings from ground-loop or water-loop pumps. Additionally, two customers identified as institutional from the sector code were validated as residential customers. One residential customer was validated as a small C&I customer.

For residential PV system PY2 projects, the realization rate was 102% ± 3% for both energy and peak demand savings, with 95% confidence. For nonresidential PV system PY2 projects, the realization rate was 112% ± 1% for both energy and peak demand savings, with 95% confidence. This is because the generation meter reads taken during the non-residential site visits were greater than the output predicted by PVWatts version 1, resulting in an increase in energy and demand savings.

Net-to-Gross Ratio Methodology

Free-ridership Methodology
The EM&V CSP determined the NTG ratio through self-report surveys with a sample of PY2 Q1, Q2, and Q3 participants. The free-ridership portion of survey questions were tailored to participants of the Renewable Energy Program. Responses from the survey questions were used to develop a free-ridership 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.

Spillover Methodology
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.

Net-to-Gross Ratio Findings

Free-ridership Findings
Of the 1,329 Renewable Energy Program participants in PY2, 47 PV customers and 71 GSHP customers completed the survey, for a total of 118 completed surveys. The surveys were completed in fall 2010 and spring 2011, sampling customers from PY2 Q1 through Q3. The overall free-ridership score in PY2 was 62%, and the corresponding NTG ratio was 38%.

Spillover Findings
Participant spillover was found to be 0.2%. Twenty-seven percent of the survey respondents (32 of 118) stated they made energy efficiency improvements without receiving a rebate. Eleven of the 32 reported that the program was highly influential, and that it was unlikely they would have installed measures had they not been influenced by the program.

Residential respondents reported installing eight renewable energy systems (solar PV or solar thermal), three water heaters, two clothes dryers, three clothes washers, three refrigerators or freezers, two stoves, one geothermal heat pump, one dishwasher, and one dehumidifier. Three respondents installed efficient lighting, four installed more insulation, and two installed efficient windows.

Non-residential respondents reported installing one high-efficiency motor, four VSDs, six refrigeration-related measures (such as case fans), five refrigerators, and four efficient room AC units. In addition, respondents made 11 lighting upgrades, installed four lighting controls, and installed four energy management systems (EMSs).

PY2 Q1 participants were asked if they installed additional PV capacity since receiving a rebate for their PV system. Four out of 46 respondents reported installing additional PV panels without receiving an additional rebate from PPL Electric. One respondent installed an additional 2 kW of panels, while the other three respondents installed an additional 1 kW of panels.

3.7.3 Program Sampling

Table 3.44 shows the expected and actual participation for PY2.

Table 3.44: Renewable Energy Program Expected and Actual PY2 Participation

Sector	Measure	Expected PY2 Participation	Actual PY2 Q1 – Q4 Participation
Residential	PV	260[a]	128
Non-Residential		15[a]	8
Residential	GSHP	225	1,117
Non-Residential		75	76
Total		575	1,329

Sector	Measure	Expected PY2 Participation	Actual PY2 Q1 – Q4 Participation

NOTES:
[a] In the Renewable Energy Program QA/QC and EM&V Plan, it was reported that 260 residential and 15 nonresidential systems were expected in PY1, and participation targets in PY2 were unspecified. However, there were no rebated PV systems in PY1, therefore the expected participation from PY1 is reported here as the expected PY2 participation.

The EM&V CSP conducted several activities for the Renewable Energy Program QA/QC, impact, and process evaluations. Participant surveys included questions affecting all evaluation activities. A sample of participants from PY2 were also selected for site visits. Table 3.45 shows the target and achieved sample sizes of PY2 projects for the various data verification activities. Some customers received more than one verification activity.

Table 3.45: Summary of Data Collection Activities for PV and GSHP Systems

Technology	Data Collection Activity	Target for PY2[a]	Completed in PY2[b]
PV	Site Visits	57	62
	Records Verification	56	81
	Participant Surveys	47	47
GSHP	Site Visits	57	46
	Records Verification	68	121
	Participant Surveys	68	71

NOTES:
[a] Site visits and surveys are conducted at the customer level; therefore, the target is the number of customer sites.
[b] Counts are based on unique CSP Job Numbers for the records review. Some sites installed multiple systems, and therefore have more than one CSP Job Number.

For both PV and GSHP, the sample size was calculated based on the population frame, a 50% coefficient of variance, and a target confidence and precision level of 90/10 for records review and 95/10 for site visits. The sample was stratified by technology and sector. Residential sites were chosen randomly, though projects for customers who received a larger incentive were a high priority for records review, surveys, and site visits, as it indicated they had installed a larger capacity system. Nonresidential customers were also selected based on incentive amount; the largest capacity sites were selected for records review, surveys, and site visits. Projects for nonresidential customers were also marked as higher priority sites for surveys and site visits than projects for residential customers; however, not all responded.

The sampling plan was updated in late 2010 based on the SWE sampling instructions that circulated in November 2010 (PowerPoint® from Technical Working Group meetings), and was updated again in March 2011 based on the final Sampling Guidance Memo circulated by the SWE.

3.7.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.7.5 Program Partners and Trade Allies

PPL Electric's customer programs specialist provides general program management and oversight, develops the program communications plan, initiates program marketing to trade allies, monitors the program, reviews large project and institutional applications, responds to customer interconnection questions, grants final eligibility approval for all projects, resolves program issues, and approves project installations, invoices, program data, and reports.

PPL Electric's administrative CSP, Helgeson Enterprises, also plays a vital role in the Renewable Energy Program operation. Their responsibilities include reviewing rebate reservation forms, project documentation, and project completion reports; making initial determinations on project eligibility; issuing rebate payments; and tracking and reporting program data.

Trade allies, primarily renewable energy system installers, provide technical assessments at customer sites and install the PV systems and GSHPs.

3.7.6 Program Finances

A summary of the project finances are presented in Table 3.46.

Table 3.46: Summary of Program Finances: TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$772,641	$3,783,173	$3,783,173
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$772,641	$3,783,173	$3,783,173
B.1	Design & Development[a]	$0	$0	$0
B.2	Administration[a]	$0	$0	$0
B.3	Management[b]	$15,249	$99,937	$169,179
B.4	Marketing[a]	$0	$0	$0
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$15,249	$99,937	$169,179
C	**EDC Evaluation Costs**[a]	$0	$0	$0
D	**SWE Audit Costs**[a]	$0	$0	$0
	Total Utility TRC Costs	$787,890	$3,883,110	$3,952,352

	Category	IQ	PYTD	CPITD
E	Participant Costs[c]	N/A	$53,448,699	$58,366,276
	Total TRC Costs	$15,249	$53,548,636	$58,535,456
	Discounted Costs (TRC)	N/A	$53,548,636	$54,568,890
F.1	Annualized Avoided Supply Costs –Residential[d]	N/A	$75.79	$75.79
F.2	Annualized Avoided Supply Costs – Small C&I	N/A	$61.10	$61.10
F.3	Annualized Avoided Supply Costs – Large C&I	N/A	$51.14	$51.14
G	Lifetime Avoided Supply Costs	N/A	$15,594,479	$19,279,330
	Total Lifetime Economic Benefits	N/A	$15,594,479	$19,279,330
	Discounted Lifetime Economic Benefits	N/A	$15,594,479	$18,124,184
	Program Benefit-to-Cost Ratio	N/A	0.29	0.33

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] EDC evaluation, SWE audit, and a majority of EDC implementation costs are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[b] Includes PPL Electric's implementation, management, and oversight of this program.
[c] The participant costs reported are net incentives paid by PPL Electric. The incremental cost is equal to the sum of the incentives and the participant costs.
[d] The annualized avoided supply costs represent the average annual avoided cost for the sector in PY2.

3.8 HVAC Tune-Up Program

The HVAC Tune-Up Program, which claimed savings for the first time in PY2 Q3, is offered to all commercial and small industrial customers with an existing split or packaged HVAC rooftop unit. Owners or tenants occupying an existing building are the primary recipients of program services. The program offers financial incentives to contractors to help offset the cost to diagnose and make energy saving retrofits.

The HVAC Tune-Up Program is designed to increase the operating performance of small rooftop HVAC and split system units in light commercial buildings. The efficiency opportunities include three main areas:

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

The objectives of the HVAC Tune-up Program include:

- Optimize HVAC unit performance.
- Assist commercial customers in lowering their energy bills and operating costs.

- Obtain participation of no less than 5,770 customers through 2013, with a total reduction of 22,180 MWh/yr and 11 MW.[17]

A more detailed description of the HVAC Tune-Up Program objectives and theory are provided in the program QA/QC and EM&V Plan.

3.8.1 Program Logic

The HVAC Tune-Up Program theory can be summarized as follows:

> Servicing of HVAC units will optimize unit performance, reduce energy consumption, and decrease demand through the expected life of each measure. Diagnostic tools and technicians' experience will be used to determine the applicable service measures for each unit. Long-term energy savings are expected from units that operate optimally.

The program logic model highlights the key program features, as understood by the EM&V CSP, indicating logical linkages between activities, outputs, and outcomes. Program inputs are Act 129 and the SWE Audit Plan guidelines; funding and other support from PPL Electric; and the expertise of the program implementer and subcontractors.

The logic model's elements are:

- **Program activities:** The program's primary activities include marketing and outreach, providing customer incentives to HVAC service technicians, and developing measurement, evaluation, and *quality control procedures.*
- **Program outputs:** Outputs include marketing materials produced and disseminated to customers; customers subsequently enrolling in the programs; and quality control, measurement, and evaluation procedures being activated.
- **Short-term outcomes** (one year): Outcomes include marketing materials—both online and through other media—that generate participant interest, appointment scheduling, and rebate processing requests. Successful HVAC servicing will lead to a decrease in participants' utility bills, as well as provide energy and demand savings for PPL Electric.
- **Intermediate outcomes** (two to three years): The main outcome is more knowledgeable HVAC service technicians. As this occurs, technicians will be able to better service units to deliver optimal performance. This will result in energy savings, customer satisfaction, environmental benefits, and PPL Electric's customer base becoming more sensitive to energy efficiency.
- **Long-term outcomes** (four to seven years): Outcomes include more customers being aware of the benefits of servicing their HVAC units, and seeking out and expecting energy saving improvements. In addition, more HVAC contractors will be trained to conduct diagnostic tune-ups and more will participate in the program, and the HVAC tune-ups will become standard practice, leading to increased energy savings and decreased service calls.

[17] These numbers are a combined total for all target customer segments.

3.8.2 Program Measurement and Verification Methodology

The *ex post* evaluation empirically measures the savings from diagnostic tune-ups. Fourteen HVAC contractors reported diagnostic servicing. A total of 189 economizer incentives, 141 refrigerant cycle adjustment incentives, and 17 thermostat incentives were reported in PY2. The EM&V CSP commenced field work in PY2 Q4. Implementation of the CMP for HVAC tune-ups was achieved by following the steps described below.

1. Conduct on-site inspections for a stratified, random sample of HVAC units before and after servicing. The EM&V CSP will visit sites either before or after servicing to verify data collected by the service technicians.
2. Calculate energy savings from an analysis of baseline or post-servicing site data and a review of implementers' calculation methodology.
3. Summarize results from on-site inspections and calculation review.

Sample sizes and stratifications for on-site verification are discussed in the Program Sampling section below. Five contractors were selected from the 14 participating in the program. The verifications, at a minimum, capture the key inputs used by the Field Diagnostic Services, Inc. (FDSI) Savings Estimator program. Key inputs include building information, climate zone, unit capacity, age, fan power, refrigerant properties, and thermostat settings (operating hours). To independently verify efficiency, the EM&V CSP also collected compressor model numbers where possible and recorded true power.

Sample Attrition
The program goal was to verify 20 units before and after contractors performed service. The pre-servicing verification was conducted on 20 systems during the week of May 9, 2011. Of the 20 units tested, only six units were diagnosed by contractors in PY2. Energy savings were reported to PPL Electric for only one of those six units. Of the five contractors, one (TYCO Electronics) decided not to participate in the program. Two others (Controlled Environment Technologies and CBRE - BANA Mid-Atlantic) did not service any of the randomly selected units in PY2 and serviced only one of nine units in PY3 because they were too busy to perform tune-up service. The EM&V CSP attempted to complete the minimum sampling requirement of 20 systems by verifying additional units in September 2011.

In total, 32 units were tested by the EM&V CSP:

- Thirteen units serviced in PY2.
- Units serviced in PY2 for which an incentive was not officially received.
- Units serviced in PY3.
- Thirteen units never serviced by contractors.

***Ex ante* Adjustments Methodology**
FDSI originally proposed deemed savings by measure, but changed their approach to use their Savings Estimator software that computes savings using site-specific inputs. Savings are claimed and reported by PPL Electric via information captured in the EEMIS database. A side-by-side comparison of EEMIS and FDSI records was conducted to compare reported energy savings from all measures. All records were provided in digital text documents or Microsoft Excel® files.

***Ex ante* Adjustments Findings**

No *ex ante* adjustments were made for HVAC tune-ups. A comparison of provided FDSI records to EEMIS reports revealed slightly different savings estimates because the FDSI automated reports were missing several records. According to FDSI, these records were processed manually before the automatic system was completed. The missing records were provided upon request. With these records included, there are no discrepancies between the two databases.

Savings Realization Rate Methodology

Savings were claimed in EEMIS for PY2. The following evaluation steps were completed to verify savings in PY2.

1. Review of FDSI's calculations and inputs.
2. On-site verification of baseline unit conditions and nameplate data for 20 units. Re-verification of units serviced by contractors and verification of additional units as necessary

Tune-up servicing may include multiple measures performed on a single unit, depending on the outcome of the diagnostic test results. Calculations and inputs were thoroughly reviewed for each measure. The measures include refrigerant charge adjustment, economizer optimization, and thermostat optimization. Refrigerant charge adjustments are performed to improve refrigeration cycle efficiency. Economizer adjustments aim to optimize the use of free cooling. Thermostat control improvements aim to reduce equipment run time. Interactive effects may happen when multiple measures are performed. The EM&V CSP reviewed the methods for each measure, aiming to assess the reported savings values for reasonableness by independently calculating savings.

FDSI provided several documents which contain 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,* clarifies the methods used to estimate compressor capacity and COP described in US Patent No. 6,701,725. The expected performance and measured performance values are used to develop an efficiency index (EI) and capacity index (CI). A calculation review of these indices, along with field verification, was completed to evaluate energy savings associated with refrigerant charge adjustments. These indices were independently calculated for comparison and to assess the reasonableness of savings values.

The EM&V CSP also reviewed documents provided by FDSI to assess how economizer and thermostat savings are calculated. The primary documents describing energy savings associated with economizer adjustments are *Calculation of Energy Savings for FDSI Commercial offering Details Document* and *Calculation of Energy Savings for FDSI Commercial Programs Methodology*. The required inputs were used to determine economizer and thermostat type and control strategy. FDSI's savings estimator software provides energy savings estimates given the contractors inputs. The EM&V CSP reviewed the savings calculation methodology with an engineering review of the algorithms. In addition to this review, the EM&V CSP used Honeywell's Rooftop Energy Solutions Savings Estimator Version 4.2 to evaluate energy savings estimates with the same or similar inputs. The EM&V CSP inspected HVAC systems and gathered all other pertinent information while on site, as well as recorded findings that were used to independently estimate savings.

In addition to reviewing all the digital records provided by FDSI and EEMIS, the EM&V CSP verified numerous details, measurements, and set points (described in the subsequent section). By thoroughly reviewing the savings calculation methodology and by verifying contractor inputs taken in the field, the EM&V CSP successfully verified reported savings.

Savings Realization Rate Findings
As described above, the EM&V CSP reviewed all calculations provided by FDSI and found that the methodology is sound and rigorous. Savings estimates were independently calculated using various methods, discussed in Appendix H.

Savings Estimator Software and Interactive Effects
The EM&V CSP conducted verification site visits to capture the key inputs used by the Savings Estimator program including climate zone, unit capacity, age, fan power, refrigerant charge, economizer control, and thermostat settings (operating hours). For comparison, the energy savings were estimated based on efficiency increases due to refrigerant charge adjustments and verified system operational characteristics. In addition, the reported economizer and thermostat savings were evaluated for reasonableness.

The Savings Estimator software simultaneously calculates energy use and savings for all measures performed on one system. An overview of the inputs and standard data is provided in Appendix H. The calculation methodology accounts for interactive effects when multiple measures are implemented. For example, if efficiency is improved due to refrigerant charge adjustment, but the system runs less because the economizer is repaired, savings for each measure are reduced accordingly.

Upon confirmation of energy savings estimated with the Savings Estimator software, the EM&V CSP determined a 100% realization rate for units with verified inputs identical or equivalent to those recorded by contractors. This detailed review and field verification shows that the calculations and assumptions are sound and generally conservative. Additionally, contractors appear to have taken great care when inputting all system, building, and controls information. Table 3.47 outlines the realized energy and demand savings.

Table 3.47: Realized Energy and Demand Savings

Measure Type	Reported Savings (kWh/yr)	*Ex ante* Savings (kW)	Realization Rate (kWh/yr and kW)
Refrigerant Charge Adjustment	400,549	462	100%
Economizer Adjustment	20,707	0	100%
Thermostat Adjustment[a]	46,255	-16.25	100%
Program level Savings	467,511	445.75	100%

NOTES:
[a] The reported thermostat savings are negative due to interactive effects (i.e., efficiency improvements decrease savings during peak periods when thermostat adjustments have no affect on demand).

Net-to-Gross Ratio Methodology

The EM&V CSP determined the NTG ratio through participant surveys by interviewing 10 of the 14 program contractors. The survey included participant spillover and free-ridership questions. Information obtained by computing the NTG ratio will only be used to refine and improve program delivery.

Free-ridership Methodology
For this program, the contractor receives the incentive for performing diagnostic tune-ups, so it is the contractor who may be the free-rider. That is, contractors who conduct the HVAC diagnostics and advanced tune-ups as standard practice, but who take advantage of the program incentives, would normally be classified as free-riders.

Spillover Methodology
To examine spillover attributable to the HVAC Tune-up Program, contractors were asked if the program influenced their decisions to add new energy efficient equipment or services to their customer offerings. They were also asked whether they would continue to use the Service Assistant™ diagnostic tool in absence of the program.

Net-to-Gross Ratio Findings
Surveys conducted with HVAC contractors aimed to establish their standard practices and to determine the effect of the program on their normal business practices. Based on the free-ridership and spillover estimates derived from the PY2 customer surveys, the overall HVAC Tune-up Program NTG ratio is 1.0 for energy and demand.

Table 3.48: Net to Gross Verification Rate

Measure Type	*Ex ante* Savings (kWh/yr)	Net Savings (kWh/yr)	NTG for kWh	*Ex ante* Savings (kW)	Net Savings (kW)	NTG for kW
Refrigerant Charge Adjustment	400,549	399,184	1.0	462	461	1.0
Economizer Adjustment	20,707	23,498	1.1	0	0	-
Thermostat Adjustment	46,255	46,255	1.0	-16.25	-16.25	1.0
Program-level Savings	467,511	468,937	1.0	445.75	444.75	1.0
NOTES:						

Free-ridership Findings
Each contractor was asked if they had heard of and/or used the Service Assistant diagnostic tool, or any other similar tool prior to the program. One of the 10 contractors interviewed reported using FDSI's analysis tool prior to joining PPL Electric's program. Additional follow-up questions were asked to confirm that the same measures were implemented by this contractor prior to joining the program. One other participating contractor reported using a different diagnostic tool similar to the Service Assistant™ diagnostic tool, but was unable to provide details. Furthermore, this contractor only used the tool for refrigerant analysis.

One contractor is a free-rider, and the savings reported by this contractor were deducted from the gross reported savings. Note that this contractor reported negative savings for economizer adjustments, thus slightly increasing the net energy savings. According to FDSI, when the economizer program was written,

the recommended set point was chosen based on a balance between comfort and energy savings, with a slight bias toward comfort so the contractor did not receive unnecessary complaints after the change. When negative savings were reported for numerous economizers, FDSI implemented a change (on October 25, 2010). If the economizer is already set to take advantage of energy savings, a balance with comfort is no longer recommended.

Table 3.49: Free-Ridership Findings

Measure Type	*Ex ante* Savings (kWh/yr)	Free-ridership (kWh/yr)	Net kWh/yr	*Ex ante* Savings (kW)	Free-ridership (kW)	Realization Rate
Refrigerant Charge Adjustment	400,549	1,365	399,184	462	1	461
Economizer Adjustment	20,707	(2,791)	23,498	0	-	0
Thermostat Adjustment	46,255	0	46,255	-16.25	-	-16.25
Program-level Savings	467,511	444.75	468,937	445.75	1	444.75
NOTES:						

Spillover Findings

Two of the contractors interviewed mentioned they were likely to continue use of the Service Assistant diagnostic tool in absence of the program. Of the 10 respondents, only one reported adding any new energy efficiency services attributable to the program. Additional energy savings from spillover is therefore not quantifiable. Since the program is ongoing, spillover in absence of the program is not claimed for PY2.

3.8.3 Program Sampling

Sampling procedures follow the HVAC Tune-up CMP approved by the SWE. To verify baseline conditions, the EM&V CSP asked contractors for a list of sites they planned to visit by May 31, 2011 (the end of PY2). Because building owners are the technician's customers, contractors were asked to secure owner approval for the evaluation site visits because units are usually located on a rooftop and accessed by entering the business. To ensure an unbiased sample, the EM&V CSP selected sites with multiple rooftop units and verified a random sample of units at each site. The contractors did not know which units were verified. A random sample was achieved by selecting every third unit on any given rooftop, and a maximum of four units per rooftop.

The sample was based on individual serviced units, and not projects that could include multiple units. Servicing can include multiple measures, depending on the outcome of the diagnostic test results. The unit sample size was based on the SWE's sampling guidelines, requiring sample sizes meeting 85% confidence with 15% precision. When the evaluation plan was developed, 80 units had received diagnostic test-in. Based on a population of 80 and an 85/15 confidence and precision level (with a coefficient of variation of 0.5), the sample size was 19. At the end of PY2, 291 units had received diagnostic test-in. Because of the increase in population, the sample size was adjusted to 22 units.

3.8.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.8.5 Program Partners and Trade Allies

PPL Electric contracted with a third-party, FDSI, to implement the HVAC Tune-up Program. FDSI manages and provides training for the service contractors who implement program measures, and FDSI reviews program data that is submitted electronically by service contractors. FDSI created a brochure describing the program to participating contractors and maintains a Website about the program that includes a list of participating contractors.

HVAC tune-up programs are typically designed to deliver diagnostic tune-ups. Trade allies (the service contractors) implement the measures offered through this program. The work is performed by service contractors, who use the Service Assistant diagnostic tool and associated software to identify opportunities to improve unit performance. This is an upstream program delivered by the service contractors, to whom incentives are paid.

HVAC contractors have different types of agreements with their customers. They may have a regularly-scheduled maintenance contract for a specific number of visits per year, or they may be called only for emergencies or upon equipment failure. The end-use customer rarely, if ever, requests the type of diagnostic service available through this program; the contractor provides the service as an added benefit for their customers or as a way to attract new customers.

PPL Electric's administrative CSP, Helgeson Enterprises, responds to customer questions through its call center and is also responsible for processing program rebates (as specified by FDSI). Service contractors are responsible for uploading measure data from the Service Assistant diagnostic tool to FDSI, and FDSI is responsible for sending program data to PPL Electric for uploading to EEMIS.

3.8.6 Program Finances

A summary of PPL Electric's project finances are shown in Table 3.50.

Table 3.50: Summary of Program Finances - TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants[a]	$1,200	$9,115	$9,115
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$1,200	$9,115	$9,115
B.1	Design & Development[b]	$0	$0	$0
B.2	Administration[b]	$0	$0	$0

	Category	IQ	PYTD	CPITD
B.3	Management[c]	$62,405	$597,662	$635,473
B.4	Marketing[b]	$0	$15,488	$15,488
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$62,405	$613,150	$650,961
C	**EDC Evaluation Costs**[b]	$0	$0	$0
D	**SWE Audit Costs**[b]	$0	$0	$0
	Total Utility TRC Costs	$63,605	$622,265	$660,076
E	**Participant Costs**	N/A	$9,115	$9,115
	Total TRC Costs	$62,405	$622,265	$660,076
	Discounted Costs (TRC)	N/A	$622,265	$613,981
F.1	**Annualized Avoided Supply Costs –Residential**	N/A	$75.79	$75.79
F.2	**Annualized Avoided Supply Costs – Small C&I**	N/A	$61.10	$61.10
F.3	**Annualized Avoided Supply Costs – Large C&I**	N/A	$51.14	$51.14
G	**Lifetime Avoided Supply Costs**	N/A	$171,913	$171,913
	Total Lifetime Economic Benefits	N/A	$171,913	$171,913
	Discounted Lifetime Economic Benefits	N/A	$171,913	$159,179
	Program Benefit-to-Cost Ratio (actual is low because of significant start-up costs and limited savings)	N/A	0.28	0.26

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] Incentives are paid to participating HVAC tune-up contractors, who are considered to be the participant.
[b] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[c] Includes PPL Electric's implementation, management, and oversight of this program.

3.9 Home Assessment & Weatherization Program

The Home Assessment & Weatherization Program claimed savings for the first time in PY2 Q3. The program is designed to provide PPL Electric residential customers with information on their home's energy performance and recommendations on the most effective, highest priority energy efficiency actions they can take in their homes. Eligible customers must live in single family residences and have electric heat or air conditioning. Recognizing the varying economic conditions and interest levels among PPL Electric residential customers, the program provides two tracks:

1. The customer pays $50 for a walk-through home energy survey.
2. A comprehensive energy audit is conducted that includes diagnostic testing (a blower door test to measure infiltration and a combustion efficiency test), supported by a rebate of $150 for

customers with electric air conditioning only, or $250 for customers with electric cooling and heating.

The objectives of the Home Assessment & Weatherization Program include:

- Provide customers with the opportunity to participate in a walk-though survey or comprehensive energy audit.
- Provide customers with opportunities to reduce their energy costs and increase their energy efficiency.
- Encourage customers to weatherize their homes by providing rebates for related measures.
- Install low-cost energy saving measures as part of both the survey and the audit, which may result in immediate savings.
- Promote other PPL Electric energy efficiency programs.
- Obtain participation of no less than 5,940 customers through 2013, with a total reduction of 5,960 MWh/yr and 590 kW based on planning estimates for the measures claiming savings.

3.9.1 Program Logic

The Home Assessment & Weatherization Program offers customers two levels of energy audits and opportunities to engage in weatherization activities. The theory can be summarized as follows:

> By offering customers incentives and two levels of energy audits, customers will engage in audit activities and install low-cost energy saving measures. Customers will be educated on the long-term energy and cost-saving benefits of higher-efficiency equipment. Some customers will install additional weatherization measures. Energy and demand savings are expected from the installation of low-cost and larger energy efficiency measures.

The program logic examines key program features and describes linkages between inputs, activities, outputs, and outcomes. The program logic elements are as follows:

- **Program inputs:** Program inputs include the target customers, PPL Electric staff support, the program applications and forms, market actor support and expertise, energy audits, and other technical equipment necessary for program implementation.
- **Program activities:** The primary program activities include marketing, providing educational materials, audits, installation of low-cost measures during initial audits, installation of major measures, and rebates sent to customers.
- **Program outputs:** Outputs include the marketing activities, program participants, measures installed, the quality of the installations, and the incentives.
- **Short-term outcomes** (one year): Outcomes include increased program awareness, established participant eligibility, established eligibility for individual measures, participant homes having energy saving items installed, as well as more efficient equipment and energy efficiency measures installed, and participants having increased knowledge of EE&C.
- **Intermediate outcomes** (two to three years): Outcomes include installation of cost-effective measures and reduced energy use by participating households through efficient equipment and conservation from residents.

- **Long-term outcomes** (four to seven years): Outcomes are the desired final program impacts, including cost-effective energy savings resulting from energy efficient upgrades and conservation behaviors.

