Annual Report

Program Year 6: June 1, 2014 – May 31, 2015

Presented to:

Pennsylvania Public Utility Commission

Pennsylvania Act 129 of 2008

Energy Efficiency and Conservation Plan

Prepared for:

PPL Electric Utilities

November 16, 2015

Prepared by:

CADMUS

ANNUAL REPORT

Program Year 6: June 1, 2014 – May 31, 2015

Presented to:

PENNSYLVANIA PUBLIC UTILITY COMMISSION

Pennsylvania Act 129 of 2008

Energy Efficiency and Conservation Plan

November 16, 2015

Prepared by Cadmus

For

PPL Electric Utilities

November 16, 2015

This page intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This page intentionally left blank

ACRONYMS

Phase II Verified / (Phase II-VG)	Verified/ Ex Post Cumulative Program/Portfolio Phase II Inception to Date
Phase II Reported	Reported/ Ex Ante Cumulative Program/Portfolio Phase II Inception to Date
Phase II+CO	Cumulative Program/Portfolio Phase II Inception to Date including Carry Over Savings from Phase I (this is cumulative Phase II verified savings)
ARP	Appliance Recycling Program
C&I	Commercial and Industrial
CBO	Community-Based Organization
CEE	Consortium for Energy Efficiency
CEI	Continuous Energy Improvement
CF	Coincidence Factor
CFL	Compact Fluorescent Lamp
CSP	Conservation Service Provider or Curtailment Service Provider
Cv	Coefficient of Variation
DR	Demand Response
ECM	Electronically Commutated Motor
EDC	Electric Distribution Company
EE&C	Energy Efficiency and Conservation
EM&V	Evaluation, Measurement, and Verification
EEMIS	Energy Efficiency Management Information System
EISA	Energy Independence and Security Act
EUL	Expected Useful Life
GNI	Government, Nonprofit, and Institutional
GNE	Government, Nonprofit, and Educational
GSL	General Service Lamp
HERS	Home Energy Reports
HEW	Home Energy Worksheet
HOU	Hours of Use
HPWH	Heat Pump Water Heater
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
ISR	In-Service Rate
KPI	Key Performance Indicator
kW	Kilowatt

kWh	Kilowatt-hour
LED	Light Emitting Diode
LEEP	Low-Income Energy Efficiency Program
LIHEAT	Low-Income Home Energy Assistance Program
LIURP	Low-Income Usage Reduction Program
LEAP	Low-Energy Assistance Program
M&V	Measurement and Verification
MW	Megawatt
MWh	Megawatt-hour
NPV	Net Present Value
NTG	Net-to-Gross
O&M	Operations and Maintenance
PUC	Pennsylvania Public Utility Commission
PY5	Program Year 2013, from June 1, 2013 to May 31, 2014
PY6	Program Year 2014, from June 1, 2014 to May 31, 2015
PY7	Program Year 2015, from June 1, 2015 to May 31, 2016
PY8	Program Year 2016, from June 1, 2016 to May 31, 2017
PYX QX	Program Year X, Quarter X
PYTD	Program Year to Date
QA/QC	Quality Assurance/Quality Control
SEER	Seasonal Energy Efficiency Rating
SEMP	Strategic Energy Management Plan
SKU	Shelf Stocking Unit
SPIF	Sales Performance Incentive Fund
SSMVP	Site-Specific Measurement and Verification Plan
SWE	Statewide Evaluator
T&D	Transmission and Distribution
TRC	Total Resource Cost
TRM	Technical Reference Manual
UEC	Unit Energy Cost
USP	Universal Services Program
VSD	Variable Speed Drive
WRAP	Act 129 Winter Relief Assistance Program

REPORT DEFINITIONS

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

REPORTING PERIODS

Phase I

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

Phase II

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

Program Year-to-Date (PYTD)

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

SAVINGS TYPES

Preliminary

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

Reported Gross

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

Adjusted Ex Ante Gross

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

Verified Gross

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

Verified Net

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

TOTAL RESOURCE COST COMPONENTS

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

Administration, Management, and Technical Assistance Costs

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

EDC Costs

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

Participant Costs

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

Total TRC Costs

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

Total TRC Benefits

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

1 Overview of Portfolio

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

Implementation of Phase II Act 129 programs began June 1, 2013. This report documents the progress and effectiveness of the Phase II EE&C accomplishments for PPL Electric Utilities in Program Year 6 (PY6), defined as June 1, 2014, through May 31, 2015, as well as the cumulative accomplishments of the programs since inception of Phase II. This report additionally documents the energy savings carried over from Phase I. The Phase I carryover savings count toward EDC savings compliance targets for Phase II.

PPL Electric Utilities' evaluation, measurement, and verification conservation service provider (EM&V CSP), The Cadmus Group, Inc. (Cadmus), evaluated the programs, which included measurement and verification of the savings. The final verified savings for PY6 are included in this annual report.

In PY6, PPL Electric's portfolio included twelve active programs:[1]

1. The Prescriptive Equipment Program offers nonresidential customers rebates and incentives from a list of specific energy efficiency measures and services. The program also offers a direct discount component for lighting.
2. The Residential Retail Program offers upstream incentives for energy-efficient lighting and rebates for other energy-efficient products found in retail stores.
3. The Custom Incentive Program offers incentives for custom measures to nonresidential customers.
4. The Appliance Recycling Program (ARP) offers customers incentives to have their outdated refrigerators, freezers, and air conditioners recycled.
5. The Act 129 Winter Relief Assistance Program (WRAP) provides weatherization to low-income customers using Act 129 funding to expand the existing Low-Income Usage Reduction Program.
6. The Student and Parent Energy-Efficiency Education Program provides school-based energy efficiency education through in-classroom workshops for students in various grade levels, training for teachers, and community workshops for parents in low-income neighborhoods.
7. The Residential Home Comfort Program offers energy-saving measures and rebates for new construction and retrofitted existing homes.
8. The E-Power Wise Program provides low-income customers with information about energy use, along with home energy kits.
9. The Master Metered Low-Income Multifamily Housing Program offers energy efficiency improvements in master metered multifamily low-income housing buildings.
10. The Continuous Energy Improvement (CEI) Program provides technical support for schools to develop and implement a Strategic Energy Management Plan (SEMP).

[1] Program list organized by the largest contributor to portfolio savings to the smallest. The individual program chapters are presented in this order. Program information in portfolio-level tables are organized in alphabetical order.

11. The Residential Energy Efficiency Behavior & Education Program encourages customers to take energy-saving actions, providing periodic reports with energy-saving tips and usage comparisons to other peer customers.
12. The Low-Income Energy Efficiency Behavior & Education Program encourages low-income customers to take energy-savings actions, providing periodic reports with energy-saving tips and usage comparisons to other peer customers. No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it was launched late in PY6. The program evaluation will occur in PY7 when data are available and more complete.
13. The School Benchmarking Program works with school administrators to evaluate total building energy use using the Environmental Protection Agency's Portfolio Manager Tool. No energy savings are planned or claimed for this program.

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

Table 1-1: PY6 Portfolio Executive Summary - Programs

Program	Phase II Reported Gross Energy Savings (MWh/Year)	Phase II Adjusted *Ex Ante* Gross Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings[1] (MWh/yr)	Phase II NTG Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[2] ($/Annual kWh)	Cost of Conserved Energy [3] (TRC Costs/ Lifetime kWh)	Phase II Participants
Appliance Recycling	16,568	16,489	15,692	0.79	3.30	$2,786	$0.18	$0.029	19,584
Continuous Energy Improvement[4]	-	1,390	1,159	1.00	0.46	$632	$0.55	$0.199	0
Custom Incentive	28,079	28,079	27,288	0.47	1.39	$3,747	$0.14	$0.053	125
E-Power Wise	3,488	4,236	3,241	1.00	3.39	$636	$0.20	$0.031	6,317
Low-Income Energy-Efficiency Behavior and Education[5]	-	-	-	-	-	$1,138	-	-	72,988
Low-Income WRAP	7,626	7,626	7,335	1.00	0.77	$9,871	$1.35	$0.135	6,839
Master Metered Multifamily Housing	3,364	3,300	3,586	0.81	1.44	$1,402	$0.39	$0.058	86
Prescriptive Equipment	181,214	181,215	170,418	0.75	1.87	$32,555	$0.19	$0.048	6,042
Residential Energy-Efficiency Behavior and Education[6]	-	30,424	29,568	1.00	1.29	$1,959	$0.07	$0.063	130,626
Residential Home Comfort	6,255	6,207	6,493	0.60	0.66	$3,449	$0.53	$0.180	6,823
Residential Retail	141,791	143,323	141,777	0.72	3.75	$13,308	$0.09	$0.032	398,494
School Benchmarking[7]	-	-	-	-	-	$278	-	-	37
Student & Parent Education	11,055	14,339	10,523	1.00	2.68	$3,128	$0.30	$0.039	42,647
Indirect Costs	-	-	-	-	-	$21,704	-	-	-
Total	**399,440**	**436,628**	**417,081[8]**	**0.75**	**1.78**	**$96,592 [8]**	**$0.23**	**$0.055**	**690,608**
Adjustment for Residential Energy-Efficiency Behavior and Education Double-Counted Savings [9]			-13	-	-	-	-	-	-
Adjusted Portfolio Savings	-	-	**417,068[8]**	-	-	-	-	-	-

[1] Excludes expiring one-year measure life savings. This includes 356 MWh for E-Power Wise and 2 MWh for Master Metered Multifamily Program; totaling 357 MWh (rounded).
[2] Total EDC Costs divided by first year kWh savings.
[3] Total TRC Costs divided by levelized lifetime kWh savings.
[4] CEI participants and their PY6 energy and energy savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until the first quarter (Q1) of PY7. Cadmus considered the PY6 savings reported in PY7 as the adjusted *ex ante* savings for PY6. See the program chapter for discussion of the approach to the impact evaluation to determine verified savings.
[5] No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it launched late in PY6. The program evaluation will occur in PY7 when data are available.
[6] Residential Energy-Efficiency Behavior and Education energy savings for PY6 were not reported in EEMIS until PY7 Q1. Cadmus considered the PY6 savings reported in PY7 as the adjusted *ex ante* savings for PY6. See the program chapter for discussion of the approach to the impact evaluation to determine verified savings.
[7] The School Benchmarking Program is not designed to deliver energy savings.
[8] Total will not equal sum of column due to rounding.
[9] See Appendix F discussing methods to determine double-counted savings. Total 12.94 MWh/yr rounded to 13 MWh/yr.

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

Table 1-2: PY6 Portfolio Executive Summary - Sectors

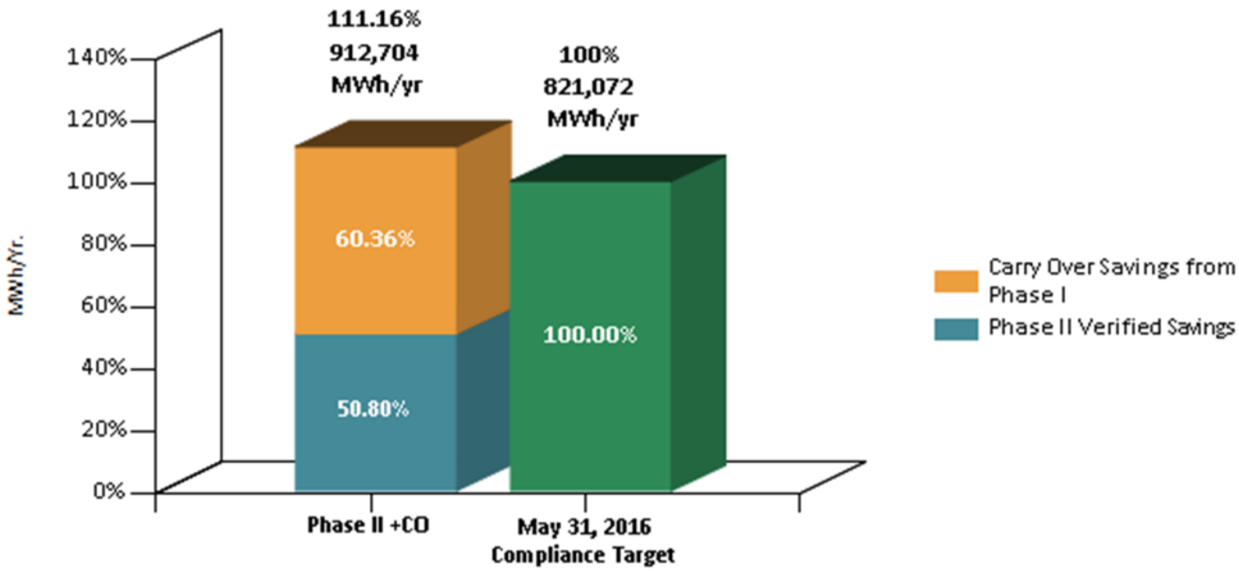
Sector	Phase II Reported Gross Energy Savings (MWh/Year)	Phase II Adjusted *Ex Ante* Gross Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II NTG Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC Costs/ Lifetime kWh)	Phase II Participants
Government/Nonprofit/ Education	48,721	50,046	47,352	0.75	1.13	$13,614	$0.29	$0.076	2,949
Large C&I	64,680	64,681	61,937	0.65	2.07	$7,713	$0.12	$0.034	265
Low Income	11,114	11,862	10,576[3]	1.00	0.84	$11,645	$1.10	$0.124	106,816
Residential	137,327	171,938	165,681	0.79	2.58	$23,410	$0.14	$0.045	555,704
Small C&I	137,598	138,100	131,535	0.73	2.48	$18,507	$0.14	$0.041	24,874
Indirect Costs	-	-	-	-	-	$21,704	-	-	-
Total	**399,440**	**436,628[4]**	**417,081[4]**	**0.75**	**1.78**	**$96,592 [4]**	**$0.23**	**$0.055**	**690,608**
Adjustment for Residential Energy-Efficiency Behavior and Education Double-Counted Savings [5]			-13	-	-	-	-	-	-
Adjusted Residential Savings		-	-	-	-	-	-	-	-
Adjusted Portfolio Savings		-	-	-	-	-	-	-	-

[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.
[3] Excludes 19,903 MWh/yr of savings attributable to low income participants in other residential programs. These savings count toward the Low-Income compliance target.
[4] Total will not equal sum of column due to rounding.
[5] See Appendix F discussing methods to determine double-counted savings. Total 12.94 MWh/yr rounded to 13 MWh/yr.

1.1 SUMMARY OF PROGRESS TOWARD COMPLIANCE TARGETS

PPL Electric Utilities has achieved 111% of the energy savings compliance target, based on cumulative portfolio Phase II inception to date including carryover savings from Phase I ("Phase II+CO") verified gross energy savings, as shown in Figure 1-1.

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



According to the Phase II Implementation Order, PPL Electric Utilities is allowed by the PUC to "carry over" into Phase II the Phase I verified energy savings that exceeded the Phase I compliance target. Table 1-3 shows the incremental annual MWh savings from Phase I PPL Electric Utilities that are carrying over into Phase II.

Table 1-3: Phase II Verified Gross Savings and Verified Gross Savings from PY4 Carried Into Phase II[1]

Sector	PYTD Verified Gross Savings (MWh/yr)	Phase II Verified Gross Savings (Cumulative Phase II MWh/yr)[2]	Verified Gross Savings Carried Over from Phase I (Cumulative Annual MWh/Yr)	Phase II+CO Verified Gross Savings (Cumulative MWh/Yr)
Government/Nonprofit/Education	26,497	47,352	92,143	139,496[3]
Large C&I	46,818	61,937	-	61,937
Low Income	6,596	10,576	-	10,576
Residential	81,084	165,681	-	165,681
Small C&I	56,378	131,535	-	131,535
Total	**217,373**	**417,081**	**495,636**	**912,717**
Adjustment for Residential Energy-Efficiency Behavior and Education Double-Counted Savings [4]	-13	-13		-13
Adjusted Residential Savings	81,071	165,668		165,668
Adjusted Portfolio Savings	**217,360**	**417,068**		**912,704**

[1] Values in this table refer to savings at the point of consumption. Due to line losses, savings at the point of generation are systematically larger.
[2] Excludes expiring one-year measure life savings.
[3] Sum of savings for government/nonprofit/education sector will not equal cumulative total due to rounding.
[4] See Appendix F discussing methods to determine double-counted savings. Total 12.94 MWh/yr rounded to 13 MWh/yr.

Table 1-4 shows the lifetime MWh savings from Phase I PPL Electric Utilities that are carried over into Phase II.

Table 1-4: Phase II Verified Gross Lifetime Savings and Verified Gross Lifetime Savings from PY4 Carried Into Phase II[1]

Sector	PYTD Verified Gross Savings (Lifetime MWh)	Phase II Verified Gross Savings (Lifetime MWh)	Verified Gross Savings Carried Over from Phase I (Lifetime MWh) [2]	Phase II+CO Verified Gross Savings (Lifetime MWh)
Government/Nonprofit/ Education	356,721	646,811	1,349,379	1,996,190
Large C&I	691,244	910,384	-	910,384
Low Income	83,906	135,484	-	135,484
Residential	607,051	1,204,727	-	1,204,727
Small C&I	757,572	1,576,729	-	1,576,729
Total	**2,496,495[3]**	**4,474,134[3]**	**5,235,829**	**9,709,964**

[1] Values in this table refer to savings at the point of consumption. Due to line losses, savings at the point of generation are systematically larger.
[2] The SWE requested reporting lifetime carryover in this table to demonstrate lifetime savings from Phase I and Phase II. Because there was no compliance target for lifetime savings in Phase I, lifetime carryover is estimated by multiplying the proportion of lifetime to annual savings from Phase I by the Phase I annual carryover.
[3] Total will not equal sum of columns due to rounding.

Table 1-5 shows the verified first year net MWh and lifetime net MWh for PY6 and for Phase II.

Table 1-5: Phase II Verified Net First-Year and Lifetime Savings[1]

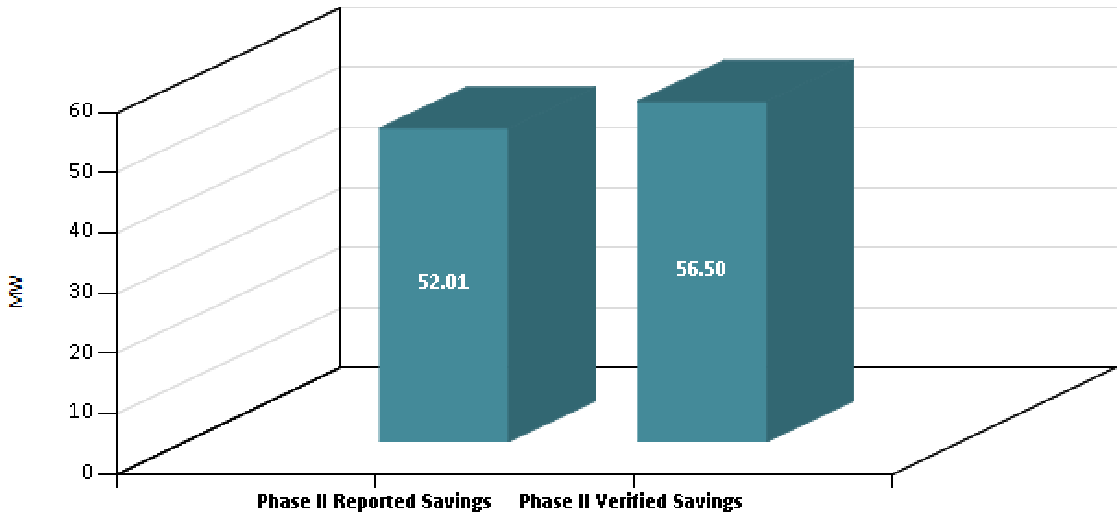
Sector	PYTD Verified Net Savings (MWh/yr)	Phase II Verified Net Savings (Cumulative Phase II MWh/yr) [2]	PYTD Verified Gross Savings (Lifetime MWh)	Phase II Verified Net Savings (Lifetime MWh) [3]
Government/Nonprofit/ Education	19,720	35,377	356,721	483,227
Large C&I	29,538	40,363	691,244	593,274
Low Income	6,596	10,576	83,906	135,484
Residential	61,601	131,362	607,051	955,184
Small C&I	37,529	95,899	757,572	1,149,562
Total	**154,984**	**313,577**	**2,496,495** [4]	**3,363,821**
Adjustment for Residential Energy-Efficiency Behavior and Education Double-Counted Savings [5]	-13	-	-	-
Adjusted Residential Savings	61,588	-	-	-
Adjusted Portfolio Savings	**154,972** [6]	**313,564**	-	-

[1] Values in this table refer to savings at the point of consumption. (MWh compliance targets refer to savings at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Excludes expiring one-year measure life savings.
[3] Verified net lifetime savings are not computed at the record level. The sector-level estimates are computed by multiplying the proportion of net to gross annual savings for each sector by the total lifetime savings for that sector. This same computation is made at the portfolio level. Because lifetime savings are a function of measure life, these estimates are to be considered approximate, and estimates by sector will not equal the portfolio-level estimate.
[4] Total will not equal sum of columns due to rounding.
[5] Appendix F discusses methods to determine double-counted savings. Total 12.94 MWh/yr rounded to 13 MWh/yr.
[6] Applying the estimate of 75% NTGR for Residential Retail Upstream Lighting, referred to in Section 3.4.2 and Table 1-15, rather than the 52% currently used to compute PY6 verified net savings, would increase the portfolio verified net savings by approximately 11,000 MWh.

In addition, PPL Electric Utilities has achieved 56.50 MW of gross verified demand reduction during Phase II.[2] See Figure 1-2 below. Additional detail on achieved demand reduction by program can be found in Table 1-12 and Table 1-13 of this section.

2 Unlike Phase I, there is no compliance target for demand reduction in Phase II. The Commission, however, requires that demand reduction savings in Phase II be reported including line losses, as in Phase I. Verified demand reduction savings include line losses but reported savings do not.

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



Sixty measures are available at no cost to low-income customers. These measures offered to the low-income sector comprise 54% of the total measures offered. As required under Act 129, this exceeds the fraction of the electric consumption of the utility's low-income households divided by the total electricity consumption in the PPL Electric Utilities territory (8.64%).[3] These values are shown in Table 1-6 and Table 1-7.

Table 1-6: Low-Income Sector Compliance (Number of Measures)

	Low-Income Sector	All Sectors	% Low-Income	Goal
Number of Measures Offered	60	111	54.05%	8.64%

Table 1-7: Low-Income Sector Compliance (Percentage of Savings)

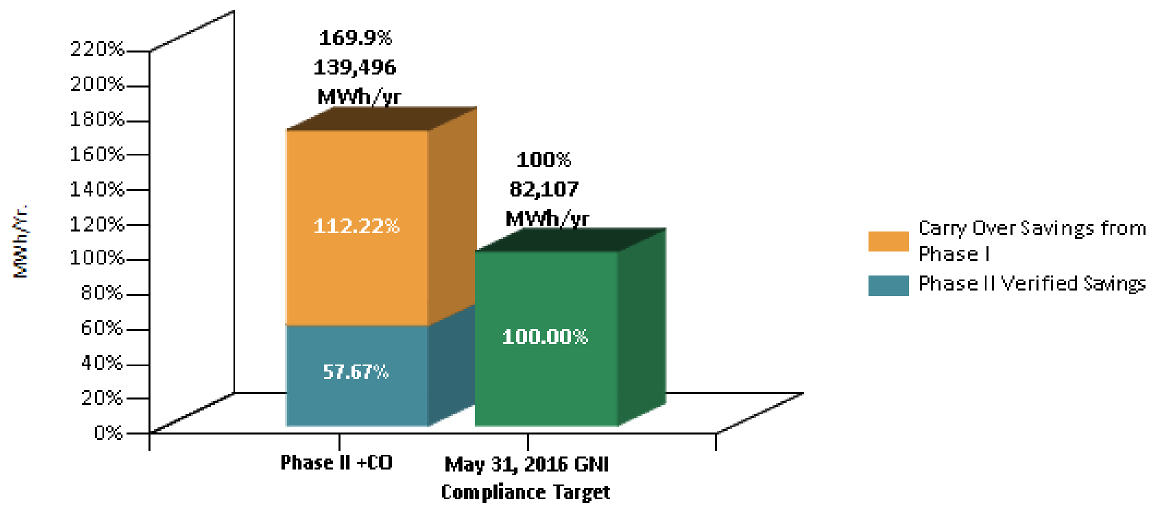
	Phase II Verified Gross Energy Savings (MWh/yr)
Low Income Verified Gross Savings from Other Residential Programs (Incremental Annual MWh/yr)	19,903
Low Income Verified Gross Savings from Low Income Programs (Incremental Annual MWh/yr)	10,576
All Low Income Verified Gross Savings (Sum of First Two Rows)	**30,479**
Progress Toward Low Income Compliance Target (Previous Row divided by Phase II MWh/yr Target)	82.49%
Compliance Target (MWh/yr)	**36,948**

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

The Phase II verified gross energy savings achieved through programs specifically designed for income-eligible customers is 10,576 MWh/yr and is 19,903 MWh/yr through other programs; this is 82% of the 4.5% Phase II total portfolio verified gross energy savings target for the low-income sector.

PPL Electric Utilities achieved 170% of its May 31, 2016, energy reduction compliance target for the government, nonprofit, institutional, and educational (GNE) sector based on cumulative program/portfolio savings from Phase II+CO verified gross energy savings achieved from the inception of Phase II through PY6 and including carryover savings from Phase I as shown in Figure 1-3.

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



A summary of the number of participants, Phase II verified gross energy savings (MWh/Yr), Phase II demand reduction (MW), and incentives paid ($1,000) is shown in Table 1-8.

Table 1-8: Summary of Phase II Performance by Sector

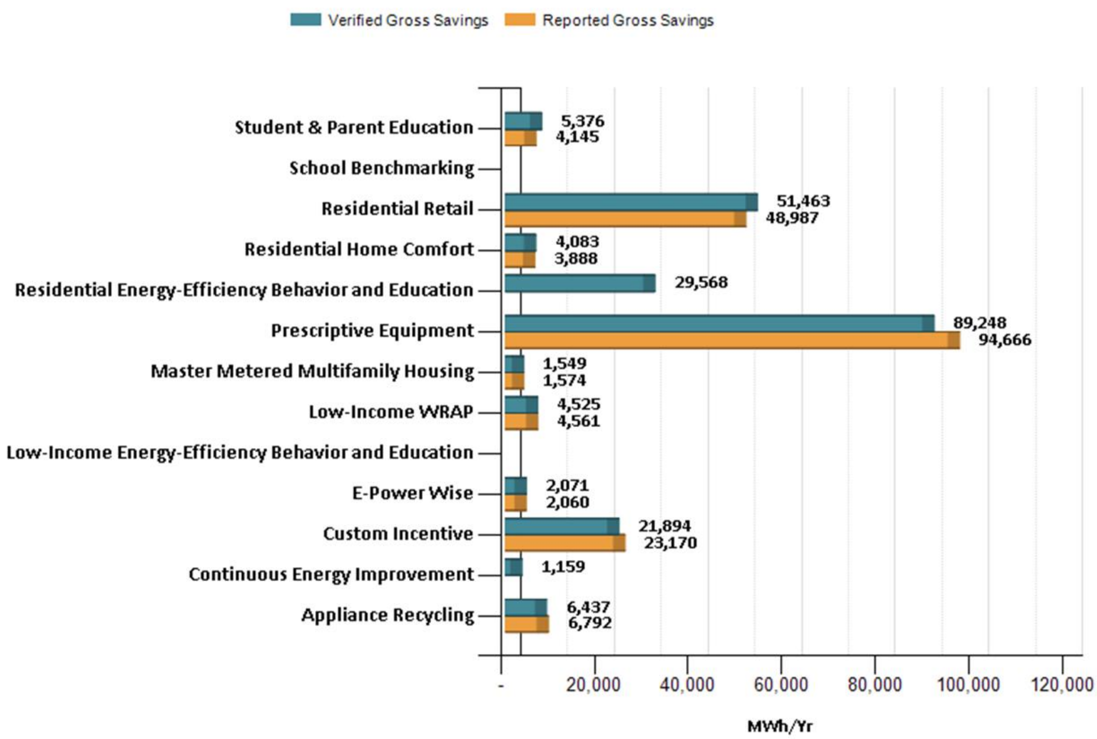
Sector	Participants	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Verified Gross Demand Reduction (MW) [1]	Incentives ($1000)
Government/Nonprofit/Education	2,949	47,352	7.87	$8,784
Large C&I	265	61,937	7.01	$5,034
Residential	555,704	165,681	14.27	$9,107
Small C&I	24,874	131,535	25.92	$12,517
Low Income	106,816	10,576	1.44	$0
Phase II Total	**690,608**	**417,081**	**56.50**	**$35,442**
Adjustment for Residential Energy-Efficiency Behavior and Education Double-Counted Savings		-13		
Adjusted Residential Savings		165,668		
Adjusted Portfolio Savings		**417,068**		

[1] Verified gross demand reductions include T&D losses.

1.2 SUMMARY OF ENERGY IMPACTS

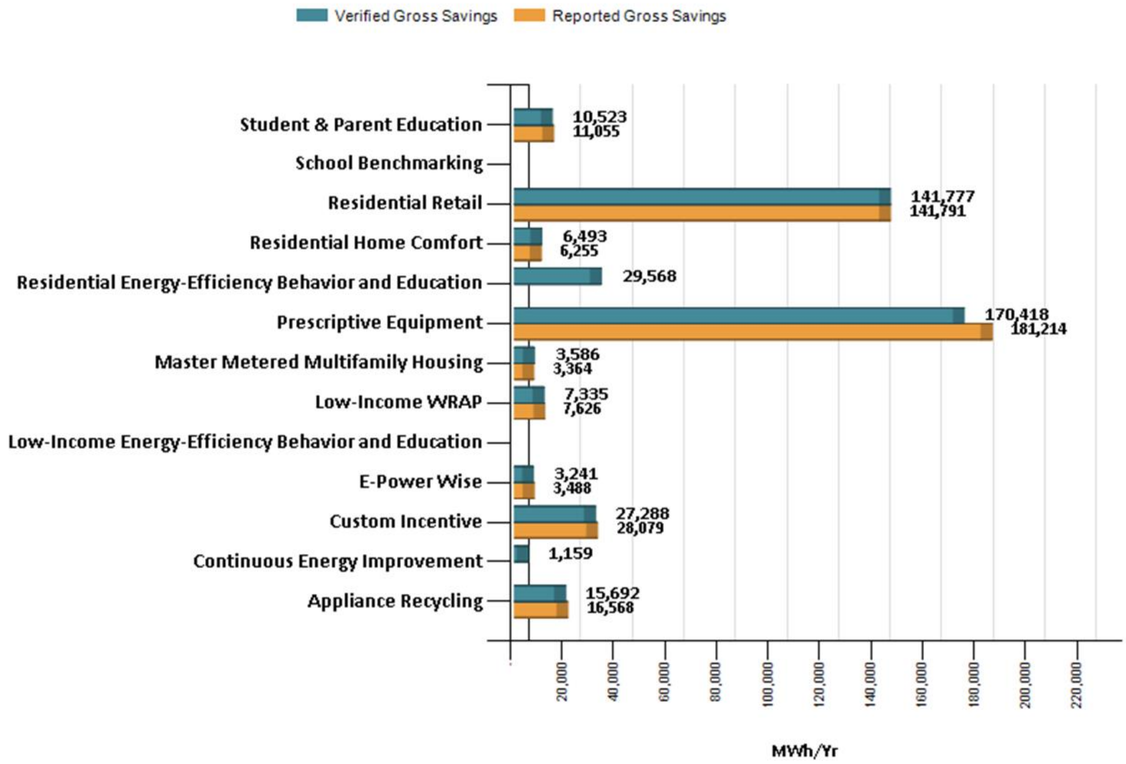
A summary of the reported and verified energy savings by program for PY6 is presented in Figure 1-4**.** The School Benchmarking Program is not designed to deliver energy savings. No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it was launched late in PY6. The program evaluation will occur in PY7 when data are available.

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



A summary of the Phase II reported and verified energy savings by program is presented in Figure 1-5. The School Benchmarking Program is not designed to deliver energy savings. No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it was launched late in PY6. The program evaluation will occur in PY7.

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



Summaries of energy impacts by program through PY6 are presented in Table 1-9 and Table 1-10.

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

Program	Participants		Reported Gross Impact (MWh/Year)	
	PYTD	Phase II	PYTD	Phase II[1]
Appliance Recycling	8,074	19,584	6,792	16,568
Continuous Energy Improvement [2]	-	-	-	-
Custom Incentive[3]	69	125	23,170	28,079
E-Power Wise	3,602	6,317	2,060	3,488
Low-Income Energy-Efficiency Behavior and Education	72,988	72,988	-	-
Low-Income WRAP	4,048	6,839	4,561	7,626
Master Metered Multifamily Housing	49	86	1,574	3,364
Prescriptive Equipment	3,694	6,042	94,666	181,214
Residential Energy-Efficiency Behavior and Education	130,626	130,626	-	-
Residential Home Comfort	4,269	6,823	3,888	6,255
Residential Retail[4]	171,116	398,494	48,987	141,791
School Benchmarking[5]	15	37	-	-
Student & Parent Education[6]	21,611	42,647	4,145	11,055
Total Portfolio	**420,161**	**690,608**	**189,843**	**399,440**

[1] Excludes expiring one-year measure life savings.
[2] PY6 participants and savings were reported in PY7 Q1.
[3] Beginning in PY6 Q1, the methodology for counting participants for the C&I Custom Incentive Program changed. The participant count is now based on the number of jobs contributing to reported savings for the specified period, as opposed to the number of projects created in that period.
[4] The Residential Retail Program contains an upstream lighting component, in which exact participation is not known. Cadmus estimated the number of participants in this component of the program by dividing the total number of bulbs discounted or given away by a bulb-per-participant value derived from the most recent residential and commercial customer telephone survey data. The total participant count for this program comprises equipment-rebate participants, midstream equipment-incentive participants (midstream incentives were discontinued during PY5), and an estimated number of lighting participants.
[5] The School Benchmarking Program does not claim energy or demand savings.
[6] Beginning in PY6 Q3, the methodology for counting participants for the Student & Parent Education Program changed. The participant count is now based on the number of kits distributed, instead of the previously reported number of classrooms. This change was applied to data for all of Phase II.

Table 1-10: Verified Gross Energy Savings by Program

Program	PYTD Reported Gross Energy Savings (MWh/yr)	PYTD Adjusted Ex-Ante Gross Energy Savings (MWh/yr)	PYTD Energy Realization Rate	PYTD Verified Gross Savings (MWh/yr)	PYTD Achieved Precision	PYTD Confidence	Phase II Verified Gross Savings (MWh/yr) [1]	Phase II Achieved Precision	Phase II Confidence
Appliance Recycling	6,792	6,775	95.01%	6,437	2.2%	85%	15,692	2.2%	90%
Continuous Energy Improvement[2]	-	1,390	83.38%	1,159	26.4%	85%	1,159	30.2%	90%
Custom Incentive	23,170	23,170	94.50%	21,894	4.9%	85%	27,288	6.2%	90%
E-Power Wise	2,060	2,807	73.78%	2,071	3.6%	85%	3,241	3.5%	90%
Low-Income Energy-Efficiency Behavior and Education[3]	-	-	-	-	-	-	-	-	90%
Low-Income WRAP	4,561	4,561	99.21%	4,525	6.4%	85%	7,335	4.5%	90%
Master Metered Multifamily Housing	1,574	1,526	101.48%	1,549	5.8%	85%	3,586	4.9%	90%
Prescriptive Equipment	94,666	94,666	94.28%	89,248	2.4%	90%	170,418	2.1%	90%
Residential Energy-Efficiency Behavior and Education[4]	-	30,424	97.19%	29,568	7.5%	85%	29,568	8.6%	90%
Residential Home Comfort	3,888	3,835	106.46%	4,083	1.3%	85%	6,493	1.0%	90%
Residential Retail	48,987	52,990	97.12%	51,463	11.6%	90%	141,777	4.2%	90%
School Benchmarking[5]	-	-	-	-	-	-	-	-	-
Student & Parent Education	4,145	6,696	80.29%	5,376	0.2%	85%	10,523	0.6%	90%
Total Portfolio	**189,843**	**228,841[6]**	**94.99%**	**217,373**	**3.2%**	**90%**	**417,081**	**1.8%**	**90%**
Adjustment for Residential Energy-Efficiency Behavior and Education Double-Counted Savings [7]				-13	-	-	-	-	-
Adjusted Portfolio Savings	-	-	-	**217,360**	-	-	-	-	-
Phase I Carryover	-	-	-	-	-	-	**495,636**	-	-
Total Ph II+CO	-	-	-	-	-	-	**912,717[6]**	-	-

[1] Excludes expiring one-year measure life savings.
[2] CEI participants and their PY6 energy and energy savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until the first quarter (Q1) of PY7.
[3] No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it was launched late in PY6. The program evaluation will occur in PY7 when data are available.
[4] Residential Energy-Efficiency Behavior and Education energy savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until the first quarter (Q1) of PY7.
[5] The School Benchmarking Program is not designed to deliver energy savings.]
[6] Total will not equal sum of columns due to rounding.
[7] Appendix F discusses methods to determine double-counted savings. Total 12.94 MWh/yr rounded to 13 MWh/yr.

The Continuous Energy Improvement Program precision is above the 15% relative precision target, at the program level, specified in the Evaluation Framework. However, the savings contribution from this program is a negligible proportion of total portfolio savings. Cadmus calculated the precision of savings estimates for energy and demand using the standard error of the regression coefficient(s) that determine savings. The resulting precision of a regression model is difficult to predict or control. Additional sample points cannot be added, and the evaluator has little control over the variability of the results. The precision on the CEI Program modeling is primarily influenced by two factors—model specification and sample size—and the model specification is largely determined by information provided by the participants. Changes that occur on site that affect energy usage or potential variable omission can lead to model misspecification, where a portion of the error in the model is left unaccounted for. This CEI Program analysis is also constrained by sample size, with only eight schools participating. Cadmus anticipates that as more schools participate in the CEI Program and additional, site-specific information is provided, the program precision will improve.

Table 1-11 provides the achieved precision through PY6 and Phase II for each sector, with confidence levels for the sectors and portfolio specified in the Evaluation Framework.

Table 1-11: Achieved Precision for Energy Savings by Sector

Sector	PYTD Achieved Precision	Phase II Achieved Precision	Confidence
Government/Nonprofit/Education	13.5%	8.2%	90%
Low Income	5.2%	3.2%	90%
Nonresidential	2.2%	2.0%	90%
Residential	6.7%	3.2%	90%
Total Portfolio	**3.2%**	**1.8%**	**90%**

1.3 Summary of Fuel Switching Impacts-From Electricity to Fossil Fuels

In PY6, PPL Electric Utilities continued the fuel switching pilot program, which was offered for the first time in PY5. This program offered rebates to customers who used electric space or water heat and installed new efficient non-electric space or water heating equipment. Rebates were limited to the first 100 applicants (residential and nonresidential) in three programs—Residential Home Comfort, Residential Retail, and Prescriptive Equipment, but only customers in the Residential Retail and Residential Home Comfort Programs participated in PY6. A total of 32 fossil fuel measures were rebated through this pilot program.

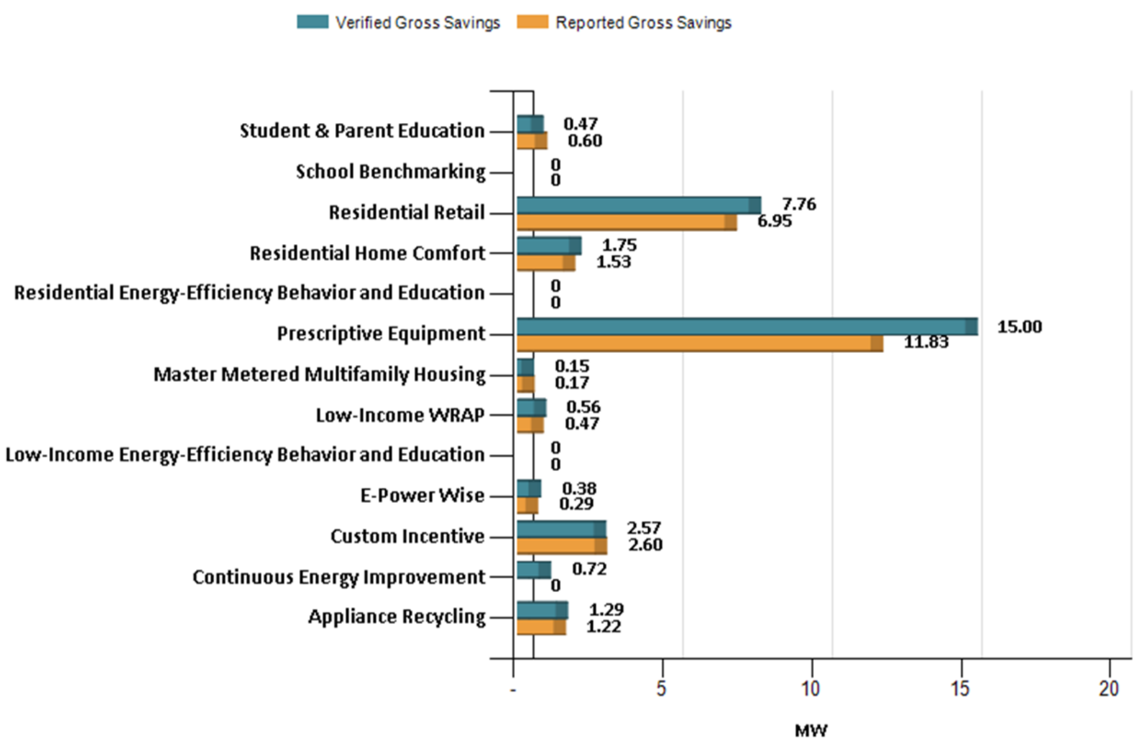
For fuel-switching pilot measures, eligibility for electricity savings is based on conversion from a standard electric water heater. Per-unit energy and demand savings are deemed in the Pennsylvania TRM. Cadmus applied the deemed values from either the 2013 or the 2014 Pennsylvania TRM, depending on the year within which the measure was installed. Fuel-switching measures account for 19 MWh/yr and 0.00175 MW of PPL Electric Utilities' total PY6 verified gross savings and $6,000 of incentives paid.

Cadmus conducted a phone survey of the pilot program's participants to determine the reasons participants switched fuels and the influence of the incentives offered. The results and findings are outlined in Appendix K: Fuel-Switching Pilot Analysis: Electricity to Fossil Fuels.

1.4 SUMMARY OF DEMAND IMPACTS

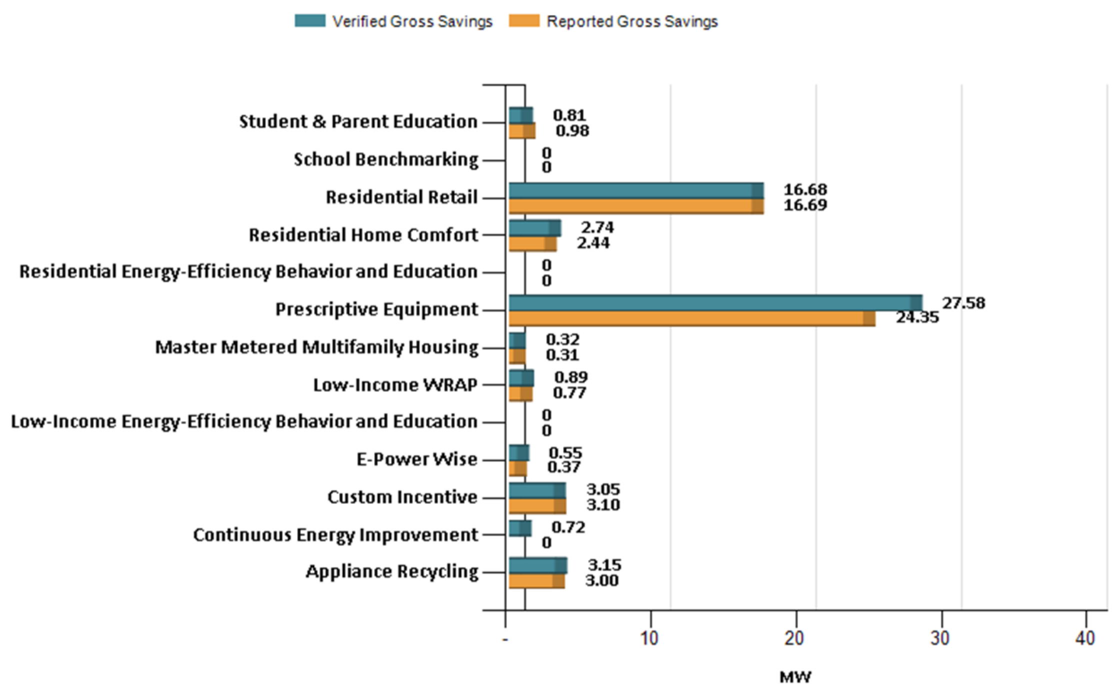
A summary of the reported and verified demand reduction by program for PY6 is presented in Figure 1-6. The impacts below reflect the line loss factors shown in Table 1-18.

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



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

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



A summary of demand reduction impacts by program through PY6 is presented in Table 1-12 and Table 1-13.

Table 1-12: Reported Participation and Gross Demand Reduction by Program

Program	Participants		Reported Gross Impact (MW)	
	PYTD	Phase II	PYTD	Phase II[1]
Appliance Recycling	8,074	19,584	1.22	3.00
Continuous Energy Improvement[2]	-	-	-	-
Custom Incentive[3]	69	125	2.60	3.10
E-Power Wise	3,602	6,317	0.29	0.37
Low-Income Energy-Efficiency Behavior and Education[4]	72,988	72,988	-	-
Low-Income WRAP	4,048	6,839	0.47	0.77
Master Metered Multifamily Housing	49	86	0.17	0.31
Prescriptive Equipment	3,694	6,042	11.83	24.35
Residential Energy-Efficiency Behavior and Education[4]	130,626	130,626	-	-
Residential Home Comfort	4,269	6,823	1.53	2.44
Residential Retail[5]	171,116	398,494	6.95	16.69
School Benchmarking[6]	15	37	-	-
Student & Parent Education[7]	21,611	42,647	0.60	0.98
Total Portfolio	**420,161**	**690,608**	**25.66**	**52.01**

[1] Excludes expiring one-year measure life savings.
[2] CEI participants and their PY6 energy savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until the first quarter (Q1) of PY7.
[3] Beginning in PY6 Q1, the methodology for counting participants for the C&I Custom Incentive Program changed. The participant count is now based on the number of jobs contributing to reported savings for the specified period, as opposed to the number of projects created in that period.
[4] Both the Residential and Low-Income Energy-Efficiency Behavior and Education Program demand impacts were not reported in PY6.
[5] The Residential Retail Program contains an upstream lighting component, in which exact participation is not known. Cadmus estimated the number of participants in this component of the program by dividing the total number of bulbs discounted or given away by a bulb-per-participant value derived from the most recent residential and commercial customer telephone survey data. The total participant count for this program is comprised of equipment-rebate participants, midstream equipment-incentive participants (midstream incentives were discontinued during PY5), and the estimated number of lighting participants.
[6] The School Benchmarking Program is not designed to deliver energy savings. The program does not claim energy or demand savings.
[7] Beginning in PY6 Q3, the methodology for counting participants for the Student & Parent Education Program changed. The participant count is now based on the number of kits distributed, instead of the previously reported number of classrooms. This change was applied to data for all of Phase II.]

Table 1-13: Verified Gross Demand Reduction by Program

Program	PYTD Reported Gross Demand Savings (MW)	PYTD Adjusted *Ex Ante* Gross Demand Savings (MW) [1]	PYTD Demand Realization Rate	PYTD Verified Gross Demand (MW) [1]	PYTD Achieved Precision	PYTD Confidence	Phase II Verified Gross Demand Savings (MW)	Phase II Achieved Precision	Phase II Confidence
Appliance Recycling	1.22	1.33	96.97%	1.29	1.5%	85%	3.15	2.3%	90%
Continuous Energy Improvement	-	0.17	425.44%	0.72	28.3%	85%	0.72	32.4%	90%
Custom Incentive[2]	2.60	2.72	94.55%	2.57	6.5%	85%	3.05	6.8%	90%
E-Power Wise	0.29	0.39	98.03%	0.38	4.3%	85%	0.55	4.3%	90%
Low-Income Energy-Efficiency Behavior and Education[3]	-	-	-	-	-	-	-	-	90%
Low-Income WRAP	0.47	0.57	99.12%	0.56	6.6%	85%	0.89	4.8%	90%
Master Metered Multifamily Housing	0.17	0.17	91.06%	0.15	6.1%	85%	0.32	10.0%	90%
Prescriptive Equipment	11.83	12.64	118.67%	15.00	6.1%	90%	27.58	3.7%	90%
Residential Energy-Efficiency Behavior and Education[4]	-	-	-	-	-	85%	-	-	90%
Residential Home Comfort	1.53	1.71	102.25%	1.75	1.2%	85%	2.74	0.9%	90%
Residential Retail	6.95	7.91	98.07%	7.76	11.7%	90%	16.68	5.5%	90%
School Benchmarking[5]	-	-	-	-	-	-	-	-	-
Student & Parent Education	0.60	0.98	47.78%	0.47	0.3%	85%	0.81	0.7%	90%
Total Portfolio	**25.66**	**28.58**[6]	**107.23%**	**30.65**	**4.3%**	**90%**	**56.50**	**2.5%**	**90%**
Phase I Carryover	-	-	-	-	-	-	-	-	-
Total Ph II+CO	-	-	-	-	-	-	-	-	-

[1] *Ex Ante* and Verified gross demand reductions include T&D losses.
[2] CEI participants and their PY6 energy and energy savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until the first quarter (Q1) of PY7.
[3] No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it was launched late in PY6. The program evaluation will occur in PY7.
[4] Residential Energy-Efficiency Behavior and Education demand savings were not reported in PY6.
[5] The School Benchmarking Program is not designed to deliver energy savings.
[6] Total will not equal sum of columns due to rounding.

Although there are no compliance targets for demand reduction, Table 1-14 provides the achieved precision for verified demand impacts through PY6 and Phase II for each sector.

Table 1-14: Achieved Precision for Demand Reduction by Sector

Sector	PYTD Achieved Precision	Phase II Achieved Precision	Confidence
Government/Nonprofit/Education	26.7%	22.6%	90%
Low Income	4.9%	3.3%	90%
Nonresidential	5.3%	3.4%	90%
Residential	8.1%	3.9%	90%
Total Portfolio	**4.3%**	**2.5%**	90%

1.5 SUMMARY OF PROGRAM YEAR 6 NET-TO-GROSS RATIOS

Per the 2013 TRC Order, EDCs are required to conduct net-to-gross (NTG) research. Net-to-gross ratios are not used for compliance purposes, but are used for cost-effectiveness reporting and future program planning purposes and should be applied to gross savings in order to calculate net verified energy and demand savings for Table 1-15. Table 1-15 presents a summary of net-to-gross ratios by program.

Table 1-15: PY6 Net-to-Gross Ratios by Program

Program Name	Freeridership (%)	Spillover (%)	NTG Ratio PY6	PY6 Verified Net Energy Savings (MWh/Yr)	PY6 Verified Net Demand Savings (MW/Yr)	NTG Categories Included
Appliance Recycling[3]	13%	0%	87%	5,600	1.03	Self-report participant freeridership, secondary market impact, induced replacement, participant spillover.
Continuous Energy Improvement	0%	0%	100%	1,159	0.68	Self-report participant freeridership
Custom Incentive	55%	0%	45%	9,853	1.10	Self-report participant freeridership, spillover. Freeridership determined using PY5 and PY6 combined.
E-Power Wise	0%	0%	100%	2,071	0.35	Low-income program offers energy conservation kit at no cost to customers. No freeridership.
Low-Income Energy-Efficiency Behavior and Education	0%	0%	100%	0	0.00	Low-income program offers home energy report at no cost to customers. No freeridership.
Low-Income WRAP	0%	0%	100%	4,525	0.52	Low-income program offered at no cost to customers. No freeridership.
Master Metered Multifamily Housing	14%	0%	86%	1,328	0.12	Self-report participant freeridership for rebated equipment, spillover.
Prescriptive Equipment	28%	2%	74%	66,148	10.41	Self-report participant freeridership, spillover.

Program Name	Freeridership (%)	Spillover (%)	NTG Ratio PY6	PY6 Verified Net Energy Savings (MWh/Yr)	PY6 Verified Net Demand Savings (MW/Yr)	NTG Categories Included
Residential Energy-Efficiency Behavior and Education	0%	0%	100%	29,568	0.00	Billing analysis uses treatment and control group; results are net savings
Residential Home Comfort	46%	6%	60%	2,450	0.97	Self-report participant freeridership, spillover.
Residential Retail	48%[2]	0%	52%[2]	26,907[2]	3.74[2]	Self-report participant freeridership, spillover for rebated equipment. Demand elasticity modeling for lighting freeridership; not adjusted for nonparticipant spillover and other market effects or market progress indicators
School Benchmarking	0%	0%	100%	0	0.00	Not applicable
Student & Parent Education	0%	0%	100%	5,376	0.43	Classroom education and energy conservation kits offered in school curricula at no cost to the student participants. No freeridership.
Portfolio[1]	**30%**	**1%**	**71%**	**154,984**	**19.36**	**Not applicable**

[1] Weighting determined by the sum of PY6 program verified net energy savings divided by PY6 program verified gross energy savings
[2] Results are somewhat inconclusive and do not include adjustments (upward) for market effects and market progress indicators[The net-to-gross ratio estimate is more likely to be 75%. Applying a 75% NTGR, discussed in Section 3.4.2, rather than the 52% currently used to compute PY6 verified net savings, increases the PY6 verified net savings to 38,324 MWh/yr and PY6 net verified demand savings to 5.35 MW/yr.
[3]Cadmus did not estimate a net-to-gross ratio but instead estimated the net per-unit savings and program-level net savings. This is because replacements were accounted for in the gross savings. The replacement status of the appliance determines the appropriate gross savings value to be applied; therefore, Cadmus calculated the net savings not from the gross savings but rather from the unit energy consumption (UEC) multiplied by part use (represented as UEC*part use). This avoids double-counting the penalty to the program for replacements.
[4]Value is 7 MWh less that the value reported in Table 5-12 because NTG estimates in this table were rounded to a whole percent.

Table 1-16 presents the net-to-gross ratios from PY5 compared to PY6.

Table 1-16: PY5 and PY6 NTG Ratios by Program

Program Name	NTG Ratio PY5	NTG Ratio PY6
Appliance Recycling	74%	87%
Continuous Energy Improvement	100%	100%
Custom Incentive	55%	45%
E-Power Wise	100%	100%
Low-Income Energy-Efficiency Behavior and Education[1]	-	-
Low-Income WRAP	100%	100%
Master Metered Multifamily Housing	77%	86%
Prescriptive Equipment	75%	74%
Residential Energy-Efficiency Behavior and Education[1]	-	100%
Residential Home Comfort	58%	60%
Residential Retail	83%	52% (adjusted 75%)
School Benchmarking[2]	-	-
Student & Parent Education	100%	100%
(Weighted by program savings for programs reporting NTG Ratios)[3]	**79%**	**71%**

[1] Program launched late in PY6 therefore no NTG ratio was calculated in PY5 or PY6; no freeridership expected.
[2] No savings are claimed for School Benchmarking.
[3] Weighting determined by the sum of PY6 program verified net energy savings divided by PY6 program verified gross energy savings.

Of note is the change in NTGR from PY5 to PY6 for the Residential Retail program. The majority of the estimate is attributable to upstream lighting. A demand elasticity model estimated 16% freeridership for CFLs in PY5 and 48% freeridership for LEDs in PY5. Given the difference in PY5 and PY6 estimates, data anomalies and lack of sufficient data documenting marketing and promotional activities in PY6, that this is the first year LEDs are discounted, no estimate of nonparticipant spillover, and the evidence collected in the various market effects studies of upstream lighting, Cadmus concludes that a net-to-gross ratio estimate of 75% is likely to be more realistic for this program. Data issues likely had some impact on the freeridership estimates, but the larger impacts are market effects. In the light of these observations, these estimates will be updated in PY7 and in the first year of Phase III as more data on the LED market becomes available.

1.6 SUMMARY OF PORTFOLIO FINANCES AND COST-EFFECTIVENESS

A breakdown of the portfolio finances is presented in Table 1-17.

Table 1-17: Summary of Portfolio Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs [6] ($1,000)
1	Incremental Measure Costs	$74,133	$104,648
2	EDC Incentives to Participants	$24,632	$33,588
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$49,782	$71,749
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$34,122	$58,581
6	Design & Development	$82	$1,444
7	Administration, Management, and Technical Assistance[1]	$26,233	$43,230
8	Marketing[2]	$2,969	$6,945
9	EDC Evaluation Costs	$3,913	$5,356
10	SWE Audit Costs	$925	$1,605
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$2,095	$2,166
12	Total TRC Costs [3] (Sum of rows 1, 5 and 11)	$110,631	$166,084
13	Total NPV Lifetime Energy Benefits	$144,717	$256,000
14	Total NPV Lifetime Capacity Benefits	$12,961	$19,737
15	Total NPV O&M Saving Benefits	$10,918	$20,507
16	Total NPV TRC Benefits[4]	$168,596	$296,243
17	TRC Benefit-Cost Ratio[5]	1.52	1.78

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

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

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

[3] Total TRC Costs includes Total EDC Costs (Program Overhead plus Incentives) and Participant Costs.

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

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

[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report or the total expenditures reported in Tables 1-1 and 1-2. The total value of PY6 indirect costs included in rows 6-10 was $10,248 ($1,000).

1.7 SUMMARY OF COST-EFFECTIVENESS BY PROGRAM

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

Table 1-18: PYTD TRC Ratios by Program

Program Name	TRC NPV Benefits ($1000)	TRC NPV Costs ($1000)	TRC Benefit-Cost Ratio	Discount Rate	Energy Line Loss Factor	Demand Line Loss Factor
Appliance Recycling	$3,909	$1,109	3.52	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
Continuous Energy Improvement	$315	$445	0.71	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
Custom Incentive	$15,308	$11,640	1.32	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
E-Power Wise	$1,387	$376	3.69	8.14%	8.33%	8.33%
Low-Income Energy-Efficiency Behavior and Education	$0	$870	N/A[5]	8.14%	8.33%	8.33%
Low-Income WRAP	$4,743	$6,481	0.73	8.14%	8.33%	8.33%
Master Metered Multifamily Housing	$1,087	$727	1.50	8.14%	6.23%	6.23%
Prescriptive Equipment	$75,523	$47,059	1.60	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
Residential Energy-Efficiency Behavior and Education	$2,612	$1,251	2.09	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
Residential Home Comfort	$4,245	$6,342	0.67	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
Residential Retail	$54,596	$21,991	2.48	8.14%	Multiple[1],[2],[3],[4]	Multiple[1],[2],[3],[4]
School Benchmarking	$0	$126	0.00	8.14%	6.23%	6.23%
Student & Parent Education	$4,872	$1,967	2.48	8.14%	6.23%	6.23%

[1] Residential line loss factor of 8.33%
[2] Small C&I line loss factor of 8.33%
[3] Large C&I line loss factor of 4.12%
[4] GNE line loss factor of 6.23%. The GNE line loss factor is the average of Small/Large C&I and is consistent with the line loss used in PPL Electric's EE&C plan. Going forward, the actual participant rate class will be used to determine the blended GNI line loss factor.
[5] No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it was launched late in PY6. The program evaluation will occur in PY7. TRC will be calculated in PY7.

1.8 COMPARISON OF PROGRAM YEAR 6 PERFORMANCE TO APPROVED EE&C PLAN

Table 1-19 below shows PY6 expenditures compared to the budget estimates set forth in the EE&C plan. The percentage difference column shows the percentage by which the actual expenditures differ from budgeted expenditures.