3.9.2 Program Measurement and Verification Methodology

***Ex ante* Adjustments Methodology**

Savings for the low-cost, direct install measures are deemed on a per unit basis for each unit installed using savings estimates provided by the EM&V CSP. Savings are claimed and reported by PPL Electric via information captured in the EEMIS database. Adjusted *ex ante* savings reflect any updates in savings calculations made to the TRM since PPL Electric's plan was approved, including changes to algorithms in the TRM. For 20 Watt CFL mini-spirals, algorithms in the 2010 TRM were used to adjust the *ex ante* claimed savings. Because there were no algorithms for smart power strips, 1.5 GPM faucet aerators, or 3/4-inch water heater pipe insulation in the 2010 TRM, algorithms in the Interim TRM Protocols were used to adjust the *ex ante* claimed savings for these measures. There were no savings calculation algorithms for water heater temperature setbacks in either version of the TRM, so there is no *ex ante* adjustment for this measure; however, there were also no claimed savings for this measure in the PY2 Q2 through Q4 participant data.

***Ex ante* Adjustments Findings**

Table 3.51 shows the results of the *ex ante* adjustment factors and calculations for each direct install measure. 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 for PY2 Q2 through Q4, as described above.

Table 3.51. Summary of *Ex ante* Adjustments to Reported Per Unit Savings for Direct Install Measures

Measure	*Ex ante* kWh/yr	TRM-Adjusted *Ex ante* kWh/yr	*Ex ante* kW	TRM-Adjusted *Ex ante* kW
20 Watt CFL Mini Spiral	50	60	0.002	0.001
Smart Power Strip	244	184	0.003	0.013
Faucet Aerator, 1.5 GPM	45	61	0.01	0.056
Water Heater Pipe Insulation, 3/4-inch	109	124	0.01	0.011
Water Heater Temperature Setback to 120°	61	NA	0.01	NA
NOTES:				

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 review. The realization rate determined from the sample was applied to the population.

No savings for bonus rebate measures—ceiling and wall insulation, and air and duct sealing—were uploaded to EEMIS during PY2, and therefore no savings were claimed for these measures through PY2.

Because no savings are available to adjust, the EM&V CSP did not calculate a realization rate for these measures.

Savings Realization Rate Findings

The EM&V CSP calculated *ex post* savings for the program based on findings from the records review and telephone surveys.

The EM&V CSP found a total of 1,291 participants in EEMIS prior to the QA/QC records review. The QA/QC records review revealed that three PPL Electric residential accounts had more than one set of records in EEMIS. Of the three records:

- One was a duplicate record; the account number and measure information were repeated twice in the database. The data was adjusted to remove the duplicate information.
- Two participants received both a survey and an audit. The data was adjusted to remove the survey records and associated measures from the database.

As a result of the QA/QC records review, the EM&V CSP reduced the total number of participants in the program to 1,288. The QA/QC review is described in greater detail in Table 3.52.

Table 3.52: QA/QC Adjustments for Duplicate Records

Measure	Number of Measures Claimed in EEMIS	Adjusted Number of Measures
20 Watt CFL Mini Spiral	7,430	7,414
Smart Power Strip	1,321	1,318
Faucet Aerator - Kitchen, 1.5 GPM	681	681
Faucet Aerator – Bathroom, 1.5 GPM	437	436
Hot Water Pipe Insulation	1,033	1,030
Home Audit – Central AC	120	120
Home Audit – Electric Heat	269	268
Home Survey	902	900
NOTES:		

The EM&V CSP developed realization rates that include adjustments made as a result of the records review and adjustments made for customer-verified installation measure quantities and measure retention. Table 3.53 shows the resulting realization rates for each direct install measure.

Table 3.53: Realization Rates for Direct Installation Measures

Measure	*Ex ante* Adjusted Savings[a] (kWh/yr)	Energy Realization Rate (kWh/yr)	*Ex ante* Adjusted Savings[a] (kW)	Demand Realization Rate (kW)
20 Watt CFL Mini Spiral	60	93%	0.001	93%
Smart Power Strip	184	56%	0.013	56%
Faucet Aerator - Kitchen, 1.5 GPM	61	90%	0.056	90%

Faucet Aerator - Bathroom; 1.5 GPM	61	115%	0.056	115%
Pipe Insulation, 3/4-inch	124	96%	0.011	96%
Water Heater Setback	NA	NA	NA	NA
NOTES: [a] These are per-unit energy and demand savings values.				

Because the sample was drawn at the 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, because 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 totaled 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 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 inter-dependent realization rates, standard variance calculations yield valid program-wide precision estimates. The results of this analysis are presented in Table 3.54.

Table 3.54: PY2 Summary of Savings and Realization Rates for Home Assessment & Weatherization Program

	Total Surveys and Audits	Total *Ex ante* Reported Savings	Total TRM-adjusted *Ex ante* Savings	Total *Ex post* Savings	Realization Rate	Precision (with 85% confidence)
kWh/yr	1,288	856,731	883,209	708,721	80%	9.2%
kW		40	98	87	90%	10.2%
NOTES:						

Table 3.54 contains precision calculations that are valid at the program level and were used for calculating final verified program savings. The measure-level calculations are also valid, and may be used to inform discussions which do not critically rely on precision estimates for program-wide savings.

Net-to-Gross Ratio Methodology

Free-ridership 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 and install major weatherization measures in the absence of the program. Participant surveys with customers installing recommended measures will be used to assess free-ridership.

Spillover Methodology

Spillover refers to reductions in energy consumption and/or demand caused by the presence of the energy-efficiency program. These are savings beyond those achieved by participants in the program.

Participant spillover refers to the participant's installation of measures in addition to those incented by the program, where the program influenced the participant to install the additional measures.

To estimate spillover, participant surveys included questions to determine whether customers took additional energy efficiency actions as a result of program participation.

Net-to-Gross Ratio Findings

Free-ridership Findings

Because no rebates for the installation of recommended measures were uploaded into EEMIS during PY2, the EM&V CSP will field surveys in PY3 with a sample (or census) of PY3 participants. No final adjustment for net savings will be made until required by the PA PUC.

Spillover Findings

One-third of the PY2 Q2 and Q3 survey respondents (21 of 68) stated they made energy efficiency improvements without receiving a rebate, reporting the installation of approximately 60 additional energy efficient measures. Respondents rated the program as being highly influential (rating between 8 and 10 on a 10-point scale) for 12 of those measures, and three of those 12 measures had associated savings. Table 3.55 provides a list of the measures installed with associated savings.

Table 3.55. Measures Installed by Survey and Audit Participants Without Receiving a Rebate

Measure	Quantity Installed	Influence of Program Rating	Annual Spillover (kWh/yr)	Total Annual Spillover (kWh/yr)
Programmable Thermostat	1	8	333	333
Refrigerator	1	8	100	100
Clothes Washer	1	9	146	146
Total	3			579
NOTES:				

Table 3.56 presents the spillover kWh/yr savings as a percentage of total program savings for these respondents.

Table 3.56. Home Assessment & Weatherization Program Spillover Savings as a Percentage of Total Program Savings

Program	Spillover Savings (kWh/yr)	Program Savings (kWh/yr)	Spillover
Home Assessment & Weatherization	579	35,868	2%
NOTES:			

The analysis of responses yielded an overall spillover of 2%. Table 3.57 provides a summary of the NTG results. The analysis was calculated at the 90% confidence level.

Table 3.57: Summary of NTG for Home Assessment & Weatherization Program

Program	Free-ridership Score	Participant Spillover	NTG	NTG Precision
Home Assessment & Weatherization	0%	2%	102%	±7%
NOTES:				

3.9.3 Program Sampling

The EM&V CSP drew a random sample to meet specifications of the SWE revised sampling requirements in Guidance Memo 0003. The EM&V CSP conducted telephone surveys of 68 randomly selected customers who participated in PY2. The surveys assessed participant satisfaction with the program, sources of program information, and verified the measures and measure quantities recorded in EEMIS. Because 80% of the program participants in PY2 opted for the walk-through surveys, the target for completed telephone surveys from this group was 80% of the 68 total surveys, or 55 completes. The target for completed telephone surveys with participants who had the comprehensive audit was 20% of 68, or 13 completes.

As specified in the Evaluation Plan and the revised sampling plan, the EM&V CSP selected a sample of 25 records for verification through a records review. Records were stratified by audit type: walk-through survey (EEMIS measure code PEU), comprehensive audit of all electric items (PEY1), and comprehensive audit of CAC only (PEY2). The EM&V CSP selected half of the sample points from records that had walk-through surveys. The remaining six points were split evenly between the two comprehensive audit types: all-electric and CAC only.

3.9.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.9.5 Program Partners and Trade Allies

Eic | Comfort Home (EIC) is the implementation CSP for the Home Assessment & Weatherization Program. EIC's responsibilities include coordinating training for the program administrative CSP and trade allies (Building Performance Institute (BPI) trained auditors), distributing marketing materials to trade allies, developing quality control standards and verifying trade ally qualifications, and uploading customer and assessment data into the PPL Electric tracking system. EIC also conducts walk-through home surveys, including a visual inspection of the home, evaluating major electric energy-using equipment (e.g., lighting systems, space conditioning and hot water heating equipment, and appliances), and evaluating building envelope characteristics to identify areas for cost-effective electric efficiency upgrades. EIC provides customers with an energy survey report that includes recommendations for appropriate follow-up activities.

Trade allies are entities that provide services for participants of the Home Assessment & Weatherization Program. Trade allies include weatherization contractors or HVAC contractors installing qualifying equipment. PPL Electric's network of BPI trained building analysts and certified energy auditor trade allies deliver comprehensive energy audits. The EM&V CSP will identify trade allies through the customer applications and from records kept by the PPL Electric Home Assessment & Weatherization Program managers and CSPs.

PPL Electric's administrative CSP, Helgeson, responds to customer questions through its call center. Helgeson is also responsible for verifying customer eligibility, processing rebates, uploading customer and assessment report data into an internal tracking systems, and uploading data to EEMIS.

U Marketing develops marketing and communication plans and materials and informs trade allies and customers about the program through direct mailings and mass media.

PPL Electric's EM&V and QA/QC CSP conducts sample-based installation verification, reviews participant data, and verifies impacts and calculations.

3.9.6 Program Finances

A summary of PPL Electric's project finances are presented in Table 3.58.

Table 3.58: Summary of Program Finances - TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$96,221	$143,018	$143,018
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$96,221	$143,018	$143,018
B.1	Design & Development[a]	$0	$0	$0
B.2	Administration[a]	$0	$0	$0
B.3	Management[b]	$101,723	$574,266	$604,268
B.4	Marketing[a]	$0	$0	$0
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$101,723	$574,266	$604,268
C	**EDC Evaluation Costs**[a]	$0	$0	$0
D	**SWE Audit Costs**[a]	$0	$0	$0
	Total Utility TRC Costs	$197,944	$717,285	$747,287
E	**Participant Costs**	N/A	$350,519	$350,519
	Total TRC Costs	$101,723	$924,786	$954,788
	Discounted Costs (TRC)	N/A	$924,786	$886,285

	Category	IQ	PYTD	CPITD
F.1	Annualized Avoided Supply Costs –Residential	N/A	$75.79	$75.79
F.2	Annualized Avoided Supply Costs – Small C&I	N/A	$61.10	$61.10
F.3	Annualized Avoided Supply Costs – Large C&I	N/A	$51.14	$51.14
G	Lifetime Avoided Supply Costs	N/A	$561,903	$561,903
	Total Lifetime Economic Benefits	N/A	$561,903	$561,903
	Discounted Lifetime Economic Benefits	N/A	$561,903	$520,280
	Program Benefit-to-Cost Ratio	N/A	0.61	0.59

NOTES:
Definitions for terms in this table are subject to TRC Order.
[a] EDC evaluation, SWE audit, and a majority of EDC implementation costs are common and are not attributable to individual programs. Common costs are distributed to sector portfolios for cost recovery purposes. In this report, all common costs are accounted for in the portfolio.
[b] Includes PPL Electric's implementation, management, and oversight of this program.

3.10 Energy Efficiency Behavior & Education Program

The Energy Efficiency Behavior & Education Program encourages customers to implement free or low-cost measures and to adopt practices and behaviors that reduce energy consumption. PPL Electric implements the program under a contract with OPOWER.

Participants in the Behavior & Education Program receive a Home Energy Report from OPOWER. The Home Energy Reports include the following information:

- Comparisons of a customer's usage in the current year to consumption during the same months of the previous year.
- Comparison of a customer's consumption to the consumption of other, comparable customers in the same geographical area. This is known as the neighbor comparison.
- Tips about how to save energy and reduce demand during peak times. These tips include:
  - General conservation tips such as turning down the thermostat, turning off lights, shortening showers, etc.
  - Low-cost energy efficiency tips, such as replacing incandescent lights with CFLs, installing weather stripping, and using power strips.
  - Tips about ways to reduce peak loads during peak load season, and ways to shift energy use to off-peak periods.
  - Information on promotions of other PPL Electric residential programs.

No financial incentives are provided through this program.

The specific objectives of the Energy Efficiency Behavior & Education Program are to:

- Educate customers about free (no cost) or very low-cost measures and behaviors that can significantly reduce energy consumption or demand.
- Educate customers about PPL Electric's online resources and EE&C programs.
- Encourage customers to adopt more energy efficient behaviors and to install energy efficiency measures in their homes.
- Obtain participation of approximately 100,000 customers through 2013.

According to the program theory, by educating customers about their energy use and conservation strategies, customers will gain knowledge to increase their energy efficiency and achieve cost savings. In addition, customers will become more engaged with PPL Electric.

PY2 was the first year of PPL Electric's Energy Efficiency Behavior & Education Program. The program was implemented using an experimental research design with random assignment of customers to treatment and control groups.

PPL Electric customers who met the following criteria were eligible for participation in the Energy Efficiency Behavior & Education Program:

- Single family residential customer
- One electric meter
- A complete billing history from 2009
- Annual energy use above the average of 18,000 kWh

From this customer population, OPOWER randomly selected 50,000 customers for a treatment group and 50,000 customers for a control group. Treatment group customers received Home Energy Reports beginning in April 2010 on one of three delivery schedules. Control group customers did not receive Home Energy Reports and were not informed that they belonged to the control group.

OPOWER sent the last of the PY2 Home Energy Reports at the end of February 2011. Customers received them in early to mid-March 2011. Customers did not receive reports in April or May 2011.

3.10.1 Program Logic

The program theory for the Energy Efficiency Behavior & Education Program can be summarized as follows:

> By using various communication channels to make customers more aware of the importance of energy efficiency and peak energy reduction, and by giving them knowledge about how to reduce energy use and peak demand, customers will change their energy using behaviors. Energy and demand savings are expected from these behavior changes.

The program's logic model highlights its key features as understood by the EM&V CSP, indicating logical linkages between activities, outputs, and outcomes.

The logic model's elements are:

- **Program inputs:** Program inputs are PPL Electric customers; PPL Electric staff (including management, coordinators, and marketing); vendors providing Home Energy Reports; and the Home Energy Reports and energy efficiency messaging.
- **Program activities:** The program's primary activities include developing messaging, advertising campaigns, and other public awareness activities and educational materials; and education of individuals and others targeted by activities.
- **Program outputs:** Outputs verifying activities include the activities developed and the marketing materials created.
- **Short-term outcomes** (one year): Outcomes result from designated customers participating in the program, including increased public awareness of the importance of energy efficiency and knowledge of ways to address it.
- **Intermediate outcomes** (two to three years): Outcomes consist of customers being influenced by program efforts to change their energy use behavior and associated energy reduction from behavioral changes and no- or low-cost measures.
- **Long-term outcomes** (four to seven years): Outcomes include the reduction of energy use and demand from the installation of no- and low-cost measures.

The Energy Efficiency Behavior & Education Program logic model can be found in Section 1 of the program Evaluation Plan.

3.10.2 Program Measurement and Verification Methodology

This EM&V methodology is based on Option C-Whole Facility of the IPMVP for annual energy savings[18] (Billing Regression Analysis as per Section 3.3.3.3.6.2.3 of the SWE Audit Plan). Billing analysis—using data on energy use in participating and nonparticipating homes before and after the treatment—was used to estimate savings attributable to the program.

OPOWER provided the EM&V CSP with monthly billing histories of treatment and control group customers and selected customer information. The monthly billing histories began in January 2009 and ended in May 2011. Because some customer accounts became inactive, not all treatment and control group customers had 16 months of pre-period and 12 months of post-period consumption data.

OPOWER also provided information about the first report date for treatment group customers and the date that control group customers would have received a report if they were in the treatment group. This "pseudo-first report date" was used to define the post-period for control group customers. OPOWER also provided information about the reports schedule for each treatment group customer.

The EM&V CSP employed a non-parametric, difference-in-differences regression model of monthly energy consumption with customer home fixed effects to estimate the energy savings program

[18] 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. www.evo-world.org.

impacts.[19] Identification of the program savings impact was derived from the random assignment of eligible customers to treatment and control groups and on measurements of consumption before and after the treatment. Any difference between the treatment and control group customers in the reduction in consumption between the pre- and post-periods will be attributable to the program. The large size of the treatment and control groups means that even small treatment effects (< 1%) can be detected.

***Ex ante* Adjustments Methodology**

Calculation of the *ex ante* savings estimates was the responsibility of the program's third-party implementer. Total *ex ante* savings in PY2 were 12,699 MWh/yr. These savings were calculated based on data from OPOWER programs in other utility service territories with verified estimates of program impacts. The program's third-party implementer reported *ex ante* savings, along with any references and assumptions used in their calculation, to the SWE prior to program implementation.

***Ex ante* Adjustment Findings**

There are no TRM adjusted *ex ante* savings.

Savings Realization Rate Methodology

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

Savings Realization Rate Findings

Table 3.59 outlines estimates of program impacts from several specifications of Equation J1 in Appendix J of this report. 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.[20] As would be expected because of the program's experimental design, the program impacts are precisely estimated and robust to changes in the model specification. The coefficient on *Post x program* in Table 3.59 is an estimate of the average daily savings from the program.

Table 3.59: Conditional Average Program Treatment Effects

	Model 1	Model 2	Model 3
Post	-2.239	-2.170	-2.459
	(0.042)	(0.073)	(0.041)
Post x program	-0.684	-0.686	-0.689
	(0.060)	(0.060)	(0.060)
Customer fixed effects	yes	yes	yes
Month-by-year fixed effects	no	yes	no
Weather polynomials	no	no	yes
R^2	0.004	0.231	0.258

[19] The model specifications are described in Appendix J.

[20] 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
N	2,588,227	2,588,227	2,588,227

NOTES:
The dependent variable is average daily consumption (kWh) in a month. Standard errors are shown in parentheses. Models estimated by OLS and standard errors adjusted for clustering at the customer level.

Model 1 includes customer fixed effects but not controls for weather. The conditional average treatment effect of the Energy Efficiency Behavior & Education Program was -0.68 kWh per home per day with a 95% confidence interval of -0.80 to -0.57 kWh. This point estimate translates to 20.8 kWh per home in monthly electricity savings, or 1.3% of average daily consumption using the average monthly consumption of control group customers as a baseline.

The second specification (Model 2) adds month-by-year fixed effects to capture the impacts of weather and other time-dependent variables on consumption. The third specification (Model 3) drops the month-by-year fixed effects and adds third-degree polynomials for heating and cooling degree days. The inclusion of controls for weather significantly increases the R^2 of the model, but the estimated program treatment effects are robust to the changes in Models 2 and 3, and are almost identical to Model 1. Appendix J includes additional results, showing how the program impacts varied between metropolitan areas by consumption deciles and by report frequency.

Time Path of Program Savings

Equation J2 in Appendix J of this report allows the conditional average treatment effect of the program to vary over months of the year. Figure 3.1 shows the results of estimating Equation J2. OPOWER sent the first reports in April 2010, and by May there was evidence of modest program savings (0.28 kWh or 0.71%). Savings then increased steadily before reaching a steady state. The ramping of savings is consistent with gradual adoption of measures after receiving the first reports, a pattern found in other OPOWER program evaluations.

Figure 3.1: Conditional Average Treatment Effects over Time

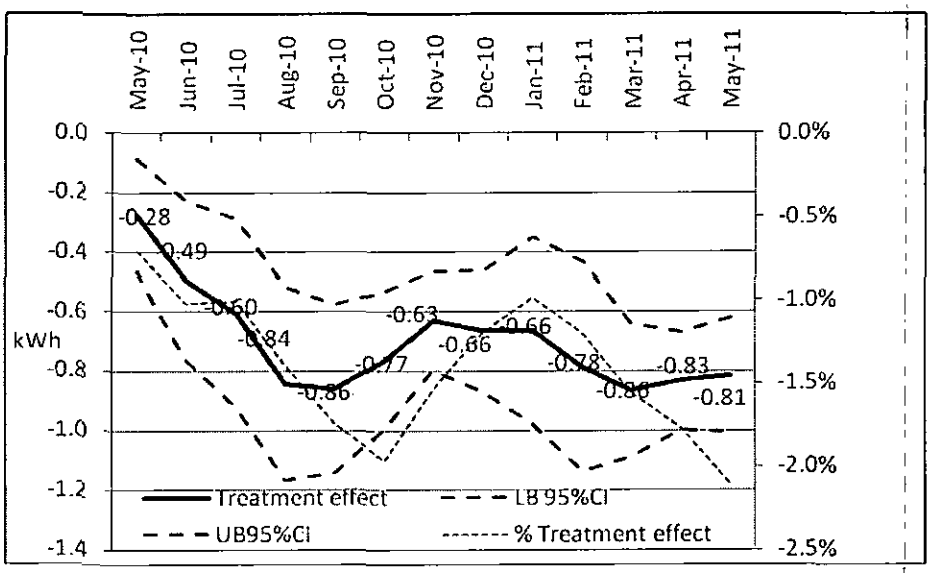


Figure 3.1also shows that savings follow a seasonal pattern. Absolute savings increase during the summer and early fall, reaching a peak of approximately -0.85 kWh per day in July, August, and September (note that a month's bill will include some days from the previous month). Savings then decrease slightly in the late fall before increasing again during the winter months. The time path of savings suggests that the Energy Efficiency Behavior & Education Program savings are weather sensitive.

PY2 Estimate of Energy Efficiency Behavior & Education Program Savings

PY2 ran from June 2010 to May 2011, so savings during the second program month (May 2010) are not included in the PY2 savings estimate. The EM&V CSP used the estimates of monthly treatment effects to estimate PY2 savings. Specifically, PY2 savings were estimated as the weighted sum of the conditional average monthly treatment effects:

$$\text{PY2 Savings} = \sum_{p'=1}^{12} \beta_{2p'} * \text{Days}_{p'} * \text{TreatedHomes}_{p'}$$

Where:

p'	=	Indexes the months of PY2
$\beta_{2p'}$	=	The conditional average kWh savings in month p' from Equation J2
$\text{Days}_{p'}$	=	The number of days in month p'
$\text{TreatedHomes}_{p'}$	=	The number of homes receiving the treatment in that month or in a previous month and whose account was still active

Table 3.60 shows the estimate of PY2 savings and associated 95% confidence intervals. It also shows the PY2 annual savings for the average program home based on the following equation:

$$\text{PY2 Savings} = \sum_{p'=1}^{12} \beta_{2p'} * \text{Days}_{p'}$$

Table 3.60: PY2 Energy Efficiency Behavior & Education Program Savings Estimates

	Point Estimate (kWh/yr)	Lower Bound 95% Confidence Interval (kWh/yr)	Upper Bound 95% Confidence Interval (kWh/yr)
Program savings	13,286,440	15,392,857	11,180,024
Typical home savings[a]	268	311	226

NOTES:
[a] Typical home savings assumes that the first report was received in April 2010.

The total Energy Efficiency Behavior & Education Program savings are estimated to be 13,286 MWh/yr with a 95% confidence interval of 15,393 to 11,180 MWhs. For the average home, annual savings were 268 kWh/yr, or 1.5% of consumption, using the post-treatment control group annual consumption as a baseline.

Net-to-Gross Ratio Methodology

Free-ridership Methodology
The difference-in-differences regression methodology controlled for free-riders, who are treated customers that would have adopted energy efficiency behaviors or measures in the absence of the Home Energy Reports. The inclusion of a randomly assigned control group of customers in the analysis accounts for free-riding behavior.

Spillover Methodology
Spillover in treated homes would be 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 particular measures, spillover savings in treated homes is 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. However, there is no evidence that spillover from treated to non-treated homes in information programs is significant. This type of spillover was not accounted for.

Net-to-Gross Ratio Findings
There is not a separate NTG calculation for the evaluation of this program. The savings estimates account for free-ridership and spillover.

3.10.3 Program Sampling

A survey of customers receiving Home Energy Reports was conducted in February 2011 and will be conducted annually. The EM&V CSP surveyed, via telephone, a sample of 300 customers receiving Home Energy Reports during the program year. The surveys covered customers' exposure and recall of the Home Energy Reports, their satisfaction with the reports and messaging, concerns with the neighbors' comparison as shown in the Report, reasons for opting-out of the Reports, and changes in their energy efficiency measures and behaviors.

The sample was stratified by metropolitan area. The sample strata were sufficiently large to achieve the required levels of statistical confidence and precision.

3.10.4 Process Evaluation

The *PPL Electric Implementation of Act 129 Energy Efficiency & Conservation Plan, Program Year One Process Evaluation* was submitted on September 15, 2010. The PY2 process evaluation is filed concurrently with this report.

3.10.5 Program Partners and Trade Allies

OPOWER is the third-party implementation CSP for the Energy Efficiency Behavior & Education Program. OPOWER 's responsibilities include selecting homes eligible for participation, preparing and distributing the Home Energy Reports, analyzing program impacts, and reporting results to PPL Electric.

Trade allies would be entities that provide services for participants of the Energy Efficiency Behavior & Education Program. There are no trade allies for this program.

PPL Electric's administrative CSP (Helgeson) responds to customer questions through its call center. Participants can call Helgeson to update information about their home characteristics used to generate Home Energy Reports.

PPL Electric's EM&V and QA/QC CSP reviews participant data and verifies impacts and calculations.

3.10.6 Program Finances

A summary of PPL Electric's project finances are presented in Table 3.61.

Table 3.61: Summary of Program Finances: TRC Test

	Category	IQ	PYTD	CPITD
A.1	EDC Incentives to Participants	$0	$0	$0
A.2	EDC Incentives to Trade Allies	$0	$0	$0
A	**Subtotal EDC Incentive Costs**	$0	$0	$0
B.1	Design & Development	$0	$0	$0
B.2	Administration	$0	$0	$0
B.3	Management[a]	$623,601	$815,014	$957,080
B.4	Marketing	$0	$0	$0
B.5	Technical Assistance	$0	$0	$0
B	**Subtotal EDC Implementation Costs**	$623,601	$815,014	$957,080

	Category	IQ	PYTD	CPITD
C	EDC Evaluation Costs[b]	$0	$0	$0
D	SWE Audit Costs	$0	$0	$0
	Total Utility TRC Costs	$623,601	$815,014	$957,080
E	Participant Costs	N/A	$0	$0
	Total TRC Costs	$623,601	$815,014	$957,080
	Discounted Costs (TRC)	N/A	$815,014	$896,710
F.1	Annualized Avoided Supply Costs –Residential	N/A	$75.79	$75.79
F.2	Annualized Avoided Supply Costs – Small C&I	N/A	$61.10	$61.10
F.3	Annualized Avoided Supply Costs – Large C&I	N/A	$51.14	$51.14
G	Lifetime Avoided Supply Costs	N/A	$1,232,711	$1,232,711
	Total Lifetime Economic Benefits	N/A	$1,232,711	$1,232,711
	Discounted Lifetime Economic Benefits	N/A	$1,232,711	$1,141,399
	Program Benefit-to-Cost Ratio	N/A	1.51	1.27

NOTES:
Definitions for terms in the following table are subject to TRC Order.
[a] Includes PPL Electric's implementation, management, and oversight of this program.
[b] EDC Evaluation, SWE Audit, and a majority of EDC Implementation costs are common and are therefore not attributable to individual programs. Common costs are distributed to sector portfolios for cost-recovery purposes. In this report, all common costs are accounted for in the portfolio.