Table 1-19: Comparison of PY6 Program Expenditures to PY6 EE&C Plan [1]

Program	PY6 Budget from EE&C Plan ($1000)	PY6 Actual Expenditures ($1000)	% Difference from PY6 EE&C Plan [(Actual-Planned)/Planned]
Appliance Recycling	$1,472	$1,109	-25%
Continuous Energy Improvement	$510	$413	-19%
Custom Incentive	$3,826	$2,776	-27%
E-Power Wise	$620	$376	-39%
Low-Income Energy-Efficiency Behavior and Education	$631	$870	38%
Low-Income WRAP	$6,831	$6,481	-5%
Master Metered Multifamily Housing	$946	$655	-31%
Prescriptive Equipment	$17,774	$22,140	25%
Residential Energy-Efficiency Behavior and Education	$1,017	$1,251	23%
Residential Home Comfort	$3,692	$2,261	-39%
Residential Retail	$12,016	$8,081	-33%
School Benchmarking	$125	$126	1%
Student & Parent Education	$2,360	$1,967	-17%
Total Direct Costs	**$51,821**	**$48,506**	**-6%**
Indirect[2]	$12,020	$10,248	
Total	**$63,841**	**$58,754**	**-8%**

[1] Total will not equal sum of column due to rounding.
[2] Planned indirect costs were estimated for Phase II, not by program year. For this table, program year costs are assumed to be one-third in each program year.

Table 1-20 shows PY6 actual reported gross program savings compared to the PY6 energy and demand savings estimates filed in the EE&C plan (these are estimated verified savings). The percentage difference column shows the percentage by which the reported gross savings differ from planned savings.

Table 1-20: Comparison of PY6 Actual Program Savings to EE&C Plan for PY6[1]

Program	PY6 MWh/yr Savings Projected in EE&C Plan	PYTD Reported Gross Energy Savings [1] (MWh/Year)	Energy % Difference [(PY6 Actual-Planned)/PY Planned]	PY6 MW Savings Projected in EE&C Plan[2]	PYTD Reported Gross Demand Savings (MW) [2]	Demand % Difference [(PY6 Actual-Planned)/PY Planned]
Appliance Recycling	8,243	6,792	-18%	1.12	1.22	9%
Continuous Energy Improvement[3]	583	-	-100%	0.10	0.00	-100%
Custom Incentive	34,301	23,170	-32%	5.62	2.60	-54%
E-Power Wise	1,797	2,060	15%	0.23	0.29	26%
Low-Income Energy-Efficiency Behavior and Education[4]	2,695	-	-100%	0.35	-	-100%
Low-Income WRAP	3,901	4,561	17%	0.50	0.47	-6%
Master Metered Multifamily Housing	2,736	1,574	-42%	0.45	0.17	-63%
Prescriptive Equipment	88,874	94,666	7%	16.85	11.83	-30%
Residential Energy-Efficiency Behavior and Education[4]	10,925	-	-100%	1.41	-	-100%
Residential Home Comfort	3,748	3,888	4%	0.62	1.53	147%
Residential Retail	50,180	48,987	-2%	9.26	6.95	-25%
School Benchmarking[5]	-	-	0%	-	-	0%
Student & Parent Education	4,318	4,145	-4%	0.56	0.60	7%
Program Total	**212,302[5]**	**189,843**	**-11%**	**37.08**	**25.66**	**-31%**

[1] PPL Electric Utilities does not believe this table is relevant because it compares EE&C Plan savings on a verified basis to actual savings on a reported basis and believes Table 1-21 is more meaningful.
[2] Planned MW reductions include T&D losses; Reported Gross MW reductions do not include T&D losses.
[3] CEI participants and their PY6 energy and energy savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until PY7 Q1.
[4] Both the Residential and Low-Income Energy-Efficiency Behavior and Education Program energy savings were not reported in PY6. They were reported in early PY7.
[5] The School Benchmarking Program is not designed to deliver energy savings. The program does not claim energy or demand savings.
[6] Total will not equal sum of column due to rounding.

Table 1-21 shows PY6 actual verified program savings compared to the energy and demand savings estimates filed in the EE&C plan (these are estimated verified savings). The percentage difference column shows the percentage by which the verified gross savings differ from planned savings.

Table 1-21: Comparison of PY6 Actual Program Savings to EE&C Plan for PY6 Verified Savings

Program	PY6 MWh/yr Savings Projected in EE&C Plan	PYTD Verified Gross Energy Savings (MWh/Year)	Energy % Difference [(PY6 Actual-Planned)/PY Planned]	PY6 MW Savings Projected in EE&C Plan[1]	PYTD Verified Gross Demand Savings (MW) [1]	Demand % Difference [(PY6 Actual-Planned)/PY Planned]
Appliance Recycling	8,243	6,437	-22%	1.12	1.29	15%
Continuous Energy Improvement	583	1,159	99%	0.10	0.72	620%
Custom Incentive	34,301	21,894	-36%	5.62	2.57	-54%
E-Power Wise	1,797	2,071	15%	0.23	0.38	65%
Low-Income Energy-Efficiency Behavior and Education[2]	2,695	-	-100%	0.35	0.00	-100%
Low-Income WRAP	3,901	4,525	16%	0.50	0.56	12%
Master Metered Multifamily Housing	2,736	1,549	-43%	0.45	0.15	-66%
Prescriptive Equipment	88,874	89,248	0%	16.85	15.00	-11%
Residential Energy-Efficiency Behavior and Education	10,925	29,568	171%	1.41	0.00	-100%
Residential Home Comfort	3,748	4,083	9%	0.62	1.75	182%
Residential Retail	50,180	51,463	3%	9.26	7.76	-16%
School Benchmarking[3]	-	-	0%	-	0.00	0%
Student & Parent Education	4,318	5,376	25%	0.56	0.47	-16%
Program Total	**212,302[4]**	**217,373**	**2%**	**37.08**	**30.65**	**-17%**

[1] Planned and actual MW reductions include T&D losses.
[2] No savings are reported for the Low-Income Energy-Efficiency Behavior and Education Program as it was launched late in PY6. The program evaluation will occur in PY7.
[3] The School Benchmarking Program is not designed to deliver energy savings. The program does not claim energy or demand savings.
[4] Total will not equal sum of column due to rounding.

The process evaluation sections in the program-specific chapters provide additional information about PY6 achievements against planned savings. The impact and process evaluations also discuss program updates and changes. PPL Electric Utilities may adjust programs in PY7 to manage participation and savings.

Most programs exceeded savings compared to plans described in the EE&C Plan approved June 5, 2015,[4] as shown in Table 1-20 and Table 1-21. Residential Retail achieved savings within 5% of the planned savings. Residential Home Comfort achieved savings within 10% of the planned savings. E-Power Wise, Low-Income WRAP, Appliance Recycling and the Student and Parent Energy-Efficiency Education programs all achieved savings within 25% of the planned savings. The Continuous Energy Improvement

4 Planned savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015.

and Residential Energy-Efficiency Behavior and Education programs greatly exceeded the planned savings, with Continuous Energy Improvement exceeding by almost 100% of the planned savings and Residential Energy-Efficiency Behavior and Education exceeding by over 100% of the planned savings.

The Custom Incentive Program is designed primarily for larger commercial and industrial (C&I) customers. Typical projects involve complex decision making and have a long lead time from conception to implementation. This program had a few large projects that submitted applications in PY5 and PY6 but were not completed within either program year. However, there are many projects in progress which are expected to complete implementation in PY7, bringing the achievement closer to planned savings. In addition, the large stratum projects experienced lower than expected savings on installed products compared to initial rebate reservations. Several small stratum projects experienced lower than expected savings on installed products compared to reported kWh savings.

The Master Metered Multifamily Program achieved fewer savings than planned through PY6. However, a number of projects are in progress and the program is expected to meet planned savings by the close of PY7.

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

1.9 PORTFOLIO LEVEL/CROSS-CUTTING PROCESS EVALUATION SUMMARY FOR PROGRAM YEAR 6

Cadmus evaluated PPL Electric Utilities' portfolio of energy efficiency programs, as described in the Phase II Energy Efficiency and Conservation (EE&C) Plan for the sixth program year (PY6) under Pennsylvania Act 129. Phase II of Act 129 covers June 2013 through May 2016. PY6 covers June 2014 through May 2015.

This section focuses on the process evaluation of PPL Electric Utilities' PY6 portfolio. It identifies opportunities and offers recommendations to improve the overall effectiveness of the design and implementation, enrollment processes, quality assurance, and other elements for all of PPL Electric Utilities' energy efficiency programs. It examines the portfolio's overall achievement and planned savings for each program. It also explores participant feedback, energy-efficiency attitudes and behaviors, and challenges to energy efficiency improvements.

Each program is assessed in more detail in individual chapters of this report. These program chapters contain a summary of the program's achievements against planned savings and a summary of findings from the program-specific evaluation activities.

1.9.1 Evaluation Activities

Process evaluation activities varied by program in PY6. The main activities that Cadmus, the EM&V CSP, conducted were:

- Participant and nonparticipant telephone surveys
- Database and records review for quality assurance and quality control (QA/QC)
- Shelf-stocking study for residential lighting
- Program staff and implementation conservation service providers (ICSPs) interviews
- Surveys and interviews of vendors, contractors, manufacturers, and others

- Key performance indicators (KPIs)
- Logic model review
- Focus groups

Any modifications to individual program evaluation activities from the EM&V plans are included in each program chapter.

Table 1-22 lists the evaluation activities conducted for each program in PY6 along with the total number of survey and interview respondents reached for each program. A more detailed explanation of each programs' survey methodology is contained in the program chapters and their addendums. For three programs—Appliance Recycling, Residential Retail, and Residential Home Comfort—Cadmus conducted a cross-program survey in addition to a program-specific survey.

1.9.1.1 Survey Scales

The statewide evaluator (SWE) suggested that a mid-point be added to many of the survey questions with response scales. Where possible, Cadmus adjusted response choices as suggested. In surveys with new questions, a midpoint was added where reasonable. But in some cases the scale was not changed. For example, PPL Electric Utilities uses some satisfaction questions for its internal metrics so response scales for these questions were not adjusted. For some questions asked in PY5 that are used to track changes over time, Cadmus kept the scales (typically a four-word scale) consistent through PY6 and will retain the scale for the same questions in PY7.

1.9.2 Participant Experience

1.9.2.1 Program Satisfaction

Cadmus asked respondents how satisfied they were with the program and found that most were satisfied with the program in which they participated. Respondents in the Appliance Recycling, Student and Parent Energy-Efficiency Education, Continuous Energy Improvement, and Prescriptive Equipment programs rated their satisfaction higher than respondents in other programs. Respondents in the Residential Energy-Efficiency Behavior & Education program were asked to rate their satisfaction with the home energy reports; they gave lower satisfaction ratings than respondents in other programs.

Table 1-22: PY6 Process Evaluation Activities by Program

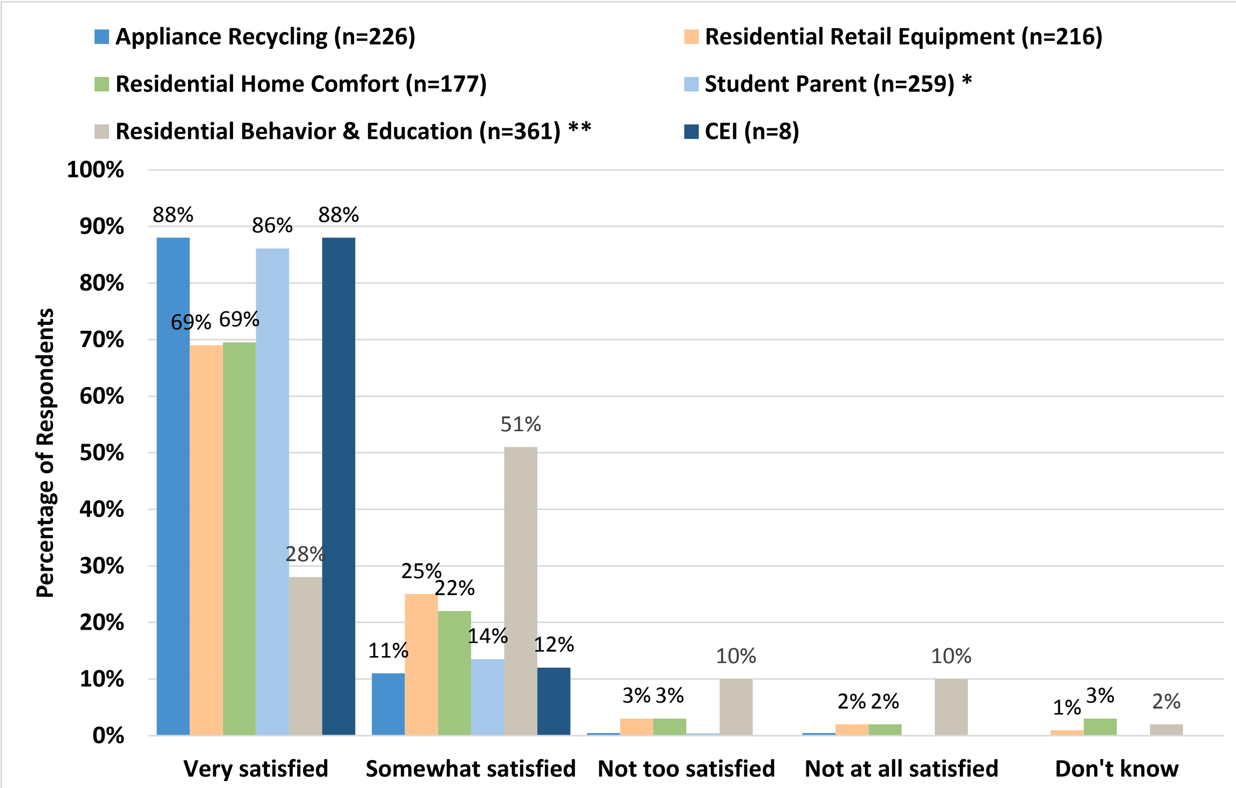
Program	Process Evaluation Activity						
	Participant Survey	Nonparticipant or Partial Participant Survey	KPIs	QA/QC Review	Stakeholder Interview	Trade Ally Interview	Logic Model Review
Appliance Recycling	226 [1]	147 [2]	X	X	2	0 [3]	X
Continuous Energy Improvement	8	-	X	X	2	-	X
Custom Incentive	15	5 [4]	X	X	2	3	X
E-Power Wise	-	-	X	X	2	5	X
Master Metered Low-Income Multifamily Housing	144 [5]	-	X	X	2	-	X
Prescriptive Equipment	75	-	X	X	2	40	X
Residential Energy Efficiency Behavior & Education	541	-	X	X	X	-	X
Residential Home Comfort	177[1]	-	X	X	2	12	X
Residential Retail (Efficient Equipment and Lighting)	216[1]	686[6]	X	X	2	17	X
School Benchmarking [7]	-	-	-	-	-	-	-
Student and Parent Education	259	-	X	X	4	-	X
WRAP	71	-	X	X	1	-	X

[1] Number of completed surveys includes program surveys and surveys completed as part of the cross-program survey, which included participants of the Residential Retail, Residential Home Comfort, and Appliance Recycling programs.
[2] Overall, 146 customers (48 from general population survey, 50 from program surveys, and 48 from the cross-program survey) were identified as having disposed of an appliance. However, only 49 had disposed of a working appliance and had not received an incentive.
[3] Cadmus attempted to reach the one participating retailer but was unable to complete an interview after multiple attempts.
[4] Cadmus completed surveys with participants who began the application process but did not complete it to receive an incentive (these are considered partial participants).
[5] Includes tenant leave-behind surveys and owner/operator telephone surveys.
[6] Surveys include Residential General Population Upstream Lighting survey (n=301) and Small Business Cross-Sector Sales survey (n=385).
[7] Evaluation activities were completed early in PY6 for PY5 but not included in the PY5 report. Findings included in the PY6 report.

The next section discusses the general reasons for dissatisfaction. Individual program chapters provide more specific reasons.

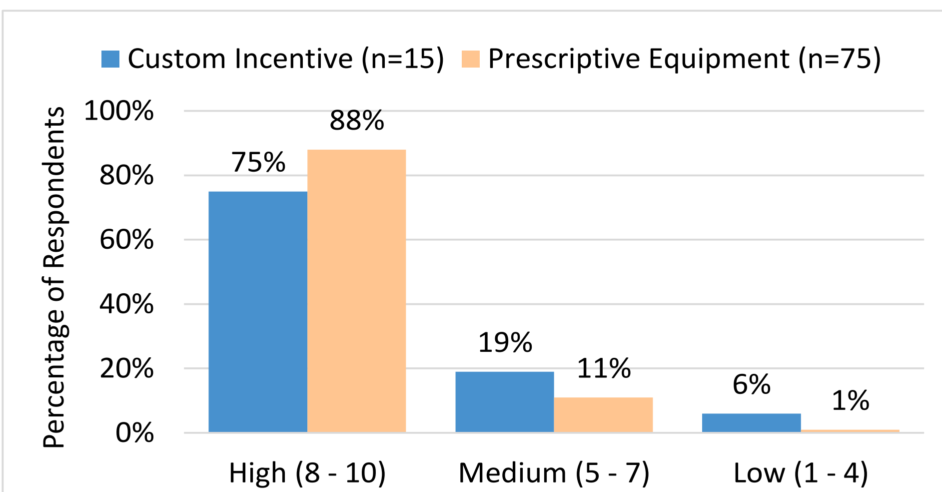
Cadmus used three different scales when researching overall program satisfaction. Figure 1-8 shows program satisfaction for the respondents who rated their satisfaction using a word scale.
Figure 1-9 shows the 10-point scale used for the Custom Incentive and Prescriptive Equipment programs. Cadmus used these scales because they matched the response scales PPL Electric Utilities used in online surveys it has previously conducted. The WRAP survey is a new activity for Cadmus in PY6; in previous program years, PPL Electric Utilities conducted the survey using the 5-point scale, as shown in Figure 1-10.

Figure 1-8: PY6 Program Satisfaction



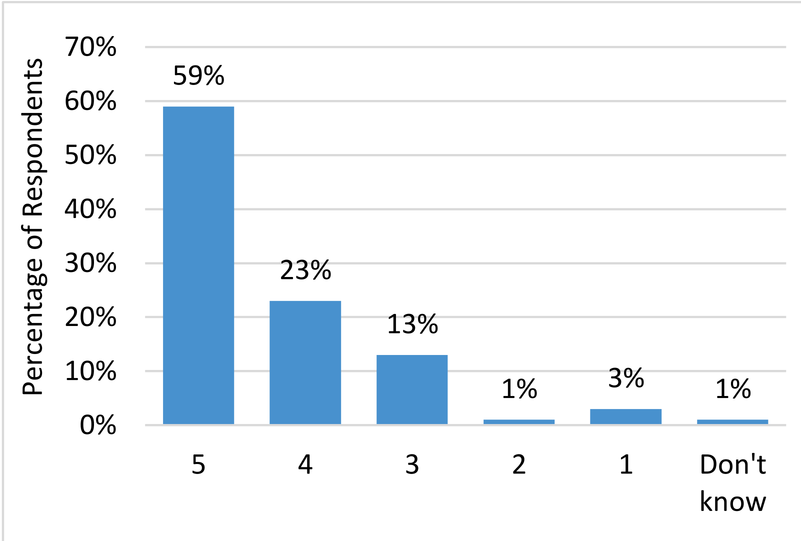
Source: Survey questions, "Thinking about your overall experience with the program, how would you rate your satisfaction?", "How satisfied were you overall with [program name]"** Some percentages do not total 100% due to rounding.

Figure 1-9: PY6 Custom Incentive Program and Prescriptive Equipment Program Satisfaction



Source: Question, "Thinking about your overall experience with the program, how would you rate your satisfaction using a 1 to 10 scale where 10 means "outstanding" and 1 means "unacceptable"?

Figure 1-10: PY6 WRAP Baseload Participant Satisfaction



Source: Question, "How satisfied are you with the WRAP program?" (n=71)

Over half the respondents (56%, n=540) in the Appliance Recycling, WRAP, Residential Home Comfort, and Residential Retail programs said they had recommended the program to a friend, relative, or colleague.[5] This is consistent with PY5 findings, where 57% (n=615) said they recommended the program.

1.9.2.2 Reasons for Dissatisfaction with a Program

Cadmus asked survey respondents about their experiences with specific aspects of the programs. Although the vast majority reported high satisfaction with their overall program experience, a small number of respondents said they were dissatisfied with some aspect of the program. Their reasons are discussed in greater detail in the program-specific chapters of this annual report.

In general, participants' reasons for dissatisfaction were:

- ***Rebates.*** Rebates took too long to receive, were too low, or were not what was expected.
- ***Program partners and contractors.*** Participants had poor experiences with implementers or contractors.
- ***Home Energy Reports.*** Participants said neighbor comparisons were either inaccurate or unfair (neighbor comparisons are delivered through the Residential Energy-Efficiency Behavior & Education Program and the Low-Income Energy-Efficiency Behavior & Education Program).
- ***Application.*** Paperwork took too long to complete, there was too much of it, it was too complex, or it took too long to receive approval to proceed.[6]

5 Respondents who did not answer this question were removed from the base.

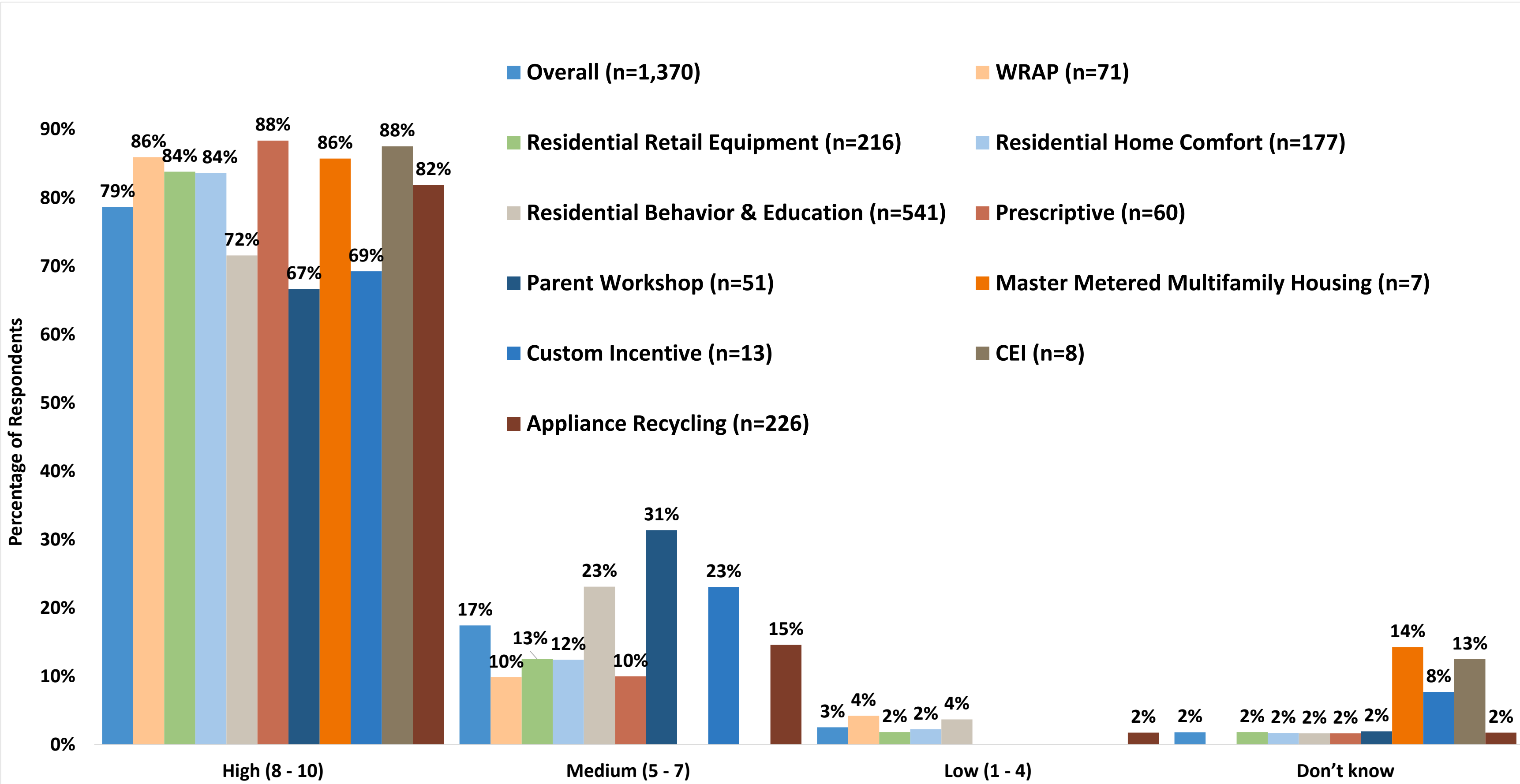
6 Comments from participants in Prescriptive Equipment and Custom Incentive programs.

1.9.2.3 Satisfaction with PPL Electric Utilities as a Utility

Most program participants were very satisfied with PPL Electric Utilities as an electric service provider. As illustrated in Figure 1-11, in PY6 the majority of respondents across all programs rated their satisfaction with PPL Electric Utilities as an 8, 9, or 10 on a scale of 1 to 10, with 10 meaning *outstanding*. Seventy-nine percent of respondents (n=1,370) rated PPL Electric Utilities as an 8 or higher. This is slightly higher than in PY5 when 72% of all survey respondents (n=1,133) rated their satisfaction with PPL Electric Utilities as 8 or higher.

Cadmus also asked survey respondents if their experiences with the programs had changed their opinion of PPL Electric Utilities. Over half of PY6 respondents (58%, n=1,206) said their opinion of PPL Electric Utilities had not changed as a result of their participation in one of its incentive programs; 39% said their opinion had *improved significantly* or *somewhat*.

Figure 1-11: PY6 Satisfaction with PPL Electric Utilities as a Provider of Electricity



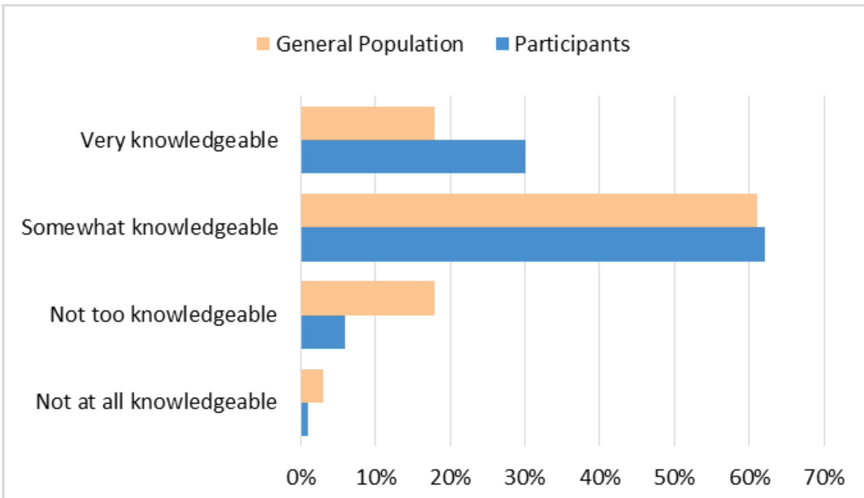
Source: Survey Question, "Using a 10-point scale where 1 means unacceptable and 10 means outstanding, using any number from 1 to 10, how do you rate PPL Electric Utilities overall as a provider of Electric Utilities service to your home?"

1.9.3 Comparisons Across Programs: Energy Efficiency Knowledge, Actions, and Purchasing Patterns

1.9.3.1 Knowledge of Ways to Save Energy

Cadmus asked respondents of the residential participant surveys and the residential general population survey to rate their own level of knowledge about ways to save energy at home. Most program participants reported they were either *somewhat knowledgeable* (62%, n= 570) or *very knowledgeable* (30%, n=570) (Figure 1-12). Compared to the general population, participants were much more likely to categorize themselves as *very knowledgeable*, a statistically significant difference (30%, n=570 participants vs. 18%, n=301 general population, p < .05).[7] Although causation cannot be determined, participants were asked to rate their knowledge *prior* to participating in the program, which may indicate that participants are simply more energy-savvy and that the difference is not due to program experience.

Figure 1-12: Self-Ranked Knowledge about Ways to Save Energy (Residential Customers)



Participant Source: QE1, "Before you received a rebate from PPL Electric Utilities, how would you rate your knowledge on ways to save energy in your home?" n=570, answers compiled from participant surveys with Residential Retail, Appliance Recycling, Residential Home Comfort, and Student-Parent participants.

General Population Source: QB1, "How would you rate your knowledge on ways to save energy in your home?" n=301.

Cadmus also found a difference between programs in participants' prior knowledge about energy efficiency. Thirty-four percent of both Appliance Recycling and Residential Home Comfort respondents said they were *very knowledgeable* compared to just 21% of Residential Retail and 19% of Student and Parent Energy-Efficiency Education respondents. This difference is statistically significant (p < .05).

When Cadmus asked respondents if they had become more knowledgeable *since* participating in the Appliance Recycling, Residential Retail, or Residential Home Comfort programs, the majority (62%, or 278 of 446) said they had, which indicates PPL Electric Utilities' programs are successfully educating customers about energy efficiency, one of the utility's long-term objectives.[8] However, knowledge differed by program. Respondents in the Residential Home Comfort Program were significantly more likely to say

---

7 Cadmus conducted a t-test to determine statistical significance.

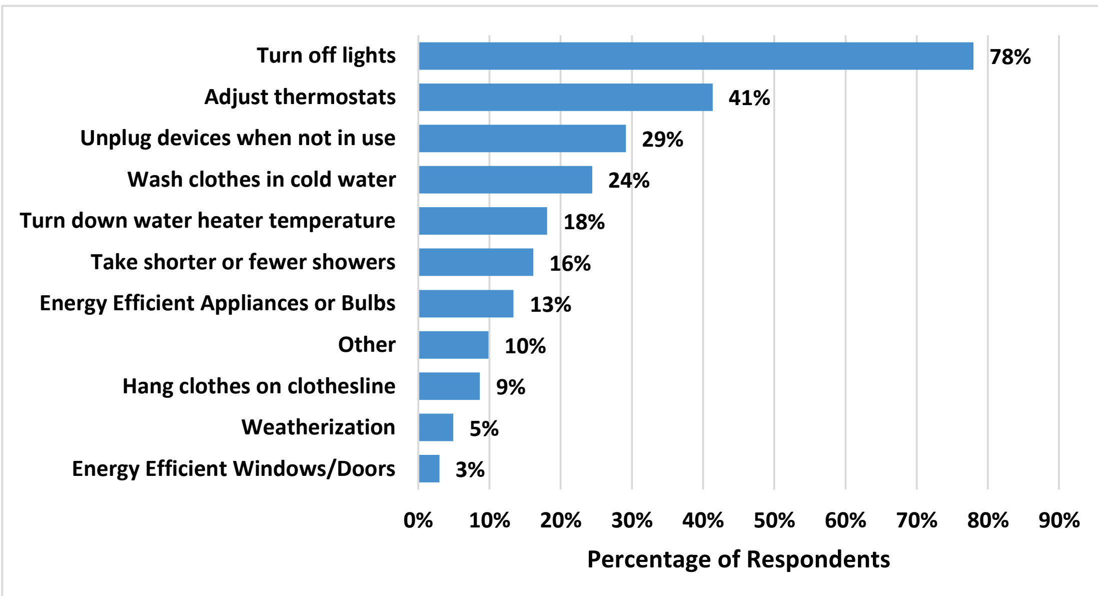
8 Question not asked of student-parent participants.

their level of knowledge had increased (68%, or 101 of 148) than respondents in the Appliance Recycling Program (58%, or 130 of 226), a statistically significant difference ($p < .05$). This finding is logical because the Home Comfort Program is designed to deliver home energy audits and offer incentives for equipment upgrades.

1.9.3.2 Steps Taken to Save Energy at Home

Nearly all respondents reported they regularly take steps to save energy at home. There were no major differences between participants (96%) and the general population (93%). The most common behaviors cited by respondents (n=508) were turning off lights when leaving the room (78%), adjusting the thermostat (41%), and unplugging devices when not in use (29%) (Figure 1-13). Participant respondents were those that had participated in the Appliance Recycling, Residential Retail, Residential Home Comfort, or WRAP programs.[9]

Figure 1-13: Steps Taken to Save Energy at Home in PY6



Source: QE4, "What steps do you take?" (n=508). Responses combined from the general population survey and the participant surveys for Appliance Recycling, Residential Retail, Residential Home Comfort, and WRAP programs. Multiple responses allowed; percentages add to over 100%.

PY6 respondents reported engaging in the same top three energy-saving actions as respondents in PY5 but at a higher percentage. Further, PY6 respondents also reported taking other steps more often, such as turning down the water heater temperature, washing clothes in cold water, or air-drying clothes. Table 1-23 compares the percentage of respondents who reported these behaviors in PY5 and PY6.

---

9 Participants in the Energy-Efficiency Behavior & Education program were also asked about their energy saving behaviors after receiving home energy reports, and those results are discussed specifically in this program's chapter.

Table 1-23: Growth of Energy-Saving Actions Between PY5 and PY6

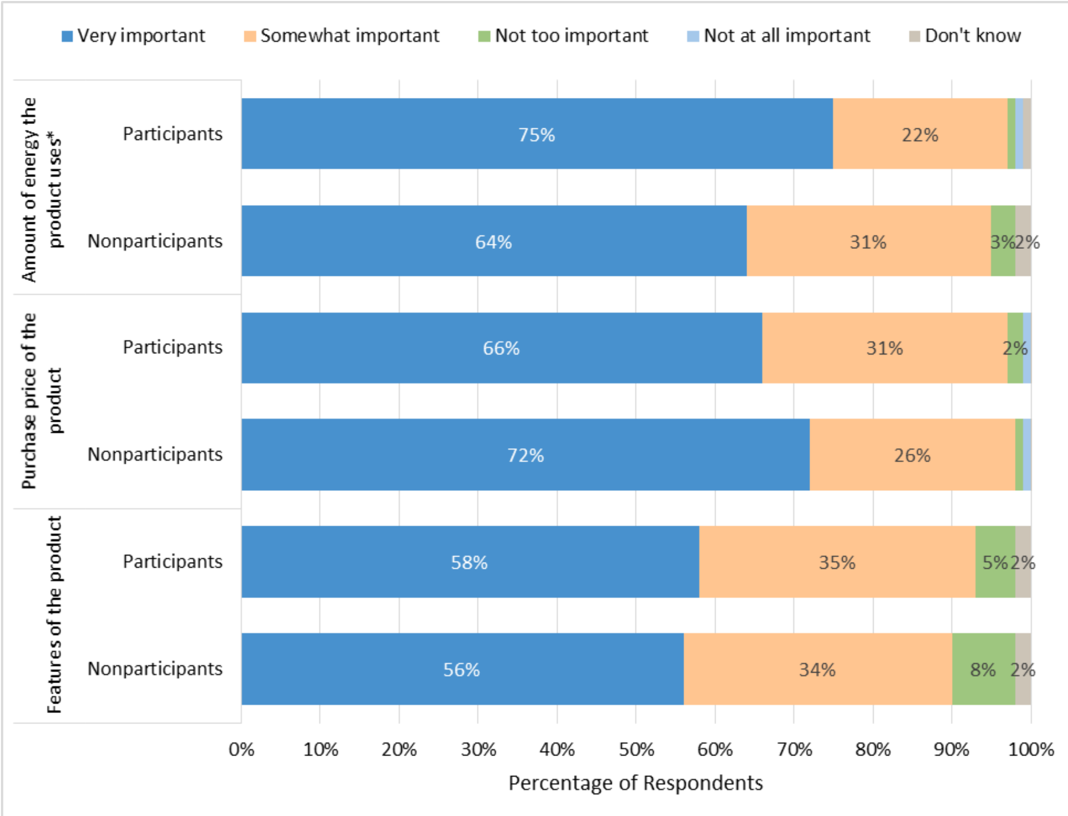
Activity	Percentage of Respondents	
	PY5	PY6
Turn off lights	71%	78%
Adjust thermostats	33%	41%
Unplug Devices	20%	29%
Wash clothes in cold water	5%	24%
Turn down water heater temperature	9%	18%
Hang clothes on clothesline	1%	9%
PY5 percentages (n=533) derived from the aggregated responses in the Appliance Recycling, Residential Retail, and residential general population surveys. PY6 percentages (n=508) derived from the aggregated responses in the Appliance Recycling, Residential Retail, Residential Home Comfort, WRAP surveys, and residential general population surveys.		

1.9.3.3 Important Factors when Making Product Purchases

Cadmus asked residential participant respondents and general residential population respondents about three factors they might consider when buying new home appliances or products. These factors were the amount of energy the product uses, the purchase price of the product, and product features or attributes. Respondents gave rankings on a four-point word scale of *very, somewhat, not too,* and *not at all important*. A very similar proportion of respondents (n=818) rated product price (68%) and amount of energy the product uses (71%) as *very important,* indicating these factors are difficult to prioritize for the consumer.

However, participants and the general population differed—participants were significantly more likely to rank energy use as a *very important* consideration than was the general population (p < .05). The general population respondents were more likely to rank price as a *very important* consideration than were participants, although this difference was not as stark (p < .10). Figure 1-14 illustrates the importance of each factor to the participants and general population respondents.

Figure 1-14: Decision-Making Factors for Purchasers



Source: E5a-E5c, "When shopping for products or appliances that use energy in your home, how would you rate the importance of each of the following:" *Results are significant for the *very important*, *somewhat important*, and *not too important* responses for this statement (p<0.05) (Nonparticipants n=301 and Participants n=517).

In PY5, survey findings showed that older participants were more likely to consider energy efficiency as *very important* when making a product or appliance purchase than were younger participants. Although the wording of the question was changed slightly in PY6, the results were the same as in PY5.[10] Respondents 45 years old and older were more apt to view the energy efficiency of a product as *very important* (Table 1-24 shows PY6 results).

Table 1-24: Percentage of PY6 Respondents Reporting Energy Use as *Very Important*, by Age

Age (Years)	Percentage of Respondents
65 and older[1]	78%
55 to 64[2]	78%
45 to 54[1]	76%
35 to 44	64%
25 to 34	68%
[1] Results are significantly different than those in the 35-44 age group (p < .10). [2] Results are significantly different than those in the 35-44 age group (p < .05)	

10 The PY6 question asked respondents to rank the importance of the amount of energy the product uses, among other factors.

Also, similar to the findings in PY5, age was a predictor in how people categorized their own knowledge of energy efficiency. Respondents who were 45 years old or older were significantly more likely to say they were *very knowledgeable* about ways to save energy at home than were younger age groups (ages 35 years old and younger) ($p < .05$).

Cadmus asked a comparable question of nonresidential customers. Small business general population respondents and the participants in the Prescriptive Equipment Program were asked how much energy efficiency typically factors into their decisions about making capital upgrades. Answers were on a four-word scale by *very important, somewhat important, not too important,* or *not important at all.* There was no statistically significant difference in the percentage of those who reported *very important* between participants (50%, n=60) and the general population (45%, n=385).

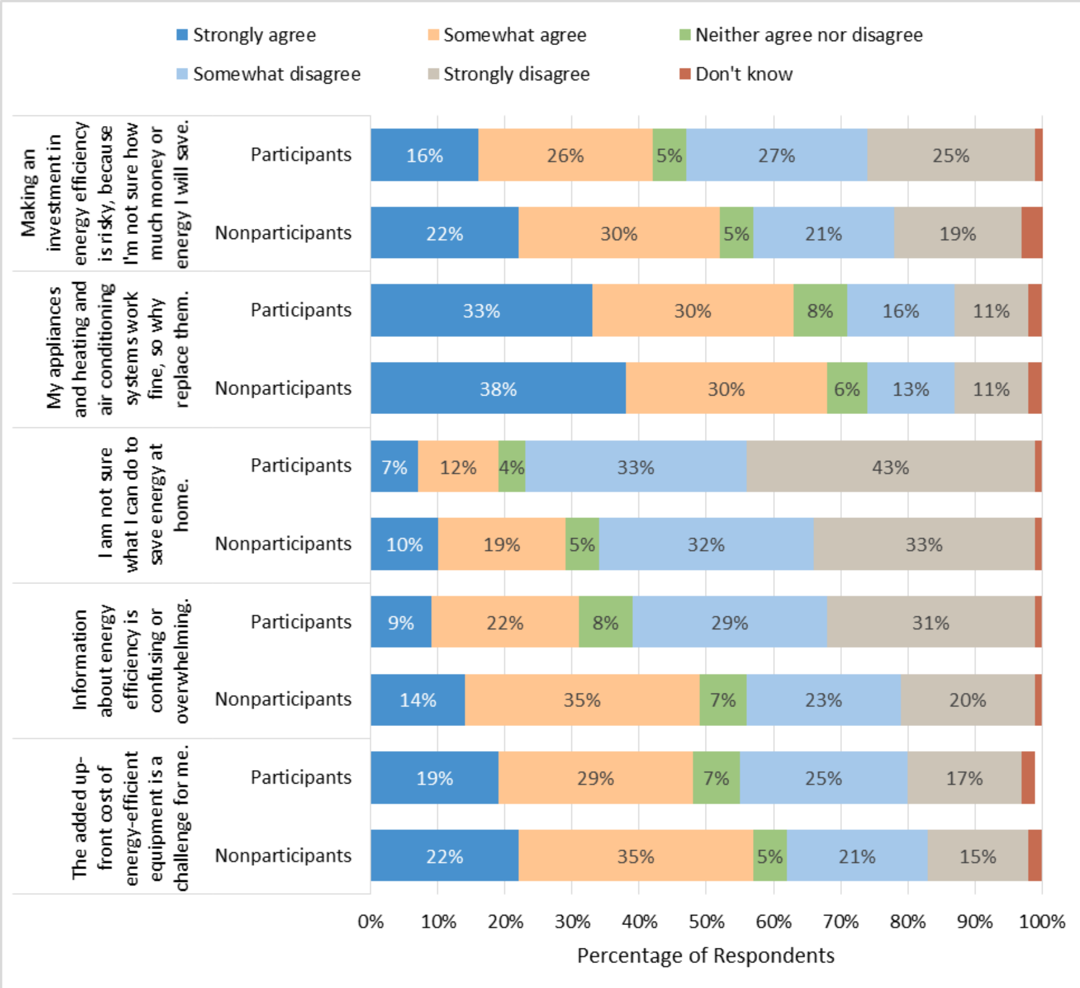
Similar to PY5, the PY6 results indicated that residential customers are placing more emphasis on energy use when making decisions about purchases and investments than are nonresidential customers.

1.9.3.4 Challenges to Making Energy Efficiency Improvements

When asked about challenges faced in making energy-efficient upgrades to their homes, many residential customers can only give one answer—cost. However, this subject is complex and cost may be just one of several market barriers faced by PPL Electric Utilities customers. Others may be societal norms, cultural habits or bias, lack of knowledge and/or reliable information about energy efficiency, and other factors.

In PY6, Cadmus sought to identify specific barriers by presenting a series of scenarios and asking respondents to relate to them. We asked both participants and the general population survey respondents to rate their agreement with five challenge scenarios, or statements, using a five-point word-scale. Results are shown in Figure 1-15.

Figure 1-15: Participant and General Population Agreement with Challenge Scenarios



Source: QE8. "Please rate your agreement with the following statements. Please tell me if you strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, or strongly disagree." (Nonparticipants n=301 and participants n=1,050 – 1,121 depending on the statement). Participant data aggregated from Residential Retail, Appliance Recycling, Residential Energy-Efficiency Behavior & Education, Residential Home Comfort, and WRAP program surveys.

Most respondents agreed with the statement, *"My appliances and heating and air conditioning systems work fine, so why replace them?"* (33% of participants, n=1,068 and 38% of the general population, n=301, *strongly agreed*). If added to those who said they *somewhat agreed,* this obstacle appears to be relevant for about two-thirds of the residential population.

Although most respondents seemed to know what they could do to save energy at home and did not perceive information about energy efficiency as confusing, a significant portion agreed there *was* risk in investing in energy efficiency because of the unknown return on investment (42% of participants, n=1,114, and 52% of the general population, n=301, either *strongly* or *somewhat agreed* with this scenario).

Cadmus found a significant difference between participants and the general population respondents on the three statements about knowledge of energy efficiency. The general population was significantly more likely ($p < .05$) to *strongly agree* with:

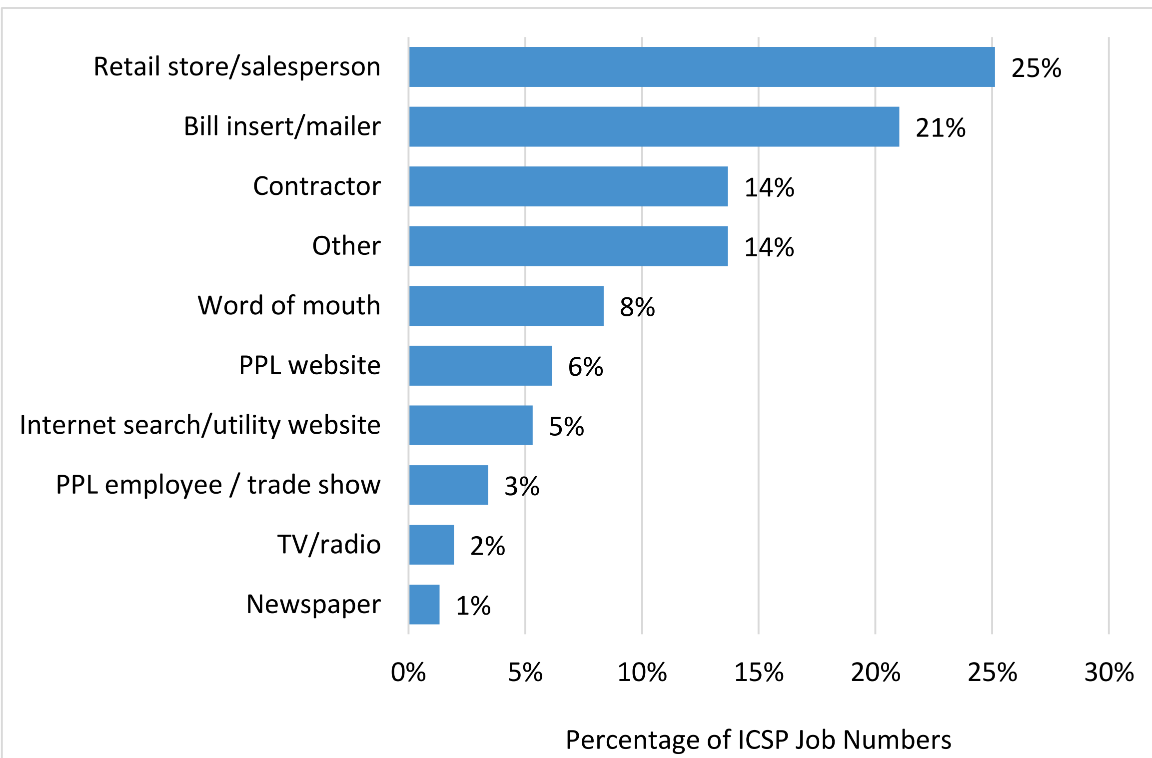
- *"Making an investment in energy efficiency is risky, because I'm not sure how much money or energy I will save."*
- *"I am not sure what I can do to save energy at home."*
- *"Information about energy efficiency is confusing or overwhelming."*

This difference further supports the fact that participants in PPL Electric Utilities' programs are more energy-savvy than their general population counterparts, although causation cannot be determined.

1.9.4 Program Awareness

Cadmus reviewed the answers participants selected on their rebate forms for how they learned about the program and completed the analysis on unique CSP job numbers. One-quarter of participants learned about the program from a retail store and another 21% learned about the program from a bill insert or mailer. Figure 1-16 shows all of the responses.

Figure 1-16: How Participants Learned About the Program



Source: PPL Electric database (n=14,497)

1.10 PROCESS AND IMPACT EVALUATION RECOMMENDATIONS FOR PROGRAM YEAR 6

Table 1-25 includes all process and impact recommendations for each PPL Electric Utilities program and the portfolio. These are also discussed in the individual program chapters.

Table 1-25: Phase II Process and Impact Evaluation Recommendations from PY6 Evaluations

Applicability	Recommendations
Portfolio Level	Cadmus recommends PPL Electric Utilities request PaPUC approval to discontinue the fuel switching survey (fossil fuel to electricity) in Phase III. This survey was conducted in Phase I and Phase II to demonstrate the degree to which customers switch from fossil fuels to electricity to receive a rebate. Survey findings consistently show the rebates have had a marginal to no impact on the customer's decision to switch from fossil fuels to electric equipment.
Appliance Recycling	Increase program marketing and focus on the low season months such as summer and fall, if PPL Electric would like to levelize monthly participation to reduce the seasonal swing in participation.
Appliance Recycling	Consider a leave-behind flyer or post card that includes information on all PPL Electric program offerings, including Act 129 programs, to ensure participants are aware of all program resources available.
Appliance Recycling	Consider investigating customer segments to identify which segments have yet to participate; identifying segments and characterizing them can yield marketing and outreach ideas.
Continuous Energy Improvement	The ICSP should continue using its current regression methods and could consider a few improvements.
Continuous Energy Improvement	The ICSP should revisit the coincidence factor and consider increasing it to be more in line with a coincidence factor calculated by dividing the verified demand reduction by the verified energy savings.
Continuous Energy Improvement	The energy managers of the participating school districts praised the dynamic, motivating, and competitive environment that the ICSP created in PY6. PPL Electric Utilities could consider ways to create the same engaging and competitive environment within each school district to better motivate teachers, school staff, and students of individual schools.
Continuous Energy Improvement	Consider investigating opportunities for creating self-sustaining organizations such as student clubs with a focus on energy efficiency to minimize the required amount of teacher engagement and maintain the continuity of the behavioral energy efficiency efforts.
Continuous Energy Improvement	Consider reducing the incentive amount, eliminating the incentive in the second year, or eliminating the incentive altogether.
Custom Incentive	Continue to work to reduce the program freeridership; Cadmus and PPL Electric could explore options for the Custom program to offer dedicated, ongoing support to large business customers.
Custom Incentive	Consider ways to improve responsiveness to customers questions such as tracking such questions and answers to determine if the response is timely.
Custom Incentive	Add more detail to online tools regarding the amount of time each step in the participation process may take.
Custom Incentive	Revise program materials to mention that a third-party may be needed to assist or supply pre and post verification data.
E-Power Wise	To encourage installation of the water-saving devices, consider adding additional details to the agency training slides to highlight the various benefits to installing the water products. Consider installation demonstrations using sink and showerhead props and real-life examples that are applicable to low-income families so they will feel empowered to install the water-saving devices. Also emphasize the interactive effects of reducing the hot water temperature and the money a family can save when it installs the products and turns down the temperature.
E-Power Wise	Continue to explore the feasibility of offering different energy-savings kits with varied products in Phase III as a way to increase installation rates of the water-saving devices. PPL Electric Utilities could provide a general kit that includes LED bulbs and a power strip for all participants as well as the option to offer the water-saving devices, depending on the recipient's hot water fuel source.
E-Power Wise	Consider communicating information regarding the Master Metered Low-Income Multifamily Housing (MMMF) program to the E-Power Wise agencies.

Applicability	Recommendations
E-Power Wise	Explore the potential for distributing LED bulbs to Phase I participants. Agencies or RAP could distribute LEDs with an installation survey similar to the current survey in the energy-savings kit and, once returned, these customers could be included in the monthly gift card raffle.
E-Power Wise	Consider alternatives for the furnace whistle: increase energy education around the furnace whistle; or remove the furnace whistle from the energy-savings kit; and/or consider a rebate for a new furnace filter.
Low-Income WRAP	Identify additional KPIs, such as participant satisfaction, and upgrade LEAP to collect and report them. To assess program satisfaction on an on-going basis, consider administering an online survey or leave-behind postcard survey to all participants.
Low-Income WRAP	Consider steps to control or reduce program delivery costs, such as setting a standard labor cost across the program and reviewing the measures and measure costs to prioritize measures offered in Act 129 and those offered in USP LIURP.
Master Metered Multifamily Housing	Review the program saving potential in common areas of individually metered multifamily buildings and if necessary, in other building types that may be eligible for program participation.
Master Metered Multifamily Housing	For Phase III, establish program saving targets based on an updated estimate of the remaining saving potentials in the eligible master metered multifamily sector.
Master Metered Multifamily Housing	For Phase III, extend program eligibility requirements beyond GNE and low-income.
Master Metered Multifamily Housing	Consider providing additional educational materials about faucet aerators, low-flow showerheads, and thermostatic shower restriction valves.
Master Metered Multifamily Housing	Consider a review of measure persistence for low-flow aerators and thermostatic shower restriction valves.
Prescriptive Equipment	Continue with the preapproval process, however contractors and customers may need more support in completing applications as the process evaluation found that customer satisfaction with the rebate process declined in PY6 as compared to PY5.
Prescriptive Equipment	Provide more support in filling out the applications by giving examples of completed applications on the website and naming a point of contact for questions about the applications.
Prescriptive Equipment	Continue to provide guidance to the ICSP and quality assurance checks on completed projects regarding TRM requirements; likewise, Cadmus will provide quality assurance spot checks of ICSP Appendix C and E spread sheets to see if site-specific coincidence factors are used where required, and inform the ICSP of any discrepancies that are uncovered.
Prescriptive Equipment	Consider requiring the ICSP to use the 2016 TRM LED fixture code generator for all LED fixtures in PY7.
Prescriptive Equipment	Continue to stay in touch with contractors about specific lighting technologies (T5s, T8 high bay lighting, LED screw-ins, LED exit signs, and occupancy sensors) as the market matures and prices continue to drop.
Prescriptive Equipment	Explore new incentives for LEDs as replacements for linear fluorescent lamps.
Prescriptive Equipment	Consider strategies for providing more contractor support to improve awareness of the program and available rebates by creating a contractor-specific communications plan, providing equipment-specific technical training to contractors, providing educational materials for customers, and exploring a bonus or SPIF for contractors.
Prescriptive Equipment	Conduct further research to determine manufacturers' interest in and the feasibility of offering a midstream or upstream incentive program in PPL Electric Utilities' service territory.
Residential Energy-Efficiency Behavior and Education	Continue delivering the paper and e-mail home energy reports as planned.
Residential Energy-Efficiency Behavior and Education	Continue to promote PPL Electric Utilities energy efficiency programs through the home energy reports to inform customers about energy-saving opportunities.
Residential Energy-Efficiency Behavior and Education	Focus on ways to deliver a better customer experience with the home energy reports by having early discussions with the Phase III ICSP on personalization, gamification, and online services.
Residential Home Comfort	Continue to offer and market bonus rebates to reduce financial participation barriers to participating in audits.

Applicability	Recommendations
Residential Home Comfort	Consider dropping the rebate for SEER 15 ductless heat pump systems and raising the minimum efficiencies for each rebate tier by at least one SEER; consider starting the minimum efficiency eligibility at SEER 18 and reserve the highest rebate for customers installing systems with a minimum efficiency rating of SEER 22.
Residential Home Comfort	Consider eliminating the SEER 15 rebate raising the minimum SEER requirement for the air source heat pump rebate to SEER 16 or above to push installation of equipment that is significantly above the baseline of SEER 14., and increase savings.
Residential Home Comfort	The $1200 limited time offer for SEER 16 ASHP rebates was very successful in moving the market. Consider re-offering the $1200 ASHP rebates for SEER 16 and above in Phase III if savings are needed and the budget can accommodate this (over $1/annual kWh saved acquisition cost).
Residential Home Comfort	Consider extending marketing to manufactured homes retailers through personal contact and/or personal e-mail messages ; messaging could describe the benefits of the program and rebate.
Residential Home Comfort	Consider further study to assess the potential market for electrically heated manufactured homes.
Residential Home Comfort	Continue to market to new home builders by emphasizing their selling power.
Residential Home Comfort	Consider expanding the list of products rebated through the prescriptive path or offer the same prescriptive product rebate, but with a reduced rebate if appliances are not installed.
Residential Home Comfort	When marketing the HERS approach option, refer to the MLS entries.
Residential Retail	Consider replacing refrigerators with another product that is more likely to have impact on savings, can benefit from rebates, and increase customer satisfaction.
Residential Retail	Work with the ICSP and Cadmus to explore ideas for marketing campaigns to reach and educate water heater installers, to encourage them to stock and promote heat pump water heaters.
Residential Retail	Continue to research changes in residential customer purchasing behavior with regard to LEDs, in preparation for optimal program impact in Phase III.
Residential Retail	For Phase III, consider developing marketing for the general residential population (bill inserts, etc.) that highlights the promotional price of discounted LEDs.
Residential Retail	Work with retailers to utilize LED product placement as a lower cost mechanism for generating sales lift (rather than more aggressive incentives) and to reduce freeridership.
Residential Retail	Consider ways to organize the program to decrease LED freeridership by focusing on products or channels with lower freeridership.
Residential Retail	Use customer surveys to explore ways to encourage CFL recycling.
Student & Parent Education	Continue to recruit new schools and educators.
Student & Parent Education	Consider increasing the grade-appropriate classroom instructions and discussion about the furnace whistle, showerhead, and faucet aerator items.
Student & Parent Education	Explore new program implementation ideas such as rotating kits, product trade-ins, and donating unused products.
Student & Parent Education	Consider revising the workshop curriculum by including more topics that align with STEM or modify existing curriculum topics to align with STEM.
Student & Parent Education	Offer grade-appropriate breakout sessions or grade-specific workshop dates.
Student & Parent Education	Test the idea of using an online HEW completion process proposed by the ICSP with the Innovation student cohort.
Student & Parent Education	Consider a streamlined online HEW data collection process where after students enter the data online, teachers can review and submit data online, thus reducing the paperwork.
Student & Parent Education	Consider cross-program marketing through the kits.

1.11 SITE INSPECTIONS SUMMARY

Table 1-26 summarizes programs receiving verification site visits by Cadmus, the number of inspections, and resolution of discrepancies.

Table 1-26: Summary of PY6 Site Visits

Program	Measure	Inspection Firm	Number of Inspections Planned	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
Custom Incentive	All Verified Custom Projects	EM&V CSP	34	34	10	Varies; typically updated with site-specific data or through M&V
Prescriptive Equipment	Lighting	EM&V CSP	33	33	24	Updated savings based on as-built hours of use, fixture type and counts, space cooling, and building type
Prescriptive Equipment	Lighting	ICSP	N/A	3,678	N/A	Data not used for verification
Master Metered Multifamily	All	EM&V CSP	23 projects	23	23	Savings adjusted based on site-specific data
Low Income WRAP	All	PPL's third-party inspector	519	321	18	PPL's contractor resolved discrepancies Data not used for verification
Residential Home Comfort	All	ICSP	5% of all jobs	934	6	ICSP resolved discrepancies Data not used for verification
Total[1]			**609+**	**5,023+**	**81**	

[1] Where the inspection count was provided, the totals include inspections conducted by the ICSP, which were not used in verification activities. Totals do not include the count of tenant units inspected in the sampled Multifamily Program's projects.

2 PRESCRIPTIVE EQUIPMENT PROGRAM

The Prescriptive Equipment Program promotes the purchase and installation of high-efficiency equipment and lighting by offering customers financial incentives to offset the higher purchase costs of such equipment and providing information on their features and benefits. This program targets small commercial and industrial (C&I), large commercial and industrial, government, nonprofit, and institutional and educational (GNE), and agricultural customers. The Prescriptive Equipment Program offers incentives for lighting, non-lighting, and agriculture equipment.

Customers can receive incentives through the standard incentive route, where the customer obtains preapproval from PPL Electric Utilities before ordering the energy-efficient equipment, installs the equipment, submits the incentive form, and receives the rebate.