Appendix A: Program Evaluation 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 relations-management 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 includes:

- Developing a business process map of the implementation and operation of the portfolio and each individual program.
- Conducting evaluability assessments to ensure that all data necessary for EM&V is properly collected.

Quality assurance provides the basis for establishing an effective implementation process and, more importantly, preserving the institutional memory of program operation and maintenance. The quality assurance process may be complemented with occasional *ad hoc* process evaluations to investigate specific issues related to a particular program's design, implementation, and operation.

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) for each element of the process, and then operationalizing metrics to track and measure the KPIs. These may include process efficiency, data integrity and accuracy, energy and demand savings, and customer satisfaction.

QA/QC has many elements in common with EM&V. Process evaluations are, in many respects, extensions and complements to the QA process. Similarly, impact evaluations and the QC process both aim to measure various outcomes of the portfolio using similar data and collection methods.

Table A-1: Generic Key Performance Indicators, Metrics, and Measurement Methods

Key Performance Indicator	Metric	Verification Method & Data Source
Process-Related Indicators		
Process Efficiency	Application processing time	Analyze data in EEMIS.
Transactional Data Quality	Error ratio(s)	Regular statistical checks of EEMIS data. Sample-based inspection of applications, invoices, and other records.
Materials and Work Quality	Number of measures installed, installation quality, operating conditions	Sample-based physical inspections.
Cost Management	Accuracy in payment processing; average, maximum, and minimum costs; cost-to-budget ratios, etc.	Sample-based inspection of invoices and rebate applications.
Customer Satisfaction	Approval or satisfaction rating	Sample-based surveys.
Impact-Related Indicators		
Market Penetration	Number of measures installed, percent of market saturated	CSP reports, analyze data in EEMIS.
Progress to Target	Actual-to-goal ratio	Monitor EEMIS.
Actual Installation	Number of measures	Sample-based inspections.
Actual Savings	Number of measures	Sample-based surveys and inspections.
Savings Realization	Realization rate	Engineering review, surveys, and on-site inspections.
Installation Quality	Operating condition	On-site inspections.
NOTES:		

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 Post* 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 savings / Ex ante (reported) savings

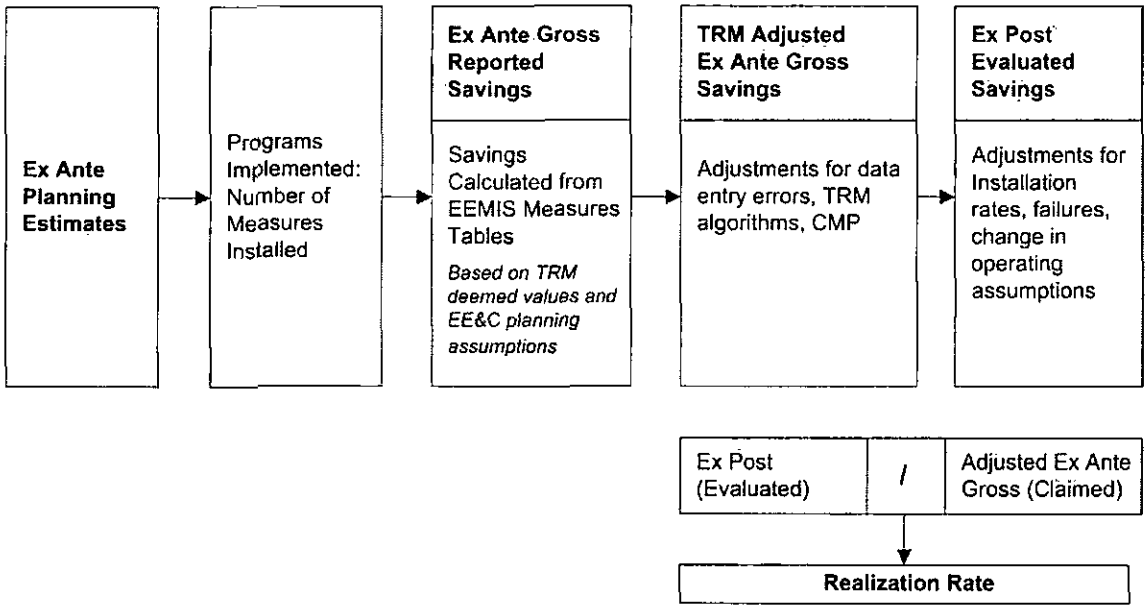
Calculation of *Ex Post* Savings

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.
- Adjustments or corrections to open variables or assumptions about measure characteristics (e.g., geographic distribution, mix of measures). These could be based on actual project application records, surveys, or site visits.
- Revised parameters used in calculation of unit savings (e.g., geographic distribution, mix of measures).
- 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.

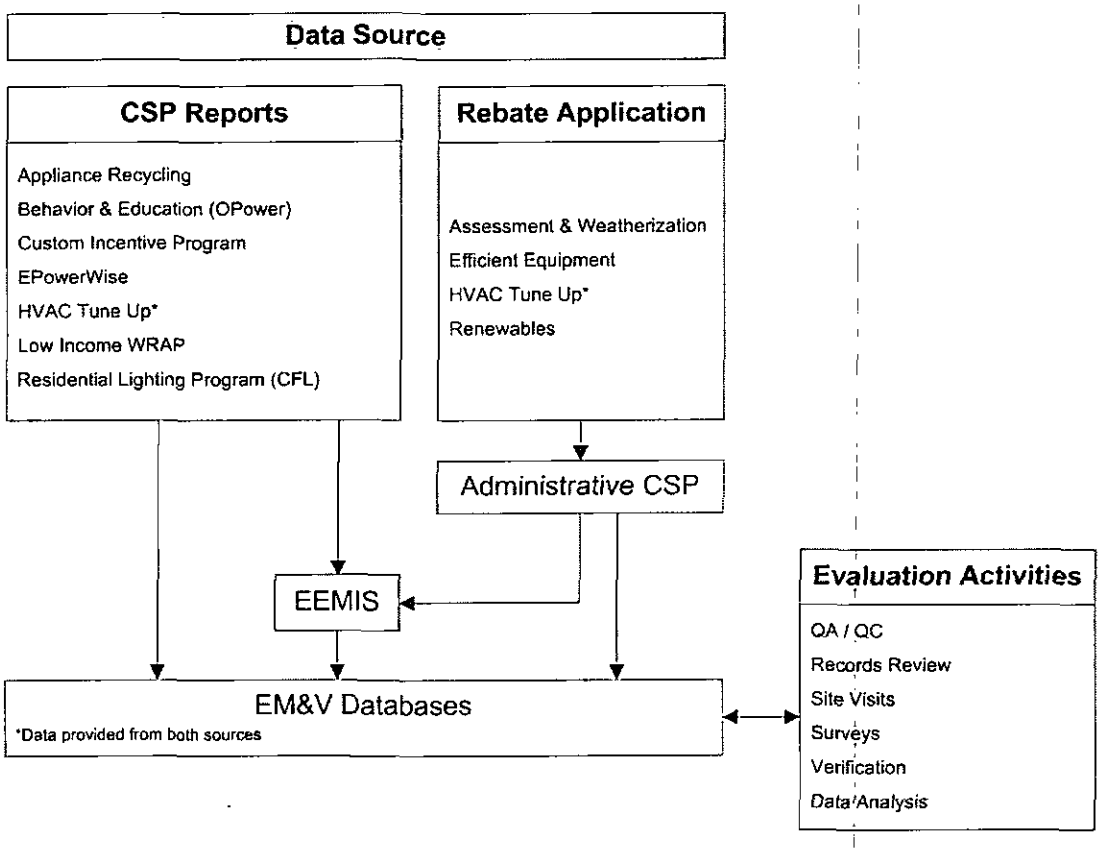
Sample-based surveys or site inspections are the main methods for verifying installations, as well as for verifying savings for measures in the TRM with fully deemed savings. For partially-deemed measures specified in the TRM, operating assumptions and other parameters will be validated using the procedures 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



Net-to-Gross Ratios

Net savings estimate program savings using a NTG ratio composed of two factors: free-ridership and spillover. Free-ridership quantifies the percentage of participants who report they would have installed a measure in the absence of the program. Spillover is the additional energy efficiency savings that occur when a program participant independently installs energy efficiency measures after participating in the energy efficiency program as a result of the program's influence. According to the Audit Plan, until a Commission order is issued, only gross savings will be reported and verified.[21] That is, gross savings will not be adjusted based on the NTG ratio. Information regarding free-ridership and spillover will be used for program planning purposes. Appendix B provides additional details regarding the methodology used in this evaluation to assess free-ridership.

[21] Statewide Evaluation Team. *Audit Plan and Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Programs*. Pp. 25, 93, and 95. December 2009.

Appendix B: Free-ridership Analyses

Introduction

On August 2, 2011, the PA PUC's issued the TRC Order, directing EDCs to collect the data necessary to determine a NTG ratio for each program and to apply that ratio to determine the cost-effectiveness of future modifications to existing program. The method for incorporating a NTG ratio in cost-effectiveness calculations was described in the California Standard Practice Manual but has not been defined in the Act 129 TRC Order.

The TRC Order also requires EDCs to submit a summary of their NTG study scope and methods, including estimated costs, for stakeholder comments and a prudency review. This appendix describes the approach that PPL Electric's EM&V CSP is using for determining NTG.

The discussion here focuses on a NTG ratio, solely in the context of EE&C programs. There is no free-ridership and spillover expected in targeted low-income programs (EPower Wise and WRAP). In addition, no free-ridership or spillover is expected in the demand response and direct load control programs (Direct Load Control and Load Curtailment), since, strictly speaking, these concepts do not apply to load curtailment programs.

Definition and Components of NTG

The draft revised 2011 Audit Plan defines net savings and the NTG ratio as follows:

> **Net Savings:** The total change in load that is attributable to an energy efficiency program. This change in load may include, implicitly or explicitly, the effects of free-drivers, free-riders, energy efficiency standards, changes in the level of energy service, and other causes of change in energy consumption or demand.
>
> **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.

As noted in the Audit Plan, there are two primary factors that differentiate net savings from gross savings—free-ridership and spillover—which are defined below.

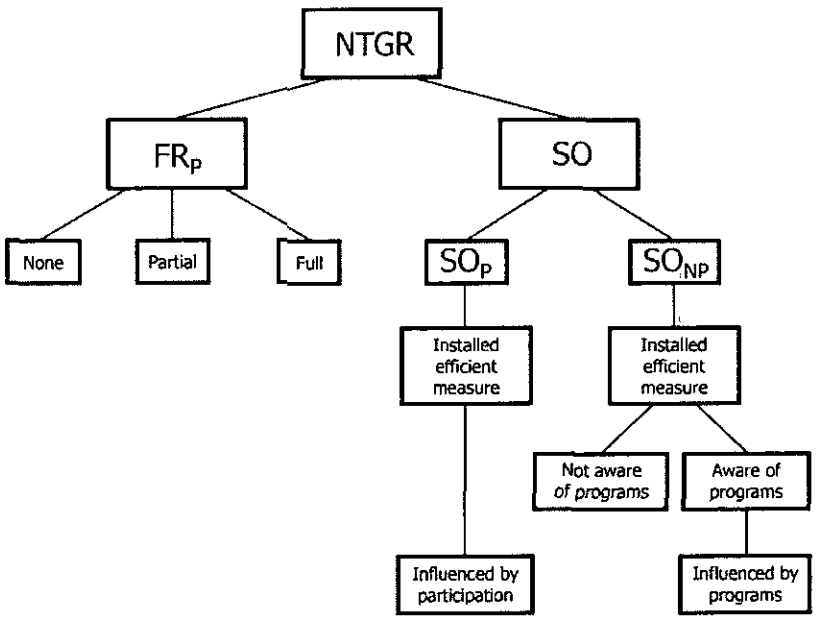
> **Free-ridership:** Participants' adoption of measures offered by the program that would have occurred in the absence of the program.
>
> **Spillover:** Reductions in energy consumption and/or demand caused by the presence of the energy efficiency program that are beyond the savings achieved by participants in the program. Spillover can be from participants and non-participants.
>
> - **Participant spillover:** 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:** The adoption of measures by eligible customers who did not participate in the program.

Market effects include changes in retail stocking practices. For example, a program can influence market practices without the consumer's knowledge, such as the SEER level of stocked heat pumps, home building practices, and the availability of products. If utility programs are successful and influence market practices (transform the market), the NTG ratio naturally declines as market transformation increases.

Therefore, in addition to non-participants who are aware of a program, non-participant spillover may also include savings from non-participants purchasing energy equipment from retailers who stock the 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. Additionally, market effects studies can be costly. For these reasons, a market effects study is not included in the NTG study outlined in this appendix. These market effects are not measured and are not considered in adjustments to compliance targets. However, these impacts could be substantial and should be acknowledged in policy decisions about the treatment of the NTG ratio. Figure B-1 outlines to components of a NTG ratio.

Figure B-1. Components of Net-to Gross Ratio*



*FR_P is participant free-ridership, SO_P is participant spillover, and SO_{NP} is non-participant spillover.

The NTG ratio and its components are usually expressed as fractions. Algebraically, the NTG ratio may be expressed as follows:

$$NTGR = (1 - FR) + SO_P + SO_{NP}$$

The NTG ratio 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 the NTG ratio in TRC calculations has not yet been specified.

Methods for Calculating NTG Ratio

Two general approaches have been used for determining the NTG ratio of most energy efficiency programs: statistical methods based on discreet choice models and self report methods. Both approaches rely on survey data, and both approaches tend to be complex, expensive to implement, and may produce imprecise results. As noted in the SWE's draft 2011 Audit Plan, calculating net savings remains more of an art than a science. Neither of these methods is ideal for upstream programs, as it is difficult, if not impossible, to identify program participants. (It is not uncommon that even the consumers who purchase upstream program measures are unaware of the program.)

Discrete choice models begin by estimating the probability of consumers' adopting particular energy efficiency measures. These probabilities are then incorporated in a quasi-experimental research design that directly estimates net savings. The disadvantages of this method are that it tends to be data intensive and it is expensive to implement.

Self-report methods rely on survey responses, which are used to estimate separate values for free-ridership, participant spillover, and non-participant spillover, which are then combined to derive the NTG ratio. For the purpose of NTG ratio 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.

Calculating NTG Ratio for Act 129 Programs

Implementation of the self-report method for each program involves conducting surveys of consumers who participated in each 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.

The EM&V CSP implemented large participant surveys in PY1 and has continued them in PY2. These surveys have served to verify measure installation, to assess program process issues including customer satisfaction, and to collect data to compute free-ridership and participant spillover. The EM&V CSP incorporated free-ridership and participant spillover batteries in these surveys and plans to continue collecting data about free-ridership and participant spillover in the context of these surveys.

The EM&V CSP has not yet conducted surveys to investigate non-participant spillover; these surveys still need to be designed and administered. Because no non-participant spillover surveys were conducted in PY2, the NTG ratio reported for PY2 will only reflect free-ridership and participant spillover.

Sample Size

Participant Surveys

The draft revised 2011 Audit Plan does not stipulate a sample size for determining free-ridership, 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 the discrepancy in sampling requirements at the program level. GM-003 and Table 4-8 of the draft 2011 Audit Plan state that verification should meet confidence and precision levels of 85/15 at the program level. However, the draft 2011 Audit Plan suggests having 90/10 at the program level and 90/20 at the measure category level for free-ridership. Therefore, the free-ridership sampling rigor required per the Audit Plan will exceed verification requirements prescribed by GM-003 and Table 4-8 of the draft 2011 Audit Plan. Since the surveys include verification and free-ridership and participant spillover batteries, sample sizes will need to be increased from verification only (85/15 at the program level) to meet free-ridership requirements (90/10 at the program level).

In PY1 and PY2, the EM&V CSP's 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, sampling targets have been determined based on *ex ante* savings strata (small, medium, and large projects), which often include specific measure categories within one stratum.

In PY3, the EM&V CSP plans to bring sample sizes closer to 90/10 by program. This sampling plan meets the Audit Plan requirements of 90/10 by program, which will amount to approximately 70 surveys per program. This sample size may be too small to extrapolate NTG results to the population of participants. For example, in a program like the Efficient Equipment Incentive Program where 25,000 rebates can easily be processed, 70 survey responses regarding purchase behaviors may not accurately represent free-ridership and spillover among all program participants. See Table B-1 for a list of survey sample sizes by PPL Electric program.

Table B-1: Participant Survey Sample Sizes for Estimating Free-ridership and Spillover

Program Survey	Program Launch	PY1 and PY2 Completed Surveys	PY3 and PY4 Annual Sample Size
Appliance Recycling Program Participants	PY1	245	75
Appliance Recycling Program Non-participants	PY1	169	Use results from PY1/PY2
Compact Fluorescent Lighting Campaign	PY1	633	300
Custom Incentive Program Participant	PY1	20	75
Energy Efficiency Behavior & Education Program Participant (no free-	PY2	319	300

Program Survey	Program Launch	PY1 and PY2 Completed Surveys	PY3 and PY4 Annual Sample Size
ridership, spillover only)			
Efficient Equipment Incentive Program Participant (residential)	PY1	304	120
Efficient Equipment Incentive Program Participant (commercial)	PY1	225	150
Renewable Energy Program (winding down in PY3)	PY1	221	Estimated 5
Home Assessment & Weatherization Program Participant (audit only)	PY2	68	34
Home Assessment & Weatherization Program Participant (with installed measures)	PY2	0	34
NOTES:			

Non-participant Surveys Proposed for PY3

The proposed sampling plan for the non-participant spillover surveys aims to produce results that will meet requirements stated in the draft 2011 Audit Plan, which recommends statistical precision at the measure category level (lighting, HVAC, motors, etc.) of 90% confidence with 20% precision. At the program level, the target is 90% confidence ±10% precision.

The sample size required to meet 90/20 is approximately 17. The proposed sample plan sets 50 points for each measure level category in the non-participant spillover surveys. The additional points will provide a more robust sample and account for any attrition resulting from incomplete responses. The EM&V CSP will fill the quota in each measure category with customers who report that they installed the measure.

In the commercial sector, the measure categories match those used for participant verification activities: lighting, HVAC, refrigeration, fans and motors, and miscellaneous residential appliances and office equipment. The EM&V CSP will proportionately allocate the non-residential sector sample to the commercial sector and to GNI sectors based on PY2 participation. The EM&V CSP proposes conducting a total of 250 commercial non-participant spillover surveys.

In the residential sector, proposed measure categories include HVAC (GSHP, ASHP, CAC, room AC), appliances (white goods), HPWHs, and other measures. The EM&V CSP proposes conducting a total of 200 residential non-participant spillover surveys. The actual measure categories for the non-participant spillover surveys will be based on the final list and distribution of measures adopted in PY2. Table B-2 outlines the survey sample sizes for estimating non-participant spillover.

Table B-2: Nonparticipant Spillover Survey Sample Size

Sector	Number of Measure Categories	Number of Sample Points per Category	Total Number of Surveys
Residential	4	50	200
Non-residential (pro-rated for commercial and GNI)	5	50	250
Total	9	100	450

Sector	Number of Measure Categories	Number of Sample Points per Category	Total Number of Surveys
NOTES:			

Free-ridership Survey Design

The self report surveys administered to program participants included separate batteries for free-ridership and participant spillover. Free-rider survey questions determine whether the participant is a free-rider, a partial free-rider, or a full free-rider. To avoid response bias, the EM&V CSP determines free-ridership by eliciting information about the participants' decision to adopt program measures through a battery of indirect questions.

For residential programs where the homeowner is the decision maker, the EM&V CSP asks the following free-ridership questions:

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 free-ridership 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 are the free-ridership questions for the non-residential sector:

1. **Already Ordered or Installed.** When you first heard about the rebate from PPL Electric for the [MEASURE], had you already purchased the [MEASURE]?
2. **Already in Budget.** Was buying the [MEASURE] included your most recent capital budget before you participated in the program?
3. **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]?
4. **Would Have Installed Without Rebate.** Would you have purchased the [MEASURE] without the rebate?
5. **Same Efficiency.** Without the rebate, would you have still purchased a [MEASURE] that was just as energy efficient, more efficient, or less efficient?

6. **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?
7. **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 free-rider.

Free-ridership Scoring Model

The EM&V CSP developed a simple model to score responses from the free-ridership questions. The EM&V CSP will then calculate the precision (standard error) for these scores based on their 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:

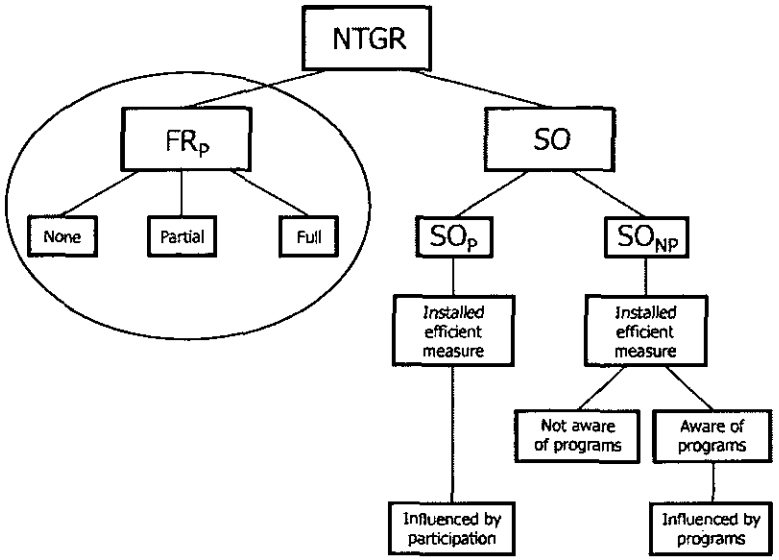
- Derives a partial free-ridership score based on the likelihood of a respondent taking similar actions in the program's absence.
- Applies a consistent set of rules to individual respondents' answers when determining free-ridership scores.
- Uses consistency checks and open-ended questions to ensure 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.

Through experience, the EM&V CSP knows that program participants do not fall neatly into free-ridership and non-free-ridership categories. For example, partial free-ridership scores are assigned to participants who had plans to install the measure prior to the program, but for whom the program or other market characteristics exerted some influence over their decision. To account for this, the 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 free-ridership scoring matrices for residential and non-residential programs.

Shown in Figure B-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 free-ridership 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.

Figure B-2. Free-ridership



Spillover Survey Design

Participant Spillover Survey Questions

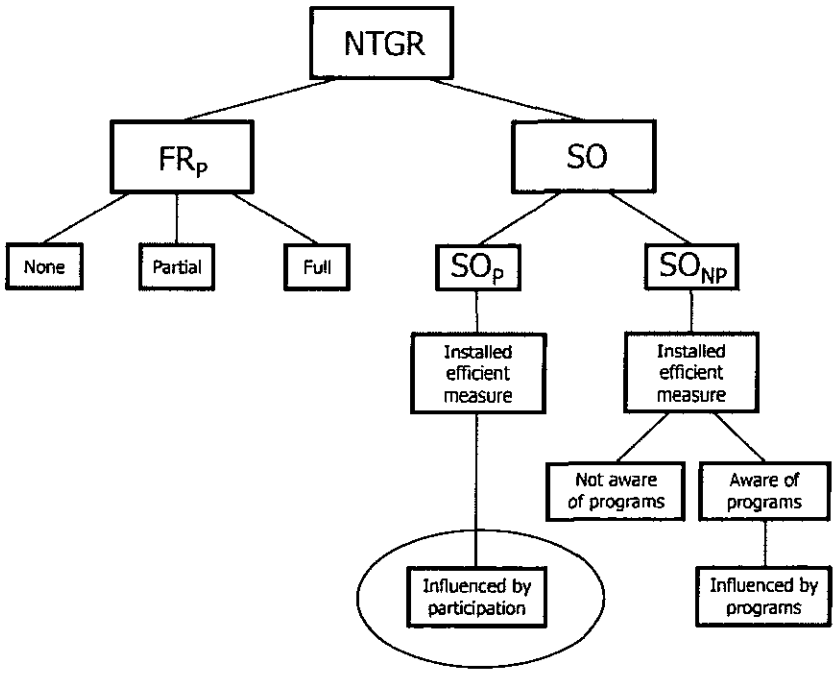
Participant spillover occurs slowly over time as the program matures and information about the program spreads. While the accuracy of the free-ridership estimate depends on eliciting responses close to the time of the measure adoption decision, spillover occurs in the longer term.

The purpose of the spillover survey battery is to determine energy efficient measures the participant installed outside of the program, without a rebate, that were influenced by the program. The EM&V CSP designed the participant spillover survey to answer three primary questions:

1. Since participating in the program being evaluated, has the participant installed additional energy efficient equipment or measures that were not rebated through a program?
2. How influential was the program in the participant's decision to install additional energy efficient measures?
3. How much or how many measures were installed?

Figure B-3 shows the participant spillover portion of the NTG ratio calculation.

Figure B-3. Participant Spillover



Savings from additional measures are considered spillover if the program significantly influenced the respondents' decisions to purchase the measures. Therefore, the spillover 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 also asks customers why they did not seek a rebate for qualifying equipment.

Non-participant Spillover Survey Questions

Non-participant spillover can be large because it involves all eligible customers. In the case of a large utility such as PPL Electric, it could be a significant energy savings number.

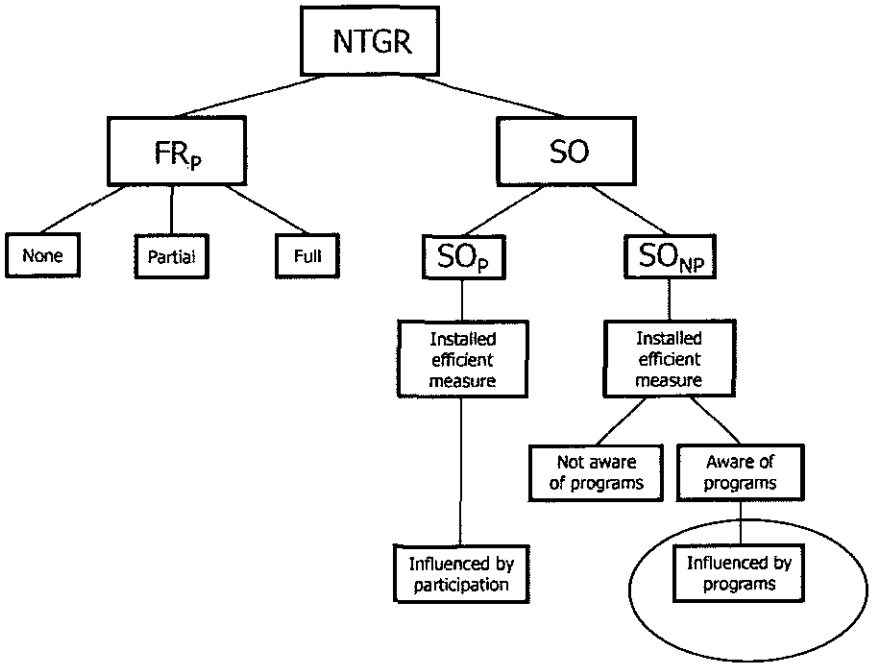
Non-participant spillover surveys assess three key factors, which taken together will identify customers and measures that contribute to spillover:

1. **Measure adoption:** The purchase and installation of energy efficiency measures without participating in a PPL Electric program.
2. **Awareness:** Knowledge of the PPL Electric programs and measures they offer.
3. **Attribution:** Whether the purchase was influenced by a PPL Electric program(s).

The EM&V CSP uses the same survey approach for residential and non-residential customers. The survey questions for both groups ask about key measure categories and key measures within each measure

category. The survey also asks customers why they did not seek a rebate for qualifying equipment. Figure B-4 shows the non-participant spillover portion of the NTG ratio calculation.

Figure B-4. Non-participant Spillover



Spillover Scoring Matrix

A top-down approach is used to calculate spillover savings. As noted in the sampling section above, the sampling quota in each measure category is filled with customers who report having 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.

This 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.