The program also offers a direct discount delivery channel. The direct discount delivery channel was designed to make it easier and more economical for small businesses and institutions to install energy-efficient lighting and commercial refrigeration upgrades. In this offering, a contractor evaluates possible upgrades and makes recommendations. The customer chooses which projects to install, and the contractor completes and submits the required paperwork on behalf of the customer to PPL Electric Utilities. The customer must obtain preapproval from PPL Electric Utilities before ordering energy-efficient equipment. The customer pays the discounted amount to the contractor up front, thereby lowering the overall cost burden; PPL Electric Utilities awards the incentive to the contractor who has already passed the savings to the customer.

The objectives of the Prescriptive Equipment Program are to: [11]

- Provide energy-saving opportunities to qualified customers.
- Increase the market penetration of high-efficiency technologies and building systems for customers by offering incentives for high-efficiency and ENERGY STAR®-rated appliances, lighting equipment, and HVAC systems.
- Approve and train contractors to conduct on-site facility assessments and to pass along PPL Electric Utilities' financial incentives for energy-efficient refrigeration and upgrades for lighting and lighting controls to the customer through a direct discount delivery channel.
- Engage contractors to provide high-efficiency technology options to customers.
- Promote other PPL Electric Utilities energy efficiency programs.
- Obtain participation of approximately 4,000 small C&I customers through 2016, with a total reduction of approximately 133,000 MWh/yr.
- Obtain participation of approximately 300 large C&I customers through 2016, with a total reduction of approximately 68,000 MWh/yr.
- Obtain participation of approximately 4,500 GNI customers through 2016, with a total reduction of approximately 51,000 MWh/yr.

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

[11] Program objectives are stipulated on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.107, 128, and 145.

Table 2-1: Phase II Prescriptive Equipment Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost [1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Prescriptive Equipment	**181,214**	**181,215**	**170,418**	**0.75**	**1.87**	**$32,555**	**$0.19**	**$0.05**	**6,042**

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

2.1 PROGRAM UPDATES

Some changes were made to the Prescriptive Equipment Program from PY5 to PY6.

Starting in PY6, for all projects, customers were required to obtain preapproval from PPL Electric Utilities before ordering energy-efficient equipment. The preapproval requirement was implemented to improve tracking of participation, spending, and savings and to reduce freeridership.

PPL Electric made an another change to eligibility requirements for the direct discount channel, from an annual usage of 100,000 kWh/yr to 50,000 kWh/yr, to limit this channel to small commercial and industrial customers.

Lastly, at the end of PY6, incentive amounts for HVAC equipment and LEDs were increased to encourage participation.

2.1.1 Definition of Participant

Participants are PPL Electric Utilities customers in the small commercial and industrial, large commercial and industrial, and government, nonprofit, and institutional and education (GNE) sectors. These customers are required to sign a participation agreement or rebate application and may submit one or more applications, depending on the project. Participants are identified in Energy Efficiency Management Information System (EEMIS), the PPL Electric program tracking database, by a CSP job ID that is unique to each project.

2.2 IMPACT EVALUATION GROSS SAVINGS

Table 2-2 shows the cumulative reported results for Phase II for the entire program. Table 2-3 shows the cumulative reported results for Phase II by sector for lighting. Table 2-4 shows the cumulative reported results for Phase II by sector for equipment.

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

Sector	Phase II Participants	Phase II Reported Gross Impact (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)	Incentives ($1000)
Residential	3	53	0.01	$1
Small C&I	3,252	94,259	14.62	$11,472
Government, Nonprofit, and Education	2,576	43,302	5.77	$8,278
Large C&I	211	43,600	3.96	$3,733
Phase II Total	**6,042**	**181,214**	**24.35**	**$23,484**

Table 2-3: Phase II Prescriptive Equipment (Lighting Measures) Reported Results by Customer Sector

Sector	Phase II Participants	Phase II Reported Gross Impact (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)
Residential	3	53	0.01
Small C&I	3,229	92,174	14.38
Government, Nonprofit, and Education	2,562	43,131	5.74
Large C&I	208	43,180	3.91
Phase II Total	**6,002**	**178,538**	**24.04**

Table 2-4: Phase II Prescriptive Equipment (Equipment Measures) Reported Results by Customer Sector

Stratum	Phase II Participants	Phase II Reported Gross Impact (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)
Small C&I	23	2,085	0.24
Government, Nonprofit, and Education	14	171	0.02
Large C&I	3	420	0.05
Phase II Total	**40**	**2,676**	**0.31**

2.2.1 EM&V Sampling Approach

For verification activity sampling, projects were stratified as lighting and non-lighting equipment (referenced as equipment for the remainder of this report).

Cadmus planned two substrata for equipment projects, agricultural projects and all other projects. However, the program did not rebate any agricultural projects. The equipment projects included only two types of equipment—commercial refrigeration efficient evaporator fans and high-efficiency refrigeration cases (there were no agricultural customers in PY6).

Lighting projects were assigned to one of four substrata—large, medium-small, small-medium, and small (Table 2-5) based on *ex ante* reported savings. Lighting and equipment strata are discussed separately below.

Table 2-5: Prescriptive Equipment Program Strata Definitions

Strata	Substrata	Groups Included
Equipment	Non-Agriculture	Refrigeration, HVAC, appliances, office equipment
	Agriculture	All projects designed for and offered to the agricultural sector
Lighting	Small	Lighting, see Table 2-8 for kWh thresholds
	Small – Medium	Lighting, see Table 2-8 for kWh thresholds
	Medium - Small	Lighting, see Table 2-8 for kWh thresholds
	Large	Lighting, see Table 2-8 for kWh thresholds

2.2.1.1 EM&V Sampling Approach: Equipment Projects

PPL Electric Utilities rebated only two types of equipment during PY6 (although many others were eligible for rebates). These were refrigeration evaporator fans and a refrigeration case.

The PY6 EM&V sample plan was designed to meet levels of 90% confidence and 10% precision for the equipment stratum. Cadmus revised the proposed sample plan (to exclude site visits) after establishing the final number of projects rebated in PY6. No site visits were conducted for PY6 equipment projects since specifications for the types of projects rebated cannot easily be verified on site. For example, evaporator fan motors are enclosed inside grocery refrigeration cases and their specifications cannot be accessed unless the case is emptied.

Nine unique customers completed 16 projects. Cadmus reviewed a census of project records (desk audit) for the 16 projects. The records review involved verifying information from EEMIS using rebate application forms, customer-submitted supporting documentation, and information recorded by the ICSP.

Due to the small sample frame, all customers were asked to complete an online survey to assess satisfaction and the target sample was to complete as many as possible. Three of the nine unique customers completed the survey. The online survey data were not used for the impact evaluation as the sample size was too small to draw any conclusions. Table 2-6 shows the target and achieved sample sizes for the equipment stratum verification activities.

Table 2-6: PY6 Prescriptive Equipment Impact Evaluation Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Equipment	16 unique account numbers; 9 unique customers	90/10 at the stratum level	16	16	Records review
			0	0	Site visits
			As many as possible	3	Online surveys
Program Total	**16**		**16**	**16**	**16 projects; more than one activity can be conducted per project.**

2.2.1.2 EM&V Sampling Approach: Lighting Projects

In PY6, Cadmus calculated an annual sample size to meet the reporting requirements of the SWE. The PY6 sample plan was based on the number and characteristics of nonresidential lighting projects anticipated in PY6.

Cadmus calculated the PY6 sample size by increasing the PY5 MWh error ratio of 0.17 to 0.30 to improve the probability of achieving reporting results at the 90% confidence and 10% precision level. The SWE reporting requirement for a program is 85/15. Cadmus set a higher bar for Prescriptive Equipment Program lighting projects because they provide the majority of savings for the Phase II nonresidential portfolio. The SWE requires portfolio savings to be verified at the 90/10 level.

Cadmus used a stratified ratio estimation approach to further divide lighting into four substrata:

- Small
- Small-medium
- Medium-small
- Large

Stratified sampling results in smaller sample sizes and promotes evaluation efficiency compared to simple random sampling. This resulted in a sample size of 28 projects, which was rounded up to 33 to provide additional assurance of achieving the target precision. Table 2-7 shows the PY6 sampling plan by quarter. Cadmus drew samples, conducted site visits, and reviewed records in Q1, Q2, and Q3. The population of PY6 projects was assumed to be homogeneous and that realization rates based on the first three quarters would apply to Q4. This assumption was checked by comparing Q4 project type, size, sector and delivery channel to earlier PY6 quarters; no significant difference was noted.

Table 2-7: PY6 Quarterly Prescriptive Equipment Program Lighting Projects Site Visit Sampling Plan

Sample Count Allocation Plan	Q1	Q2	Q3	Q4	Total
Total, Planned	11	11	11	0	33
Total, Adjusted	**11**	**11**	**11**	**0**	**33**

Substrata boundaries are established by the substratum's contribution to total gross reported kWh savings, following the methods in *Chapter 13: Sampling in The California Evaluation Framework*.[12] Cadmus determined the number of sample points for each stratum using a Neyman allocation routine that accounts for the variance in each stratum. Substrata lighting boundaries by quarter are shown in Table 2-8.

Table 2-8: PY6 Quarterly Prescriptive Equipment Lighting Program by Substratum

Substratum	Q1		Q2		Q3	
	kWh High	kWh Low	kWh High	kWh Low	kWh High	kWh Low
Small	19,039	33	9,671	-1,363	21,382	8
Small-Medium	65,057	19,142	27,039	9,673	52,999	21,435
Medium-Small	235,126	65,288	70,644	27,633	171,040	53,390
Large	11,147,730	314,423	3,333,366	72,258	3,090,152	172,383

A breakdown of reported savings by substratum is shown in Table 2-9.

Table 2-9: PY6 Prescriptive Equipment Lighting Program, Summary by Substratum

Substratum	Reported Project Count[1]	Reported Savings (MWh/yr)	Percent Reported Savings
Small	2,539	14,193	15%
Small-Medium	733	18,467	20%
Medium-Small	322	22,357	24%
Large	84	39,270	42%
Total	**3,678**	**94,287**	**100%**
[1] Defined by CSP job ID.			

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

Table 2-10 presents annual population and sample sizes by substrata.

Table 2-10: PY6 Prescriptive Equipment Lighting Impact Evaluation Sampling Strategy

Substratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Small	2,539	N/A[1]	N/A[1]	5	File Review and Site Visit
Small-Medium	733	N/A[1]	N/A[1]	4	File Review and Site Visit
Medium-Small	322	N/A[1]	N/A[1]	4	File Review and Site Visit
Large	84	N/A[1]	N/A[1]	20	File Review and Site Visit
Program Total	**3,678**	**90/10**	**28**	**33**	**File Review and Site Visit**

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

2.2.2 *Ex Ante* Adjustment Methodology and Findings

In previous program years, Cadmus adjusted the reported savings for equipment from EEMIS to align with assumptions specified in the Pennsylvania TRM resulting in adjusted *ex ante* savings. This adjustment was not necessary for the lighting and equipment projects in PY6.

2.2.3 *Ex Post* Adjustment Methodology and Findings

The *ex post* savings adjustments incorporate installation rates, adjustments for nonqualifying equipment, and adjustments for equipment details determined through the sample of projects selected for records review (desk audits) and site visits. Cadmus verified installation and qualification rates for all sampled records.

2.2.3.1 *Ex Post* Adjustment Methodology and Findings: Equipment

Records Review. The records review involved verifying information from EEMIS using rebate application forms, customer-submitted supporting documentation, and information recorded by the ICSP. Cadmus verified that the rebated equipment qualified for the program and reviewed the installed quantities. Table 2-11 shows the elements verified through records review for evaporator fan motors and refrigeration cases rebated in PY6.

Table 2-11: Prescriptive Equipment Program Record Verified Elements

Equipment	Record Verified Elements
High-Efficiency Evaporator Fan Motors	Baseline motor type, new motor type, cooler or freezer, motor wattage, operating hours
High-Efficiency Refrigeration Case	Volume, door type, refrigerator or freezer

During the records review, Cadmus identified a rebated high-efficiency refrigeration case entered into EEMIS as an ice machine. EEMIS did not provide any of the equipment specifications needed to calculate savings. Cadmus looked up the equipment specifications for volume and door type and calculated savings.

Another project reported six evaporator fans installed in coolers; however, the rebate form indicated three fans in coolers and three fans in freezers. Cadmus calculated savings based on the information on the rebate form.

Surveys. Three customers completed online surveys, but the responses were not used in the impact evaluation since the sample size was not adequate to draw any conclusions.

Site Visits. No site visits were completed for customers who received rebates for equipment projects since specifications for these types of projects cannot easily be verified on site. For example, evaporator fan motors are enclosed inside grocery refrigeration cases and their specifications cannot be accessed unless the case is emptied.

2.2.3.2 *Ex Post* Adjustment Methodology and Findings: Lighting Projects

Cadmus drew lighting samples on a rolling basis as records became available at the close of each quarter. Cadmus requested all application, ICSP reviews, and payment records for each sampled project and conducted the following M&V activities:

- Reviewed application files for data accuracy and compliance with 2014 Pennsylvania TRM requirements.[13]
- Conducted on-site verification at customer facilities for the sample of projects to determine each project's as-built conditions.
- Conducted metering studies or interval data analysis at selected facilities to determine actual lighting operating hours or to review and accept the ICSP metering studies.
- Interviewed customers to determine baseline and retrofit fixtures and estimate operating hours.
- Revised the project Appendix C inventory based on the findings from the previous steps.[14]
- Recalculated the project savings to determine the *ex post* savings for the sampled projects.
- Calculated the sample realization rate, the ratio of evaluated to reported savings, after completing the Q3 review.

The ICSP conducted site visits and inspections to develop the Appendix C lighting form for commercial lighting projects. In addition, the ICSP metered lighting hours of use for all projects with estimated savings of 500,000 kWh/yr or more as required by the 2014 Pennsylvania TRM. Cadmus checked and confirmed that the six PY6 projects with estimated savings of 500,000 kWh/yr or more were metered by the ICSP.

Cadmus' record reviews and inspections aimed to verify the installation and operation of rebated equipment and that correct values were used to calculate *ex ante* savings. Discrepancies were adjusted based on site-specific data and Cadmus calculated *ex post* savings based on site-specific data. Reasons for adjustments included corrections to:

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

Table 2-12 lists high level information about the review and site visits results.

13 Pennsylvania Public Utility Commission. *2014 Pennsylvania Technical Reference Manual.* June 2014.

14 Ibid.

Table 2-12: PY6 Prescriptive Equipment Lighting Projects – Summary of Site Visits

Substratum	Measure	Inspection Firm	Number of Inspections Planned	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
Small	Lighting	EM&V CSP	**5**	**5**	**3**	Updated savings based on as-built hours of use, fixture type and counts, space cooling, and building type
Small-Medium	Lighting	EM&V CSP	**4**	**4**	**4**	Updated savings based on as-built hours of use, fixture type and counts, space cooling, and building type
Medium-Small	Lighting	EM&V CSP	**4**	**4**	**1**	Updated savings based on as-built hours of use, fixture type and counts, space cooling, and building type
Large	Lighting	EM&V CSP	**20**	**20**	**16**	Updated savings based on as-built hours of use, fixture type and counts, space cooling, and building type
Total			**33**	**33**	**24**	

2.2.4 Summary of Evaluation Results

Table 2-13 shows the reported and verified energy savings for the PY6 Prescriptive Equipment Program. Equipment achieved 400 MWh/yr of verified savings and had a 106% realization rate. Lighting measures achieved 94,287 MWh/yr savings at a 94% realization rate.

Table 2-13: PY6 Prescriptive Equipment Summary of Evaluation Results for Energy]

Stratum	PYTD Reported Gross Impact (MWh/yr)	PYTD Adjusted *Ex Ante* Energy Savings (MWh/yr)	PYTD Energy Realization Rate (%)	PYTD Verified Gross Energy Savings (MWh/yr) [1]	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Lighting	94,287	94,287	94%	88,848	0.12	2.4%
Equipment	379	379	106%	400	N/A[2]	N/A[3]
Program Total	**94,666**	**94,666**	**94%**	**89,248**	**0.12**	**2.4%**

[1] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[2] A census of projects were reviewed for the equipment stratum.

Table 2-14 shows the reported and verified demand savings for the PY6 Prescriptive Equipment Program. Equipment projects achieved 0.05 MW of demand reduction and had a realization rate of 105%. Lighting projects achieved 14.95 MW of verified savings at a realization rate of 119%. Table 2-15 shows the reported and verified energy savings for the lighting stratum. Table 2-16 shows the results for demand savings for the lighting stratum.

Table 2-14: PY6 Prescriptive Equipment Summary of Evaluation Results for Demand

Program	Reported Gross Demand Savings [1] (MW)	Adjusted *Ex Ante* Demand Savings [2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings [2] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Lighting	11.790	12.59284	119%	14.94974	0.28	6.1%
Equipment	0.044	0.04755	105%	0.05011	N/A[3]	N/A[3]
Program Total	**11.834**	**12.640**	**119%**	**15.000**	**0.28**	**6.1%**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] Adjusted *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] A census of projects were reviewed for the equipment stratum.

Table 2-15: PY6 Prescriptive Equipment Summary of Evaluation Results for Energy Savings (Lighting Stratum)

Quarter	PYTD Reported Gross Impact (MWh/yr)	PYTD Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	PYTD Verified Gross Energy Savings (MWh/yr) [1]	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Q1	28,483	28,483	98%	27,903	N/A	N/A
Q2	23,072	23,072	94%	21,750	N/A	N/A
Q3	20,820	20,820	89%	18,560	N/A	N/A
Q4	21,911	21,911	94%	20,636	N/A	N/A
Program Total	**94,287** [2]	**94,287**[2]	**94%**	**88,848**[2]	**0.12**	**2.4%**

[1] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[2] Program total does not match total of Q1, Q2, Q3, and Q4 due to rounding.

Table 2-16: PY6 Prescriptive Equipment Summary of Evaluation Results for Demand Savings (Lighting Stratum)

Quarter	PYTD Reported Gross Demand Savings [1] (MW)	PYTD Adjusted *Ex Ante* Demand Savings [2] (MW)	Demand Realization Rate (%)	PYTD Verified Gross Demand Savings [2] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Q1	2.844	3.02641	131%	3.95997	N/A	N/A
Q2	2.736	2.92465	117%	3.43557	N/A	N/A
Q3	3.043	3.24898	109%	3.53407	N/A	N/A
Q4	3.167	3.39279	118%	4.02013	N/A	N/A
Program Total	**11.790**	**12.593**	**119%**	**14.950**	**0.28**	**6.1%**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] Adjusted *Ex Ante* and Verified gross demand reductions include T&D losses.

The PY6 MW reduction realization rate increased to 119% from its PY3-PY5 average of 93%. The increase was due to the SWE requirement for site-specific coincidence factors whenever site-specific hours of use are used. The ICSP was not aware of this change until Q3, but it developed procedures to comply with the site-specific requirement in PY7.

The GNI sector reported gross savings were 25% of the total lighting savings. The 2014 Evaluation Framework requires that these savings be reported separately at the 85/15 confidence/precision level,[15] as though they were from an independent program as stated here:

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

In accordance with the framework, GNE sector lighting savings are reported as in Table 2-17 for energy and Table 2-18 for demand.

Table 2-17: PY6 Prescriptive Equipment Program Summary of Evaluation Results For Energy (GNI Lighting Sector) [1]

Sector	Reported Gross Energy Savings (MWh/yr)	GNI MWh/Total Lighting (%)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)[2]	Observed Coefficient of Variation (Cv) or Error Ratio in Sample	Relative Precision at 85% C.L.
Government, Nonprofit, and Educational	23,514	25%	84%	19,798	0.28	8.2%

[1] Realization rate based on sample size (n) of 9.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.

Table 2-18: PY6 Prescriptive Equipment Program Summary of Evaluation Results For Demand (GNI Lighting Sector) [1]

Sector	Reported Gross Demand Savings[2] (MW)	GNI MW/Total Lighting (%)	Demand Realization Rate[2] (%)	Verified Gross Demand Savings[3] (MW)	Observed Coefficient of Variation (Cv) or Error Ratio in Sample	Relative Precision at 85% C.L.
Government, Nonprofit, and Education	3.1	26%	100%	3.1	0.24	16.6%

[1] Realization rate based on sample size (n) of 9.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross demand savings due to rounding.
[3] Verified gross demand savings for the GNI Lighting Sector do not include T&D losses.

15 Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase II Energy Efficiency and Conservation Programs.* Page 56. Prepared by GDS Associates, Inc., and Nexant. June 1, 2014.

2.3 IMPACT EVALUATION NET SAVINGS

Cadmus conducted an analysis to determine net savings for the Prescriptive Equipment Program lighting projects. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance plans are met using verified gross savings.

2.3.1 Net-to-Gross Ratio Methodology

Freeridership is a measure of the savings that participants would have achieved on their own without the program's treatment; these savings are subtracted from verified gross savings. Participant spillover, on the other hand, credits additional savings that participants achieved on their own, where their experience with the program was highly influential. Participant spillover adds to gross savings.

The SWE defined the methods used to determine net savings, including instructions provided in the Evaluation Framework and Guidance Memos. For this program, Cadmus included freeridership and spillover that were estimated in accordance to the SWE net-to-gross guidelines, which uses information from self-report surveys from participating customers. Participant telephone surveys collected data to assess these metrics.

2.3.2 Net-to-Gross Ratio Sampling

The target sample size for assessing net savings was 75 completed surveys (of the sample population of 2,161 unique contacts), as shown in Table 2-19.[16] Cadmus completed surveys with 60 participants in the prescriptive lighting component of the Prescriptive Equipment Program. Cadmus completed online surveys with three of the nine unique participants who received rebates for installing equipment projects; however the surveys were not used to assess net savings because the sample size was not large enough to draw meaningful conclusions about freeridership.[17] No agricultural projects were rebated in PY6.

Cadmus completed online surveys with 12 of the 139 unique participants of the direct discount delivery channel; however, these surveys did not ask questions to assess the net-to-gross ratio. There were no significant changes to that portion of the program in PY6, and PY5 freeridership for direct discount participants was low at 8%. Therefore, net-to-gross was not expected to change in PY6.

16 The sample population consisted of 2,309 unique contacts after adding contacts for the Direct Discount Lighting and Non-lighting strata, removing duplicate contacts, and contacts who already completed a survey in the past year.

17 Of the 16 unique customers, there were 10 unique e-mail addresses. Of the ten, one contact was removed because they were already contacted within the past year for a survey.

Table 2-19: PY6 Prescriptive Equipment Sampling Strategy for NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted [1]
Standard Path Lighting	Participants	2,161	N/A	N/A	75	60	100%
Direct Discount Lighting	Participants	139	N/A	N/A	0	0[2]	100%
Equipment	Participants	9	N/A	N/A	As many as possible	0[2]	100%
Program Total	**Participants**	**2,309**	**N/A**	**N/A**	**75**	**60**	**100%**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete surveys.
[2] Though some direct discount and equipment participants completed online surveys, these results were not used to determine net-to-gross ratios.

The freeridership and spillover estimates for the Prescriptive Equipment Program, estimated in accordance with the SWE net-to-gross guidelines, are shown in Table 2-20. In PY6, freeridership was 28%, spillover was 2%, and the net-to-gross ratio was 74%. This is an improvement over PY5, where the net-to-gross ratio was 63% for standard lighting participants.

Freeridership may have decreased due to the preapplication requirement in PY6, as this eliminates participation by customers who find out about the rebate after installing their project. Cadmus reviewed prescriptive lighting programs in fall of 2013 and found that typical net-to-gross ratios for these programs ranged from 71% to 96%.[18]

Table 2-20: PY6 Prescriptive Equipment Summary of Evaluation Results for NTG Research

	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Standard Lighting	28%[1]	2%	74%	0.0839	14%
Program Total	**28%**	**2%**	**74%**	**0.0839**	**14%**

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

2.4 PROCESS EVALUATION

2.4.1 Research Objectives

The purpose of the process evaluation was to assess program processes and make recommendations for improved program operation. The main process issues in the Prescriptive Equipment Program are process efficiency, delivery infrastructure, and customer response.

18 Cadmus. Net-to-Gross Benchmarking Findings: Prescriptive Equipment (Nonresidential) Program. Completed for PPL Electric Utilities. September 2013.

In particular, the process evaluation focused on these areas:

- The effectiveness of the program (including the direct discount delivery channel) in generating awareness and disseminating information
- The effectiveness of the program (including the direct discount delivery channel) to encourage customers to install the program products
- Customer satisfaction
- Opportunities and barriers
- Possible program enhancements

In addition, Cadmus conducted a limited study on the effects the program is having on the market. The study consisted of three activities—documenting the baseline to the extent possible, developing a simple market change theory including indicators to assess change, and assessing progress toward meeting these metrics or indicators. Data were collected through primary research (interviews with contractors).[19]

2.4.2 Evaluation Activities

For the Prescriptive Equipment Program, the PY6 process evaluation activities were these:

- Program staff and implementer interviews (n=2)
- Participant surveys (n=75)
    - Lighting participants (n=60)
    - Direct discount delivery channel participants (n=12)
    - Equipment participants (n=3)
- Contractor interviews (n=41)
    - Lighting contractors (n=15)
    - HVAC contractors (n=15)
    - HVAC distributors (n=4)
    - Refrigeration contractors (n=7)
- HVAC contractor focus groups (2 groups, n=18)
- Database and quality assurance/quality control (QA/QC) review of records

The research activities were consistent with the evaluation plan except for these:

- Cadmus planned to survey agricultural customers, except no agricultural equipment was rebated in PY6; therefore, there were no participants who received rebates for agricultural equipment to interview.
- Cadmus planned to survey a larger sample of participants who received incentives for equipment, however the participation rate was lower than expected. We attempted to complete surveys with as many equipment participants as possible.

The PY6 sampling strategy for the Prescriptive Equipment Program is shown in Table 2-21.

19 The SWE's *Phase 2 Evaluation Framework* discusses Market Effects Studies in Section 3.6.2.3 and 4.5.1.4.

2.4.3 Methodology

Cadmus' methodology for the PY6 process evaluation included interviews to gather high-level perspectives from program staff about the Prescriptive Equipment Program, from lighting contractors about the lighting market, and from refrigeration contractors about the refrigeration market. We also interviewed HVAC contractors and distributors and conducted focus groups with HVAC contractors. We conducted a telephone survey with participants receiving prescriptive rebates for commercial lighting and online surveys with participants of the direct discount delivery channel.

2.4.3.1 Program Staff and Implementer Interviews

In April and May 2015, Cadmus conducted interviews with the program managers from PPL Electric Utilities and DNV GL, the ICSP. The interviews focused on key performance indicators, program design changes, and implementation successes and challenges.

2.4.3.2 Participant Surveys

Cadmus administered the online customer satisfaction surveys during June, July, and August 2015. This participant survey assessed satisfaction with the program and with the ICSP.

Cadmus conducted surveys with participants using two different methods. An online survey assessed satisfaction of participants who installed equipment and those who participated in the direct discount delivery channel. A telephone survey with a random sample of participants who received a prescriptive rebate for lighting and lighting controls informed the net savings analysis.

Cadmus administered the telephone survey with lighting participants between April and July 2015. The sample excluded participants of the Continuous Energy Improvement and Custom Incentive programs because of limited participation in those programs. Those participants were included in the program-specific sample.

To obtain the sample for the direct discount delivery channel, Cadmus obtained a list of completed projects from the ICSP. Because the ICSP keeps a list of customers who are in various stages of the application process, Cadmus cross-referenced this list with the Efficiency Management Information System (EEMIS) data and removed records that were not included in the EEMIS database to isolate only those records that had received incentive payment.

Table 2-21: PY6 Prescriptive Equipment Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted [1]	Evaluation Activities
PPL Electric Program and ICSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, impact, program staff interview
Lighting	Participants	2,161	N/A	N/A	75	682	60	100%	Process, impact, net-to-gross participant survey
Equipment	Participants	9	N/A	N/A	As many as possible	6 [2]	3	100%	Process, online participant survey
Direct Discount Delivery Channel	Participants	139	N/A	N/A	As many as possible	76 [2]	12	100%	Process, online participant survey
Agriculture	Participants	0	N/A	N/A	As many as possible	0	0	N/A	N/A
Lighting Contractors	Participants (PY4-PY5)	280	N/A	N/A	15	280	15	34%	Process, trade ally interview, market effects
HVAC Contractors	Participants (PY4-PY5)	353	N/A	N/A	15	353	15	21%	Process, Trade Ally interview, Market effects
HVAC Distributors	In Pennsylvania	Unknown	N/A	N/A	4	14	4	Unknown	Process, Trade Ally interview, Market effects
Refrigeration Contractors	Participants	11	N/A	N/A	As many as possible	11	7	100%	Process, Trade Ally interview, Market effects
Program Total		**2,955**			**111+**	**1,424**	**118**		

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete surveys.
[2] Number of e-mail invitations Cadmus sent.

The equipment participants were identified through the EEMIS database. As with the telephone survey, Cadmus excluded from the population any participants of the Continuous Energy Improvement and Custom Incentive programs because of limited participation in those programs. Cadmus also excluded any participants already included in the call list for the telephone survey.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they were implemented consistently.

Cadmus attempted to contact, by telephone, all participants receiving prescriptive rebates for lighting. Calling multiple times over several days at different times of the day and scheduling callbacks, when possible, reduces possible nonresponse bias so that it will have minimal impact.

Cadmus sent all participants receiving equipment rebates who were included in the sample frame an initial e-mail invitation and two reminder e-mail invitations to encourage response. The response rate (50%; 3 of 6) is reasonable; therefore, we assumed that any possible bias will have minimal impact.

Cadmus sent all participants in the direct discount delivery channel with valid e-mail addresses an initial e-mail invitation and two reminder e-mail invitations to encourage response. Although the response rate (16%; 12 of 76) is reasonable, the number of available e-mail addresses was low (76 unique e-mail addresses out of 1,081 unique participants); therefore, it is difficult to determine the impact this had on the final analysis.

In some instances, the same customer completed multiple projects. This required generating a final survey sample of unique decision-makers to ensure that no customer was contacted more than once. For all three survey efforts, Cadmus contacted all unique decision-makers from the Q1 through Q4 who had not participated in other commercial programs and had not been contacted in the past year by PPL Electric Utilities.