The EM&V CSP will identify rebated measures by cross-referencing survey respondents with participant databases (EEMIS records). Although energy savings result from the measures installed by these participants, those savings are already attributed to the program from which they received a rebate; savings cannot be attributed a second time to the program referred to with the survey questions. Moreover, the EM&V CSP will drop measures from analysis that are not in the TRM or where the quantity or additional specifics are unknown (e.g., insulation and windows).

Savings will be determined 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, the EM&V CSP will assign savings for that air conditioner to the respondent.

Survey respondents that stated the additional measures were energy efficient lighting or CFLs were excluded from the savings calculations in PY2. For residential customers, the EM&V CSP assumed respondents referred to purchase of CFLs. Because the CFLs were discounted upstream, including CFLs in spillover could double count savings. Therefore, no savings were assigned to CFLs in the residential sector.

In the commercial sector, energy efficient lighting could refer to any number of fixture types and pre-installation conditions. Detailed questions were not asked to determine the baseline condition and lighting installed without rebates. Therefore, no spillover savings are assigned to the commercial sector lighting measures. In PY3, the EM&V CSP will consider adding detail to questions regarding energy efficient lighting to better assess spillover for this measure.

NTG Ratio Calculations

As explained above, the NTG ratio is composed of three elements:

$$NTGR = (1 - FR) + SO_P + SO_{NP}$$

In order to calculate the NTG ratio, free-ridership and spillover (both participant and non-participant) must be expressed as a ratio of *ex post* verified gross savings. This is accomplished by estimating the total savings determined to be attributable to free-ridership, participant spillover, and non-participant spillover as follows:

$$NTGR = \frac{Gross\ Verified\ Savings - FR\ Savings + SO\ Savings_{Part} + SO\ Savings_{Nonpart}}{Gross\ Verified\ Savings}$$

In surveys, where free-ridership is calculated directly as a fraction, total savings attributable to free-ridership may be estimated using the following relationship:

$$kWhFR = \%_{FR} * Gross\ Verified\ Program\ Savings$$

Average participant spillover is estimated in surveys not as a ratio, but as an average kWh per participant; that is, for all measures (i) in the sample:

$$SO_P = N_P * \frac{\sum_{i=1}^{n} Spillover\ Savings_i}{n_{Part}}$$

Total participant spillover for the whole program may then be calculated as the product of the average kWh and the population of participants:

$$Total\ kWhSO_P = N_P * kWhSO_P$$

Similarly, the total non-participant spillover savings are estimated as the product of the sample average spillover savings (non-participant sample who installed an incented measure and were aware of the

program but did not participate) and the non-participant population size (where N and n represent the number of customers in the population and the survey sample, respectively):

$$Total\ kWhSO_{sp} = N_{sp} * \frac{\sum_{i=1}^{n} Spillover\ Savings_i}{n_{Nonpart}}$$

PY2 NTG Results

In PY2, the EM&V CSP completed 1,438 participant surveys, as shown in Table B-3. Surveys included questions for free-ridership and spillover, tailored to the program specifics (sector, measures, and delivery channel). Nonparticipant spillover surveys were not conducted in PY2.

Table B-3: PY2 Surveys Including NTG Questions

Program	FR	SO	Number of Times Survey Fielded	Number of PY2 Completed Surveys
Appliance Recycling Program Participant	X	X	2	142
Appliance Recycling Program Nonparticipant	X	X	2	134
Compact Fluorescent Lighting Campaign (upstream program)	X	X	2	282
Custom Incentive Program	X	X	1	20
Energy Efficiency Behavior & Education Program		X	1	320
Efficient Equipment Incentive Program (residential)	X	X	2	224
Efficient Equipment Incentive Program (commercial)	X	X	2	141
Renewable Energy Program	X	X	2	118
Home Assessment & Weatherization Program Participant (audit only)		X	1	68
Total			15	1,572
NOTES:				

For the Appliance Recycling Program, responses to the participant and nonparticipant surveys taken together determine what customers would have done in the absence of the program (i.e., free-ridership).

In the upstream CFL Campaign, participants are not known since the discount is offered the manufacturer, and customers may not know they purchased a discounted bulb. The survey was designed to catalog respondents as being aware or unaware of CFLs, and aware or unaware of PPL Electric's discounted CFL Campaign. Respondents who are aware of CFLs were asked the free-ridership questions.

The Energy Efficiency Behavior & 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 free-ridership in this program. To assess spillover, surveys asked respondents about their participation in other rebate programs and about their installation of energy efficiency measures.

In programs with commercial participants, or measures with variable savings (such as the Renewable Energy Program's PV and GSHP measures), free-ridership scores were weighted by the verified savings before applying the free-ridership score to the population. That is, once the free-ridership scores were determined for each participant, a savings weighted score was computed. 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.

Spillover savings were not applied to lighting measures. In the residential sector, 28 survey respondents across all programs reported purchasing 418 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. In the non-residential sector, five respondents reported 85 efficient lighting installations. Not enough detail is known about the baseline and post-installation fixtures to assign savings to these measures, nor to determine if these were CFLs or commercial lamps and fixtures. In PY3, additional questions will be asked to better ascertain possible savings from these measures.

Shown in Table B-4, participant spillover savings ranged from no spillover to 6% of program savings. Survey respondents from the Renewable Energy Program, the Custom Incentive Program, and non-residential participants of the Efficient Equipment did not report installing any additional un-rebated measures (i.e., they did not report spillover).

Free-ridership ranged from 15% for non-residential participants of the Efficient Equipment Incentive Program who installed lighting measures, to 69% for Custom Incentive Program participants. Retroactive measures were allowed for projects completed and reported in PY2. Separating out the retroactive projects from the rest, the Custom Incentive Program reported 75% free-ridership among retroactive projects, whereas 50% to 55% free-ridership was reported among respondents for the Renewable Energy Program and the Efficient Equipment Incentive Program.

Table B-4: PY2 NTG Results

Program	Total Survey Responses	Total Unique Spillover Respondents	Survey Sample Spillover KWh/yr	Survey Sample Program kWh/yr	Participant Spillover	Free-ridership	NTG	NTG Precision
Appliance Recycling Program	276	11	9,955	289,536	3%	43%	61%	6%
Home Assessment & Weatherization Program	68	3	579	35,868	2%	0%	102%	7%
Renewable Energy Program	118	3	2,383	733,684	<1%	63%	37%	7%
Efficient Equipment Incentive Program (residential)	224	14	11,031	196,709	6%	52%	54%	7%
Efficient Equipment Incentive Program (commercial, non-lighting measures)	99	1	6,435	182,481	4%	47%	57%	6%
Efficient Equipment Incentive Program (commercial, lighting measures)	42	0	0	7,530,436	0%	15%	85%	7%
Custom Incentive Program	19	0	0	NA	0%	69%	31%	NA
CFL Campaign	282	NA	NA	NA	NA	NA	77%	NA
NOTES:								

Appendix C: Compact Fluorescent Lighting Campaign NTG

Free-ridership , 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 PY2 free-ridership, 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 174 customers who had purchased one or more CFLs in the past three months were used in the NTG analysis (out of 282 total respondents who completed the telephone survey).

Free-ridership was analyzed on a per-CFL basis rather than per customer. The 174 respondents had collectively purchased 1,259 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 or received a CFL free-of-charge within the last 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.

Free-Ridership, Spillover, and NTG Findings
PY2 survey respondents who were aware of the program reported purchasing a total of 649 CFLs in the past three months. Based on their responses to a battery of free-ridership questions, the weighted mean free-ridership rate for CFLs purchased by category 1 respondents (aware of the program) was 48%, with an upper bound of 59% and a lower bound of 37%.

Respondents in category 2 (unaware of the program) reported they had collectively purchased 610 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, free-ridership among recent purchasers who were unaware of the program was 48% (the average of those who were aware of the program). At the low end, free-ridership for recent purchasers who were unaware of the program was 37% (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 C-1.

(1) Net FR = {(CFL_{Aware} * FR_{Aware}) + ($CFL_{Unaware}$ * Not-Influenced$_{Unaware}$) - ($CFL_{Unaware}$ * Influenced$_{Unaware}$)) / CFL_{Total}

(2) NTG = 1 – Net FR

Where:

Net FR = Net free-ridership, defined as free-ridership minus spillover.

CFL_{Aware} = Number of CFLs recently purchased by respondents who were aware of the program.

FR_{Aware} = Free-ridership rate for respondents who were aware of the program (derived from the battery of free-ridership 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 free-ridership case:

(1) Net FR = ((649 * 48%) + (610 * 48%) – (610 * 52%)) / 1,259 = 23%
(2) NTG = 1 – 23% = 77%

For the high-range free-ridership case:

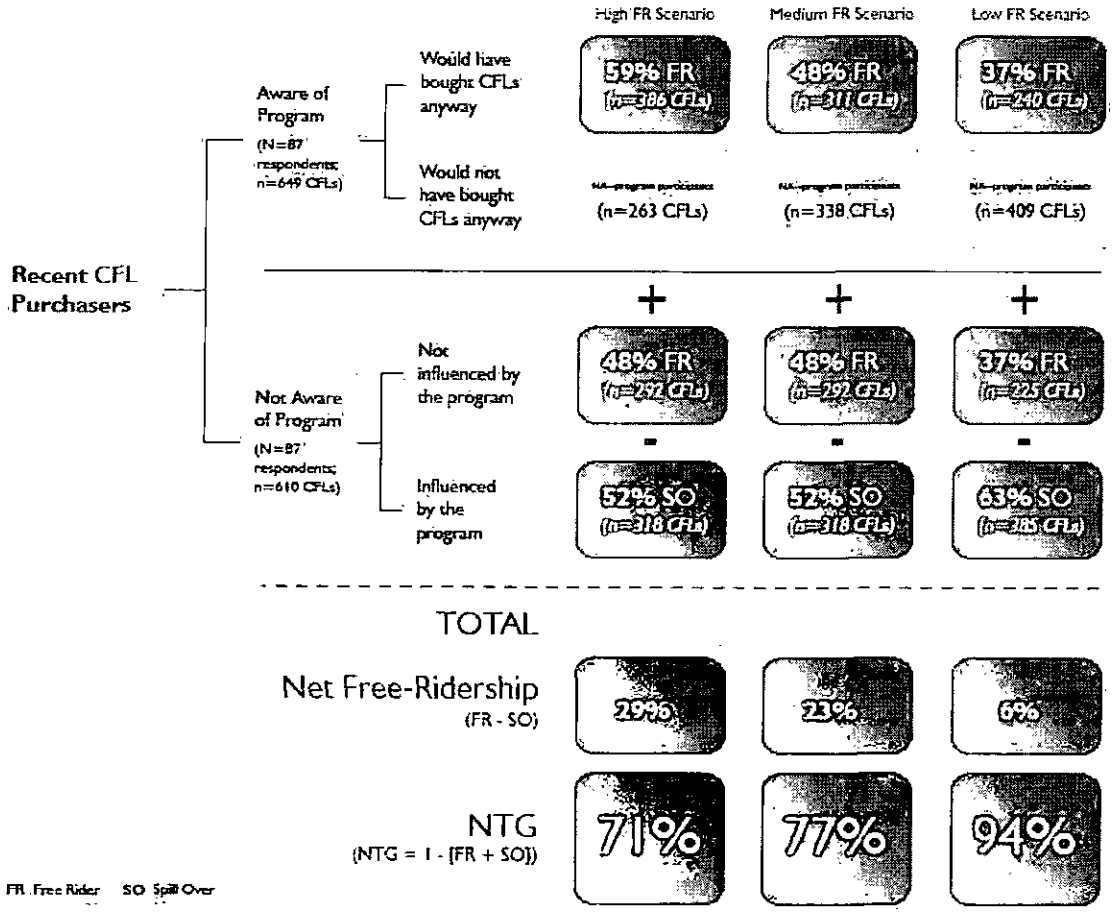
(1) Net FR = ((649 * 59%) + (610 * 48%) – (610 * 52%)) /1,259 = 29%
(2) NTG = 1 – 29% = 71%

And for the low-range free-ridership case:

(1) Net FR = ((649 * 37%) + (610 * 37%) – (610 * 63%)) / 1,259 = 6%
(2) NTG = 1 – 6% = 94%

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 at the higher end of the 71% to 94% range. The EM&V CSP therefore estimates NTG for the CFL Campaign as 85%.

Figure C-1. CFL Campaign Net-to-Gross Calculation



Corporate-Level CFL Retailer Interviews

No corporate-level retailer interviews were conducted in PY2. The EM&V CSP conducted corporate-level retailer interviews in PY1 and used results from those interviews to inform the PY2 NTG analysis.

In PY1, retailer respondents were asked if they thought their sales of ENERGY STAR CFLs in central and eastern Pennsylvania during 2010 would be the same, higher, or lower—and by how much—if PPL Electric's upstream incentives had not been available. All of the respondents replied that their sales would have been lower in the absence of the CFL Campaign. Their estimates were that sales of standard ENERGY STAR CFLs would have been 50% to 95% lower (sales of specialty CFLs, a small fraction of total CFL sales, reportedly would have been 45% to 83% lower in absence of the program).

In PY1, the retailer respondents were also asked to estimate the percent of their total CFL sales in central and eastern Pennsylvania they could attribute to PPL Electric's CFL Campaign. While one respondent was unable to provide an estimate, the other respondents gave answers ranging from 70% to 95%.

For each retailer, the EM&V CSP divided the respondent's first estimate (the drop in CFL sales that the retailer would expect in absence of the program) by their second estimate (the percent of total CFL sales attributable to the program). This ratio provided an approximation of the program's NTG ratio, ranging from 53% to 100%, with an average of 78%.

While the retailer sample size was not large enough to provide statistically valid results, and the individual retailers' responses were based on rough estimates, the retailer survey nevertheless provides an estimate of the CFL Campaign's NTG ratio.

Appendix D: Custom Incentive Program Project Verification

Project Verification

This appendix provides a summary of each project and the savings verification process for the Custom Incentive Program in PY2. There have been a total of 54 projects.

1. Q1 - Project 44 was a bulk purchase of CFLs. The baseline and installation rates were verified through a site visit. It was confirmed that all lamps were installed, with none being reserved as spares. The quantity and wattage of the installed fixtures were consistent with the invoices.
2. Q2 - Project 2 was a process reconfiguration at a wastewater treatment facility. It included the replacement of motors and the installation of VFDs. The project was included in the sample, and verified savings were calculated based on a site visit and analysis of metering data. The baseline and post-installation motor performance was metered at the PPL Electric service meter using a 15-minute interval data, recording utility-grade meter.
3. Q2 - Project 33 involved replacing 45 Watt incandescent lamps with 7 Watt LED lamps in a decorative outdoor application. Both pre-installation and a post-installation inspections were conducted. The operating hours and calculations were also reviewed.
4. Q2 - Project 63 was a lighting project involving the replacement of metal halide fixtures with induction fixtures in a manufacturing facility. The project was included in the sample, and verified savings were calculated based on a site visit and examination of invoices submitted with the application. The verified savings were obtained from the TRM lighting audit tool. Final savings are based on the TRM lighting tool with the prescribed deemed EFLH, verified counts, and custom wattage for the induction fixtures. Measure costs were verified from invoices provided by the customer.
5. Q3 - Project 14 was an EMS expansion at a secondary school. Upgrades to the building EMS software have allowed for greater precision in controlling the system set points throughout the facility. The project is in the large sample. Verified savings were determined in accordance with the SSEMVP with 12 months of post-installation metering data.
6. Q3 - Project 28 involved replacing high-intensity discharge lamps in a cold storage warehouse with LED fixtures that have integrated occupancy sensors. The project is in the custom program because PPL Electric had no prescriptive incentive for high bay LED lighting. The project is in the large sample. Verified savings were calculated based on pre- and post-installation site visits. The savings was obtained using the TRM lighting audit tool and a custom lighting controls savings factor (SVG) determined through logging. The SSEMVP is a site-specific application of the SWE-approved CMP for custom lighting controls.
7. Q3 - Project 32 was a large lighting retrofit project which converted an array of fixtures to induction fixtures in three parking garages. The project is in the custom program because PPL Electric had no prescriptive incentive for induction lighting. The project is in the large sample. Verified savings were calculated based on pre- and post-installation site visits and an SSEMVP. The final savings were based on the TRM lighting tool with the metered hours of operation, verified counts, and deemed SVG of 50%.
8. Q3 - Project 37 was a large T12 to T8 conversion in a large office building. The project is in the custom program because PPL Electric had no prescriptive incentive for 1-lamp T8 fixtures. The

project is in the large sample. Verified savings were calculated based on a site visit and EMS trend data used to determine the EFLH. The savings were obtained using the TRM lighting audit tool.

9. Q3 - Projects 42, 43, 45, 51, 94, and 115 involved installations of EMS systems in small retail stores. The projects are in the large sample. Verified savings will be determined in accordance with the SSEMVP once 12 months of post-installation metering data is available.
10. Q3 - Projects 81, 86-93, 123, 125, and 126 involved installations of EMS systems in medium-sized retail stores. These 12 projects are in the large sample. Verified savings were determined in accordance with the SSEMVP using 12 months of post-installation billing data. Two of the sites could not be evaluated using billing analysis, so the realization rate from the other 10 projects was applied to them.
11. Q3 - Project 50 was an EMS installation at an elementary school. The measure involved converting pneumatic controls to direct digital controls, plus installing demand control ventilation (DCV). The project is in the large sample. Verified savings were determined in accordance with the SSEMVP using 12 months of pre-installation and 12 months of post-installation metering data. A site visit was also performed.
12. Q3 - Project 65 was a compressed air project in an industrial facility. The customer purchased and installed a new 250 HP VSD rotary screw air compressor to replace an existing 300 HP constant speed compressor. The project is in the large sample. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data. A site visit was also performed.
13. Q3 - Project 80 was a custom lighting project involving the replacement of exterior fixtures in a parking lot. The project was included in the sample, and verified savings were calculated based on a site visit and examination of invoices submitted with the application. The verified savings were obtained from the TRM lighting audit tool.
14. Q3 - Project 122 was a compressed air project in an industrial facility. The project involved upgrades to the compressed air system from a pair of single-stage air compressors using modulating control to a single, double-staged compressor controlled by a VFD. The project is in the large sample. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data. A site visit was also performed.
15. Q4 - Project 1 was a retrofit compressed air project in an industrial facility. The project updated, fixed, and installed five components of the compressed air system. The project is in the large sample and has been verified. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data.
16. Q4 - Project 11 was a compressed air project in an industrial facility. The existing constant speed screw air compressor was replaced with a new 100 HP air compressor equipped with a VSD. The project is in the large sample and has been verified. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data.
17. Q4 - Project 39 was a custom retrofit project on a college campus that resulted from a performance contract. The project consists of six measures, including lighting retrofits, vending miser controls, HVAC upgrades, and HVAC control improvements implemented for a total of 22 buildings. The project is in the large sample and a post-installation inspection was conducted. Verified savings were determined in accordance with the SSEMVP. The lighting savings include the use of metering data collected by the energy services company. Billing analysis is used for a portion of the project.

18. Q4 - Project 48 was a process cooling project in an industrial facility. The project involved abandoning one of the two process cooling water systems and upgrading the remaining one so that the entire plant could be run off of a single system. VFDs were also added to the remaining pumps and cooling tower fans. The project is in the large sample and has been verified. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation short-term metering data.
19. Q4 - Project 70 was a compressed air project in an industrial facility. The project involved adding new high pressure dryers, a compressed air storage tank, and a flow control valve. The project is in the large sample and has been verified. Verified savings for the storage tank and controls were determined in accordance with the SSEMVP using pre- and post-installation metering data. Verified savings for the dryers were based on verification only, as addressed in the SSEMVP.
20. Q4 - Project 72 was a large lighting project that took place in a refrigerated distribution center. The project was a one-for-one replacement of 400 Watt HPS fixtures with 160 Watt LED fixtures with integrated occupancy sensors. The project is in the large sample and has been verified. Verified savings were determined from the TRM lighting tool and metered hours of operation (EFLH). A customer lighting controls SVG was determined from the metering.
21. Q4 - Project 75 was a compressed air project that took place in an industrial facility. A compressed air load was replaced with a system that used electricity but no compressed air. Specifically, low pressure blowers were installed on three rinsers to replace compressed air nozzles. Two new rinse lines were also installed with the low pressure blowers. The project is in the large sample and has been verified. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data, as well as using compressed air plant efficiency data determined during an air audit.
22. Q4 - Project 103 was a process cooling water project in an industrial plant. The project is a complete replacement of the equipment serving two cooling water loops at the plant. Air cooled chillers, condensers, pumps, and other cooling system components were replaced. Frigel dry coolers now serve much of the load that was previously served by air cooled chillers. The project is in the large sample. Extensive data is collected by the site's supervisory control and data acquisition system, and this data has formed the basis of the verification. The verification savings followed the outline provided in the SSEMVP.
23. Q4 - Project 105 was a custom VFD project in an industrial facility. A VFD was installed on a blower that pulls air from the plastic production process and filters it before being released into the atmosphere. The VFD controls the blower speed to modulate the necessary suction pressure without the use of a damper. The project is in the large sample. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data.
24. Q4 - Project 107 was a retrofit custom VFD project in a manufacturing facility. A 400 HP direct control drive was replaced with an air conditioning motor with VFD. The project is in the large sample. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data.
25. Q4 - Project 110 was a large retrofit lighting project in a refrigerated warehouse. It was a one-for-one replacement of 74 total 400 Watt metal halide fixtures with 160 Watt LED fixtures with integrated occupancy sensors. The project is in the large sample. Verified savings were determined in accordance with the SSEMVP and the TRM lighting tool. Metering was used to determine the EFLH and a custom controls SVG.

26. Q4 - Project 136 was a compressed air project installed in an industrial facility. The existing air compressor was replaced with a new compressor and equipped with a VFD. The project is in the large sample. Verified savings were determined in accordance with the SSEMVP using pre- and post-installation metering data.

The remaining 12 projects that received incentive payment from PPL Electric in PY2 Q4 are in the small strata. Of these, six were directly verified. The realization rate determined for the verified small projects was applied to the reported savings for the unverified small projects. Table D-1 and Table D-2 list the projects in the small savings strata that received incentive payment from PPL Electric in PY2 Q4. The projects in the sample are:

1. Project 137 was a custom lighting retrofit project that replaced 87 metal halide fixtures with 87 induction fixtures, according to the lighting inventory form. The project is in the small strata and was selected for the sample. It was verified in accordance with the SSEMVP. These replacements are all in a single parking garage. The project is in the PPL Electric custom program because there is no prescriptive incentive for induction lighting. A site visit was also conducted.
2. Project 180 was a lighting retrofit project which converted metal halide fixtures to 65 Watt CFLs, and was completed in a single office space. The project was in the custom program because PPL Electric had no prescriptive incentive for CFL's of this wattage. A site visit was also conducted.
3. Project 188 involved the installation of vending miser controls on 24 cold beverage machines throughout a school district. These devices reduce energy consumption due to lighting and refrigeration during periods of consumer inactivity. A site visit was conducted to verify the installation and the capacity of the vending machines. The TRM algorithm was used to determine savings.
4. Project 201 was a small lighting retrofit project which replaced 23 1-lamp 8-foot T12 fixtures with 17 1-lamp T8 fixtures. The fixtures are all in one space. The measure is in the custom program because PPL Electric has no prescriptive incentive for one lamp fixture replacements. A site visit was conducted.
5. Project 202 involved installing a VSD on a 200 HP motor that drives a process material handling and exhaust blower. Controllers slow the motor speed to save energy when the blower is not required. Savings are based on the program implementer's metering of the post-retrofit motor kW. A site visit was also conducted.
6. Project 219 was an exterior lighting retrofit project which replaced 332 high pressure sodium fixtures with LED fixtures. Replaced fixtures were located on the street and a walkway. The project was in the custom program because PPL Electric does not have a prescriptive incentive for these LED fixtures. A site visit was conducted.

Table D-1: Custom Incentive Projects Paid in PY2 Q4 and Included in the Sample Frame

Project Number	Reported kWh/yr Savings	Reported kW Savings	Measure Description	Measure Category	Measure Sub-Category
137	67,759	15	Data Center - Lighting	Lighting	Other
180	40,787	15	Data Center – Lighting	Lighting	Other
188	34,368	-	*Industrial Process* - Other Electric	Other	Other
201	3,350	1	Data Center – Lighting	Lighting	Other
202	130,878	26	Custom Motors	Other	Other
219	211,285	49	Data Center – Lighting	Lighting	Other
104	148,139	28	Permanent Operational Changes (Cooling DX)	Cooling	Cooling
113	17,632	2	Permanent Operational Changes (Cooling DX)	Cooling	Cooling
141	30,749	4	Data Center – Lighting	Lighting	Other
161	14,231	9	Custom Motors	Other	Other
205	168,278	33	Data Center – Lighting	Lighting	Other
213	10,081	4	Data Center – Lighting	Lighting	Other
NOTES:					

Table D-2: Custom Incentive Projects Paid in PY2 Q4 and Included in the Sample

Project	Reported kWh/yr Savings	Reported kW Savings	Verified kWh/yr Savings	Verified kW Savings	Realization Rate kWh/yr Savings	Realization Rate kW Savings
137	67,759	15	72,081	-	106%	0%
180	40,787	15	37,079	13	91%	88%
188	34,368	-	31,918	-	93%	100%
201	3,350	1	3,826	1	114%	137%
202	130,878	26	205,074	42	157%	160%
219	211,285	49	211,285	-	100%	0%
Total	488,427	106	561,263	56	115%	53%
Average					111%	77%
NOTES:						

Appendix E: 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 0.35% of rebated appliances in the Efficient Equipment Incentive Program involved fuel switching, the actual incidence is less than 0.04%.

Efficient Equipment Incentive Program

Since the Efficient Equipment Incentive Program's inception, PPL Electric has issued over 100,000 rebates to residential customers. Of those, only 391 (0.35%) have been reported by customers as replacing gas equipment. Follow-up questions to these 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 motivated by the program rebates.

Table E-1 summarizes the rebated measures that, according to customer reports, replaced gas equipment. The table summarizes the number of customer-indicated gas replacement measures, total rebates issued for the measure, and the percentage of total rebates that were reported as gas replacement. Of these rebated measures, most customers indicated that they replaced a gas device with a CAC system, followed by customers who replaced a gas device with an ASHP. Because comparable gas equipment does not exist for many of the rebated measures, some customer responses are clearly incorrect. For example, refrigerators, dishwashers, and clothes washers do not have gas equivalent measures.

Table E-1: Summary of Rebate Forms

Measure Name	Rebate Forms Indicating Measure Replaced Gas Device	Total Rebates Issued (PY1 and PY2)	Percent of Total
CAC - SEER 16	168	2,377	7.07%
CAC - SEER 15	33	421	7.84%
CAC - SEER 14.5	13	160	8.13%
ASHP - SEER 16	80	3,666	2.18%
ASHP - SEER 15	36	2,910	1.24%
ASHP - SEER 14.5	3	100	3.00%
Heat Pump Hot Water Heater	41	1,552	2.64%
Clothes Washer	6	31,842	0.02%
Dishwasher	5	18,150	0.03%
ENERGY STAR Refrigerator	5	30,806	0.02%

Measure Name	Rebate Forms Indicating Measure Replaced Gas Device	Total Rebates Issued (PY1 and PY2)	Percent of Total
Programmable Thermostat	1	10,749	0.01%
NOTES:			

At the close of PY2, the EM&V CSP fielded a survey of residential Efficient Equipment Incentive Program participants that included questions related to fuel switching. The fuel-switching questions were designed to determine whether gas devices were actually replaced as indicated on rebate forms, and, if so, if 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.

Of 72 surveyed households, 60 (80%) confirmed during follow-up questioning that they had replaced a gas device. Ten said they had not replaced a gas device and two did not know if they had. Respondents reported a total of 69 replaced devices, 56 of which were gas heating systems or gas water heaters. Thirteen of the replaced devices were gas air conditioning systems, gas stoves, and oil furnaces (Table E-2).

Table E-2: Summary of Replaced Gas Devices

Gas Device	Number Replaced
Gas furnace or boiler	45
Gas water heater	11
Gas air conditioning system	4
Gas stove	3
Oil furnace	3
Other	3[a]
NOTES: [a] Other included an air humidifier, a propane furnace, and a gas dryer.	

Of the 69 devices replaced, 50 (72%) were replaced because they were broken, did not work correctly, or were old and in need of replacement. Twelve units were replaced because of the cost of operation or efficiency. One customer replaced an oil furnace with a gas furnace to be more compatible with the AC system. Two customers installed gas stoves because they prefer to cook with gas.[22] One customer replaced a gas water heater that was not large enough with a HPWH, while another customer replaced a gas boiler during a remodeling project due to placement issues (Table E-3).

[22] PPL Electric does not offer a rebate for electric stoves. This is an example of customer confusion: the rebates received by these customers were for a dehumidifier, a CAC, and two refrigerators.

Table E-3: Summary of Reasons for Replacing Gas Devices

Reason	Count
Didn't work right or old and in need of replacement	37
It was broken/failed	13
To reduce the cost of operation/more efficient	12
Other	5
To get a rebate	2
NOTES:	

Figure E-1 and Figure E-2 show the response patterns for customers who replaced gas heating[23] and gas water heating equipment, respectively. In Figure E-1, for gas heating equipment, the initial column of responses ("Reason for Replacement") shows the customer's reason for replacing a gas furnace. Of the 39 units replaced, 31 were replaced because of equipment issues, while six customers indicated they had concerns about the efficiency of the replaced unit or wanted to be more efficient. Only two of the 39 gas furnaces were replaced in order to get a rebate, but those two were replaced by another gas furnace, not electric equipment.

The second column of responses ("Installed Replacement Equipment") demonstrates that the majority of gas furnaces (32 of 39) were replaced with gas furnaces, including the two units customers replaced in order to receive a rebate. In none of these instances did a customer receive an incentive for a gas furnace from PPL Electric.

The third column ("Rebate Received for Replaced Equipment") shows that 14 customers indicated they received a rebate for the replacement equipment. Equipment rebated to the respondents through the Efficient Equipment Incentive Program is summarized in final column ("PPL Issued Rebates"). A comparison of the installed replacement equipment with the rebates issued shows that in only four of the 39 instances did customers replace gas equipment with electric equipment and receive a rebate for that equipment (all ASHPs).[24] In none of those cases, however, did the customer indicate the equipment was replaced in order to receive a rebate. Instead, customers were replacing broken, poorly operating, or inefficient furnaces.

[23] Gas heating equipment is classified as gas furnaces for simplicity.

[24] Four respondents indicated they had replaced their gas furnace with a heat pump hot water heater. The EM&V CSP, accounting for customer confusion and issued rebates, recoded these responses as ASHPs.

Figure E-1: Responses for Customers Replacing Gas Heating Equipment

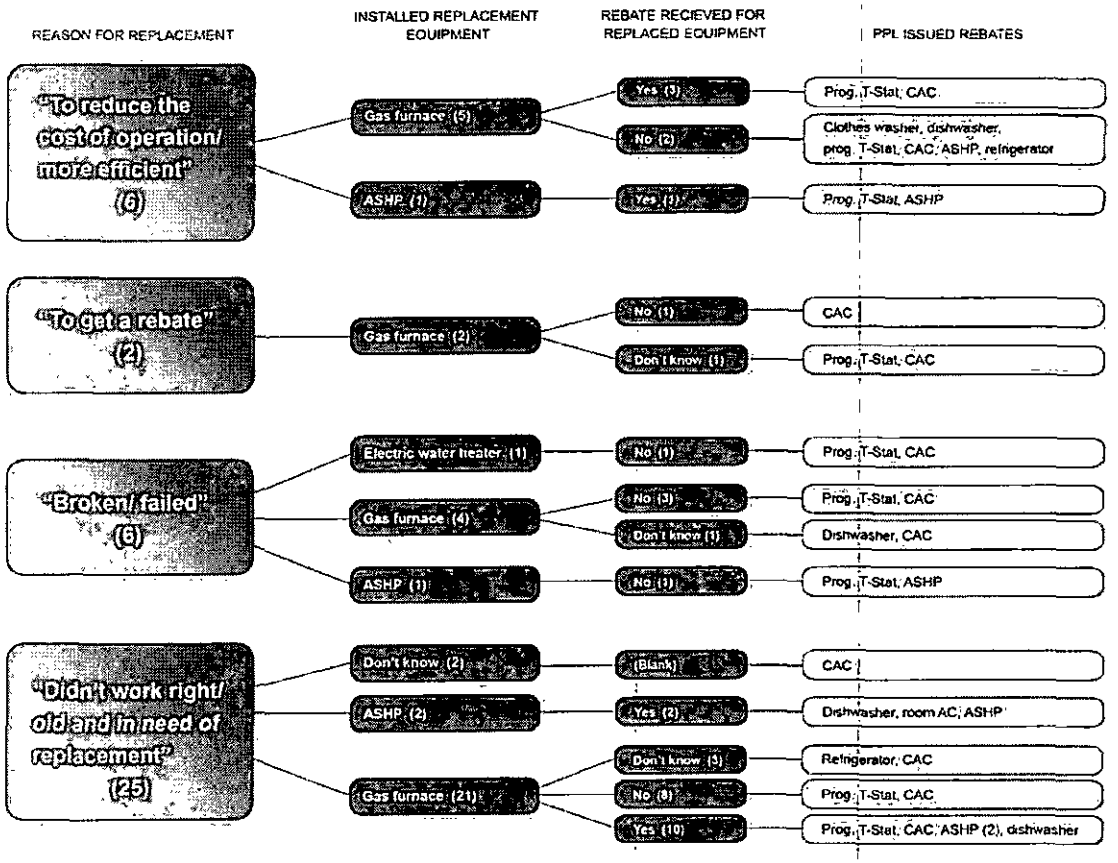
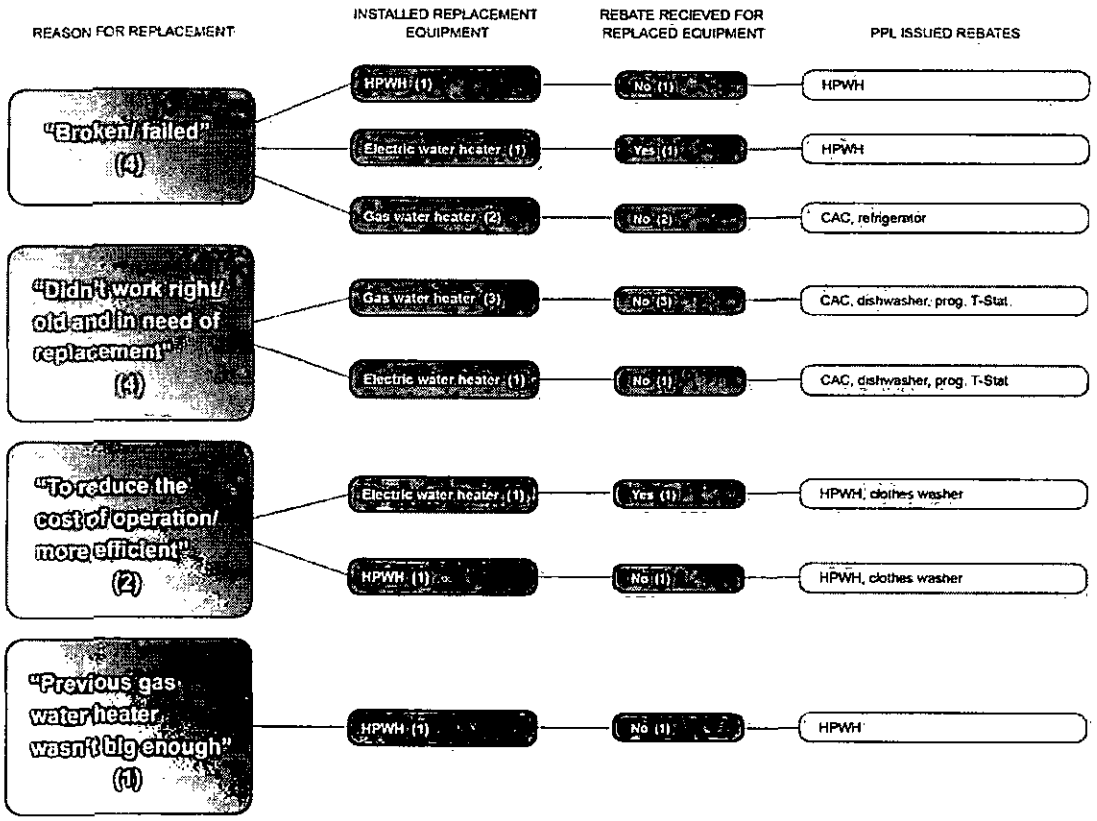


Figure E-2 presents responses for customers who replaced gas water heaters.

Figure E-2: Responses for Customers Replacing Gas Water Heaters



As with gas furnaces, the majority of respondents replaced their water heater because they were broken, poorly operating, or inefficient. One customer indicated that the replaced water heater was undersized. Of 11 gas water heaters, five were replaced with another gas water heater[25] and three were replaced with a HPWH. The remaining three respondents indicated they replaced the gas furnace with an electric water heater. A comparison of these responses with the issued rebates reveals that customers installed and received PPL Electric rebates for a total of five HPWHs. In none of those cases, however, did customers indicate that receiving a rebate was the motivating factor for replacing gas equipment.

While 0.35% of customers have reported fuel switching for equipment rebated through the Efficient Equipment Incentive Program, survey data indicates that the actual incidence of fuel switching is much lower than reported.

[25] This group of customers received rebates for CACs or refrigerators and indicated on their rebate applications they had replaced gas equipment.

Renewable Energy Program

In spring 2011, the EM&V CSP assessed fuel switching for the Renewable Energy Program through self-report surveys with a sample of PY2 Q2 and Q3 participants. The fuel switching portion of survey questions were tailored to participants of the Renewable Energy Program. In PY2, 159 GSHP rebate recipients reported on their rebate application that they switched from a non-electric fuel to an electric GSHP for space heating. Four of the 159 rebate recipients responded to the survey, and were asked to confirm that they had switched space heating equipment from a non-electric fueled system (e.g., natural gas or heating oil) to an electric system.

Two of the four survey respondents confirmed fuel switching their space heating systems. One respondent switched from a propane heating system to a GSHP. The propane heating system was reported to be functioning, but old and in need of replacement. The other respondent switched from a gas furnace to a GSHP. The gas furnace was functioning, and was not old or in need of replacement. This respondent previously had CAC, and so the air conditioning capability of the GSHP was not a factor in their decision.

Appendix F: Method to Select Sampled Sites into C&I Light Logger Studies

Introduction

This appendix describes the methods the EM&V CSP used to verify the C&I lighting projects in the Efficient Equipment Incentive Program (prescriptive rebates) in PY2. The method was used to determine whether a light logger study should be conducted at each site selected from the verification sample. This determination was based on cases where published EFLH appeared to be substantially different from actual operating hours.

This appendix also describes how annual operating hours were estimated for C&I lighting projects in the Efficient Equipment Incentive Program after May 31, 2011. In PY3, EPS, PPL Electric's CSP, will use this approach when providing assistance to commercial customers enrolling in the program.

PY2 Verification

Approach to Selecting Sites for Light Logger Studies

The 2010 PA TRM applies to all projects enrolled on or before May 31, 2011 (PY2). All projects installed in Q2 and Q3 will be reviewed, as well as projects administered by EPS during PY2 Q4, to determine if logging is needed. For those projects included in the verification sample that require a logger study, that study will be performed as part of the EM&V CSP's annual evaluation, and will verify reported savings. Adjustments may be made to reported savings, determined by information found during the verification process.

Based on interviews with facility staff, it may be determined that the Appendix C EFLH values are not appropriate for a particular project. While the threshold for determining this non-appropriate classification will vary with the value of a project's savings and the individual site characteristics, a light logger study is generally indicated if the true operating hours appear to differ from EFLH values by 50% or more. For example, some establishments may operate every day, 24 hours per day, while the published TRM EFLH are for operation during 3,800 hours. If the TRM EFLH are used to verify savings, over half of the operating hours would not be included in the analysis, and legitimate savings would not be counted. For these types of sites included in the verification sample, a logger study will be conducted. Interval data will be requested from PPL Electric and will be analyzed in the verification study. It is possible that savings will be verified in addition to those reported using the Appendix C EFLH.

As another example, during verification it may be found that a retrofitted building is no longer in business. In that case, the hours differ from the published EFLH values by 50% or more, and an adjustment in operating hours may be needed. While a logger study may not be needed, interval data will be requested from PPL Electric. The interval data will document and support findings that the building is abandoned or operating at severely reduced hours. Operating hours and savings will be adjusted accordingly.

Logger Deployment

When EFLH are estimated from a light logger study, the loggers should be deployed for a minimum of two weeks that represent the building's typical operating schedule. Light loggers must be located on fixtures that were selected by a sampling routine that ensures that the study results will be statistically meaningful.

Process for Selecting Lighting Fixtures for a Logger Study

The process for randomly selecting representative samples of fixtures for logging at the site is described in several standard M&V and evaluation documents. The process assumes that a lighting inventory is available in a spreadsheet format. In general, the process involves the following steps:

1) Determine the sample size for the number of fixtures that will be verified at the site. This is a function of the number of usage groups and the estimated savings and number of fixtures in each group. Stratified sampling usually results in smaller sample sizes than simple sampling approaches. The sample size is the sum of number of fixtures that will be logged[26] in each usage group. The minimum number of loggers per usage group is three. Sample sizes are normally increased by 10% to compensate for potential logger failure. There are publically available spreadsheet tools that can be used to determine sample sizes within the site.
2) In a spreadsheet, use a random number generator to assign unique numbers to each line in the lighting inventory. Sort the inventory by usage group and random number. In each usage group, select the line with the highest random number for logging. Repeat the process until the number of selected lines equals the sample size for each usage group.
3) Deploy the required number of light loggers in any fixture in each line selected for sampling. Leave loggers in place for a minimum of two weeks, longer if a building's schedule is variable.
4) Retrieve loggers and analyze results. Annual hours are calculated for each usage group by extrapolating from the percent "on" time during the logging period. All raw and processed data should be preserved and available for review.
5) Calculate project savings by using logger-determined usage group annual hours in the lighting inventory spreadsheet. The inventory should reflect the as-built condition.

Projects Enrolled After May 31, 2011

Approach to Selecting Sites for Light Logger Study

The approach, in accordance with the 2011 TRM, is to interview building managers regarding operating schedules and then select the appropriate building type/usage group and associated EFLH estimate(s) that are stipulated in the 2011 PA TRM. Light loggers are used only if a project's building type/usage group is not listed in the 2011 PA TRM, or if the stipulated EFLH values are not appropriate for the project building/usage group.

For projects enrolled after May 31, 2011, with an estimated change in connected load of 50 kW or more, the 2011 PA TRM states:

[26] Strictly speaking, the sample size should be a function of the number of switches in a usage group, but since this information is rarely collected in lighting inventories, fixture quantities are substituted.

> *"EFLH values must be estimated for each group by facility interviews supplemented by either logging or stipulated values from Table 3-2. Facility interviews must first identify the usage group in which each fixture qualifies. Then either results from logging or Table 3-2 will determine the appropriate EFLH for each usage group. Where participants disagree with stipulated values or the appropriate facility type and/or space type is not listed in Table 3-2, logging hours is appropriate."*[27]

TRM Table 3-2 stipulates EFLH values by usage groups for 16 building types. Following the instructions in the TRM quoted above, EFLH for a project are estimated by usage groups based on interviews with energy managers or other staff familiar with the building. In most cases, if the building type/usage group is listed in Table 3-2, the EFLH will be estimated using the Table 3-2 stipulated values. Otherwise, in the following cases the EFLH estimate will be determined by a light logger study:

- For buildings/usage groups not listed in Table 3-2 and for which there is no equivalent building/usage group listed (e.g., a veterinarian is not listed but may have EFLH equivalent to a hospital's medical clinic; hence, logging would not be required).
- When, based on interviews with facility staff, the implementer or evaluator determines that the Table 3-2 EFLH values are not appropriate for a particular project, such as for a grocery store operating 24/7 or a sit-down restaurant open only for dinner or on weekends. While the threshold for determining the non-appropriate classification will vary with the value of a project's savings, a light logger study is generally indicated if the true hours appear to differ from 2011 TRM EFLH values by 50% or more.
- The TRM does not state the percent deviation (for example, 20% or 50%) between TRM tables and the apparent actual hours of operation for use as the threshold to determine whether a light logger study is needed. The threshold recommended here and the final decisions regarding the threshold are internal policy and procedural decisions.

Light loggers must be located on fixtures that are selected by a sampling routine that ensures that the study results will be statistically meaningful.

For projects enrolled after May 31, 2011, with an estimated change in connected load less than 50 kW, the 2011 PA TRM states that *"...stipulated whole building hours of use must be used as shown in Table 3-5."*[28] If a building is not listed in Table 3-5, the 2011 PA TRM states that EFLH must be estimated by a light logger study or an alternative method. An example of an alternative method is using the results from two or three logger studies in small retail chain stores for other like-size stores in the chain that keep the same schedule. Interviews alone are usually not sufficient for estimating the EFLH for these smaller projects, unless there is supporting evidence such as a time clock or EMS schedule, or posted hours of operation as with a retail store.

Logger Quantity and Duration

[27] Pennsylvania PUC. *Technical Reference Manual.* Page 128. June 2011.
[28] Ibid.

When EFLH are estimated from a light logger study, the loggers should be deployed for a minimum of two weeks that represent the building's typical operating schedule. For projects with an estimated change in connected load of 50 kW or more, a minimum of three loggers should be deployed per usage group. Only those usage groups representing 80% of the kWh/year estimated savings need be logged; the remaining usage group(s) annual hours can be based on interviews only.

For projects with an estimated change in connected load less than 50 kW, EFLH by building type applies and no usage groups are required. A minimum of three loggers deployed for a minimum of three weeks will suffice for these projects. The loggers should be installed in spaces representative of building operating schedules (e.g., open offices, warehouse).

Documentation

If the 2011 PA TRM stipulated EFLH is not used, then a statement shall be placed in the project records that describes the reason for the deviation. The statement should fully document the logger study. Electronic copies of the raw and processed data logger files shall also be placed in the project record. Likewise, if the 2011 PA TRM EFLH is not used, a logger study is not conducted (e.g., if the usage group is a very small contributor to overall project savings), findings and the decision shall be fully documented in the project record.

Evaluator Review

The EM&V CSP will periodically review samples of lighting projects for accuracy and adherence to the 2011 PA TRM guidelines. Light loggers will be deployed only if, in the evaluator's judgment, the use of stipulated hours is an inappropriate application of building types in Table 3-2 or Table 3-5.

Appendix G: E-Power Wise Program and Behavior Savings Calculations

Program Savings

This appendix provides the inputs and calculations used to determine energy savings for the E-Power Wise 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 Faucet Aerator" algorithm provided in the TRM, as follows:

$$\Delta kWh = ISR \times [(F_B - F_P) \times T_{Person\text{-}Day} \times N_{Persons} \times 365 \times \Delta T_L \times U_H \times U_E \times Eff^{-1}] / (F/home)$$

$$\Delta kW_{peak} = ISR \times Energy\ Impact \times F_{ED}$$

The assumptions for variables used in these equations are provided in Table G-1.

Table G-1: Low-flow Faucet Aerator Calculation Assumptions

Parameter	Description	Type	Value	Source
F_B	Average Baseline Flow Rate of Aerator (GPM)	Fixed	2.2	TRM
F_P	Average Post-measure Flow Rate of Sprayer (GPM)	Fixed	1.5	TRM
$T_{Person\text{-}Day}$	Average Time of Hot Water Usage per Person per Day (minutes)	Fixed	4.95	TRM
N_{Per}	Average Number of People per Household	Fixed	2.48	TRM
ΔT	Average Temperature Differential Between Hot and Cold Water (°F)	Fixed	25	TRM
U_H	Unit Conversion: 8.33 BTU/Gallons,°F	Fixed	8.33	TRM
U_E	Unit Conversion: 1 kWh/3,413 BTU	Fixed	1/3413	TRM
Eff	Efficiency of Electric Water Heater	Fixed	0.90	TRM
F_{ED}	Energy to Demand Factor	Fixed	0.00009172	TRM
F/home	Average Number of Faucets per Household	Fixed	3.5	TRM
ISR[a]	In-service Rate	Variable	Variable	Participant Kit Surveys

NOTES:
[a] Used interchangeably with installation rate.

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:

$$\Delta kWh = ISR * ((((GPM_{base} - GPM_{low}) / GPM_{base}) * people * gals/day * days/year) / showers) * lbs/gal * (TEMP_{ft} - TEMP_{in}) / 1{,}000{,}000) / EF / 0.003412$$

$$\Delta kW_{peak} = ISR * \Delta kWh * EnergyToDemandFactor$$

An ISR was included in the first calculation above in order to account for the fact that survey data indicated less than a 100% installation rate for this measure. The assumptions for variables used in these equations are provided in Table G-2.

Table G-2: Low-flow Showerhead Calculation Assumptions

Parameter	Description	Type	Value	Source
GPM_{base}	Baseline Showerhead GPM	Fixed	2.5	TRM
GPM_{low}	Low-flow Showerhead GPM	Variable	2	Participant Kit Surveys
people	Average Number of People per Household	Fixed	2.48	TRM
gals/day	Average Gallons of Hot Water Used by Shower per Day	Fixed	11.6	TRM
days/year	Number of Days per Year	Fixed	365	TRM
showers	Average Number of Showers in Household	Fixed	1.6	TRM
lbs/gal	Pounds per Gallon	Fixed	8.3	TRM
$Temp_{ft}$	Assumed Temperature of Water Used by Faucet	Fixed	120	TRM
$Temp_{in}$	Assumed Temperature of Water Entering House	Fixed	55	TRM
EF	Recovery Efficiency of Electric Hot Water Heater	Fixed	0.9	TRM
conversion	Constant to Converts MMBtu to kWh	Fixed	0.003412	Participant Kit Surveys
EnergytoDemandFactor	Summer Peak Coincidence Factor for Measure	Fixed	0.00009172	TRM
ISR[a]	In-service Rate	Variable	Variable	Participant Kit Surveys

NOTES:
[a] Used interchangeably with installation rate.

CFL Savings

The energy savings for the 15 Watt CFL and 20 Watt CFL distributed in the participant kits are calculated by inputting the installation rates determined by the participant kit surveys into the "ENERGY STAR CFL Bulbs (screw-in)" algorithm provided in the TRM, as follows:

$$\Delta kWh = ((CFL_{watts} X (CFL_{hours} X 365))/1000) X ISR_{CFL}$$

$$\Delta kW_{peak} = (CFL_{watts})/1000 X CF X ISR_{CFL}$$

The assumptions for variables used in these equations are provided in Table G-3.

Table G-3: CFL Savings Calculation Assumptions

Parameter	Description	Type	Value	Source

Parameter	Description	Type	Value	Source
CFLhours	Average Hours-of-use per Day per CFL	Fixed	2.9	TRM
CF	Demand Coincidence Factor	Fixed	5%	TRM
ISRcfl	In-service Rate per CFL	Fixed	84%	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 interchangeably with installation rate.				

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:

$$\Delta kWh = ((W_{inc} * h_{inc}) - (WNL * h_{NL})) * 365 / 1000 * ISRNL$$

$$\Delta kW_{peak} = 0 \text{ (assumed)}$$

The assumptions for variables used in this equation are provided in Table G-4.

Table G-4: Electroluminescent Nightlight Savings Calculation Assumptions

Parameter	Description	Type	Value	Source
W_{NL}	Watts per Electroluminescent Nightlight	Fixed	0.03	TRM
Winc	Watts per Incandescent Nightlight	Fixed	7	TRM
h_{NL}	Average Hours-of-use per Day per Electroluminescent Nightlight	Fixed	24	TRM
h_{inc}	Average Hours-of-use per Day per Incandescent Nightlight	Fixed	12	TRM
ISR_{NL}	In-service Rate per Electroluminescent Nightlight, to be Revised Through Surveys	Variable	Variable	Participant Kit Surveys
NOTES:				

Behavior Savings

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 are used to determine the ISR—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 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.
- **Refrigerator and Freezer Plug Load Savings:** Savings achieved by customers who unplugged their refrigerator or freezer for a portion of the year.
- **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.

Water Heater Energy Savings

Water heater energy savings is potentially two-fold 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:

$$\text{Electricity Impact (kWh)} = kWh_{wh} + kWh_{wm}$$

Where:

kWh_{wh} = Energy savings of water heater
kWh_{wm} = Energy savings of washing machine

The first component of this equation (kWh_{wh}) is the energy savings achieved as a result of a reduction in the temperature setting of the hot 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 hot water heater component of the hot 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:

$$\textit{Water Heater Setting Savings } (\Delta kWh_{wh}) = (kWh_f + (kWh_{cw} X\ CW)) X\ ISR_{wh} X\ ISR_{ewh}$$

The assumptions for variables used in this equation are provided in Table G-5.

Table G-5: Water Heater Setting Savings (kWh_{wh}) Calculation Assumptions

Parameter	Description	Type	Value	Source
kWh_f	Energy Impact of Water Heater Temperature Reduction on Faucet Hot Water Use	Fixed	119	CMP
kWh_{cw}	Energy Impact of Water Heater Temperature Reduction on Clothes Washer Use	Fixed	84	CMP
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
NOTES:				

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 hot 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:

$$\textit{Washing Machine Setting Savings, Without Water Heater Temperature Adjustment } (\Delta kWh_{wm}) = ISR_{wm} \times ((CW\%_{post} - CW\%_{pre}) \times kWh_{cw2})) \times ISR_{ewh}$$

$$\textit{Washing Machine Setting Savings, With Water Heater Temperature Adjustment } (\Delta kWh_{wm}) = ISR_{wm} \times ((CW\%_{post} - CW\%_{pre}) \times kWh_{trcw}) - kWh_{cw}) \times ISR_{ewh}$$

The assumptions for variables used in this equation are provided in Table G-6.

Table G-6: Washing Machine Setting Calculation Assumptions (kWh_{wm})

Parameter	Description	Type	Value	Source

Parameter	Description	Type	Value	Source
ISR_{wm}	In-service Rate per Water Heater Temperature Reduction	Variable	Variable	Phone Surveys
$CW\%_{post}$	Percent of Clothes Washing Loads Washed in Cold Water Post-participation	Variable	Variable	Phone Surveys
$CW\%_{pre}$	Percent of Clothes Washing Loads Washed in Cold Water Pre-participation	Variable	Variable	Phone Surveys
kWh_{cw2}	Energy Impact of Laundering in Cold Water Without Reducing Water Heater Setting	Variable	Variable	Phone Surveys
kWh_{trcw}	Energy Impact of Laundering in Cold Water After Reducing Water Heater Setting	Fixed	393	CMP
kWh_{cw}	Energy Impact of Water Heater Temperature Reduction on Clothes Washer Use	Fixed	478	CMP
ISR_{ewh}	In-service Rate per Electric Water Heater Versus Other Fuel Water Heater	Variable	Variable	Phone Surveys
NOTES:				

The resulting savings will be applied to the population as a whole, accounting for saturation of electric water heaters.

Unplugged Refrigerator and Freezer

Participants are encouraged to unplug their refrigerators and freezers if they are not necessary. Surveys determine 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. The energy savings for the reduction in use of the refrigerator or freezer is calculated by inputting the number of months the equipment was turned off, as determined by the participant kit surveys, into the "Unplug Refrigerator and Freezer Savings" algorithm provided in the CMP, as follows:

$$\textit{Refrigerator and Freezer Plug Load Savings } (kWh_{RF}) = R_{kWh} X (R_{Post} - R_{Pre}) + F_{kWh} X (F_{Post} - F_{Pre})$$

The assumptions for variables used in this equation are provided in Table G-7.