Table 2-21 above summarizes the process evaluation survey sampling strategy for the Prescriptive Equipment Program for PY6. More details about sample attrition and the outcome of each record are presented in Addendum A. Participant Survey Attrition and Final Disposition.

2.4.3.3 Contractor and Distributor Interviews

Lighting, HVAC, and Refrigeration Contractors. In September 2014, Cadmus completed 30 phone interviews with lighting and HVAC contractors participating in PPL Electric Utilities' energy efficiency programs. In September 2015, we completed seven interviews with refrigeration contractors who had participated in the Prescriptive Equipment Program. The population of participating contractors was derived from those listed in EEMIS, and we contacted all contractors. This list originated from information the participant provided on their rebate application form.

The primary purpose of the lighting and HVAC contractor interviews was to assess possible market effects of PPL Electric Utilities' energy efficiency programs. We asked contractors questions about market conditions before and after the PPL Electric Utilities rebate programs became available in 2009. Because we lacked baseline information from the pre-2009 market, we asked contractors to think back to years before rebates were available. If there was a change, we asked contractors to consider whether PPL Electric Utilities influenced this change in any way.

The purpose of the refrigeration contractor interviews was slightly different. Although we asked some questions pertaining to standard practice, the main objective was to gain a better understanding of contractors' awareness about and opinions regarding PPL Electric Utilities' refrigeration equipment incentive program, which would help PPL Electric Utilities and its ICSP plan for PY7 and Phase III.

Lighting contractors. We classified lighting contractors into large (representing between 1% and 8% of total program savings) or small strata (representing between 0% and 1% of total program savings) based on program activity. We planned to reach an equal number in the two stratum. Cadmus generated a random sample and reached 15 lighting contractors, eight in the large stratum and seven in the small stratum.

HVAC contractors. Cadmus selected a simple random sample of HVAC contractors and interviewed 15 HVAC contractors who sold ductless mini-split heat pumps or air source heat pumps and participated in the Residential Home Comfort Program. Although many of these contractors also reported serving nonresidential customers, only one contractor had sold rebated equipment to PPL Electric Utilities' business customers in the past. However, the data gathered in the interviews were still relevant for the commercial market and for the Prescriptive Equipment Program.

Refrigeration contractors. There were eleven unique contractor companies who participated in the Prescriptive Equipment program. Cadmus contacted all eleven and completed seven interviews.

2.4.3.4 Focus Groups with HVAC Contractors and Interviews with HVAC Distributors

As a follow-up to the 2014 interviews, Cadmus also conducted two focus groups with HVAC contractors serving PPL Electric Utilities' territory. We interviewed HVAC distributors serving the region in the fall of 2015.

For the focus groups, Cadmus recruited contractors who sell and/or install HVAC equipment for nonresidential customers in PPL Electric Utilities' service territory. Contractors did not need to be familiar with the Prescriptive Equipment Program to take part in the focus group. The ICSP provided the names of the contractors, which were derived from historical rebate application records dating back to 2011. The total population was 443 contractors.

Using GIS software, Cadmus mapped contractor addresses to determine the densest concentrations and the ideal locations for hosting the focus groups. We chose professional research facilities in Allentown and Harrisburg, cities with the shortest drive time (a maximum of 45 minutes) for the largest number of contractors. The total sample size in these two regions was 172 to 84 contractors in the Allentown area and 88 contractors in the Harrisburg area. From this narrowed sample frame, we contacted a simple random sample of contractors and recruited 10 participants for Allentown and eight participants for the Harrisburg group (for a total of 18).

For HVAC distributor interviews, Cadmus contacted one company recommended by PPL Electric Utilities and, through an Internet search for other possible companies that distributed heating and cooling equipment in Pennsylvania, we identified 13 more companies and reached a total convenience sample of four companies.

The focus groups and the distributor interviews were intended to examine attitudes and awareness of high-efficiency HVAC equipment and PPL Electric Utilities' program offerings and to identify any barriers and opportunities for high-efficiency equipment in the market. Cadmus also asked questions about incentive levels, the design of the Prescriptive Equipment Program, and new technologies to help PPL Electric Utilities and its ICSP plan for PY7 and Phase III.

2.4.3.5 Database and Records Quality Control Review

The EEMIS database and records quality control review verified information recorded in EEMIS by comparing it to corresponding rebate application forms, customer-submitted supporting documentation, and information recorded by the ICSP. Cadmus conducted a desk audit of a census of project records for the 16 equipment projects; projects were reviewed quarterly as they became available in EEMIS.

Cadmus calculated the PY6 sample size to conduct the quality control review for lighting projects by increasing the PY5 error ratio of 0.17 MWh to 0.30 MWh to improve the probability of achieving reporting results at the 90% confidence and 10% precision level. Cadmus used a stratified ratio estimation approach to further divide lighting into four substrata—small, medium-small, small-medium, and large.

This resulted in a sample size of 28 lighting projects, which was rounded up to 33 to provide additional assurance of achieving the target precision. We drew samples and reviewed records in Q1, Q2, and Q3. The same projects were included in the verification sample.

Table 2-22 summarizes the sampling for the database review.

Table 2-22: Prescriptive Equipment Process Evaluation Database Review

Stratum	Population Size	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Evaluation Activities
Lighting	3,678	90/10	23	33	Database review, Process, Impact
Small	2,539	N/A[1]	N/A[1]	5	
Small-Medium	733	N/A[1]	N/A[1]	4	
Medium-Small	322	N/A[1]	N/A[1]	4	
Large	84	N/A[1]	N/A[1]	20	
Equipment	16	N/A	Census	16	Database review, Process, Impact
Program Total	**3,694**	**90/10**		**49**	

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

2.4.4 Achievements Against Plan

Table 2-23 contains the program's energy savings and the progress toward the planned savings.

Table 2-23: Prescriptive Equipment Program Savings [1]

	PY5 Verified	PY6 Only			Phase II: PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	81,170	88,318	89,248	101%	252,326	170,418	67.5%
MW	12.58	16.74	15.00	89.6%	47.48	27.58	58.1%
Participation (number of projects)	2,348	N/A	3,694	N/A	15,460	6,042	39.1%

[1] Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table M6, p.119, Table O6, p. 135, and Table Q6, p. 154.

The program exceeded its planned MWh per year savings for PY6 but did not reach planned MW reductions or participation levels Two possible reasons the program achieved fewer of its planned PY6 MW savings are:

- Low uptake of appliances, HVAC, and refrigeration equipment rebates
- No uptake of agricultural equipment rebates

2.4.5 Program Delivery

The Prescriptive Equipment Program has been operating for six years and has a robust network of contractors supporting it and driving customer participation. The program is exceeding its planned energy savings with little marketing and, overall, 97% of participants are *somewhat satisfied* or *very satisfied* with their program experience in PY6.

In PY6, there were a few minor program challenges. Participation rates were low for the equipment and agricultural products, so in late PY6 PPL Electric Utilities increased rebate levels for HVAC equipment. The ICSP conducted audits with 28 agricultural customers and 17 of these occurred in the last half of PY6. Four customers that received audits implemented projects that were rebated during PY6, and all of these were lighting projects rather than agricultural equipment. The audits may result in updates of agricultural equipment during PY7. Lastly, in PY6, a preapproval requirement was implemented and the ICSP reported that more effort was required to review and approve the applications than initially anticipated.

2.4.5.1 Logic Model

The logic model for the Prescriptive Equipment Program is presented in Addendum B. Logic Model. The interviews and other process evaluation activities did not identify any changes to the logic model.

2.4.5.2 Key Performance Indicators

The logic model and PPL Electric Utilities' EE&C Plan identified these performance indicators of successful program outcomes:

- Increased customer and contractor program awareness
- Increased customer and contractor awareness of energy-efficient equipment
- Increase in the installations of energy-efficient equipment
- Energy savings
- Demand reduction
- Lower electric bills for program participants

PPL Electric Utilities and the ICSP defined plans for energy savings and set levels for other metrics they monitor. These include customer satisfaction and incentive processing time. The Prescriptive Equipment Program performance plans for these metrics in PY6 is shown in Table 2-24.

Table 2-24: Prescriptive Equipment Program KPIs

Key Performance Indicator	Metric	Goal	PY6 Result
Incentive Processing Time	Percentage of incentives processed within 6 weeks of receiving the final application	Process all rebates within 6 weeks of receiving the final application.	47% of survey respondents reported they received their incentives 8 or more weeks after submitting their application.
Energy Savings	88,318 MWh/yr for PY6	Meet PY6 planned energy savings (88,318 MWh/yr within ±5%).	Evaluated energy savings were 101% of the PY6 planned savings.
Customer Satisfaction	Percentage of satisfied customers	80% or more of surveyed customers participating in any PPL Electric Utilities program report they are satisfied with their experience.	97% of surveyed program participants were *very satisfied* or *somewhat satisfied* with their overall experience with the Prescriptive Equipment Program.

2.4.5.3 Program Update Outcomes

Some changes were made to the Prescriptive Equipment Program from PY5 to PY6.

Starting in PY6, for all projects, customers were required to obtain preapproval from PPL Electric Utilities before ordering energy-efficient equipment. The preapproval requirement was implemented to improve tracking of participation, spending, and savings and to reduce freeridership. This change had two main outcomes:

- Freeridership fell from 38% in PY5 to 28% in PY6. PPL Electric and the ICSP reported that the preapproval requirement did not impact customer or contractor participation levels. The program exceeded the savings for PY6 with little marketing (participation was driven by contractors), demonstrating that the preapproval requirement was not a barrier to achieving the planned savings.
- Program staff expected the preapproval requirement would improve customer satisfaction because customers would know the amount of the rebate before installing the equipment. However, satisfaction decreased in PY6. Respondents said the complexity of the rebate form and length of processing time were major reasons that they were not *very satisfied* with their experience.

Another change was made to the eligibility requirements for the direct discount delivery channel to limit this channel to small commercial and industrial customers. The annual consumption limit of 100,000 kWh/yr decreased to 50,000 kWh/yr. The ICSP noted that the backlog of potential savings from direct discount delivery channel projects was lower while the number of projects remained consistent, indicating that project savings size had decreased, as would be expected from smaller customers.

At the end of PY6, incentive amounts for all high efficiency HVAC equipment (air source heat pumps, air conditioners, and ductless heat pumps) and LEDs were increased to encourage higher participation rates. However, this increase occurred during Q4 of PY6, so no real change in participation was observed in PY6 and may occur in PY7.

In PY5, Cadmus made recommendations as shown in Table 2-25. An update on the status is provided in the right-most column.

Table 2-25: Prescriptive Equipment Program Status Report on Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Review corrections to application and project submittals and consider conducting additional training for trade allies.	Being considered. The ICSP continues to offer webinars to new contractors to review eligibility requirements and the rebate application process.
Consider adding a requirement to the incentive program for the standard path (prescriptive rebate delivery mechanism) stating that a lighting retrofit must result in a total annual energy consumption reduction to qualify for incentives.	Being considered. Was not implemented during PY6; however, there was only one lighting project that resulted in an increase in energy consumption.
Consider reviewing the number of commercial appliance and equipment incentives in PY4 and program progress compared to the portfolio plans to decide if a change in the amount of the incentive or marketing strategy is necessary.	Implemented. Increased incentive amount for LEDs and HVAC equipment in Q4 of PY6.
Review program information resources such as information posted to the PPL Electric Utilities program website and availability of support staff to ensure customers pursuing rebates through the standard path have the resources, such as support from program staff (ICSP), to complete their application packages.	Being considered. PPL Electric Utilities generally agrees.
Ensure that equipment trade allies are knowledgeable and well-informed about all of PPL Electric's offerings.	Being considered. PPL Electric Utilities generally agrees.

2.4.6 Participant Profile

Cadmus reviewed the EEMIS database and developed a profile of the unique Prescriptive Equipment Program participants (n=3,136). In PY6, 16 participants received rebates for equipment, mostly high-efficiency fan motors for commercial refrigeration. Of the 3,120 participants who received rebates for lighting equipment, 31% were for controls and sensors.

The majority of program participants were from the small commercial and industrial sector and the GNE sector, with few large customers. Table 2-26 depicts the sectors that participated in the Prescriptive Equipment Program by product grouping.

Table 2-26: Prescriptive Equipment Participation by Sector (Percentage of Accounts)

Target Group	Population Size	GNI	Large C&I	Small C&I
Prescriptive Equipment	16	65%	0%	35%
Prescriptive Equipment Lighting	3,120	47%	7%	46%

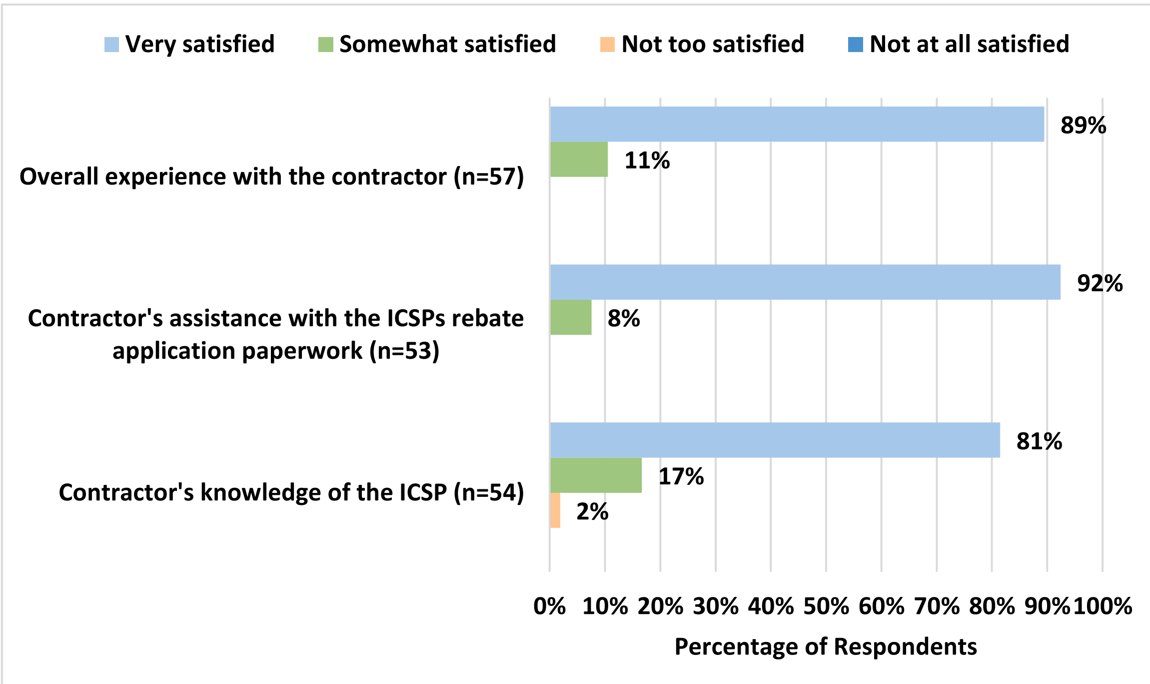
2.4.7 Participant Satisfaction

Cadmus conducted on-line and telephone surveys and asked participants about their satisfaction with a number of program elements. These fell primarily into four topic areas—the contractor, application process, rebate processing and timing, and overall program experience. Cadmus removed "don't know," "refused," and "not applicable" responses from the total.

2.4.7.1 Contractor Satisfaction

Figure 2-1 depicts various levels of satisfaction with contractors who installed rebated equipment. Two equipment respondents, 45 lighting respondents, and 12 direct delivery channel respondents said the project was installed or implemented by a contractor. Overall, 89% (51 out of 57) of respondents were *very satisfied* with their experience with the contractor. Ninety-two percent (49 out of 53) of respondents were *very satisfied* with the assistance that their contractor provided them in completing the ICSPs rebate application, and 81% (44 out of 54) were *very satisfied* with the contractors knowledge of the ICSP. One respondent was *not too satisfied* with the contractor's knowledge of the ICSP as the contractor was unable to help the respondent fill out the paperwork, which took longer than expected.

Figure 2-1: Contractor Satisfaction



Source: Survey questions E6a/F2a –E6c/F2c "How satisfied are you with..." Asked to equipment (n=3), lighting (n=60), and direct discount delivery channel respondents (n=12). Not applicable, don't know and refused responses removed.

2.4.7.2 Satisfaction with the Application Process and Requirements

The majority of survey respondents were either *very satisfied* or *somewhat satisfied* with the program eligibility requirements, terms and conditions, eligible equipment, and rebate forms. Overall, most participants were either *very satisfied* (61%, n=74) or *somewhat satisfied* (35%) with the simplicity of the application process. Table 2-27 shows customer satisfaction with the application process and program requirements.

Respondents who were dissatisfied with eligibility and qualifying equipment said that it was unclear to them which products were eligible. There was miscommunication between the contractor's explanation of the eligibility requirements and eligible equipment consistent with the program's guidelines. Other respondents said that the program was "restrictive" or "limited" in the types of lighting equipment eligible for incentives.

Respondents who were dissatisfied with the forms and process said that the equipment eligibility information was "too complex" and the application was "too long" to complete all of the required information. One respondent partially blamed the contractor for not providing adequate information as required in the application.

Table 2-27: Satisfaction with Application Process and Requirements

Satisfaction Level	The eligibility requirements (n=71)	The terms and conditions of the program (n=74)	The availability of eligible equipment that qualifies for the rebate (n=67)	The forms you had to complete and submit to obtain the rebates (n=52)[1]	The simplicity of the overall process (n=74)
Very satisfied	68%	66%	60%	52%	61%
Somewhat satisfied	31%	31%	34%	40%	35%
Not too satisfied	1%	3%	6%	8%	4%
Not at all satisfied	0%	0%	0%	0%	0%

Source: Survey questions E1f/E1g/E1h/E1b/E1k and E1d/E1e/E1f/E1j "How satisfied are you with..." Asked to equipment (n=3), lighting (n=60), and direct discount delivery channel respondents (n=12). Not applicable, don't know and refused responses removed.
[1]Lighting participant only.

2.4.7.3 Satisfaction with the Rebate Processing and Timing

Overall participants were *very* or *somewhat satisfied* with the rebate processing and timing. Sixty-five percent (n=57) were *very satisfied* with the amount of the rebate they received. Respondents who were dissatisfied with the rebate amount believed it was too low or different than what they had initially expected. Table 2-28 shows rebate process and timing.

Table 2-28: Rebate Processing and Timing

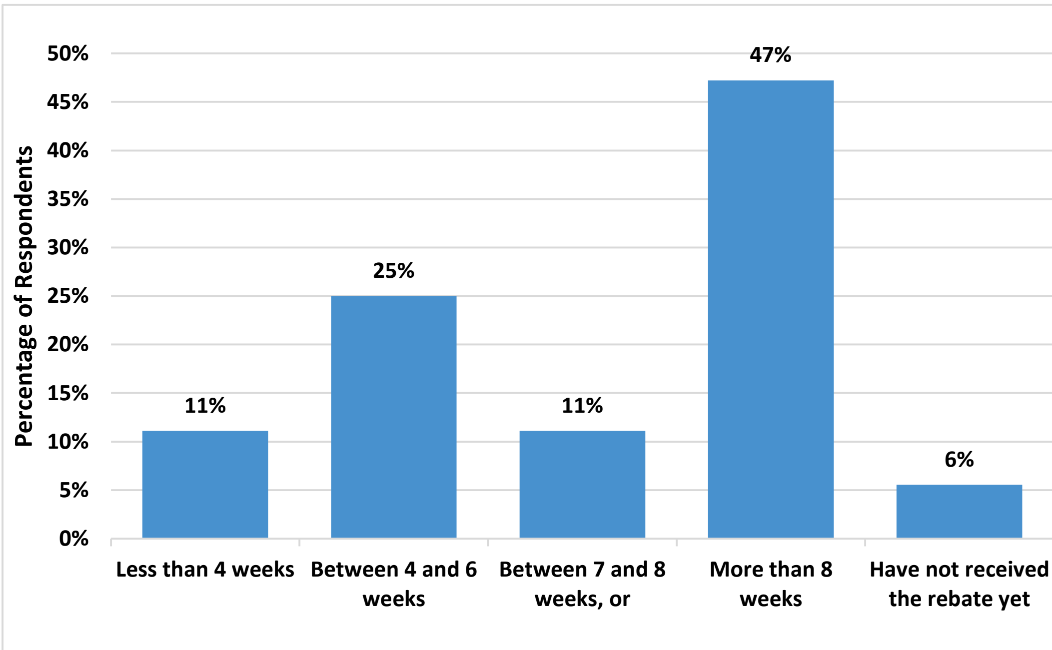
Satisfaction Level	The amount of the rebate you received (n=57)[1[	The time it took to receive your rebate after submitting the application (n=52)[2]	The time it took to complete the paperwork (n=57)	The time it took to complete the paperwork (n=11)[3]	The convenience of scheduling inspections (n=50)	The convenience of scheduling inspections (n=11)[3]
Very satisfied	65%	44%	54%	82%	70%	82%
Somewhat satisfied	32%	35%	32%	18%	28%	9%
Not too satisfied	4%	15%	11%	0%	2%	0%
Not at all satisfied	0%	0%	4%	0%	0%	9%

[1] Survey questions E1d/E1e/E1j/E1i and E1g/E1h"How satisfied are you with..." Asked to equipment (n=3), lighting (n=60), and direct discount delivery channel respondents (n=12) Not applicable, don't know and refused responses removed.
[2] Lighting participants only
[3] Direct discount delivery channel participants only.

Satisfaction with the length of time to complete program paperwork was also relatively low, with 59% of participants (40, n=68) reporting that they were *very satisfied.* Dissatisfaction stemmed from equipment eligibility requirements and having to ask contractors to provide equipment specifications (not always readily available to customers), which lengthened the process. However, examining the two program paths separately, 82% of the direct discount channel participants surveyed were *very satisfied* with the length of time to complete program paperwork, while 54% of the prescriptive rebate survey respondents were *very satisfied.* Additionally, 82% of direct discount channel participants were *very satisfied* with the convenience of scheduling inspections. These responses suggest customers are much more satisfied with the direct discount channel of the Prescriptive Equipment Program than the prescriptive rebate channel.

However, 15% (n=52) were *not too satisfied* or *not at all satisfied* with the time it took to receive their rebate upon submission of the application. Figure 2-2 depicts survey respondents' self-reported time it took for rebates to be delivered after completing their application and a majority of customers 47% (17 out of 34) said that it took more than eight weeks.

Figure 2-2: Time for Customer to Receive Rebate After Application Submission

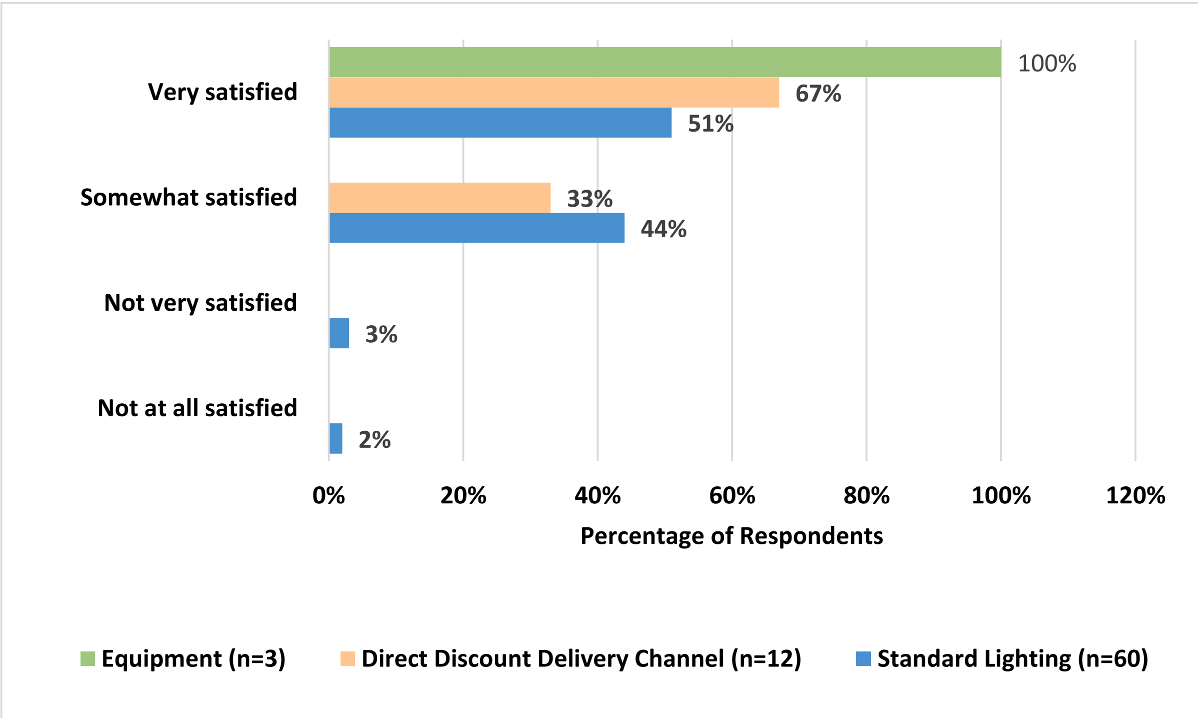


Source: Survey question H5 "After your company submitted your rebate application for the lighting products, how long did it take to receive the rebate check from PPL Electric?" Asked to lighting (n=36), Not applicable, don't know and refused responses removed.

2.4.7.4 Overall Program Satisfaction

Survey respondents rated their satisfaction with their overall program experience (as shown in Figure 2-3). Lighting participants, 51% (n=50) were *very satisfied* with the program. This was a decrease from 77% in PY5 (n=75). Additionally, 67% of direct discount delivery channel lighting participants (n=12) and 100% of equipment participants reported (n=3) they were *very satisfied*. Lighting participants were less satisfied than equipment participants (albeit the equipment sample was very small).

Figure 2-3: Overall Satisfaction with the Prescriptive Equipment Program



Source: Survey questions E7 and G1 "Thinking about your overall experience with the program, how would you rate your experience with the program?" Asked to equipment (n=3), lighting (n=60), and direct discount delivery channel respondents (n=12).

Cadmus asked participants what PPL Electric Utilities could do to improve their program experience. Participant responses generally fell into three categories:

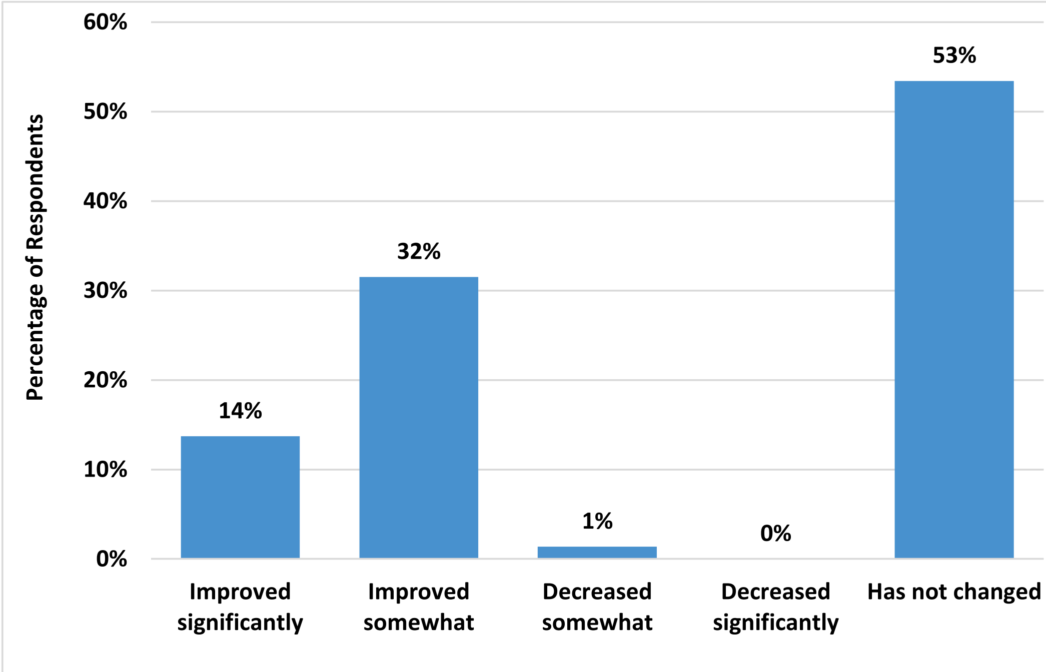
- **Applications.** Speed up the processing time for applications and the delivery of incentives (6 participants, n=33). One respondent would like to *"have an update on the status of the paperwork."* Allow editing of electronic application; one respondent said there was no way to edit the electronic application if any information was incorrect, which made the process longer.
- **Information.** Provide better information about equipment eligibility (3 respondents, n=33). Some participants thought more types of equipment should be eligible for the program and wanted more information about the availability of rebates.
- **Paperwork.** Clarify the paperwork (7 respondents, n=33). Several respondents said the paperwork was complex and they had to resubmit applications because they were initially unclear about the information that was required.

Cadmus asked participants if they would recommend the program to other businesses or colleagues following their participation. Respondents were divided—54% (30, n=56) said they *would not* recommend the program and 46% (26, n=56) said they *would*.

2.4.7.5 Satisfaction with PPL Electric Utilities

Cadmus asked participants if their participation in the program had changed how they felt about PPL Electric Utilities. Fifty-three percent of participants said that the program had not changed their opinion of the utility while 46% said their view had improved. Only one participant lowered his or her opinion. Figure 2-4 shows the effects of program participation on participants' opinion of PPL Electric Utilities.

Figure 2-4: Opinion of PPL Following Participation



Source: Survey questions K2 and G3 "Since participating in the program, has your opinion of PPL Electric..." Asked to equipment (n=3), lighting (n=58), and direct discount delivery channel respondents (n=12). Not applicable, don't know and refused responses removed.

2.4.8 Marketing and Outreach

2.4.8.1 PPL and CSP Marketing

One of the main objectives for Phase II is to improve tracking of participation, spending, and savings. With improved tracking, PPL Electric Utilities can manage program participation rates and avoid program oversubscription. PPL Electric Utilities has planned a "slow and steady" pace for applications during Phase II to closely track program participation and monitor progress toward the planned energy savings for the program. One of the ways the utility managed progress was to institute a project wait list in May 2015. (Note that all existing reserved projects and complete pre-applications received before midnight May 19, 2015, will be honored and remain eligible for rebates as long as they are completed by their reservation deadline.)

To support this pace, PPL Electric conducted limited marketing in PY5 and PY6. This strategy may have led to low participation rates for equipment; however, the program is meeting its planned energy savings through lighting projects. The program achieved 101% of its planned energy savings in PY6, so the limited marketing and pre-application process have been successful in helping PPL Electric reach its planned savings while avoiding oversubscription.

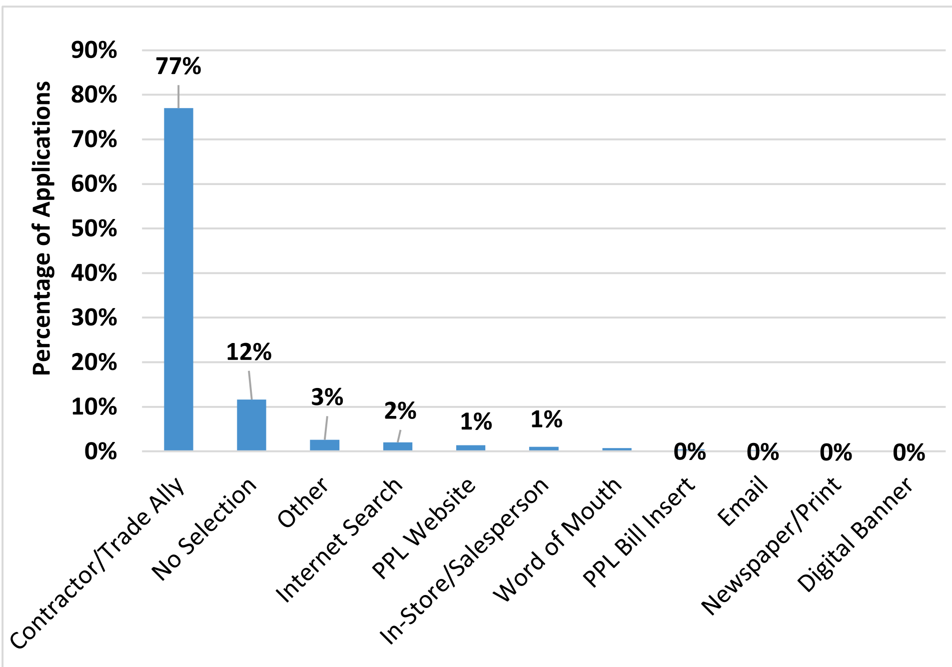
During PY6, the ICSP conducted outreach events that targeted customers and contractors. Additionally, the ICSP sent a newsletter to contractors about PPL Electric Utilities' programs, conducted webinars for new contractors participating in the program, and sponsored and hosted some events for contractors. In addition, the ICSP updated the program's website during PY6 and used Twitter to market to agricultural customers.

ICSP staff said marketing efforts would likely increase in PY7 to promote equipment. As discussed later in this report, equipment contractors reported the need for additional program information about available rebates.

2.4.8.2 Program Awareness

PPL Electric collects data on the rebate application form that indicates how participants learned about the program. These data are recorded in EEMIS. According to these data, 79% of program participants heard about the program from their contractor (Figure 2-5). This an encouraging sign because it demonstrates a high level of contractor involvement in the program and shows that the contractor network is functioning well and generating participant awareness effectively with little to no cost to the program. (The vast majority of participants received lighting incentives, so the results cannot be generalized beyond lighting). Other marketing channels that customers used included the program website and Internet searches.

Figure 2-5: How did you learn about the program?



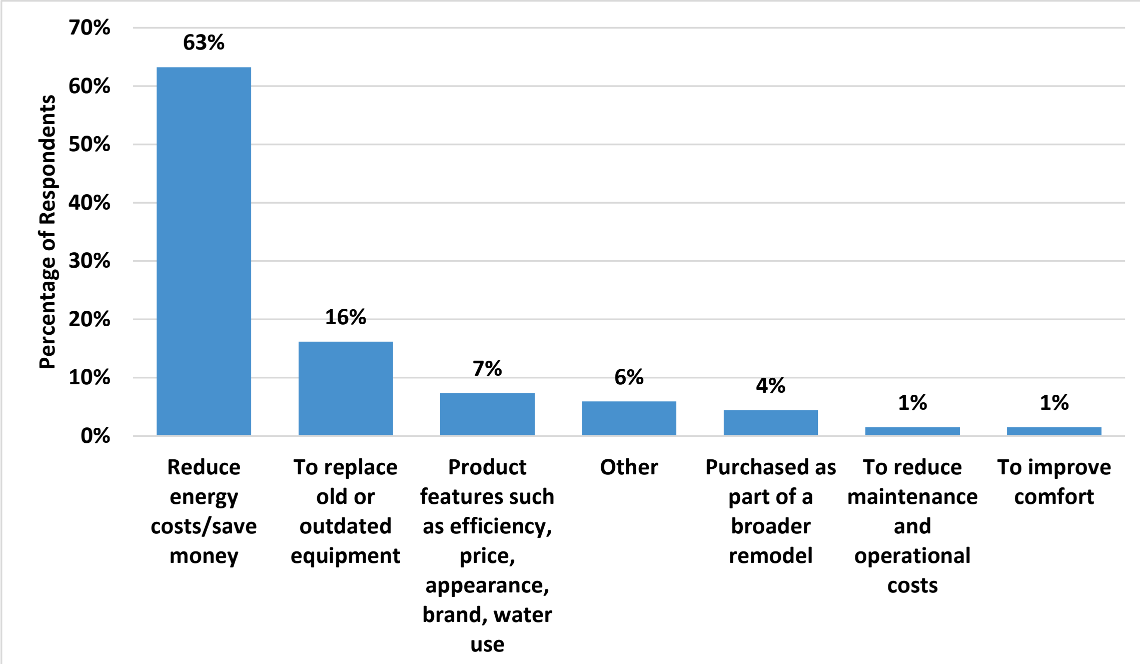
Source: From Application "How did you learn about the ICSPs rebates?" (n=1884; lighting participants only).

To gauge awareness of PPL Electric Utilities' incentives and rebates, Cadmus asked participants if they were aware of any other rebates aside from the Prescriptive Equipment Program. Thirteen participants (22%, or 13 out of 60) were aware of other PPL Electric Utilities incentives.

2.4.8.3 Knowledge About Ways to Save Energy

When asked about their attitudes and perceptions toward making energy-efficient purchases through the Prescriptive Equipment Program, most respondents reported they pursued lighting upgrades to reduce energy costs (63%; n=60). Figure 2-6 identifies respondents' motivation for participating in the program.

Figure 2-6: Motivations for Program Participation



Source: Question F1 "What were the major reasons your organization purchased the lighting equipment? " Lighting respondent (n=60) Not applicable, don't know and refused responses removed. Multiple responses allowed. May not add to 100% because of rounding.

Cadmus also asked lighting participants if they agreed or disagreed with statements about energy efficiency. Their responses are provided in Table 2-29.

- Seventy-six percent disagreed with the statement that *making efficiency improvements is an inconvenience* (45 respondents, n=59). There is almost no difference in the percentage of participants who lease their facility (78%; 7 of 9) and those who own their facility (76%; 38 out of 50). However, 19% agreed *it was too much of an inconvenience at their facility*. This is generally a concern for businesses that need the lighting kept on for longer periods for normal business operations (e.g., retail spaces where products need to be displayed for customers). The percentage of participants who agreed with this statement is almost the same for those who lease their facility (22%; 2 of 9) compared to the percentage of participants who own their facility (18%; 9 of 50).
- Although reducing costs is a strong motivator for making efficiency improvements, 45% of participants (26, n=58) agreed that *upgrades at their facility is cost-prohibitive*; slightly more participants disagreed (50%, or 29 participants, n=58). Forty-four percent of participants (4 of 9) who leased their facilities agreed with this statement while 45% of participants (22 of 49) who own their facilities agreed with this statement.
- Half the participants (50% or 28 participants, n=57) said they often *did not replace equipment with more efficient options if the existing equipment was still working*. This was true for 75% of participants who lease their facility (6 of 8) while only 46% of participants who own their facility agreed with this statement (22 of 48).
- Additionally, 62% of the participants (33, n=53) believed they *had significant input about the equipment at their facility* (disagreeing with the statement that they did not have much input about equipment installed at their facility). Sixty-nine percent of participants who own their facility (31 of

45) disagreed with this statement while only 25% of participants who lease their facility disagreed (2 of 8). This indicates that the program has been successful in reaching the decision-maker when asking about equipment purchases.

- Asked if they had made all the efficiency improvements that were possible without substantial investment, 63% (36 respondents, n=57) agreed they *had made all the investments they could without substantial investment*. Eighty-nine percent of participants who lease their facility (8 of 9) agreed with this statement while 58% of participants who own their facility (28 of 48) agreed.

Table 2-29: Attitudes toward Energy Efficiency

Satisfaction Level	Making upgrades at our facility is too much of an inconvenience (n=59)	Making energy efficiency upgrades to this facility is cost-prohibitive. (n=58)	We don't replace working equipment, even if it is not energy efficient. (n=57)	Decisions about equipment upgrades are made at the corporate level and we don't have much input at this facility. (n=53)	My company has made all the energy efficiency improvements we can without a substantial investment. (n=57)
Strongly agree	5%	16%	18%	9%	21%
Somewhat agree	14%	29%	32%	21%	42%
Neither agree nor disagree	5%	5%	9%	8%	4%
Somewhat disagree	29%	36%	26%	32%	23%
Strongly disagree	47%	14%	16%	30%	11%
Source: Question F15b- F15h "When purchasing new appliances or considering energy-efficient improvements, do you agree with…" lighting respondents (n=60). Not applicable, don't know and refused responses removed.					

2.4.9 Trade Ally Interviews and Focus Groups

2.4.9.1 Lighting Contractors

Satisfaction. Cadmus asked contractors about their satisfaction with PPL Electric Utilities. Fourteen of 15 contractors interviewed reported they have interacted with a PPL Electric Utilities representative, and all 14 said they were satisfied with their experience. Eight contractors said they were *very satisfied*, and six were *somewhat satisfied*. Contractors were asked if their opinion of PPL Electric Utilities had changed since they began working with the utility, and two contractors said their opinion had *improved significantly*, seven said their opinion had *improved somewhat*, five reported *no change,* and one reported *decreased slightly*. This contractor said, "*The rebate program was simple and easy to use, but it is difficult to get a hold of people at PPL who are knowledgeable*."

Market Barriers. Cadmus asked contractors about challenges related to selling and procuring energy-efficient lighting.

Selling. Contractors said cost was the main market barrier to selling energy-efficient equipment to customers, followed by customer awareness of the benefits of energy efficiency. These and other barriers are listed in Table 2-30.

Table 2-30: Barriers to Selling Energy-Efficient Lighting Equipment

Market Barrier	Number of Responses
Cost or return on investment	9
Awareness; education; understanding the benefits of EE	4
Finding time for the program (the audit and report)	1
Program pre-approval timelines	1
Lack of geothermal rebate for residential customers	-

When asked why customers chose not to purchase or install energy-efficient options, 14 contractors (n=15) said cost was the primary reason customers will not move forward with an energy-efficient lighting project. One lighting contractor said most of his customers "*try to hit a 2 to 3 year payback and they might not have the capital presently to invest in a lighting project*."

Buying. Fewer contractors noted challenges procuring energy-efficient equipment from manufacturers. Three said that LED product availability could be an issue, resulting in long lead times and delays. One said this used to be a larger issue but was improving:

> *"With the LED market, 5 years ago, it was difficult getting things in a timely manner. A lot of things were coming from China and took a while to get. But now, most things are manufactured in the U.S. and are easy to get."*
>
> Another contractor said a quarter of the firm's equipment is still imported. *"U.S. Customs [was an issue]. They can always be a challenge. About 25% of our equipment comes directly overseas to our warehouses; 75% from California."*

Suggestions for Overcoming Marketing Barriers and Improving the Program. Lighting contractors had these suggestions for PPL Electric Utilities:

- Increase rebate level (4 responses).
  - *"[Increase the rebates] specifically for LED fixtures, because the price point is still a sticking point for customers."*
  - Assist with advertising/promotion (3 responses).
- Improve approval turn-around times (3 responses).
  - *"Effective 6/1 this year, their turnaround time has been subpar (they've always been very good in the past)… since 6/1, the LED mapping really slows down how quickly we can get back to our customers. Anything we can do to speed things up as quick as possible is always in the best interest of the customer. When we have to tell a customer to wait a week or two weeks and delay the process, that's not always the best thing."*
- Expand program offerings, focus on next "tier" (2 responses).
  - *"Offer rebates for some of the newer LED fixtures that are available (high bays, office lighting, stairwell lighting), some of the other utilities offer these."*

- Increase communication with contractors about incentives (2 responses).
  - *“Let me know what’s on the market so I can inform my customers about it. If I give my customers an informed response to their questions, if PPL gives me the knowledge, and if PPL were more involved with their contractors, I would be able to sell more. I can’t remember the last time I got anything from PPL.”*
- Change direct discount limits (1 response).
  - *“They need to increase the kW [limit] for Direct Discount, which would increase the number of customers that qualify.”*
- Add on-bill financing options (1 response).

2.4.9.2 HVAC Contractor and Distributors

Experience with High-Efficiency Equipment. To explore contractor experience with high-efficiency equipment, Cadmus asked focus group respondents and distributor interviewees what proportion of their commercial HVAC sales and installations were for high-efficiency equipment. Most said their commercial HVAC sales were not in high-efficiency equipment. The majority estimated that between 10% and 30% of their commercial HVAC sales and installations were high-efficiency. Similar to the HVAC contractors, most of the distributors’ HVAC sales were not in high-efficiency equipment. Two of the four distributors said only 10% to 15% of their sales were in high-efficiency equipment.

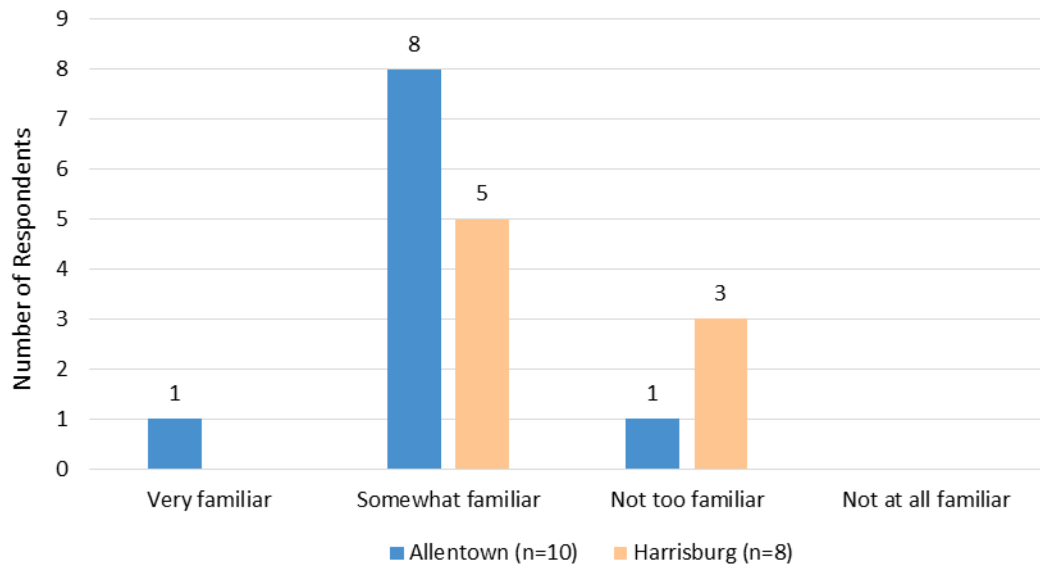
Customer Familiarity with High-Efficiency Equipment. Cadmus asked all focus group respondents to rate their perceptions of their customers’ familiarity with high-efficiency HVAC equipment. As Figure 2-7 shows, the majority said their customers were *somewhat familiar* with high-efficiency HVAC equipment. When asked to elaborate, respondents said a small proportion of their customers—one Allentown respondent estimated about 30%—were motivated to install energy-efficient options and were knowledgeable about high-efficiency equipment. However, their remaining customer base was primarily concerned about upfront costs and did not have the time or motivation to investigate high-efficiency options. They said their average customer was not familiar with high-efficiency equipment.

Similarly, most contractors said their customers rarely asked them about financial incentives and were more focused on the availability of and immediate need for equipment. These respondents believed most customers only thought about their HVAC equipment when it failed and needed replacement, and they were not searching for rebate opportunities.

Barriers to Selling High-Efficiency HVAC Equipment. Focus group respondents identified four major challenges in encouraging their customers to choose high-efficiency HVAC equipment options—upfront costs, bidding and competition, split incentives, and product availability.

Upfront Costs. Respondents in both focus groups agreed that upfront cost was one of the greatest barriers they faced in encouraging their commercial customers to upgrade to high-efficiency equipment. They explained that their commercial customers are constrained by the organizations’ capital budgets and often attracted to the lower price of standard efficiency equipment; these customers are not as motivated by the potential energy savings associated with higher-efficiency options.

Figure 2-7: Contractor Perceptions of Customer Familiarity of High-Efficiency Equipment



Source: Focus Group Pre-Group Activity Q4. "In your opinion, how familiar are your commercial customers with high-efficiency HVAC equipment options?"

Even when customers were aware of and interested in higher efficiency, respondents believed these incremental costs were prohibitive to most of their customers. As one Harrisburg respondent said:

> *"Everyone wants the Cadillac but then when they sign on the dotted line they drive off in a Chevy. They want to see the cost of the high-efficiency unit, but then they end up buying the bottom line or mid-range unit."*

Similar to the focus group respondents, when asked what their commercial customers are most interested in when making a purchase, all four distributors interviewed cited price as a primary interest for customers.

Bidding and Competition. Respondents also explained that competition with other contractors created a challenge for promoting high-efficiency equipment to their customers. Their customers often solicit bids from multiple contractors and typically choose the lowest. Respondents felt pressured to offer their customers the lowest-cost options to try to win the job. As a result, some respondents said they completely refrained from bidding high-efficiency equipment. As one Allentown respondent said: *"When we try to go high efficiency, we get out-bid every time. So, we don't even bother anymore."*

Split Incentives. Most respondents also found split incentives were a significant barrier—commercial building owners and building tenants are different entities with different interests. Usually building owners have the authority and responsibility to make capital improvements but lack any motivation to invest in upgrades that would more directly benefit the tenant (such as utility cost savings, facility comfort level). Respondents had difficulty motivating these building owners to invest in high-efficiency upgrades. Some said that instead of recommending their typical "good, better, best" equipment, they refrained completely from recommending high-efficiency HVAC equipment because past experience showed that building owners commonly opt for the lowest-cost options.

Product Availability. Allentown and Harrisburg focus group respondents (contractors) differed on their views regarding access to, and availability of, high-efficiency equipment options. Allentown respondents found it difficult to find high-efficiency HVAC equipment in stock at their distributors. They said some smaller units (three tons or less) were usually readily available, but they needed to place a special order with the manufacturer for larger units or units with custom features. They estimated it could take four to eight weeks for this equipment to arrive. However, their customers were often replacing equipment out of necessity and needed their equipment installed immediately. These respondents said customers were not willing to, and often could not afford, to wait months for equipment installation.

In contrast, Harrisburg respondents said that high-efficiency HVAC equipment was readily available through their distributors. They said a few of their local distributors even offered meetings and classes to discuss high-efficiency equipment such as electronically commutated motors (ECMs) and ductless mini-split heat pumps and they had taken advantage of these training opportunities.

In interviews with distributors to further explore availability high-efficiency equipment options from distributors and manufacturers, Cadmus asked about access to and availability of high-efficiency equipment. Similar to the contractors in the focus groups, distributors offered no consensus regarding access to and availability of high-efficiency equipment.

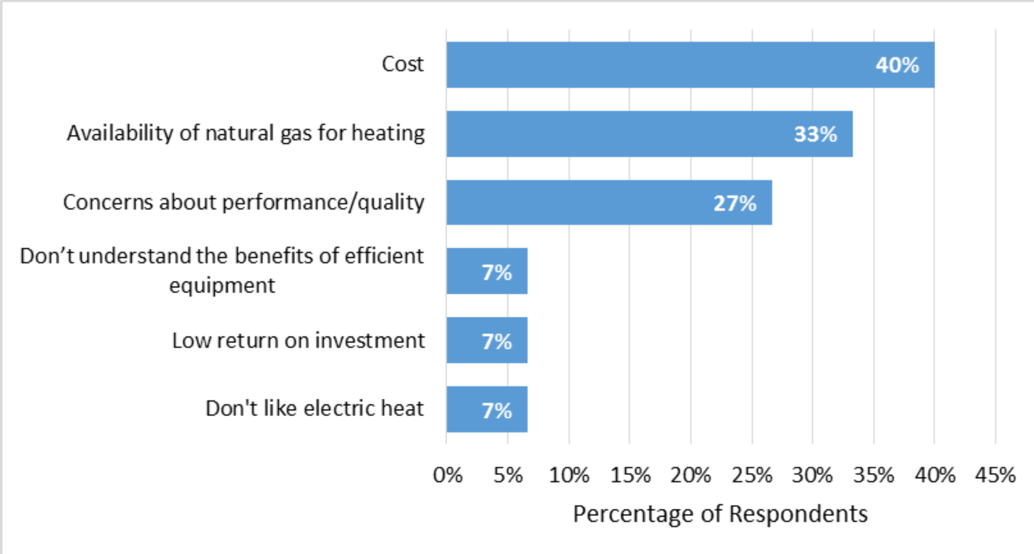
- Three out of the four distributors estimated that after placing orders with manufacturers, they might receive their equipment within five days to several weeks, and they said this did not differ between standard and high-efficiency equipment.
- The fourth distributor, however, believed the timeline did differ for standard and high-efficiency equipment, estimating that standard equipment would be delivered within three to four weeks but high-efficiency equipment would take six to eight weeks for delivery. When asked whether they experienced any challenges in obtaining high-efficiency equipment from manufacturers, the same distributor explained that the longer lead times for high-efficiency equipment was a challenge, since the manufacturers he worked with typically did not have high-efficiency equipment in stock and high-efficiency equipment was put into production at the time of order.

Barriers for Customers Purchasing High-Efficiency Heat Pumps. During in-depth interviews with HVAC contractors in September 2014, contractors most commonly said cost was a barrier to purchasing heat pumps, but they cited other challenges much more frequently than lighting contractors did.

- One contractor said that for his customers *"if natural gas is available, heat pumps are not cost-effective."*
- Another said, *"Customers are sometimes still misinformed on the performance and comfort level of modern heat pumps."*

Figure 2-8 shows the reasons that contractors said customers did not purchase a high-efficiency heat pump.

Figure 2-8: Reasons Customers Do Not Purchase a High-Efficiency Heat Pump



Source: Question C7. "If a customer chooses not to purchase a heat pump, what are the typical reasons?" Percentages may add up to more than 100% due to multiple mentions.

Awareness of PPL Electric Utilities Programs. Cadmus asked focus group respondents if they were aware of PPL Electric Utilities' commercial HVAC rebates and, of those who were aware, what experience they had had. Respondents expressed limited awareness of PPL Electric Utilities' commercial HVAC rebate offerings, and most had no prior experience working with customers through the program. Although several respondents in both focus groups were familiar with PPL Electric Utilities' HVAC offerings for residential customers, most were unfamiliar or lacked experience with the commercial HVAC offerings. Similarly, a few respondents said they had completed PPL Electric Utilities' residential rebate paperwork for their customers but had no experience with paperwork for commercial rebates.

Perceived Effectiveness of PPL Electric Utilities Rebates. Cadmus gave the groups a list of PPL Electric Utilities' current commercial HVAC rebates and asked if they thought these rebate amounts would be effective in encouraging commercial customers to purchase and install high-efficiency equipment.

Respondents in the Allentown group differed from the Harrisburg group on their perceptions of the effectiveness of current rebate levels. Allentown respondents believed that the incentives for smaller heat pump systems (less than 5.4 tons) could be effective for encouraging customers to upgrade to higher-efficiency equipment. One respondent commented about ductless mini-split heat pumps:

> *"When you're talking about commercial application and small ton and using residential grade equipment, that's where you're going to find most of your [interest in] higher efficiency."*

For the larger systems, however, the Allentown respondents believed the incentives were not sufficient and needed to be higher to encourage customers to upgrade to high-efficiency equipment. Several respondents agreed that the rebates needed to cover at least half the incremental cost for upgrading from standard to high-efficiency equipment.

In contrast to Allentown respondents, Harrisburg focus group respondents thought the rebates, regardless of equipment size, were insufficient to encourage customers to choose equipment of a higher efficiency.

Respondents in both groups liked that PPL Electric Utilities offered incentives for larger equipment on a per-ton (as opposed to per-unit) basis, and they wanted PPL Electric Utilities to continue doing so.

Perceived Effectiveness of Limited-Time Offers. After focus group respondents discussed PPL Electric Utilities' standard 2015 rebate offerings, we informed them that the utility was offering a limited-time rebate increase on heat pumps from April 1, 2015, through July 1, 2015. Specifically, we emphasized the rebate for air-source heat pumps less than 5.4 tons, which was increased from $200 to $1,200 per unit for systems with a cooling efficiency of 16 SEER or higher.

Earlier in the discussion, one respondent in each group mentioned this rebate increase unprompted. However, both respondents were more familiar with the equivalent offering for residential customers. Although the Allentown respondent received proactive communication from program staff about the residential offering, he was surprised to later discover the same rebate existed for commercial customers. The Harrisburg respondent discovered that this opportunity was available for commercial customers during the focus group discussion.

In both groups, respondents agreed that $1,200 was an appropriate increase and believed it was likely to boost demand for this equipment type. However, several respondents doubted that limited-time promotions in general were effective in increasing customer demand. Instead, they believed that equipment failure was the primary driver and, therefore, customers were unlikely to upgrade solely on the availability of rebates. Although the higher rebate might convince a customer already in need of replacement to purchase a more efficient unit, it would not raise demand from customers not in immediate need. As one Harrisburg respondent noted:

> *"It's only lucky that their equipment failed during that limited time."*

Respondents also expressed concerns about the shortened timelines necessitated by the limited-time offerings. They believed these promotions did not provide sufficient time to inform contractors and allow them to promote the program and complete installation and paperwork for their customers. They were apprehensive that, after learning about the enhanced rebate, customers might still miss the opportunity and then be dissatisfied with the contractor. One Allentown respondent commented:

> *"The only thing worse than no rebate is [making a decision based] on a rebate that then can't be collected."*

Potential Program Improvements. To explore potential program improvements, Cadmus asked respondents about their interest in two hypothetical program offerings: a direct discount program (a model that involves paying the rebate to the contractor, enabling the customer to receive an immediate discount), and, for Harrisburg respondents, a midstream or upstream incentive offering. We also asked respondents to identify additional support they would like from PPL Electric Utilities.

Direct Discount Program. Respondents offered no consensus about their interest in participating in a direct discount program. Some respondents in both focus groups were open to this type of design, but others were skeptical about burdening contractors with additional risk. Respondents in both groups were concerned that if their rebate paperwork was flawed or ineligible, they would lose money, having already provided the discount to customers. One Harrisburg respondent stated:

> *"Now you are asking the contractor to be the bank. What if you don't end up getting the rebate money? The profit margins on these jobs is not high enough to cover that type of loss."*

Respondents also wanted to know how long it would take for PPL Electric Utilities to process their rebate check. A Harrisburg respondent stated that after submitting the rebate application, his company could not afford to wait more than four weeks to receive payment.

Respondents also found rebate applications, in general, cumbersome and time-consuming. Several respondents did not want to be responsible for completing this paperwork for their customers. Others believed it was the responsibility of the contractors to complete paperwork for customers, though they still found rebate applications burdensome.

Midstream and Upstream Incentive Offering. Because the Allentown focus group expressed concerns about direct discounts, Cadmus tested the Harrisburg respondents' reactions to a midstream or upstream incentive, where distributors (midstream) or manufacturers (upstream) receive the rebate and pass the savings directly to the contractor. These Harrisburg respondents were skeptical of midstream and upstream incentives. Some doubted they would receive the discount, believing there was a risk that the distributor or manufacturer could keep the incentive instead of passing it on to the contractors. They were also concerned that even if they received the discount, the distributor or manufacturer might wait to reimburse the contractor until *after* receiving payment from PPL Electric Utilities instead of offering the direct discount to the contractor at the time of purchase.

To further explore the potential for PPL Electric Utilities to offer midstream incentives, Cadmus asked distributors if they were aware of similar midstream incentive programs and if they would be interested in participating. None of the four distributors had heard of or were familiar with this type of incentive program, but all expressed some interest in participating.

Two distributors explained that offering this type of incentive could make it easier for their businesses to sell and stock energy-efficient equipment. One said that having the distributor offer the rebate would allow them to integrate PPL Electric Utilities' offering with other rebates and discounts, such as manufacturers' rebates, they already provide to their customers. Another distributor said his company would probably be interested, but only if the rebate was high enough. For example, he estimated that a rebate of between $300 and $1,000 for high-efficiency rooftop units could help sales and be worthwhile for his company to participate in a midstream program.

Although all four distributors indicated some level of interest, two said participating in the program would ultimately be the decision of their company's upper management, which would need to weigh the benefit of the rebates versus the cost of hiring or assigning an employee to process and complete the rebate paperwork in house.

Additional PPL Electric Utilities Support. In addition to offering higher rebates, contractors requested additional support and communication from PPL Electric Utilities. As one respondent explained:

> *"PPL Electric's best advocate, without a doubt, is the sales person. The sales person can make it or break it. If you're taking care of the sales person, believe me, they'll take care of you."*

He wanted PPL Electric Utilities' to support contractors by offering rebates, advertising directly to customers, and providing contractor bonuses. Respondents in both focus groups suggested similar support.

- **Communication.** Focus group respondents requested additional communication for both contractors and customers. Contractor respondents wanted clear, concise, and up-to-date information about rebate offerings. A few appreciated the table that listed rebate levels (provided during the discussion).