Table G-7: Unplugged Refrigerator and Freezer Savings (kWh_{RF}) Calculation Assumptions

Parameter	Description	Type	Value	Source
R_{kWh}	kWh of Refrigerator	Fixed	144	CMP
R_{Post}	Sum of Months per Year Refrigerator(s) was/were Turned Off Post-participation	Variable	Variable	Phone Surveys
R_{Pre}	Sum of Months per Year Refrigerator(s) was/were Turned Off Pre-participation	Variable	Variable	Phone Surveys
F_{kWh}	kWh of Freezer	Fixed	144	CMP
F_{Post}	Sum of Months per Year Freezer(s) was/were Turned Off Post-participation	Variable	Variable	Phone Surveys
F_{Pre}	Sum of Months per Year Freezer(s) was/were Turned Off Pre-participation	Variable	Variable	Phone Surveys
NOTES:				

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 or not 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:

$$\textit{Home Temperature Setpoint Savings } (kWh_{temp}) = HT_{kWh} \times ISR_{HT} + AC_{kWh} \times ISR_{AC}$$

The assumptions for variables used in this equation are provided in Table G-8.

Table G-8: Adjust Home Temperature Settings Savings (kWh_{temp}) Calculation Assumptions

Parameter	Description	Type	Value	Source
HT_{kWh}	kWh of Heating Temperature Reduced	Fixed	16	CMP
ISR_{HT}	In-service Rate per Heating Temperature Reduction	Variable	Variable	Phone Surveys
AC_{kWh}	kWh of Cooling Temperature Increased	Fixed	16	CMP
ISR_{AC}	In-service Rate per Cooling Temperature Increased	Variable	Variable	Phone Surveys
NOTES:				

Behavior Savings

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 two-fold 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 G-9 presents data that was collected to complete the calculations designed to estimate energy savings for this behavior change. Note that while 143 total participants were surveyed, the percentages are based on the total number of participants who responded to each question, as shown in the table.

Table G-9: Water Heater Energy Savings Variables from Survey

Baseline or Behavior Verified	Number of Respondents	Installation Rate (ISR)	Assigned Variable in CMP
Electric Water Heater on Site	137	48%	ISR_{ewh}
Washing Machine in Home/Unit	143	84%	CW
Lowered Water Heater Temperature	129	40%	ISR_{wh}
Confirmed Increase in Laundry Loads Washed in Cold Water	143	23%	ISR_{wm}
Increased Percentage of Laundry Loads Washed in Cold Water	33	40%	$CW\%_{post}$-$CW\%_{pre}$
NOTES:			

Water Heater Setting Savings Calculation Results

The energy savings for the reduction in the temperature setting of the electric hot 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:

$$CMP\ (\Delta kWh_{wh}) = (kWh_f + (kWh_{cw} X\ CW)) X\ ISR_{wh} X\ ISR_{ewh}$$

$$Verified\ (\Delta kWh_{wh}) = (119 + (84 X\ 84\%)) X\ 40\% X\ 48\%$$

$$Total\ Water\ Heater\ Setting\ Savings\ (kWh_{wh}) = 37\ kWh$$

$$Total\ Water\ Heater\ Setting\ Savings\ (kW_{wh}) = .003\ kW$$

Demand for this savings was calculated by applying the kW/kWh ratio of water heater savings observed in the faucet aerator calculation to the kWh savings for this behavior change.

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 (ΔkWh_{wm})

$$Without\ Water\ Heater\ Temperature\ Adjustment = ISR_{wm} X ((CW\%_{post} - CW\%_{pre}) X kWh_{cw2})) X ISR_{ewh}$$

$$With\ Water\ Heater\ Temperature\ Adjustment = ISR_{wm} X ((CW\%_{post} - CW\%_{pre}) X kWh_{trcw}) - kWh_{cw}) X ISR_{ewh}$$

Verified (ΔkWh_{wm})

$$Without\ Water\ Heater\ Temperature\ Adjustment = 23\% X ((40\%) X 478)) X 48\%$$

$$With\ Water\ Heater\ Temperature\ Adjustment = 23\% X ((40\%) X 393) - 84) X 48\%$$

Washing Machine Setting Savings (kWh_{wm})

Without Water Heater Temperature Adjustment = 21

With Water Heater Temperature Adjustment = 8

Total Washing Machine Setting Savings (kWh_{wm}) = 29

There was no demand savings associated with this behavior change.

The total water heater energy savings for this program is presented below.

$$\text{Electricity Impact (kWh)} = kWh_{wh} + kWh_{wm}$$

$$66\ kWh = 37kWh + 29kWh$$

Unplugged Refrigerator and Freezer
The data collected for this behavior change indicates that few people engaged in this behavior. Those who unplug their refrigerator or freezer were not able to provide enough information to calculated savings for this behavior change.

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 G-10 presents data that was collected to complete the calculations for estimating energy savings for this behavior change. Note that while 143 total participants were surveyed, the percentages are based on the total number of participants who responded to each question, as shown in the table.

Table G-10: Adjust Home Temperature Energy Savings Variables from Survey

Baseline or Behavior Verified	Number of Respondents	Installation Rate (ISR)	Assigned Variable in CMP
Turned Down Heating Thermostat	141	71%	ISR_{HT}
Air Conditioner in Home/Unit	130	68%	ISR_{EAC}
Turned Up Cooling Thermostat	93	19%	ISR_{AC}
NOTES:			

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:

$$CMP\ (kWh_{temp}) = HT_{kWh}\ X\ ISR_{HT} + AC_{kWh}\ X\ ISR_{AC} X\ ISR_{EAC}$$

$$Verified\ (kWh_{temp}) = 16\ X\ 71\% + 16\ X\ 19\%\ X\ 68\%$$

$$Total\ Home\ Temperature\ Savings\ (kWh_{temp}) = 13\ kWh$$

$$Total\ Home\ Temperature\ Savings\ (kW_{temp}) = .01\ kW$$

Demand for this savings was calculated by applying the kW/kWh ratio of energy savings observed in the TRM calculation for high-efficiency CAC replacement to the air conditioning component of the kWh savings for this behavior change.

Appendix H: HVAC Tune-Up Program Savings Calculations

Table H-1 lists all the HVAC units tested by the EM&V CSP. Of the 32 systems tested, 13 units were serviced in PY2. Three additional units were serviced in PY2. The initial test was sent to FDSI; however, these systems did not receive an incentive because the contractor did not complete the service. Three units were serviced in PY3. The remaining 13 units were not serviced. The EM&V CSP attempted to complete the minimum sampling requirement of 20 systems by verifying additional units in September 2011. The details of sites visited and units verified are provided in Table H-1.

Table H-1: Sites and Units Selected for Verification

Business	Unit Name	Model	Verified	Serviced?	Service Type
Cinemark	15	yfd151c4lcaa	May	PY2	Test in
	14	ycd120c4mcac	May	PY2	Test in
	28	yfd061c4hfbf	May	PY2	Test in
	29	ycd037c4hfbe	May	PY2	Test in
Weiler Corp	pbcrimp	tch181e400ba	May	PY2	Test in, Economy
	16223	50pgc12a60	May	PY2	Test in, Reference, Economy
	Exec Office	TCD-036C400A	May	No	
	wh1	tcd151b400db	September	PY2	Test-in, Economy
	vh4	tcd151b400db	September	PY2	Test in, Economy
Bank of America - 1952 MaCarthur Road	PRT-1	580FPV121224AAGA	May	PY3	Test in
Bank of America - 2126 MaCarthur Road	1	D3CG072N07925EBE	May	No	
	2	D3CG072N07925EBE	May	No	
Bank of America - 7150 Hamilton Blvd	2	GCS16-653-125-1Y	May	No	
	1	GCS16-653-125-1Y	May	No	
Tyco Bldg 38	RTU 11	J25ZJN24S4AZZ10001B	May	No	
	RTU 6	J25ZJN24S4AZZ10001B	May	No	
	1	J25ZJN24S4AZZ10001B	September	PY2	Test in
	9	J25ZJN24S4AZZ10001B	September	PY2	Test in
	10	J25ZJN24S4AZZ10001B	September	PY2	Test in
Tyco Bldg 106	AC6	200809-AMGL45557	May	No	
	AC1	RM-010-8-0-BA02-234	May	No	
Bon Ton Dist Center	RTU-1	YSC092E4RHAONF0C1A100000A2	May	No	
	none	50DP020 600	May	No	
	A-48 #4	48TJF008---601AA	May	No	
	7	48TJF008--601AA	May	No	
Bon Ton Stroudsburg	4	ted600a4dt1b4nc1a0c0000h0000000	September	PY3	Economy

Business	Unit Name	Model	Verified	Serviced?	Service Type
	6	38ae044600	September	PY3	Reference, Economy
Lowes 1867	6	48HGDL24AA-61AA6	September	PY2	Test in, Economy
	10	50HGDL24AA-61ABA	September	PY2	Test in, Economy
	17	50HG-L24AA-61ABH	September	PY2	Test in, Economy
	19	48HGDL16A-61AAK	September	PY2	Test in, Reference, Economy
	20	48HGDL16A-61AAL	September	PY2	Test in, Economy
NOTES:					

FDSI Calculation Review – Compressor Capacity and EER

One of the documents provided by FDSI is entitled *Estimating Efficiency and Capacity for Vapor Compression Cycle Equipment Calculation Algorithms.* This document clarifies the methods used to estimate compressor capacity and COP described in U.S. Patent No. 6,701,725. FDSI uses a proprietary model to develop expected values for a properly tuned system. Expected values of the performance indices (evaporating temperature, super heat, condenser over ambient temperature, and sub-cooling) are determined from using the system characteristics (system type, expansion device, and rated cooling efficiency) and independent operating parameters (return air temperature, return air wet-bulb, and outdoor temperature). Ultimately, a cooling capacity and compressor power are estimated as expected performance values.

FDSI also estimates measured (actual) performance from compressor maps using actual contractor measurements of the system. Obtaining these measured performance values requires only the following common and easily obtainable contractor measurements:

- Liquid or discharge pressure
- Suction pressure
- Liquid line temperature
- Suction line temperature
- Condenser air entering temperature

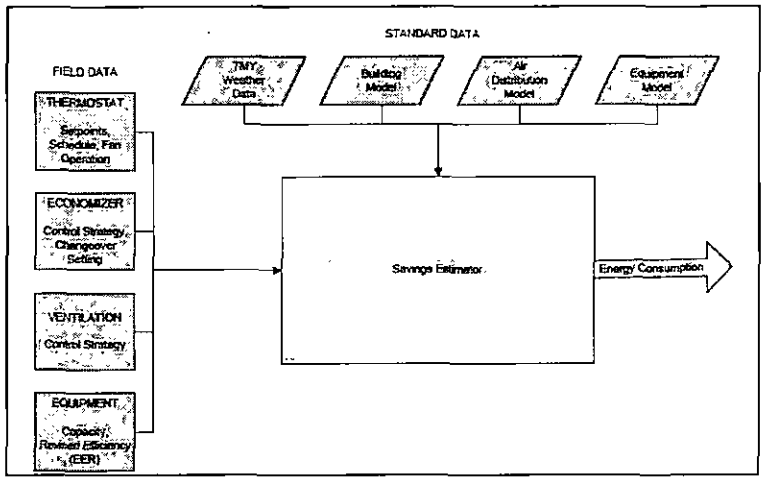
The expected performance and measured performance values are used to develop the efficiency index (EI) and capacity index (CI). The developed efficiency and capacity indices are used to estimate energy and demand savings with FDSI's Savings Estimator software.

Generic compressor map coefficients are used to estimate both refrigerant mass flow through the compressor and the compressor power. The EM&V CSP reviewed the calculation methodology and found the algorithms and logic to be sound and very rigorous. In addition to the review, analysis of a unit with known compressor maps was selected for detailed analysis.

The Savings Estimator software simultaneously calculates energy use and savings for all measures performed on one system. An overview of the inputs and standard data is illustrated in Figure H-1. This calculation methodology accounts for interactive effects when multiple measures are implemented. For

example, if efficiency is improved due to a refrigerant charge adjustment, but the system runs less because the economizer is repaired, savings for each measure are reduced accordingly.

Figure H-1: FDSI Savings Estimator Process Diagram



Independent Calculations

Compressor capacity was calculated using the actual compressor map coefficients from the compressor manufacturer. The EM&V CSP measured the actual compressor power, evaporator fan power, and condenser fan power to develop a spot EER measurement. This spot measurement was then normalized using manufacturer's capacity charts. These charts, found in the Microsoft Excel® file "HVAC TuneUp Calcs.xlsx" were used to develop a capacity normalization factor to estimate capacity with 95° Fahrenheit condenser entering temperature and a 67° Fahrenheit wet bulb. The intent is to compare measured EER to nameplate-rated EER[29] to independently develop an EI, a main input to FDSI's Savings Estimator software. A CI was developed in a similar manner. Calculations steps are as follows:

- Use compressor-specific coefficients to estimate mass flow through the compressor.
- Determine enthalpy of liquid and suction line.
- Calculate compressor capacity by multiplying enthalpy change by mass flow.
- Normalize capacity with reported manufacturer data (see Figure H-2).
- Develop a CI for comparison to FDSI's CI.[30]
- Calculate measured system EER by dividing compressor capacity by system power. System power must include evaporator and condenser fans. If the system has multiple compressors, adjust fan power accordingly (i.e., if the system has two circuits, use 50% of evaporator fan power).
- Normalize measured EER to nameplate-rated EER (if detailed manufacturers data is unavailable).
- Develop an EI for comparison to FDSI's reported EI.

[30] CI, dimensionless, is defined as the ratio of measured gross cooling capacity to expected gross cooling capacity.

Specific manufacturer data was used to generate Figure H-2. Multiple regression lines were developed for variable return air wet bulb temperature and also for variable condenser entering temperature. These values came directly from the manufacturer of the HVAC system. Details are shown in the "HVAC TuneUp Calcs.xlsx" file. The normalization is set such that nameplate-rated EER condition has a normalization factor of 1.[31] The two graphs in Figure H-2 were combined to result in the surface graph displayed as Figure H-3.

Figure H-2: Compressor Capacity Normalization Curves

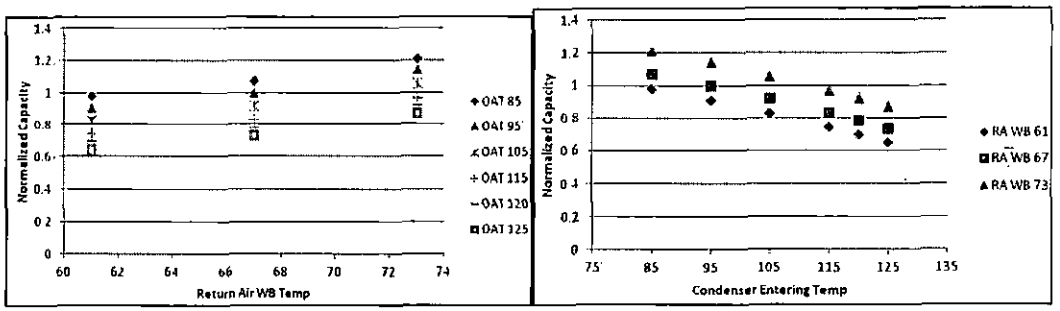
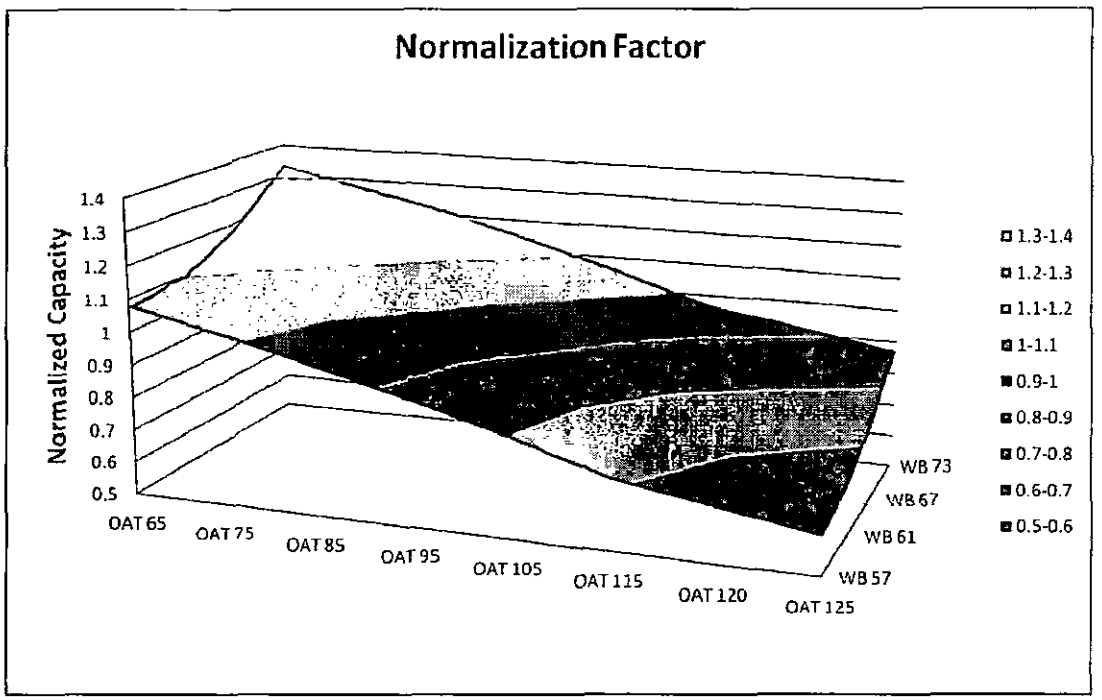


Figure H-3: Normalization Factor Profile for Unit-Specific Compressor Capacity



[31] Nameplate-rated EER is the ratio of total system cooling capacity to input power at 95°Fahrenheit condenser entering temperature and 67° Fahrenheit return air wet bulb temperature.

EER, or capacity vs. temperature data, is not always readily available from manufacturers. Nameplate-rated EER is almost always available. Nameplate-rated EER gives an expected performance with standard conditions. This is compared to the field-verified performance, which is normalized to the same standard conditions.

The purpose of independently estimating EI was two-fold:

1. System performance characteristics vary based on operating conditions (indoor and outdoor air temperatures) at the time of measurement. EI should generally remain consistent. That is to say, if a system is operating differently from expected performance, one would expect similar deviance from expected performance with a different set of conditions. If the FDSI-estimated EI is similar to the EM&V CSP-estimated EI, it is verified as being accurate.[32]
2. The relationship between EER and ambient conditions is readily available. Little is published explaining the variation of EI over a broad range of operating conditions. If the EM&V CSP confirms that EI is similar for varying outdoor air temperatures and with varying return air wet bulb temperatures, system SEER and EI from a spot measurement may be used with confidence to estimate energy savings. Additionally, EI may be used to provide an accurate estimate of savings from meter data in future studies.

Cinemark unit #15 was selected for a detailed analysis and comparison. The rooftop package unit (model #yfd151c4lcaa) is a 12.5-ton 13 SEER, 11.3 EER two-circuit system. The compressor mapping coefficients result in very different mass flow and estimated power measurements. The desired results of CI and EI, however, are similar. Table H-2 shows a summary of the detailed analysis comparing EM&V CSP to FDSI algorithms.

Table H-2 shows that the EM&V CSP values for mass flow and compressor power are quite different from FDSI values. If generic compressor maps are used, one would not necessarily expect the values for mass flow and power to accurately represent the actual values. The ratios (EI and CI) are the metrics of interest, and these are what are reported for comparison. The EM&V CSP used the coefficients unique to the actual compressor installed (Copeland Model #ZR68KC-TF5) to calculate expected capacity based on the measured suction and discharge dew point temperatures. Capacity was normalized as described above. The FDSI estimates of EI and CI, critical inputs for savings estimates, are also shown in the table.

[32] EI is only verified for one set of conditions, because only a spot measurement is taken. The EM&V CSP investigated EI and CI at various conditions to determine the relationship of the indices at variable temperatures of return air wet bulb and entering condenser (outdoor).

Table H-2: Calculation of EI and CI for Comparison

	Circuit	Enthalpy Liquid Line	Enthalpy Suction Line	M from Comp Map (lbs/hr)	Comp Capacity	Comp Capacity Normalized	CI	Measured Comp Power	Measured EER	Normalized EER	Rated EER	EI
EM&V CSP	1	97	175	965	75,449	70,935	0.97	4,312	12.64	11.82	11.3	1.04
	2	97	175	966	75,577	71,054	0.99	4,250	12.80	11.96	11.3	1.07
FDSI	1			520			1.07	2,355			11.3	1.12
	2			522			0.99	2,310			11.3	1.04
NOTES:												

Refrigeration Cycle Savings

Refrigerant line temperatures and pressures cannot simply be checked and compared, because these measurements are variable with ambient conditions. The EM&V CSP checked system charge to calculate and compare super heat and/or subcooling. The purpose was to identify systems that might require charge adjustment. In most cases, the systems selected for verification matched the super heat and subcooling values reported by the contractor. For the two systems that showed significant differences, there was no energy savings reported (only a *diagnostic test-in*).

A detailed review of EI and CI was conducted, because changes in these values significantly affect energy savings. Distinctly, the EM&V CSP used specific compressor map coefficients and actual power measurements to estimate EI and CI. The Service Assistant™ diagnostic tool and Savings Estimator software use generic compressor maps to estimate compressor capacity and power; and the EM&V CSP independently confirmed that EI and CI are consistent with the values reported by contractors using this tool and software.

Estimation of efficiency alone does not provide savings. For comparison, the EM&V CSP used the PUC TRM algorithms to estimate savings. The intent was not to develop new savings estimates, but rather to *compare and identify discrepancies. The following* algorithms are from the PUC TRM:

$$\Delta kWh = EFLH \times \frac{BTU}{hr} \times \frac{\left(\frac{1}{SEER_{base}} - \frac{1}{SEER_{ee}}\right)}{1000\frac{W}{kW}}$$

$$\Delta kW = CF \times \frac{BTU}{hr} \times \frac{\left(\frac{1}{EER_{base}} - \frac{1}{EER_{ee}}\right)}{1000\frac{W}{kW}}$$

Where:

EFLH = Equivalent full load hours
BTU/hr = Cooling capacity
CF = Coincidence factor (67% per PA PUC TRM)

Example Inputs:

605 full load hours (office: general/retail in Scranton, PA; hours from PUC TRM)
10 SEER, 12.5 ton system
Pre EI = 83.1%
Post EI = 90.5%
TRM savings = 893 kWh
Savings reported to PPL Electric = 578 kWh

Using the EI to adjust nameplate-rated SEER, the TRM algorithms generally estimate higher energy and demand savings. This type of check was completed for all verified systems reporting energy savings from refrigerant adjustment. Note that the run time hours estimated by the Service Assistant™ diagnostic

tool are actual hours the compressor runs (with variable capacity and power), and the hours in the algorithm above are EFLH.

In addition to refrigeration cycle analysis, the EM&V CSP collected information to confirm all other inputs used to estimate energy savings. For every unit verified, the information reported to PPL Electric that might affect savings estimates was either verified, confirmed reasonable, or noted if different. All inputs collected by contractors and the findings verified in the field by the EM&V CSP are summarized in Table H-3.

Table H-3: Verified Inputs

Measure	Reported Elements	EM&V CSP Verification Comments
Building information	Contractor chose building type	Verified building type and verified operation strategy (were reasonable hours used?).
Equipment type (make, model, serial number)	Contractor input unit information including site-specific unit number	All information confirmed accurate.
High side port location	Contractor input location (liquid or discharge)	One incorrect location recorded, negligible effect on savings.
Expansion device type	Contractor recorded expansion device type from visual inspection	All expansion device types accurately recorded.
Refrigerant type	Contractor recorded refrigerant type	All refrigerant types recorded correctly.
Refrigerant pressure and temperatures	Contractor recorded measurements after 15 minute run time	Took measurements to compare super heat and/or sub-cooling values. Some variation occurred, as expected. Measurements also feed into advanced algorithms which were reviewed in detail. No verified change in savings found.
Return air wet-bulb temperature	Contractor recorded measurements	Reviewed contractor measurements for reasonableness. Recorded wet-bulb temperature for use in independent savings estimate.
Fan configuration and mode	Contractor recorded configuration and mode (auto or on)	Configuration recorded correctly. Mode information accurate or N/A because an EMS controlled thermostat is used.
Capacity	Contractor input capacity from nameplate model number	All inputs correct.
SEER and EER	Contractor input, if known	Many fields missing, but there was no change to verified savings.
Economizer details (control type, settings, and strategy)	Contractor input specific details of economizer	Verified correct sensor type, position, configuration, etc.
Zone occupancy	Contractor input zone type	Records missing, set to default.
Thermostat type and details (Programming and set points)	Contractor input temperature set points and HOU	No set points were confirmed from verification for thermostat measure. Four systems were confirmed from diagnostic test of recorded set points.
Ventilation control strategy	Contractor recorded control of outside air intake	Two systems listed as DCV; unable to confirm.
NOTES:		

Economizer Savings

Verification of proper economizer function is not possible from a single site visit. Where an economizer was present, the EM&V CSP recorded the economizer details and tested its functionality. Verification of contractor-reported inputs was achieved using the following methods:

- Test economizer functionality by cycling through the system test mode to verify operation of damper motors and linkages.
- Where possible, cool the outdoor air temperature sensor with a wet sock or ice pack to test control and temperature sensor functionality.

Of the systems verified, eight had economizers; all of which received an economizer functionality test. The contractors recorded correct economizer type for all eight systems. To verify economizer savings, the EM&V CSP reviewed all savings estimates. The savings reported an average of approximately 3% of total energy use.

Two systems reported economizer savings of 10.8% and 19.4%, one of which happened to be verified in the random sample. A detailed analysis was conducted to verify savings of this system: a 15 ton, 13 SEER rooftop package unit at a manufacturing facility. The EM&V CSP verified that an economizer was present but not functional. The EM&V CSP estimated economizer energy savings using Honeywell's Savings Estimator program version 4.2. Building and zone information and operating strategy settings were inputs to the Honeywell program. The economizer strategies used in Honeywell's Savings Estimator software assume continuous ventilation based on the design peak occupancy and ASHRAE Standard 62.1-2007 for minimum outdoor air settings. This program estimates that the energy savings with the use of a differential enthalpy sensor is nearly 10%. Similarly, FDSI estimates energy savings at 10.8% for this system.

Very conservative estimates were used to predict economizer savings for this unit. The EM&V CSP confirmed the following:

1. Reasonable assumptions were input for this system.
2. Default values used are reasonable for this system.
3. FDSI's Savings Estimator estimated reasonable energy savings for economizer savings.

Thermostat Savings

The thermostat type, set points, and schedule were collected by the EM&V CSP. The purpose of collecting this information was to compare data reported by contractors. Contractors did not report thermostat measure savings for any of the systems verified in the field. Set points and thermostat type were, however, collected and used as inputs to the Savings Estimator software. The Savings Estimator calculated runtime based on thermostat hours. If no thermostat hours were entered, default thermostat settings were based on building type. For example, office building hours are set from 8:00 a.m. to 5:00 p.m. The compressor runtime hours used were reviewed for each system verified. The hours were confirmed as reasonable given the building type.

Appendix I: Additional Home Assessment & Weatherization Program Impact Analysis

The EM&V CSP conducted a QA/QC records review of the Home Assessment & Weatherization Program's PY2 records. The purpose of the records review was to verify the accuracy of data entry, the measures installed, and the measure quantity recorded. The Home Assessment & Weatherization Program claims savings for each direct installation measure installed.

An review of the PY2 participant data revealed that 13 records contained values in the "Quantity" field that were outside the number of direct installation measures allowed by the program; six of these records occurred in Q2 and two occurred in Q3. The eight records from the Q2 and Q3 data were automatically selected for the records review. The rest of the sample points for each stratum were selected via simple random sampling.

The EM&V CSP reviewed the implementation CSP's (EIC's) program tracking database and copies of the survey/audit form filled out for each participant by the surveyor or auditor. Because savings for survey and audit participants are deemed per measure for each of the direct install measures available, the EM&V CSP focused its review on whether the measures and measure quantities recorded on the survey/audit form were recorded accurately in EEMIS and in EIC's program tracking database.

Additionally, because inaccurate recording of recommended measures in EEMIS will result in rejections of customer bonus rebate applications, the EM&V CSP also reviewed the measures recommended on the survey/audit form to determine if that information had been transferred accurately to EIC's program tracking database and to EEMIS.

Finally, the EM&V CSP reviewed customer contact information for data transfer accuracy.

The EM&V CSP found the following discrepancies and reviewed them with PPL Electric. Some discrepancies may be data entry errors. PPL Electric reviewed the QA/QC report and recommendations.

- In 15 of 25 records, the measure quantities in EEMIS and EIC's program tracking database did not match the quantity recorded on the survey/audit form.
- In three of the 25 records, the measure quantities recorded on the survey/audit form match the information recorded in EEMIS but did not match the information recorded in EIC's program tracking database.
- In 12 of 25 records, the measure recommendation on the form match EIC's database but does not match the value recorded in EEMIS.
- In seven of 25 records, the measure recommendation on the form matches the value recorded in EEMIS, but the recommendation recorded in the EIC database is different.
- In three of 25 records, the customer name or street address on the survey/audit form does not match what is recorded in EIC's program tracking database or EEMIS.

As stated in the Residential Energy Assessment & Weatherization (previous program name) section of the Annual Report, the EM&V CSP noted measure quantities for CFLs and smart power strips outside the limits of the program design. The EM&V CSP then reviewed the measure quantities for the entire population of participants to determine the total number of units installed outside the program limitations. Four accounts recorded the installation of eight CFLs; one of these occurred in the PY3 data, and the EM&V CSP verified that the measure quantity of eight is correct during the records review and the phone survey.

Nine accounts recorded installation of more than one smart power strip. Two accounts recorded installation of two smart power strips; one of these accounts was included in the records review and the EM&V CSP verified the measure quantity of two is correct. The remaining seven accounts (recording installation of more than one smart power strip) recorded values of four, six, 10, and 12 smart power strips. All but one of these seven accounts occurred in the Q2 and Q3 data, and were audited in the records review. The EM&V CSP found the smart power strip measure quantities for these six accounts to be in error. (The recorded value represented the installed feet of pipe insulation and was recorded in the wrong field.) In all cases, the verified quantity was one.

Because values of eight CFLs and two smart power strips were verified in the records review and phone survey, measure quantities for these records were not adjusted. Measure quantities for accounts recording installation of smart power strips greater than two were adjusted to reflect the verified quantity of one. The EM&V CSP also made adjustments for verified measure quantities where the value recorded in EEMIS was found to be in error.

Finally, the EM&V CSP noted six account numbers with multiple record sets in the PY2 data. Three of the six accounts contained information for different addresses and surveys/audits. The EM&V CSP made no adjustment to the measure counts for these three accounts, as they represented separate events. Two accounts had both a survey and an audit. Because PPL Electric can only claim savings for one survey or audit per home, the EM&V CSP adjusted the measure counts for these two accounts to reflect only those installed during the audit. Finally, one record contained duplicate information for a comprehensive audit at the same home. The EM&V CSP adjusted the audit and measure counts to remove this duplicate information.

Appendix J: Additional Energy Efficient Behavior & Education Program Impact Analysis

Data Development

A requirement for eligibility in the Energy Efficient Behavior & Education Program was a complete billing history, and the monthly billing data provided by OPOWER were relatively clean. However, the EM&V CSP performed some additional data cleaning for the billing analysis. First, we dropped customers whose accounts became inactive or who did not have a complete pre-treatment or treatment period billing history. This resulted in a balanced panel of 44,650 treatment group customers and 44,741 control group customers in the estimation sample. We performed a probit analysis of inclusion in the estimation sample and found that inclusion was not significantly correlated with any observable customer characteristics, including annual consumption, report frequency, and metropolitan area. This suggests that customers excluded from the estimation sample were similar to those in the estimation sample.

The EM&V CSP calculated the heating degree days and cooling degree days (base of 65 degrees) for each customer bill and merged them onto the billing data. In the billing analysis, the first bill in each 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

The EM&V CSP employed a non-parametric, difference-in-differences regression model of monthly energy consumption with customer home fixed effects to estimate the energy savings program impacts. The average daily electricity (kWh) consumption (ADC) of home 'i' in month 't' is given by:

$$ADC_{it} = \alpha_i + \beta_1 POST_{it} + \beta_2 PROGRAM_{it} \times POST_{it} + \mu_{my} + \varepsilon_{it} \qquad \text{(Equation J1)}$$

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 in 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 customers were sampled from the same area and experienced the same weather. If this assumption does not hold, the model would substitute location-specific monthly weather variables for the month-by-year fixed effects).

ε_{it} = Error term for customer 'i' in month 't.'

$\beta 1$ = Coefficient representing the impact of factors affecting the consumption of all customers between the pre-treatment and treatment periods.

β_2 = Coefficient representing the conditional average treatment effect of the program (the kWh savings impact), controlling for changes in participant usage unrelated to the program.

The assumptions necessary to identify the program impacts are: (1) membership in the treatment and control groups is unrelated to energy use, conditional on month-by-year (weather) and customer fixed effects; and (2) conditional participant and non-participant consumption follows parallel trends over the estimation period. The experimental design of the program with measurements on consumption before and after the program should ensure that both assumptions are satisfied.

In this framework, it is possible to measure heterogeneous treatment effects by including interaction terms between POST x PROGRAM and observable customer characteristics. For example, the following specification would be used to estimate how savings evolve in the post-treatment period and the persistence of savings in homes in the second year of the program:

$$ADC_{it} = \alpha_i + \beta_0 PROGRAM_{it} + \beta_1 POST_{it} + \Sigma_{p=2}^{P}\beta_{2p} POST_{it} \times POSTMONTH_{ipt} + \beta_2 PROGRAM_{it} \times POST_{it} + \Sigma_{p=2}^{P}\beta_{2p} PROGRAM_{it} \times POST_{it} \times POSTMONTH_{ipt} + \mu_{my} + \varepsilon_{ipt} \text{ (Equation J2)}$$

Where:

p = Indexes the month number in the post-period for a building, (p = 1, 2, ...).

In this framework, the average savings of the initiative on homes in month 'p' in the post period equals:

Average monthly savings in post-period month 1 = β_2

Average monthly savings in post-period month p = $\beta_2 + \beta_{2p}$, for p = 2 to P.

Treatment Effects by Metropolitan Area

In PY2, the Energy Efficient Behavior & Education Program targeted residential customers in four metropolitan areas: Allentown, Harrisburg, Scranton, and Williamsport. Table J-1 shows the conditional average treatment effect of the program in each metro area for two different model specifications: one including month-by-year fixed effects and the other using polynomials in cooling degree days and heating degree days.

The program effects were estimated by interacting metro area indicator variables with the POST x PROGRAM interaction variable in Equation J1. The largest demand reductions were achieved in Allentown and Williamsport. The effect of the program in Allentown was to reduce average daily consumption by 0.79 kWh, or 1.5%. The effect in Williamsport was to reduce average daily consumption

by -0.89 kWh, or 1.7%. However, because the metro program impacts are estimated somewhat imprecisely, none of the differences between metro areas is statistically significant at the 5% level.

Table J-1: Conditional Average Program Treatment Effects by Metro Area (kWh)

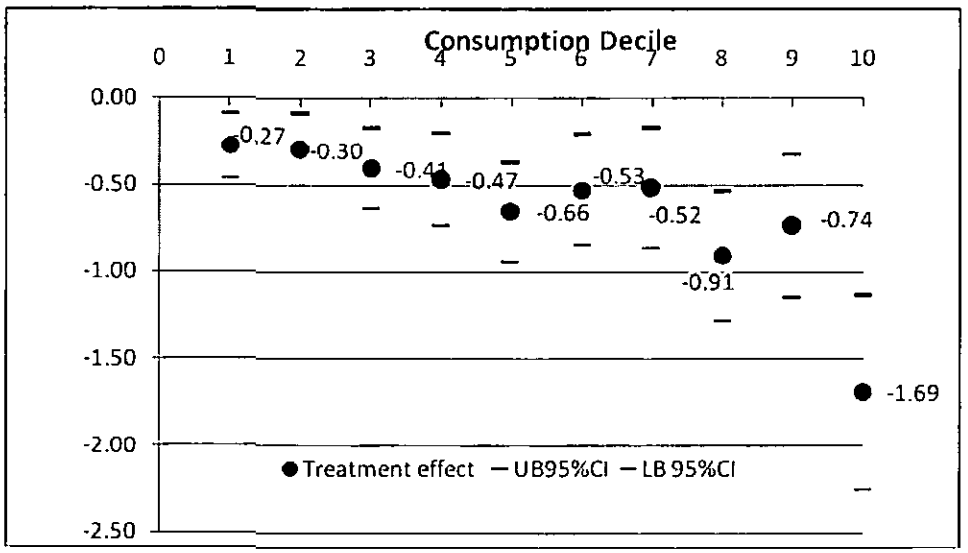
Specification	Allentown	Harrisburg	Scranton	Williamsport
Customer fixed effects, month-by-year fixed effects	-0.791	-0.618	-0.655	-0.888
	(0.108)	(0.076)	(0.299)	(0.238)
Customer fixed effects, weather polynomial	-0.789	-0.619	-0.668	-0.890
	(0.108)	(0.076)	(0.299)	(0.238)
N	815,907	1,453,303	157,918	161,099

NOTES:
The dependent variable is average daily consumption. Standard errors are shown in parentheses. Models estimated by OLS and standard errors adjusted for clustering at the customer level.

Treatment Effects by Decile

Figure J-1 shows how the program treatment effects varied by annual consumption in the pre-treatment period. Each program home was assigned to a consumption decile based on its total consumption in the year before the program. In Equation J1 with customer fixed effects and degree days, the POST x PROGRAM variable was interacted with indicators for the consumption decile. It was expected that high consumption homes would have more opportunity to reduce their consumption, and would therefore experience larger kWh reductions in response to the treatment. Furthermore, researchers have hypothesized that some low consumption homes may view information about their consumption as a license to increase their consumption, also known as the boomerang effect.[33]

Figure J-1: Conditional Average Treatment Effects by Pre-treatment Consumption Decile



[33] Allcott, Hunt. *Social Norms and Energy Conservation.* Journal of Public Economics, *forthcoming.*

As hypothesized, Figure J-1 shows an increasing relationship between pre-treatment consumption and program savings impacts. The savings impacts trend upward with consumption, from 0.27 kWh (0.9% of average daily consumption) in the first decile to 1.7 kWh (1.8%) in the top decile, though the point estimates of the treatment effects do not increase monotonically. Also, there is no evidence of a boomerang effect. Households in the lowest consumption deciles not only did not increase their consumption in response to the Home Energy Reports, they reduced their consumption by a small amount. The absence of a boomerang effect in PPL Electric's service territory is consistent with a similar finding for six other utility service territories.[34]

Treatment Effects by Report Frequency

In PY2, participants received Home Energy Reports on one of three schedules: bi-monthly, seasonal 1, and seasonal 2. Bi-monthly customers received a report every two months for a total of six during PY2; seasonal 1 customers received reports during the summer cooling and winter heating months plus one in the first month of the program for a total of seven; and seasonal 2 customers received reports during the summer cooling and winter heating months and one in each of the shoulder months (April and October) for a total of eight. It was hypothesized that savings would increase with the total number of reports and the frequency of reports during peak cooling and heating months. Thus, seasonal 2 is expected to generate the greatest savings.

Table J-2 shows the conditional average treatment effects by report frequency. All of the report frequencies generated statistically significant savings. As hypothesized, seasonal 2 resulted in the largest average savings of 0.75 kWh per home per day. The bi-monthly schedule had the next largest savings with 0.72 kWh. Homes on the seasonal 1 schedule had average daily savings of 0.1 kWh (or annual savings of 35 kWh) less than homes on the bi-monthly or seasonal 2 schedules. None of the reported frequency savings estimates are statistically different from one another.

Table J-2: Conditional Average Program Treatment Effects by Report Frequency

Report Frequency	Treatment Effect
Bi-monthly	-0.716
	(0.086)
Seasonal 1	-0.603
	(0.084)
Seasonal 2	-0.750
	(0.083)

NOTES:
The dependent variable is the average daily consumption. The model included customer fixed effects, post-program and program variables, and a polynomial in heating and cooling degree days. Standard errors are in parentheses. The models were estimated by OLS, and standard errors were adjusted for by clustering at the customer level.

[34] Ibid, Allcott.

Appendix K: 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, as well as investments in energy savings 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. In this section, we estimate 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 PY2 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 PY2 Energy Efficiency Behavior & Education Program participants (50,000) to estimate Energy Efficiency Behavior & Education Program savings counted in PPL Electric downstream rebate programs.

Table K-1 shows 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 seven downstream rebate programs in PY2. The Appliance Recycling and Home Assessment & Weatherization programs accounted for most of the savings. For example, the Energy Efficiency Behavior & Education Program resulted in approximately 6 kWh of annual savings per home from measures rebated through the Appliance Recycling Program. The Renewable Energy and Low-Income WRAP programs offset these impacts. Control group customers experienced higher savings in these programs than treatment group customers.

Table K-1: Behavioral and Education Program Savings Counted in Downstream Rebate Programs

Program	Treatment Group		Control Group		Difference (Treatment-Control)				PY2 Savings Overlap
	Ex post Savings (MWh/yr)	Per Home *Ex post* Savings (kWh/yr)	*Ex post* Savings (MWh/yr)	Per Home *Ex post* 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	1,286.3	29	1,026.6	23	259.8	6	157.8	3.6	159.0
Home Assessment & Weatherization	407.5	9.1	148.7	3.3	258.9	5.8	157.2	3.5	157.4
E-Power Wise	19.7	0.4	30.8	0.7	(11.2)	(0.2)	(11.2)	(0.2)	(11.1)
Efficient Equipment Incentive	1,509.2	33.8	1,506.3	33.7	3.0	0.1	1.8	0.1	3.7
Efficient Equipment Incentive (C&I lighting)	-	-	11.1	0.2	(11.1)	(0.2)	(6.8)	(0.2)	(6.8)
Renewable Energy	109.1	2.4	184.6	4.1	(75.5)	(1.7)	(45.9)	(1.0)	(45.7)
Low-Income WRAP	153.0	3.4	187.6	4.2	(34.6)	(0.8)	(34.6)	(0.8)	(34.2)
Total	3,485	78.0	3,096	69.2	389	8.9	218	5.0	222.4

NOTES:
Ex post savings are PY2 verified gross savings from EEMIS and pertain to treatment and control group customers in the estimation sample. Net savings are *ex post* savings multiplied by program NTG. PY2 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.

The total amount of Energy Efficiency Behavior & Education Program savings counted in other PPL Electric downstream rebate programs was 222 MWh/yr. This represents 1.7% of PY2 Energy Efficiency Behavior & Education Program savings.

Upstream Rebate Programs (CFLs)

The CFL Campaign 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 CFL Campaign savings by matching treatment and control group customers to lighting measures in EEMIS. The EM&V CSP attempted to survey Energy Efficiency Behavior & Education Program participants and non-participants about their CFL purchases to estimate the amount of Energy Efficiency Behavior & Education Program savings that were counted in the CFL Campaign. However, the EM&V CSP was unable to estimate the CFL savings overlap using this approach because the Energy Efficiency Behavior & Education Program and the CFL Campaign customer surveys yielded contradictory results and could not be used together.

Appendix L: Sampling

Introduction

In November 2010, the SWE provided the EM&V CSP with *Sampling Resolutions*, a set of guidelines that established revised and refined sampling protocols for Act 129 programs. Guidelines were refined by the SWE in February 2011. The sampling plans were revised 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 Nonresidential Portfolio
3. 85/15 for each program within each portfolio
4. GNI 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 confidence and precision levels are minimum. EDC evaluators are encouraged to exceed minimum requirements

PPL Electric Programs

There are 14 programs in PPL Electric's portfolio that were approved in the EE&C Plan. Each of the programs is in various stages of development and implementation. Of these, 10 programs claimed savings in PY2. The portfolio includes a number of programs that serve multiple sectors. Other programs will launch and claim savings in later quarters, including two programs expressly targeting demand reduction that will claim savings in 2012 (PY3). Two of the approved programs will not be launched.

Evaluation activities and measure verification included records review, participant surveys, site visits, and metering. The records reviews also played a primary role in QA/QC. Where metering was conducted, the sample was nested within site visits. Site visits, by their nature, included records review. Table L-1 shows the evaluation activities for each of the programs that claimed savings in PY2. Nonparticipant surveys were conducted for two programs to collect information for the net savings adjustments.

Table L-1: PY2 Evaluation Activities

Program	Sector	Records Review	Participant Surveys	Non-participant Surveys	Site Visits	Metering
Appliance Recycling	Primarily Residential	X	X	X		
CFL Campaign	Residential	X	X	X		
Energy Efficient Behavior & Education	Residential	X	X			

Program	Sector	Records Review	Participant Surveys	Non-participant Surveys	Site Visits	Metering
Efficient Equipment Incentive	Residential	X	X			
	Commercial	X	X		X	lighting
Home Assessment & Weatherization	Residential	X	X			
Renewable Energy	Residential, GNI	X	X		X	
Low-Income WRAP	Residential	X				
E-Power Wise	Residential	X	X			
HVAC Tune-Up	Commercial	X	X		X	X
Custom Incentive	Commercial	X	X		X	X
NOTES:						

Sample Size Specifications

For purposes of defining sample sizes according to the SWE's *Sampling Resolutions*, each sector was considered first, and each program within the sector considered second. Sample sizes by program meet or exceed rigor levels designed for 85% confidence and 15% precision (85/15). Generally, sample sizes meeting 85/15 are maximized at 20-25 sample points (using 0.5 coefficient of variation). Samples in the following tables either met or were rounded up to meet or exceed this target.

Verification samples meet or exceed required rigor levels of 90/10 for each sector, including residential, low-income, nonresidential, and GNI. Generally, sample sizes meeting 90/10 are maximized at 68-70 sample points (using 0.5 coefficient of variation).

Initial sample sizes were derived using PY2 Q1 and Q2 participation. Samples were updated each quarter to adjust the measure mix or to pro-rate by measure or sector, as appropriate for the program and sector. Final verification samples were revised in Q4 considering participation in all measure groups.

Target Sample by Program

Sampling was determined during the PY1 evaluation planning process. The original sample targets were designed to meet 90% confidence and 10% precision. In several programs, verification activities were designed to meet these targets each quarter. However, sampling was restructured during PY2, in accordance to the SWE Guidance Memo issued in November 2010 and revised in February 2011. At that time, verification for two quarters was complete or near complete. To sample participants across all quarters, addition verification activities were conducted. For nearly all programs, sampling targets and the final samples exceeded the SWE requirements. Table L-2 outlines the sampling strategy by program.

Table L- 2: PY2 Sampling Strategy by Program

Program	Confidence and Precision	Participation Population	Records Review	Participant Surveys	Site Visits	Notes
Appliance Recycling	85/15	13,083 (unique CSP Job Numbers)	70	140 participants 140 non-participants	NA	Designed to meet minimum for 90/10 (68), prorated by appliance type
CFL Campaign	90/5	All customers	70	300	NA	Upstream program; participants unknown
Energy Education Behavior & Education	90/5	50,000	70	300	NA	Billing analysis included census of participants
Efficient Equipment Incentive (residential)	85/15 in each of three stratum	113,747	75	75	NA	Samples by stratum (25 each) plus minimums by technology
Efficient Equipment Incentive (nonresidential non-lighting; medium and small stratum)	85/15 in each of two stratum	2,917	50	50	NA	Samples by stratum (25 each) plus minimums by technology
Efficient Equipment Incentive (nonresidential lighting; large stratum)	Near 90/10	1,996 (unique CSP Job Numbers)	70	70	90	Large stratum included majority of *ex ante* savings; sample must approach 90/10 Metering as needed (± 50% of TRM Appendix C EFLH)
Home Assessment & Weatherization	85/15	1,288	68	68	NA	Designed to meet minimum for 90/10 (68), prorated by audit type
Renewable Energy (targets by sector - residential and GNI)	85/15	84 GNI 1,245 Res.	19 GNI 23 Res.	19 GNI 23 Res.	19 GNI 23 Res.	Additional site visits and records needed to collect data required for analysis
Low-Income WRAP	90/10	4,415	45	NA	NA	85/15 in each of 2 samples
E-Power Wise	90/10	3,995	70	140	NA	70 in each of 2 survey groups
HVAC Tune-Up	85/15	300 serviced units	40	10 contractors	40	Midstream program; surveys with contractors Spot measurements during site visits; 20 pre and 20 post
Custom Incentive	90/10	54	All large, Sample of small	30	All large, Sample of small	Metering and spot measurements as needed
NOTES:						

Table L-3: PY2 Participant Definition by Program

Program	Participant Definition	Can there be more than one *measure per* CSP Job Number?	Sample Defined By
Appliance Recycling	CSP Job Number (unique rebates).	Yes	CSP Job Number
CFL Campaign	Number of CFLs discounted by the program divided by the average number of bulbs purchased determined through surveys.	NA; upstream discount	Survey responses
Energy Efficiency Behavior & Education	Household (unique account number).	No	Account number
Efficient Equipment Incentive	*CSP Job Number (unique rebate application).*	Yes	CSP Job Number, account number
Efficient Equipment Incentive (lighting)	Project (unique account number; multiple measures per project submitted on the same rebate form/Appendix C).	Yes	Project determined by CSP Job Number and account number
Home Assessment & Weatherization	CSP Job Number (unique rebate application) by type of energy assessment (survey, audit all electric, audit CAC only). Multiple measures can be recommended per assessment.	Yes	CSP Job Number, account number
Renewable Energy	CSP Job Number (one location per number)	Yes	CSP Job 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, CSP Job Number
E-Power Wise	Household (unique account number): 1 per CSP Job Number. The Home Energy Kit includes multiple measures, but there is one kit per household.	No	Account number, CSP Job Number
HVAC Tune-Up	Individual rooftop units that received some type of *incentive. In some cases this includes only diagnostic test-*in (determined using account number, site ID, unit ID). Multiple rooftop units per account number/address. Not all units received the same services/measures.	No, but multiple CSP Job Numbers per rooftop unit	Account number, Site ID, Unit ID, CSP Job Number
Custom Incentive	Project.	Yes	Project Job number

NOTES:

Table L-4: PY2 Participation and EM&V Activity Summary

Program	Sectors	Participation Population	Records Review	Participant Surveys	Nonparticipant Surveys	Site Visits	Metering
Appliance Recycling	Residential	13,083	Census	142	134		
CFL Campaign	Residential	All customers	Census	282			
Energy Efficiency Behavior & Education	Residential	50,000	Census	320			
Efficient Equipment Incentive	Residential	113,747	222	224		3	
Home Assessment & Weatherization	Residential	1,288	25	68			
Renewable Energy	Residential	1,245	131	111		93	
Low-Income WRAP	Residential	4,415	Census for duplicates 45 in-depth				
E-Power Wise	Residential	3,995	Census database 140 enrollment forms	143 phone 851 mail-in			
Renewable Energy	GNI	84	71	7		20	
Efficient Equipment Incentive (non-lighting)	Nonresidential	2,917	549	99		72	
Efficient Equipment Incentive (lighting)	Nonresidential	1,996 (unique job numbers)	179	42 process, NTG 74 verification		100	20
HVAC Tune-Up	Commercial	300	13	10 contractors		10	32 (spot metering)
Custom Incentive	Commercial & Industrial	54	42 large projects 6 small projects	20		42 large 6 small	35
NOTES:							

The sampling strategy for each program is discussed below.

Appliance Recycling
The records review included a census of participants in the EEMIS database. Altogether, records were verified for 13,083 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 were fielded twice, each targeting a sample of 70 respondents and meeting 90/10 criteria for confidence and precision. Nonparticipant surveys were used to determine the net savings and part-use factor. Note that the sample sizes exceeded the SWE's requirements for sampling to meet 85/15 by program.

CFL Campaign
The telephone survey sample frame was developed from PPL Electric's customer database. To ensure that the telephone survey would provide useful results for both participants and nonparticipants while staying within a reasonable budget, the survey was conducted using the maximum and minimum target numbers for completed interviews. The EM&V CSP completed surveys with 284 customer respondents in PY2 (106 respondents in PY2 Q1 and 178 respondents in PY2 Q3) out of the 1.2 million total PPL Electric residential customers. The PY2 survey efforts achieved 90/5 levels of confidence/precision.

Energy Efficiency Behavior & Education
A survey of 320 customers receiving Home Energy Reports during the program year was conducted via telephone in February 2011 and will be conducted annually. The sample was stratified by metropolitan area. The sample strata were sufficiently large to achieve and exceed the required levels of statistical confidence and precision. The sample exceeded 90% confidence with 5% precision.

In this program, savings were determined using a billing analysis, including all 50,000 participants and a comparison group of 50,000 non-participant households. The difference-in-differences approach met the 95% confidence interval.

Home Assessment & Weatherization
The EM&V CSP drew a random sample to meet specifications of the SWE's revised sampling requirements in Guidance Memo 0003. The EM&V CSP conducted telephone surveys of 68 randomly selected customers participating in PY2. The sample was pro-rated by participation in the walk-through surveys (80%) and the comprehensive audit (20%).

A sample of 25 records (meeting 85/15 sampling criteria) were selected and verified through a records review of the documentation. Records were stratified by audit type: walk-through survey (EEMIS measure code PEU), comprehensive audit of all electric items (measure code PEY1), and comprehensive audit of CAC only (measure code PEY2). The EM&V CSP selected half of the sample points from records that had walk-through surveys. Six comprehensive audits were verified, including three all-electric and three CAC only.

Low-Income WRAP
In PY2, 45 records were reviewed. Records were stratified by job type (baseload, low-cost, and full-cost) and sorted by the number of measures installed within each stratum. The sample points per quarter were distributed evenly across the three strata, with the extra sample point assigned to the full-cost

stratum. For each case type, the record with the greatest number of measures was selected and the remaining sample points were selected via a simple random sample for verification through a desk review. The final sample size of 45 meets the sampling specification in the SWE Guidance Memo 0003 (i.e., 90/10 in the low-income sector).

E-Power Wise

The EM&V CSP reviewed all of the program's enrollment records to ensure that records were traceable from the implementation contractor's database to the PPL Electric EEMIS database, and to verify that the program was counting only one kit per household. This review captured duplications across program quarters.

The EM&V CSP conducted a QA/QC review of a random sample of 140 participant enrollment forms (70 in PY2 Q1 and 70 in PY2 Q3). The sample size met 90% confidence and 10% precision each quarter. Together with the Low-income WRAP Program, the sampling exceeded requirements for 90/10 in the low-income sector.

To verify measure installation and behavior changes associated with the program, the EM&V CSP conducted telephone surveys with a stratified random sample of 73 participants who returned the written survey distributed with the kits and 70 participants who did not return the written survey. Additionally, the census of participant kit surveys (851 total) that were returned by participants were included in the analysis. However, once duplicate and bad records were removed, the total number of surveys included in the analysis was 842.

Efficient Equipment Incentive

The Efficient Equipment Incentive Program was open to all sectors. For sampling, two sectors were identified: residential and nonresidential. The GNI participants did not meet 20% of the program's total program savings. Therefore, they were not considered as an independent sector in this program but were included in the nonresidential sector.

There were over 400 measures rebated and installed through the Efficient Equipment Incentive 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.

Nonresidential Sector

The final measure groups for the Efficient Equipment Incentive Program's nonresidential participants are shown in Table L-5. Lighting measures clearly comprised the largest measure group and were treated as the large stratum. The medium stratum included the motors and refrigeration measure groups. The small stratum included HVAC measures, residential appliances, office equipment, and miscellaneous measures.

Table L-5:PY2 Efficient Equipment Incentive Program Nonresidential Strata

Stratum	Stratum Definition	Percent of *Ex ante* Savings	Measure Groups Included
Large	Top measure	87%	Lighting

Stratum	Stratum Definition	Percent of *Ex ante* Savings	Measure Groups Included
Medium	Next 10%	10%	Refrigeration and motors
Small	Last 10%	10%	All others: HVAC, appliances, office equip, other
NOTES:			

Since lighting measures were included in the large stratum and exhibited a large variability in the range of *ex ante* savings reported, this stratum was again separated into large, medium, and small stratum. The sample was re-examined each quarter, and the samples were re-drawn according to the strategy shown in Table L-6. That is, the large stratum consisted of the projects with the top 50% of reported *ex ante* savings, the medium stratum included projects with the next 30% of savings, and the small stratum included 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 were processed and recorded in EEMIS each quarter.

In Q1, 37 site visits were conducted, along with telephone interviews for 29 projects primarily meant for developing the data needed for *ex ante* and *ex post* adjustments. In Q1, a total of 56 projects were reviewed out of the population of 104 completed projects.

Verification activity for the nonresidential lighting participants is shown in Table L-6. Site visits, by their nature, included records review and verification. In Q1, there were a number of startup issues associated with rebate forms, Appendix C, and EEMIS, so that traditional sampling was not employed.

Table L-6.PY2 Efficient Equipment Incentive Program Nonresidential Stratum

Stratum	Percent of *Ex ante* Savings	Number of Sample Points by Verification Activity in PY2		
		Number of Projects	Sample	Percent of Projects Reviewed
Q1	All projects	104	56	54%
Large	Top 50%	96	30	31%
Medium	Next 30%	269	18	7%
Small	Last 20%	1,443	12	1%
Total		1,912	116	6%
NOTES:				

Non-lighting stratum were organized by measure group, as shown in Table L-7, along with the sample for the verification activities.

***Table L-7:* PY2 Efficient Equipment Incentive Program Non-residential Medium and Small Stratum**

Stratum	Measure Groups Included	Number of Sample Points by Verification Activity in PY2			
		Records Review	Surveys	Site Visits	Measures Verified in Site Visits
Medium	Refrigeration and motors	45	17	21	116

Stratum	Measure Groups Included	Number of Sample Points by Verification Activity in PY2			
		Records Review	Surveys	Site Visits	Measures Verified in Site Visits
Small	HVAC, appliances, office equipment, other	504	82	56	90
NOTES:					

Residential Sector

The same approach was used to define strata in the residential sector as that used for the large lighting strata. That is, the measure group with the top 50% of *ex ante* reported savings was included in the large stratum. Measure groups that made up close to the next 30% were included in the medium stratum. The remaining measures were included in the small stratum. Table L-8 shows the measures included in each stratum.

Table L-8: PY2 Efficient Equipment Incentive Program Residential Strata

Stratum	Stratum Definition	Percent of *Ex ante* Savings	Measure Groups Included
Large	Top 50%	57%	HVAC measures
Medium	Next 30%	37%	Appliances, HPWH
Small	Last 20%	6%	RTS, refrigeration, office equipment, other
NOTES:			

Most verification for residential measures occurred through records reviews and surveys. By design, site visits were not used to verify measure installation with the exception of ASHPs. Residential sector verification activity is shown in Table L-9.

Table L-9: PY2 Efficient Equipment Incentive Program Residential Medium and Small Strata

Stratum	Measure Groups Included	Number of Sample Points by Verification Activity in PY2		
		Records Review	Surveys	Measures Verified
Large	HVAC measures	104	57	153
Medium	Appliances, HPWH	55	51	106
Small	RTS, refrigeration, office equipment, other	63	44	108
NOTES:				

Efficient Equipment Incentive Program Non-Lighting Site Visit Verification Samples (Nonresidential Sector)

The sample sizes for non-lighting measures verification were determined by site, not by the number of measures. Table L-10 summarizes the number of site visits conducted for each measure, and the total number of measures verified at these sites. In total, 194 measures were verified at 77 sites. Some sites included more than one measure.

Table L-10: Efficient Equipment Site Visit Summary

Category	Technology	Total Site Visits	Total Measures Verified On-site
HVAC	ASHP	11	29
	CAC	7	7
	Programmable Thermostat	5	10
	Room AC (1st unit)	2	10
	DX	3	6
	Chiller	1	1
Appliances	Clothes Washer (Tier 2 MEF)	2	3
	Dishwasher	3	11
	ENERGY STAR Dehumidifier	1	2
	ENERGY STAR Refrigerator	3	11
	ENERGY STAR Computers	2	25
	ENERGY STAR Monitors	1	16
Refrigeration	Display Case Fans / Walk-in Evaporator Fans	2	4
	High-Efficiency Compressor	1	2
	Floating Head Pressure Control (Compressor)	1	2
	Compressor VSD Retrofit	1	1
Motors	ASD/VSD	13	43
	HVAC Motors - Premium Efficiency	16	31
Total		75	214
NOTES:			

Table L-11 shows the number of site visits conducted by sector.

Table L-11: Site Visits by Sector

Category	Technology	Total Site Visits	Small C&I	Large C&I	GNI	Residential
HVAC	ASHP	11	6	0	3	2
	CAC	7	5	0	2	0
	Programmable Thermostat	5	3	0	1	1
	Room AC (1st unit)	2	0	0	2	0
	DX	3	0	1	2	0
	Chiller	1	0	1	0	0
Appliances	Clothes Washer (Tier 2 MEF)	2	0	0	2	0
	Dishwasher	3	0	0	3	0
	ENERGY STAR Dehumidifier	1	0	0	1	0
	ENERGY STAR Refrigerator	3	0	0	3	0
	ENERGY STAR Computers	2	0	1	1	0

Category	Technology	Total Site Visits	Small C&I	Large C&I	GNI	Residential
	ENERGY STAR Monitors	1	0	1	0	0
Refrigeration	Display Case Fans / Walk-in Evaporator Fans	2	2	0	0	0
	High-Efficiency Compressor	1	1	0	0	0
	Floating Head Pressure Control (Compressor)	1	1	0	0	0
	Compressor VSD Retrofit	*1*	*0*	*1*	*0*	*0*
Motors	ASD/VSD	13	5	3	5	0
	HVAC Motors – Premium Efficiency	16	6	3	7	0
Total		75	29	11	32	3
NOTES:						

The total number of measures verified by sector is shown in Table L-12.

Table L-12: Total Number of Measures Verified by Sector

Category	Technology	Total Measures Verified On-site	Small C&I	Large C&I	GNI	Residential
HVAC	ASHP	29	25	0	3	1
	CAC	7	5	0	2	0
	Programmable Thermostat	10	7	0	3	0
	Room AC (1st unit)	*10*	*4*	*6*	*0*	*0*
	DX	6	0	4	2	0
	Chiller	1	0	1	0	0
Appliances	Clothes Washer (Tier 2 MEF)	3	0	2	1	0
	Dishwasher	11	0	9	2	0
	ENERGY STAR Dehumidifier	2	0	0	2	0
	ENERGY STAR Refrigerator	11	0	9	2	0
	ENERGY STAR Computers	25	0	23	2	0
	ENERGY STAR Monitors	16	0	16	0	0
Refrigeration	Display Case Fans / Walk-in Evaporator Fans	4	4	0	0	0
	High-Efficiency Compressor	2	2	0	0	0
	Floating Head Pressure Control (Compressor)	2	2	0	0	0
	Compressor VSD Retrofit	1	0	1	0	0
Motors	ASD/VSD	43	11	28	4	0
	HVAC Motors - Premium Efficiency	31	8	19	4	0
Total		214	68	118	27	1
NOTES:						

Renewable Energy

The Renewable Energy Program offered two technologies during PY2, PV systems and GSHPs. The program was open to both the residential and GNI sectors. In both sectors, installations were verified through records reviews, site visits, and engineering analyses. Table L-13 lists the site visits, and Table L-14 breaks down the site visits by sector.

Table L-13: Renewable Energy Program Site Visits

Category	Technology	Total Site Visits	Total Measures Verified
GSHP	GSHP	46	141
Solar	Photovoltaics[a]	62	56
Total		108	197

NOTES:
[a] PV sites were considered verified when cumulative generation data were collected during the site visit. Generation data could not be collected at all sites, and some sites had generation data that was deemed invalid.

Table L-14: Renewable Energy Program Site Visits by Sector

Category	Technology	Total Site Visits	Small C&I[a]	Large C&I[a]	GNI	Residential
GSHP	GSHP	46	2	0	12	32
Solar	Photovoltaics	62	1	1	6	54
Total		108	3	1	18	86

NOTES:
[a] Only residential and GNI sectors were eligible for the program. The small and large C&I projects were reclassified as residential or GNI during verification. Only one site was confirmed to be small C&I.

These tables show the sector counts by *reported* sector. Some sectors were misclassified as reported, and were re-coded upon further research. The number of measures shown in Table L-15 represents the number of measures verified at the site; these do not represent the CSP Job Numbers.

Table L-15: Renewable Energy Program Number of Measures Verified from Site Visits and Record Review by Sector

Category	Technology	Total Verified Measures	Small C&I[a]	Large C&I[a]	GNI	Residential
GSHP	GSHP	497	15	0	402	80
Solar	Photovoltaics [b]	56	1	1	5	49
Total		553	16	2	407	129

NOTES:
[a] Only residential and GNI sectors were eligible for the program. The small and large C&I projects were reclassified as residential or GNI during verification. Only one site was confirmed to be small C&I.
[b] PV sites were considered verified when cumulative generation data were collected during the site visit. Generation data could not be collected at all sites, and some sites had generation data that was deemed invalid.

In Table L-16, the total number of sites was determined using unique account numbers. The table shows the *reported* sector. Some were misclassified and corrected during the verification process. The counts for records review includes the reviews for site visits.

Table L-16: PY2 Renewable Energy Sample Strata

Technology	Sector	Total Number of Sites (Projects)	Number of Units Installed	Number of Sample Points (Sites) by Verification Activity		
				Records Review	Surveys	Site Visits
PV	Residential	128	128	73	44	54
GSHP		1,050	1,127	58	65	32
PV	Small C&I[a]	1	1	1	1	1
GSHP		4	17	2	1	2
PV	Large C&I[a]	1	1	1	1	1
GSHP		0	0	0	0	0
PV	GNI	6	6	6	1	6
GSHP		22	413	17	5	12
Total		1,212	1,693	158	118	108

NOTES:
[a] Only residential and GNI sectors were eligible for the program. The small and large C&I projects were reclassified as residential or GNI during verification. Only one site was confirmed to be small C&I.

HVAC Tune-Up

Sampling procedures follow the HVAC Tune-Up CMP approved by the SWE. The sample was based on individual serviced units, and not individual projects that could include multiple units. Servicing can include multiple measures, depending on the outcome of the diagnostic test results.

The unit sample size was based on the SWE's sampling guidelines, requiring sample sizes to meet 85% confidence with 15% precision. At the end of PY2, 300 units received a diagnostic test or services through the program. Of these, 48 units received only the diagnostic test. The remaining units had either a refrigerant charge adjustment, an economizer test (and possible repair), or a thermostat measure. Some units received more than one measure. In total, 377 measures were rebated. (The unique "UnitID" reported for each system was used to determine the total number of measures.)

The program's implementation CSP provided databases identifying all the units contractors planned to service. Of the units selected to receive pre-servicing verification, only six units were diagnosed by contractors in PY2. Energy savings were reported to PPL Electric for only one of those six units. In total, 32 units were tested by the EM&V CSP.

- 13 units were serviced through the program in PY2
- Three units were serviced in PY2 but did not receive an incentive since contractors did not submit a rebate
- Three units were not serviced through the program until PY3
- 13 units were never serviced by contractors

Table L-17 shows the number of HVAC Tune-Up Program participants in PY2, and Table L-18 shows the PY2 HVAC Tune-Up Program sample sizes.

Table L-17: PY2 HVAC Tune-Up Participants

Technology	Sector	Number of Contractors Providing Services	Number of Locations (businesses)	Number of Units Receiving Test-in	Number of Units Serviced[a]	Number of Measures Rebated
HVAC Tune-Up	*Nonresidential*	16	47	300	252	377
NOTES: [a] This is the number of units that received more than a diagnostic test-in.						

Table L-18: PY2 HVAC Tune-Up Sample

Technology	Sector	Number of Sample Points (Units) by Verification Activity			
		Surveys with Contractors	Records Review	Site Visits	Engineering Analysis
HVAC Tune-Up	Nonresidential	10	13	10	13
NOTES:					

Custom Incentive Program

Each custom project in the Custom Incentive Program was defined as being large or small for verification purposes. Large projects were identified in real time and all were 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 could also be included in the large stratum.

A sample of small projects was selected from all projects completed and rebated during PY2. Savings for this sample were verified and a realization rate determined based on this sample. The realization rate was applied to the population of the projects in the small project stratum.

Incentives were paid for 54 projects in the Custom Incentive Program in PY2. Of these, 42 were determined as large stratum (though a significant number of these had savings less than 500,000 and would be placed into the small strata under the current sampling scheme). The remaining projects were defined as small projects. There were a total of 12 small projects in PY2, from which a sample of six were selected for review and verification.

Telephone Survey Sampling Procedures

The EM&V CSP conducted telephone surveys at various intervals, following a batch-wise sampling approach. Table L-19 shows the months each survey was fielded. The sample was selected from participants in all previous quarters. Surveys served more than one purpose: they were used to verify measure installation, assess customer satisfaction, and collect data to compute the NTG ratio.

Table L-19: PY2 Telephone Survey Schedule

Telephone Surveys	PY2				PY3
	Q1	Q2	Q3	Q4	

Telephone Surveys	PY2 Q1	PY2 Q2	PY2 Q3	PY2 Q4	PY3
Efficient Equipment Incentive Program (commercial)		X			X
Efficient Equipment Incentive Program (residential)		X			X
Appliance Recycling Program		X	X	X	
Renewable Energy Program		X		X	
Home Assessment & Weatherization Program				X	
E-Power Wise Program				X	
CFL Campaign		X	X		
Energy Efficient Behavior & Education Program			X		
HVAC Tune-Up Program			X		
Custom Incentive Program				X	
NOTES:					

The EM&V CSP developed two types of telephone survey sampling procedures for PPL Electric Act 129 programs. This section discusses each of these survey sampling procedures in detail.

The first process, and most complex, was used for programs that use PPL Electric's EEMIS tracking system. The second process was developed for programs that do not utilize EEMIS and for nonparticipant surveys. These programs include the population surveyed for the upstream CFL Campaign and for the Appliance Recycling Program nonparticipant sample.

For participant surveys, a program participant is defined as a unique billing account number that installed 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 CAC and a dishwasher under the Efficient Equipment Incentive Program, that account was treated as a single participant.

EEMIS-Sourced Sampling

Participant surveys were conducted quarterly. Survey results informed various process evaluation metrics, along with the NTG analysis. During PY2, this methodology was used to select samples for telephone surveys for five PPL Electric programs:

- Appliance Recycling
- Efficient Equipment Incentive (residential and nonresidential)
- Renewable Energy
- Home Assessment & Weatherization
- E-Power Wise

The sample for these surveys was selected following a 10 step process:

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 12 months, either by the EM&V CSP or by Bellomy Research (PPL Electric's survey vendor).
6. Remove any accounts with an invalid phone number (e.g., less than 10 digits, invalid area code).
7. Apply any additional exclusion to the pool of stratified accounts; this may include items like site visits or other phone verification activities.
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 calling instructions.

Non-EEMIS Sourced Sampling

Nonparticipant and other participant surveys are conducted each year. During the 2011 program year, this methodology was used to develop calling samples for three surveys:

- CFL Campaign
- Appliance Recycling Program (nonparticipants)
- Energy Efficiency Behavior & Education Program participants (program implemented by OPower)

The sample for these surveys was drawn from PPL Electrics' customer information database or from the OPower participant database, as appropriate. A five-step process was used, as follows:

1. Select a large sample of accounts (typically 5,000 to 10,000) from PPL Electric's customer database or an alternative data source.
2. Remove any accounts that were contacted for a phone survey within the past 12 months, either by the EM&V CSP or by Bellomy Research.
3. Remove any accounts with an invalid phone number (e.g., less than 10 digits, invalid area code).
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 calling instructions.

PY2 Surveys Conducted

Shown in Table L-20, 1,572 surveys were conducted in PY2.

Table L-20: Program Population, Program Targets, Surveys Completed by Program

Program	Program Population	Program Survey Target	Survey Completes
Appliance Recycling	8,328	135	142
Efficient Equipment Incentive (residential)	68,332	239	224
Efficient Equipment Incentive (commercial)	2,917	165	141
Renewable Energy	1,145	123	118
E-Power Wise	3,212	140	143
Home Assessment & Weatherization	651	68	68
Appliance Recycling (nonparticipant)		140	134
CFL Campaign		300	282
Energy Efficiency Behavior & Education (OPower)	50,000	340	320
Total		1,671	1,572
NOTES:			

Survey Disposition

As indicated in the survey sample selection processes above, the EM&V CSP sends a set of accounts to the subcontractor conducting telephone surveys (Opinion Dynamics Corporation; ODC) for each survey that is administered. ODC tags any account that they call with a disposition code that, in general, reflects the status of the last phone call to that account. ODC receives some accounts that are not called because sample size quotas have already been met by the time that account enters the dialing system. The summary of final telephone survey dispositions for each survey administered in PY2 is shown in Table L-21.

Table L-21: Detailed Survey Disposition Codes

Disposition	Detailed Category
Not Eligible	Duplicate Phone Number
	Fax/Data Line
	Ill/Away/Deceased
	Invalid Number
	Language Barrier
	Not In Service
	Wrong Number
Unknown Eligibility Non-Interview	Answering Machine
	Busy
	Call Blocking
	Callback
	No Answer

Disposition	Detailed Category
	Not In Service
NOTES:	

Survey Attrition

The final survey attrition listed in Table L-22 shows the number of times a survey was fielded for each program, along with the population, sample frame, number provided to the survey subcontractor, and the sample attrition. The table shows the targeted number of completes along with the total completed.

Table L-22: PY2 Survey Sample Attrition

Survey	Appliance Recycling		Efficient Equipment Incentive (residential)		Efficient Equipment Incentive (non-residential)		Renewable Energy		E-Power Wise	Home Assessment & Weatherization	Appliance Recycling (nonparticipant)	CFL Campaign		Energy Efficiency Behavior & Education
Fielding	1	2	1	2	1	2	1	2	1	1	1	1	2	1
Population	2,534	5,794	19,402	48,930	334	2,583	411	734	3,212	651	[redacted]	[redacted]	[redacted]	50,000
Sample Frame	2,522	5,782	18,800	7,865	233	2,035	411	734	3,196	628	[redacted]	[redacted]	[redacted]	
Scrubbed	74	226	477	372	51	207	15	591	71	25	[redacted]	[redacted]	[redacted]	
Provided to ODC	420	390	482	902	182	623	396	143	1,227	447	9,663	4,921	4,876	4,258
Partial Complete	11	13	8	31	3	17	4	3	30	7	151	15	55	105
Refusal	27	57	17	62	7	45	12	6	99	33	2,266	244	421	576
Not Eligible	20	25	14	20	18	27	10	3	239	12	1,555	117	330	336
Unknown Eligibility Non-Interview	217	158	255	295	80	237	169	41	274	120	2,297	2,524	576	918
Other	12	9	2	12	0	9	0	1	31	11	1,753	20	0	15
Quota Full	133	128	186	482	74	288	201	89	554	264	1,641	2,001	3,494	2,308
Complete	76	66	95	129	40	101	101	17	143	68	134	104	178	320
Target Completes	70	65	100	139	40	125	101	22	140	68	140	100	221	340

NOTES:

Appendix M: Incremental Measure Costs[35]

Program	Measure	Incremental Cost	Incremental Cost Source
CFL Campaign	CFL	$3.59	Engineering Calculation
Custom Incentive Program	Average Project Cost	$130,626	Calculated from program tracking data
Efficient Equipment Incentive Program	Anti-Sweat Heater Controls	$467.50	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_glimpse.html and http://www1.eere.energy.gov/industry/bestpractices/pdfs/mc-2463.pdf, A.O. Smith Motors and Baldor Motors
Efficient Equipment Incentive Program	Chiller Pipe Insulation	$28,718.40	RSMeans 2007
Efficient Equipment Incentive Program	ASD/VSD	$8,212.88	Engineering Calculation
Efficient Equipment Incentive Program	LED Traffic Signals(12" 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

[35] As no reliable data on participant costs were available, PPL implementation costs were used as a proxy for incremental measure costs for the Appliance Recycling and HVAC Tune-Up Programs.

Program	Measure	Incremental Cost	Incremental Cost Source
Efficient Equipment Incentive Program	Indoor ENERGY STAR Light Fixtures	$20.00	ENERGY STAR
Efficient Equipment Incentive Program	CAC - SEER 14.5	$247.50	DEER and Engineering Calculations
Efficient Equipment Incentive Program	CAC - SEER 16	$765.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	ASHP - SEER 14.5	$315.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	ASHP - SEER 15	$630.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	ASHP - SEER 16	$945.00	DEER and Engineering Calculations
Efficient Equipment Incentive Program	Heat Pump Hot Water Heater	$1,079.04	RTF and Research
Efficient Equipment Incentive Program	ENERGY STAR Ice Maker	$358.00	CEE
Efficient Equipment Incentive Program	Commercial Reach-In Refrigerator	$180.00	ENERGY STAR, FTSC 2004
Efficient Equipment Incentive Program	ENERGY STAR Copier	$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	$72,548.68	Nexant Project Experience and LBNL
Efficient Equipment Incentive Program	High-Efficiency Case Fans	$8,360.79	DEER 2005 and SCE
Efficient Equipment Incentive Program	(DX) Packaged Air Conditioner System 11.0 EER	$7,335.20	DEER 2005, 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 Calculations, and Appliance Standards Awareness Project
Efficient Equipment Incentive Program	High-Efficiency Compressor	$6,644.17	DEER 2005 / 1995 DOE
Efficient Equipment Incentive Program	Air-Cooled Chiller	$11,270.03	DEER
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	(DX) Packaged Air Conditioner System 11.5 EER	$11,369.56	DEER 2005 and , CEC, and ACEEE
Efficient Equipment Incentive Program	Display Cases	$1,188.24	DEER 2005 scaled with DOE data
Efficient Equipment Incentive Program	High-Efficiency Evaporator Fans - Walk-Ins	$18,219.64	DEER 2005 and SCE
Efficient Equipment Incentive Program	Faucet Aerators	$161.59	Engineering Calculations

Program	Measure	Incremental Cost	Incremental Cost Source
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 Calculations
Efficient Equipment Incentive Program	ENERGY STAR Monitor	$10.00	ENERGY STAR
Efficient Equipment Incentive Program	Floating Head Pressure Control	$2,409.99	DEER 2005 / CALMAC Report - September 2000 / GSD
Efficient Equipment Incentive Program	ENERGY STAR Refrigerator	$30.00	ENERGY STAR
Efficient Equipment Incentive Program	Programmable Thermostat – Non-residential	$172.36	DEER, RSMeans
Efficient Equipment Incentive Program	Programmable Thermostat – Residential	$25.56	DEER
Efficient Equipment Incentive Program	ENERGY STAR Scanner	$1.00	ENERGY STAR
Efficient Equipment Incentive Program	(DX) Packaged Air Conditioner System 12.0 EER	$13,779.69	DEER 2005 and , CEC, and ACEEE
Efficient Equipment Incentive Program	ENERGY STAR Water Cooler	$1.00	ENERGY STAR
Efficient Equipment Incentive Program	SmartStrip	$30.00	http://www.amazon.com/Smart-Strip-SCG3-Autoswitching-Technology/dp/B000P1QJXQ/ref=pd_bbs_sr_2?ie=UTF8&s=hi&qid=1237924269&sr=8-2
Efficient Equipment Incentive Program (C&I Lighting)	Average Project Cost	$43,808	Calculated from program tracking data
Renewable Energy Program	PV – Residential	$47,031.00	http://www.californiasolarstatistics.ca.gov/reports/cost_vs_system_size/
Renewable Energy Program	PV – Non-residential	$1,543,440.00	http://www.californiasolarstatistics.ca.gov/reports/cost_vs_system_size/
Renewable Energy Program	GSHP – Residential	$11,328.21	Various Vendors and Studies
Renewable Energy Program	GSHP – Non-residential	$295,099.96	Various Vendors and Studies
Home Assessment & Weatherization Program	CFL	$3.59	Engineering Calculations
Home Assessment & Weatherization Program	Faucet Aerator - Bath	$0.50	Engineering Calculations
Home Assessment & Weatherization Program	Faucet Aerator - kitchen	$0.50	Engineering Calculations
Home Assessment & Weatherization Program	Hot Water Pipe Insulation	$16.94	DMME, RSMeans
NOTES:			

Appendix N: 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.[36] *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.[37] Also see *Benefit-Cost Test.*

Benefit-Cost Test: Also called *Cost-Effectiveness Test,* defined as the methodology used to compare the benefits of an investment to the costs. For programs evaluated under Act 129, the TRC Test is the required benefit-cost test as issued in the TRC Order.[38]

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

[36] 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.
[37] Ibid.
[38] Ibid.

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

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

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

– G –

Gross Impact: See *Gross Savings*.

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

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

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

– H –

– I –

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

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

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

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.

– J –

– K –

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

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

– L –

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

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

Lifetime Supply Costs: The net present value of avoided supply costs associated with savings, net of changes in energy use that would have happened in the absence of the program over the life of the energy efficiency measure, factoring in persistence of savings. See *Avoided Cost*.[39]

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

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

– M –

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.

[39] Ibid.

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).[40]

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.

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

– O –

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

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

– P –

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

[40] Ibid.

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 –

– R –

Realization Rate: The term is used in several contexts in the development of reported program savings. The primary applications include the ratio of project tracking system savings data (e.g., initial estimates of project savings) to savings that: 1) are adjusted for data errors, and 2) incorporate the evaluated or verified results of the tracked savings.

Rebate Program: An energy efficiency program in which the program administrator offers a financial incentive for the installation of energy efficient equipment.

Rebound Effect: Also called 'snap back,' defined as a change in energy-using behavior that yields an increased level of service that is accompanied by an increase in energy use and occurs as a result of taking an energy efficiency action. The result of this effect is that the savings associated with the direct energy efficiency action 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 nonparticipant spillover. Participant spillover is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy saving practices after having participated in the efficiency program as a result of the program's influence. Nonparticipant spillover refers to energy savings that occur when a program nonparticipant installs energy efficiency measures or applies energy 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 non-overlapping and together comprise the entire population. A simple random sample of each stratum is taken to create a sample based on stratified random sampling.

Stratified Ratio Estimation: A sampling method that combines a stratified sample design with a ratio estimator to reduce the coefficient of variation by using the correlation of a known measure for the unit (e.g., expected energy savings) to stratify the population and allocate a sample from the strata for optimal sampling.

– T –

Takeback Effect: See *Rebound Effect.*

Total Resource Cost (TRC) Test: A cost-effectiveness test that measures the net direct economic impact to the utility service territory, state, or region. The TRC Order[41] details the method and assumptions to be used when calculating the TRC test for EE&C portfolios implemented under Act 129. The results of the TRC test are to be expressed as both a net present value and a benefit-cost ratio.

Total Resource Cost (TRC) Test Benefits: Benefits calculated in the TRC test that include the avoided supply costs, such as the reduction in transmission, distribution, generation, and capacity costs, valued at a marginal cost for the periods when there is a consumption reduction. The PA TRC benefits will consider avoided supply costs, such as the reduction in forecasted zonal wholesale electric generation prices, ancillary services, losses, generation capacity, transmission capacity, and distribution capacity. The avoided supply costs will be calculated using net program savings, defined as the savings net of changes in energy use that would have happened in the absence of the program. The persistence of savings over time will also be considered in the net savings.[42]

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.[43]

– 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.

[41] Ibid.
[42] Ibid.
[43] Ibid.

– W –

Watt: A unit of measure of electric power at a point in time as capacity or demand. One Watt of power maintained over time is equal to one Joule per second. The Watt is named after Scottish inventor James Watt, and is shortened to W and used with other abbreviations, as in kWh (kilowatt-hours).

Watt-Hour: One Watt of power expended for one hour. 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 –

References

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.