However, they offered no consensus on the most appropriate ways to disseminate this information; rather, they requested a range of options to accommodate diverse contractor preferences, such as:

- Contractor-specific website or e-mail communications
- Program updates through e-mail, a phone app, or a call center
- Information directly from PPL Electric Utilities (meetings at their place of business)
- In both groups, some respondents wanted PPL Electric Utilities to market and advertise programs more directly to customers. Although some believed contractors are the drivers of sales, they also thought selling higher-efficiency equipment would be easier if customers were already aware of and could request rebate and equipment options. A few said their residential customers are frequently aware of and request high-efficiency equipment, but their commercial customers rarely do so.

- **Contractor Bonus.** Another suggestion from the Harrisburg focus group was to provide a sales bonus or SPIF (sales performance incentive fund) directly to contractors when their customers upgrade to higher-efficiency equipment. Most agreed that $50 to $100 would be an appropriate incentive to help offset the time to research rebate opportunities and complete paperwork for customers.
- **Simplified Paperwork.** Although most respondents were not familiar with PPL Electric Utilities' commercial HVAC paperwork, they stressed the general importance of simplified application forms and paperwork. Several believed it was the responsibility of the contractors to complete paperwork for customers, whether for equipment warranties or rebates. As one Harrisburg respondent noted:

  "If the customer had to fill out the paperwork they would never buy high efficiency."

  However, respondents found that completing paperwork (for which they were not generally compensated) could be burdensome for them and their staff, and they wanted rebate paperwork to be as simple as possible. One Harrisburg respondent noted that PPL Electric Utilities' residential rebate application forms were a good example of the simple applications that were easy for contractors to complete.

- **Multiple Options for Accessing and Submitting Paperwork.** Respondents also wanted options for accessing and submitting paperwork, such as electronic submission or allowing contractors to download and print forms from the website. Some respondents noted that an electronic submittal portal would be useful but would need to be designed to allow contractors to save work and come back later to finish (they often need to look up information to complete the rebate form).

2.4.9.3 Refrigeration Contractors

Contractor Awareness of PPL Electric's Rebates and Programs. At the time of the interview calls (in September 2015), PPL Electric had already implemented a waitlist for prescriptive equipment rebates and therefore was not currently offering refrigeration rebates. Interview questions were worded accordingly. (The waitlist was implemented in May 2015.)

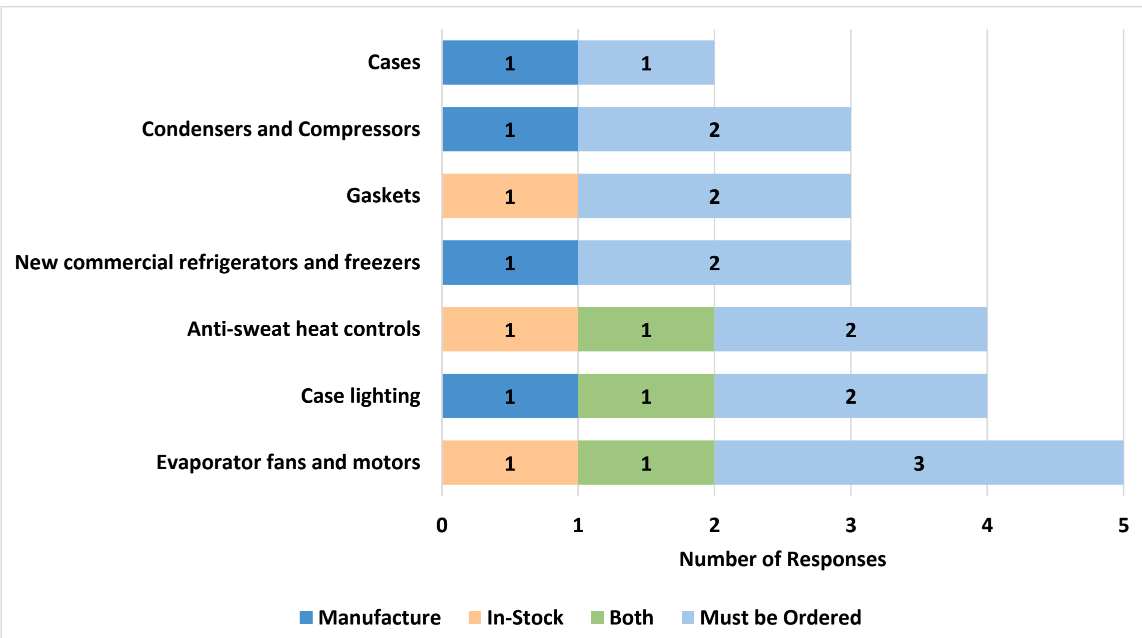
- Two of the seven respondents said they were aware refrigeration rebates were not currently offered because of the waitlist.
- Six respondents were aware that PPL Electric Utilities offered rebates for certain types of energy-efficient equipment. These respondents were then asked how they learned about the rebates, and also, if they knew about the direct discount delivery channel for small businesses available for refrigeration contractors.

- Half of the six respondents found out about PPL Electric Utilities' rebate program from someone in their company, and the other half knew about the program from industry experience.
- Five of the six were also aware of the direct discount delivery channel.

Stocking Practices. To evaluate stocking and shipment patterns for energy-efficient refrigeration equipment, Cadmus asked contractors how they procure the equipment they sell or install. Overall, there were seven different types of energy-efficient refrigeration equipment sold or installed by the contractors. (This question was not asked of one respondent who only conducted audits because it was not relevant.) The responses varied and there was no clear pattern as shown in Figure 2-9.

- One respondent manufactured the majority of the equipment and ordered the rest.
- Three respondents had to order all types of equipment that they sold or installed.
- One carried everything in stock.
- One replied all equipment types were in stock but placed orders if necessary for individual projects.

Figure 2-9: Stocking and Ordering Practices by Equipment Type

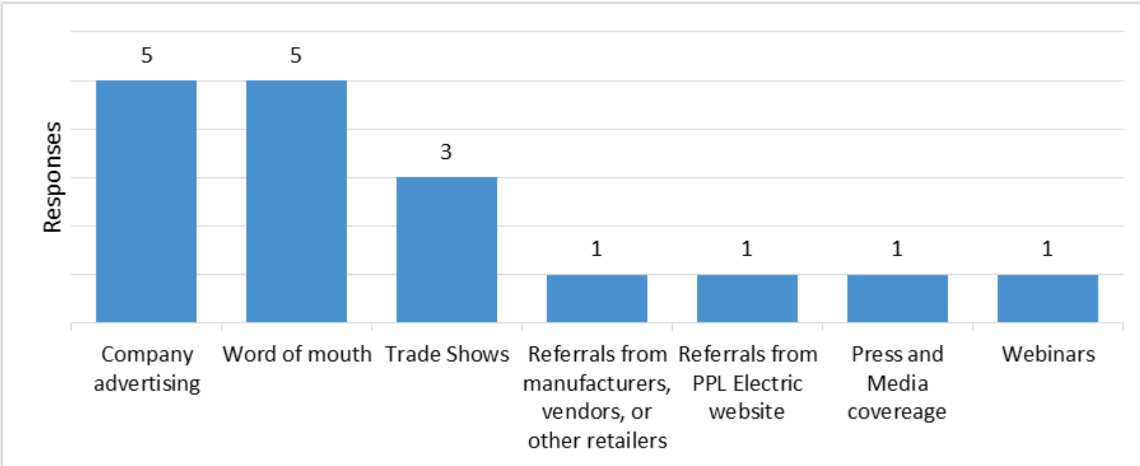


Source: Question B11. "Do you carry energy efficiency equipment in stock, or is this something you order from the manufacturer when the customer orders it? I'll ask you for each type of equipment I'm interested in."

2.4.9.4 Marketing Materials and Customer Promotion

Cadmus asked the seven respondents how they market their services. The two most common marketing techniques were word of mouth (5 of 7) and company advertising (5 of 7), such as company websites, direct mail, or cold calling. Trade shows (3 of 7) were also mentioned. Figure 2-10 shows the number of respondents who mentioned various forms of marketing and outreach.

Figure 2-10: Contractor Marketing



Source: Question B1. How do customers usually learn about your company? (n=7) NOTE: Multiple responses were possible.

The refrigeration contractors were also asked if they used any of PPL Electric Utilities' marketing materials when the rebates for refrigeration equipment were still offered. Six of seven said they did not use the materials. When asked why they did not, they said the materials were unnecessary—the refrigeration projects are too custom for overview materials, program requirements change, and they hesitate to endorse rebates because the program has run out of money in the past.

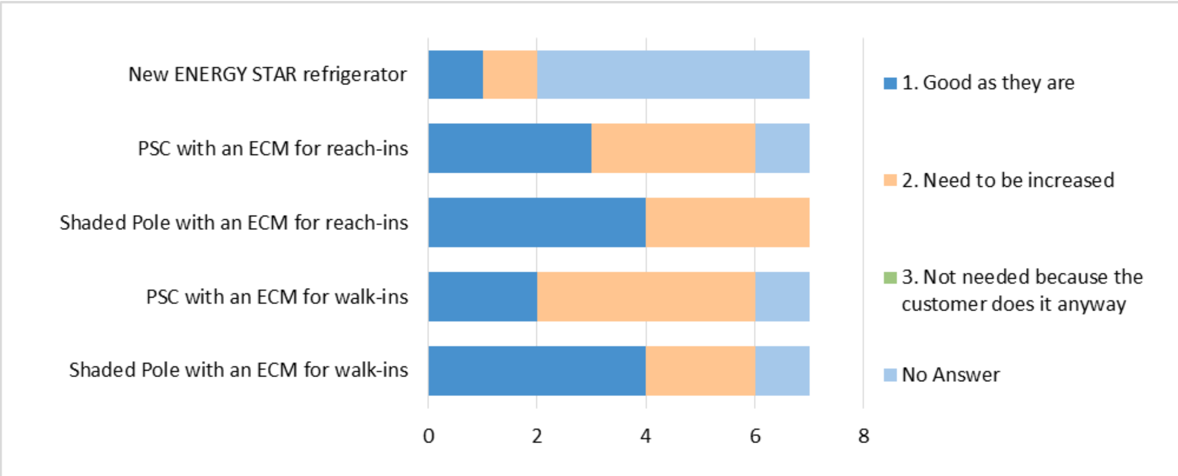
Customer Motivation and Awareness. Cadmus asked contractors what motivated their customers to purchase energy-efficient refrigeration equipment. Four respondents said the most important factor from the customer's perspective was price or return on investment. Two others cited energy efficiency as the primary factor, and one said a combination of performance and energy efficiency.

Cadmus also asked how familiar contractors' customers are with energy-efficient refrigeration technologies. Three said their customers were generally not familiar, and four said they were.

Market Barriers. We asked the contractors about market barriers to selling and installing energy-efficient refrigeration technologies and what could be done to help mitigate barriers. Three respondents said the incremental cost to consumers was a barrier, and five said either increasing the rebates or bringing the rebates back could help.

Incentive Level and Importance. Cadmus asked about specific incentive amounts that had been offered through the Prescriptive Equipment Program in the past and whether contractors and distributors thought the incentives needed to be increased, were sufficient, or were needed at all. A slight majority of respondents believed all incentive amounts needed to be increased. None thought any of the rebates were not needed because the customer would make upgrades anyway. However, a fair number of respondents also thought that some incentive levels were sufficient, depending on the technology type. The results for each technology are shown in Figure 2-11.

Figure 2-11: Incentive Amounts



Source: Question D2. "I'd like to understand if you think the rebate levels were appropriate. Please tell me if you think PPL should either: Keep the rebates the same, raise them, or stop offering them because customers don't need them." (n=7)

Cadmus asked how influential the Prescriptive Equipment Program was in respondents' decision to sell and or stock energy-efficient equipment. (This question was not relevant for the contractor who performed audits.) Five of the six respondents said it was *very important,* and one said it was *not important at all*.

One respondent who answered *very important* said,

> *"[There is a big challenge] when there isn't a rebate to offset the cost to the customer… Most of our contractors are shifting their customers to other utilities this year."*

Other respondents who work nationally agreed—they said Pennsylvania sales were lagging behind compared to other regions that were still offering rebates.

2.4.10 Market Effects

To assess market effects for the Prescriptive Equipment Program, Cadmus used the definition given by Eto, Prahl, and Schlegel: Market effects are changes in the structure of a market or behavior of participants attributable to an energy efficiency incentive program.[20] Market effects can also provide evidence that a market barrier has been partially or fully mitigated. To investigate market effects, we asked lighting and HVAC contractors a series of questions about market conditions before and after the Prescriptive Equipment Program became available in 2009. Because we lacked baseline information from the pre-2009 market, we asked contractors to think back to prior years before rebates were available. If there was a change during this time, we asked contractors to consider if PPL Electric Utilities had had any influence on this change.

[20] Eto, Joseph, Prahl, Ralph, and Schlegel, Jeff. 1996. *A Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs.* Prepared for the California Demand-Side Management Committee.

We also asked if current conditions (i.e., sales, promotional practices, quantities of equipment stocked) would remain the same if the rebates were no longer available next year. This question provided another perspective on the influence of the program rebates, helping to determine if a particular barrier has been mitigated or was an indication of less need for future program intervention. We asked about these market indicators:

- Consumer attitudes toward energy efficiency
- Promotional practices surrounding energy-efficient equipment options
- Prices of equipment
- Sales of equipment
- Stocking practices
- Business services and offerings

Cadmus gathered a significant amount of data about nine types of energy-efficient lighting equipment and three heat pump technologies (air source heat pumps, ductless mini-split heat pumps, and ground source heat pumps). Table 2-31 presents a snapshot of the changes in the market reported by contractors, including if contractors identified the PPL Electric Utilities program as influencing that change and if the market conditions would remain the same in the absence of the program. These findings represent a simple majority. (More detail on the actual frequencies, metrics, and differences between technologies is contained in a memo that Cadmus submitted to PPL Electric in November of 2014, in Addendum C. Lighting and HVAC Contractor Interview Findings.)

Table 2-31: Summary of Market Effects Determined by a Majority of Contractors

Market Indicator	Was there a Change in the Market since 2009/in Past Five Years	Did PPL Electric Influence the Change[1]	Would Current Conditions Continue in Absence of Program
Lighting			
Consumer Attitudes	Yes	Yes	N/A[2]
Promotional Practices Surrounding EE	Yes	Yes	Yes
Prices	Yes	-	N/A[2]
Sales	Yes	Yes	No, sales would decrease
Stocking	Yes	-	Split: 3 of 7 contactors reported stocking would stay the same
Business services	-	-	Split: 3 of 6 contractors reported services would stay the same
Heat Pumps			
Consumer Attitudes	Yes	-	N/A[2]
Promotional Practices Surrounding Energy Efficiency	-	-	Yes
Prices	Yes	-	N/A[2]
Sales	Yes	-	Yes
Stocking	-	-	Yes
Business services	-	-	Yes

[1] As measured by an influence rating of 4 or higher on a scale of 1 through 5
[2] Contractors were not asked if prices and customer awareness would stay the same in the absence of the program because these market factors are outside of their control

Cadmus found that for lighting products, the commercial lighting market has changed significantly over the past five years since PPL Electric began offering rebates for high-efficiency lighting. Contractors reported that customers are more aware of energy efficiency, and they promote energy-efficient lighting options now more than they did before PPL Electric began offering rebates. Prices of most technologies have decreased over the past five years and sales have increased, along with quantities stocked.

Cadmus also found that the program is still influencing the market:

- By a slight majority (eight of 15), contractors reported that they would still promote energy efficiency to the same extent if PPL Electric stopped offering rebates next year. This was the *only* market indicator that about half the respondents agreed would stay the same in absence of the program. And although half would continue to promote energy efficiency, the other (slightly less than) half would not continue to promote energy efficiency to the same extent as they do now.
- Respondents reported sales of all efficient lighting technologies would likely decrease without the program, indicating that they perceive PPL Electric's financial incentive strongly influences the customer's decision. This perception is further supported by responses of the majority of contractors who estimated the rebate affects customer's decisions to move forward at least 80% of the time, and that cost remains a barrier for end users.

Responses from HVAC contractors indicate that PPL Electric's incentives for heat pumps have not influenced the market to the same extent the rebates for lighting have. In fact, in PY5, there were no rebates issued for commercial heat pumps, which contractors attributed to the low incentive level. Focus group findings confirmed a lack of awareness among contractors about the rebates. Although contractors reported an increase in sales since the availability of the rebate, they failed to attribute this increase to the PPL Electric programs (the average influence rating was 2.7 or lower on a scale of 1 through 5 with 5 meaning *extremely influential).*

To measure market change, Cadmus recommends continuing to investigate and track the following indicators: consumer attitudes, market actor promotional practices, prices, sales, and stocking practices to see how these factors change over time. When contractors and other market actors perceive energy-efficient equipment sales and their promotion of these products to be "standard practice," this will be a strong indication that the program has influenced the market permanently and rebates may not be necessary.

2.4.11 Database Review

The EEMIS program tracking records contained all of the data needed to conduct the impact evaluation. Cadmus did not uncover any significant errors or omissions. There were no *ex ante* adjustments.

2.4.11.1 Lighting Database Review Findings

Factors affecting lighting realization rates fall into one of two categories:

- Misapplication of TRM requirements
- Differences between product and project specifications and actual conditions

TRM requirements for data sources vary because of project change in connected load and anticipated energy savings. For example, projects with a change in connected load less than 20 kW use whole-building lighting hours, while all others use site-specific hours by usage group. Some projects mixed both whole-building and site-specific hours in a single application, an error that Cadmus corrected.

Most corrections were made to individual products within projects, e.g., fixture counts, fixture types, presence or absence of space cooling, building type, and associated lighting hours of use.

2.4.11.2 Equipment Database Review Findings

During the records review for equipment, Cadmus found that one high-efficiency refrigeration case was rebated but was entered into EEMIS as an ice machine. EEMIS did not provide any of the equipment specifications needed to calculate savings, such as door type and volume of refrigeration case. Upon reviewing the records, Cadmus looked up the equipment specifications for volume and door type and calculated savings using this information.

Another project was reported in EEMIS as six evaporator fans installed in coolers; however, the rebate form showed the project had installed three fans in coolers and three fans in freezers. Cadmus calculated savings based on this information.

2.5 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, Cadmus suggests PPL Electric consider the following recommendations in PY7 and in planning for Phase III.

Conclusion
Overall, the program is operating well. A strong network of lighting contractors has kept participation steady and the program is on track to meet its planned energy savings for Phase II within 5%.

Conclusion
The preapproval process has had some positive and negative impacts on the program. The preapproval process reduced freeridership in PY6, where freeridership was 28% and in PY5 the freeridership was 38%. This is because the process requires participants to obtain approval from PPL Electric Utilities before purchasing and installing the efficient equipment and thereby eliminates participants who find out about the rebate after installing the equipment.

However, satisfaction with some aspects of the rebate application process is lower than in previous program years. The percentage of respondents who were *very satisfied* with the amount of time it took to receive the rebate after submitting the application fell to 44% from 72% in PY5. Additionally, 48% of respondents reported receiving the rebate more than eight weeks after submitting the application. This change in satisfaction is likely due to the introduction of the preapplication process in PY6.

Recommendation
PPL Electric Utilities and the ICSP could improve participant satisfaction by providing more support in filling out the applications with examples of completed applications on the website and a point of contact available to answer questions about the application forms. The ICSP could look for ways to streamline the application review and process applications more quickly. Additionally, PPL Electric and the ICSP could consider incorporating a way for applicants to track the status of their application online.

Conclusion
Realization rates for energy savings and demand reduction for lighting projects are both high. The MWh/yr gross impact realization rate is close to 100% and has been consistently greater than 90% since PY3. These high rates indicate good adherence to TRM requirements as outlined by Cadmus in annual TRM lighting guidance memos prepared for the ICSP. Additionally, the MW reduction realization rate increased to 119% from its PY3-PY5 average of 93%. Although there is no demand reduction compliance plan, the ICSP may be able to make corrections to improve reporting accuracy.

Recommendation
The most common reasons for adjustments to reported energy savings are corrections to hours of use and space cooling status. Cadmus and PPL Electric's EM&V team will continue to provide guidance to the Prescriptive Equipment ICSP and quality assurance checks on completed projects regarding TRM requirements, particularly for hours of use and space cooling status. Likewise, the EM&V teams will provide quality assurance spot checks of ICSP Appendix C and E spread sheets to see if site-specific coincidence factors are used where required and inform the ICSP of any discrepancies that are uncovered.

Conclusion
A large number of Appendix C and E fixture codes are some form of "Custom cut sheet" and therefore indeterminate. As part of the review for the PY6 gross impact evaluation, and from a more comprehensive file review conducted in PY5, the majority of "Custom" fixtures were LEDs. The generic "Custom cut sheet" entry in Appendix C and E presents difficulties when measuring and comparing the impact of groups of fixture types such as linear fluorescent vs. LED and in assigning the fixture costs needed for the cost-effectiveness analysis.

Recommendation
Consider requiring the ICSP to use the 2016 TRM LED fixture code generator for all LED fixtures in PY7. Although this will be required in Phase III, it will be very helpful to start using this in PY7 and improve the reporting and evaluation activities.

Conclusion
The commercial lighting market has changed significantly over the past five years since PPL Electric Utilities began offering rebates for high-efficiency lighting. Contractors reported that customers are more aware of energy efficiency, and they promote energy-efficient lighting options now more than they did before PPL Electric Utilities began offering rebates. Prices of most technologies have decreased over the past five years, and sales have increased along with quantities stocked.

According to contractor feedback, there is evidence that changes in consumer attitudes, increased focus on energy efficiency as part of contractor promotional strategies, and the boost in sales of energy-efficient technologies can be attributed to the Prescriptive Equipment Program. These conclusions are not surprising. The important question from a program design standpoint is whether market barriers have been mitigated to the point where program intervention is no longer necessary. This research found little indication that this is the case.

Recommendation
Findings do not suggest that the market is transformed nor that there is support for phasing out incentives for any technology in PPL Electric Utilities' portfolio of lighting offerings; however, findings do provide a good starting point to monitor the market. For example, a third of contractors suggested that sales of T5s, T8 high bay lighting, LED screw-ins, LED exit signs, and occupancy sensors would remain the same in the absence of the program. We suggest continuing to stay in touch with contractors about these technologies as the market matures and prices continue to drop. Events such as focus groups, contractor and distributor breakfasts, and lighting forums are a good opportunity to collect anecdotal information and monitor the trends in the market.

To maintain strong contractor and customer satisfaction, and to continue to push the energy-efficient lighting market, we suggest exploring new incentives for LEDs as linear fluorescent replacements. This was suggested by one contractor who noted that his business was moving heavily in this direction. Recent studies conducted by Cadmus in other jurisdictions also suggest that this technology, although expensive, has improved significantly in recent years and is becoming a more viable linear fluorescent retrofit option.

Conclusion
Participation rates for equipment, including HVAC equipment, has been lower than expected. Contractors are aware of, and knowledgeable about, high-efficiency HVAC equipment. However, they said installing such equipment is not standard practice for their commercial customers. Both contractors and distributors estimated that one-third or fewer of their commercial HVAC equipment sales and installations were high-efficiency. Moreover, contractors believed the majority of their customers were not familiar with high-efficiency equipment and not motivated to investigate (or invest in) these options; therefore, there was opportunity for PPL Electric Utilities and the ICSP to influence change.

Responses from HVAC contractors indicated that PPL Electric Utilities' commercial HVAC rebate program is not sufficiently engaging contractors. Although some respondents were familiar with the residential HVAC offerings, most were unaware of the commercial incentives and had not worked with customers through the Prescriptive Equipment Program. Increased support from PPL Electric Utilities and the ICSP is probably necessary to increase contractor engagement with PPL Electric Utilities' commercial HVAC rebates. Although contractors discussed several core barriers to installing high-efficiency equipment in the commercial sector, low awareness and lack of familiarity with the available incentives simply means that contractors are not recommending the program to customers. This is one hurdle that can be overcome to help improve participation.

Recommendation
As the Prescriptive Equipment program relies heavily on contractors to drive participation, consider strategies for providing more contractor support to improve awareness of the program and available rebates. Because the program is already on track to meet savings in Phase II and is concerned about oversubscription, PPL Electric and their ICSP may want to consider these strategies for launching the program in Phase III.

Create a contractor-specific communications plan. The ICSP already collects contractor e-mail addresses, and many HVAC specialists who are active in the Residential Home Comfort Program also work with the commercial sector.

- Create a database of HVAC contractor e-mail addresses and periodically send them specific commercial program information, such as announcements of product offerings and incentive levels in PY7. We do not recommend including this solely in a contractor newsletter as general information for all trades; instead, consider making this a more trades-targeted communication.
- Consider making periodic phone calls to check in with contractors and offer technical details or advice about the program; a reasonable frequency of communications is one to two times per quarter.
- Also explore ways that the network could accommodate the variety of contractors' communication preferences, such as offering program information through e-mail, a mobile app, and/or phone calls from program representative.
- Provide contractors with contact information for PPL Electric Utilities commercial program manager and/or the ICSP HVAC point persons (e.g., e-mail address, call center number) so they can raise questions or concerns about the program directly with a knowledgeable program representative.

Consider webinars, training, and/or information offers through existing channels. In the PY5 process evaluation, Cadmus recommended hosting more training for equipment contractors. During the Harrisburg focus group, contractors said they engaged in and appreciated the equipment-specific technical training presented by distributors. Respondents from both focus groups did not believe PPL Electric Utilities could offer relevant sales strategies because commercial applications are unique to each customer. Therefore, we suggest that PPL Electric Utilities offer training or coordinate with the training and trade shows that contractors currently attend, such as the training and buying shows that distributors already promote to their buyers. Example topics are information about PPL Electric Utilities' equipment rebates, updates about new features or offerings, case studies, and program eligibility guidelines and requirements (including paperwork).

Explore a bonus or SPIF for contractors to reward them for promoting PPL Electric Utilities' programs and selling high-efficiency equipment and to help offset the time they spend completing rebate paperwork for customers. Contractors reported that a bonus in the range of $50 to $100 per rebate application would influence them to promote rebates.

Consider preparing educational materials for customers about heat pumps. High efficiency heat pumps are a relatively new technology with misconceptions about their performance. PPL Electric Utilities could consider developing educational materials for customers and improve the dissemination of these materials through HVAC contractors. Just one contractor said he used PPL Electric Utilities materials; most contractors seemed unaware of the opportunity to work with the utility. Strengthening the PPL Electric Utilities network of educated contractors, who are prepared with the tools and knowledge to promote high efficiency heat pumps, will increase overall market awareness. In the focus groups, several respondents suggested it would be easier for them to sell high-efficiency equipment if customers were already aware of rebate offerings.

Conclusion

Widespread contractor interest in a direct discount program for equipment is not likely. Although some respondents were open to this type of design, others were skeptical because of the burden of additional risk. That is, there is risk that PPL Electric Utilities will not reimburse the contractors (pay the rebate) after contractors discount the price of equipment sold to customers; not paying the expected rebates could occur for any number of reasons, such as incomplete paperwork, untimely paperwork, or discounting ineligible equipment.

Several respondents found rebate applications too time-consuming and did not want responsibility for additional paperwork. Offering a direct discount program would require greater contractor engagement and responsibility to work with the program.

Midstream (incentive paid to the distributor) and/or upstream (incentive paid to the manufacturer) programs could address some of the barriers contractors face in selling high-efficiency equipment and working with PPL Electric Utilities' rebate programs. These types of programs shift the burden of completing paperwork away from the contractor (and customer), reduce uncertainty for both parties, and provide an immediate price reduction to the cost-conscious customer. However, respondents were skeptical of midstream and upstream incentives because they only work if the distributor or manufacturer passes along their price offset to the contractor and, subsequently, the contractor passes it to the customer. Although these incentive programs are typically designed so that contractors and/or customers receive the discount at the time of purchase, respondents expressed concerns that manufacturers and distributors would not pass on the discount. If PPL Electric Utilities offers this type of program, additional support, education, and assurances are likely necessary to ensure contractor buy-in.

All four distributors Cadmus interviewed expressed some interest in participating in a midstream incentive program. This type of program could help them sell and stock high-efficiency equipment and is an opportunity for distributors to integrate PPL Electric Utilities incentives with other rebates and discounts, such as manufacturers' rebates, that these distributors already offer to their customers. None of the distributors had previously heard of or were familiar with this type of incentive program, and two distributors indicated that corporate managers at their company, the decision-makers about program participation, might be receptive to the program but would need to weigh the benefit of the rebates versus the cost of hiring or assigning employees to complete the rebate paperwork in house.

Recommendation

Conduct further research to determine manufacturers' interest in and the feasibility of offering a midstream or upstream incentive program for HVAC and other equipment in PPL Electric Utilities' service territory. If PPL Electric Utilities offers a midstream or upstream program, ensure that its expectations are clearly defined for manufacturers, distributors, and contractors. Prior to rolling out the program, provide outreach and education to contractors and distributors so they have the necessary knowledge and support to participate. Larger distributors may need additional support to secure corporate buy-in for participation. PPL Electric may want to test this delivery channel as a pilot.

2.5.1 Status of Recommendations for Program

Table 2-32 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 2-32: Prescriptive Equipment Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Prescriptive Equipment	
Continue with the preapproval process; however, contractors and customers may need more support in completing applications as the process evaluation found that customer satisfaction with the rebate process declined in PY6 as compared to PY5.	Will be implemented in Phase III. PPL will significantly improve the application, QA/QC, and rebate processes in Phase III.
Provide more support in filling out the applications by giving examples of completed applications on the website and naming a point of contact for questions about the applications.	Will be implemented in Phase III. PPL will significantly improve the application, QA/QC, and rebate processes in Phase III.
Continue to provide guidance to the ICSP and quality assurance checks on completed projects regarding TRM requirements; likewise, Cadmus will provide quality assurance spot checks of ICSP Appendix C and E spread sheets to see if site-specific coincidence factors are used where required and inform the ICSP of any discrepancies that are uncovered.	Implemented.
Consider requiring the ICSP to use the 2016 TRM LED fixture code generator for all LED fixtures in PY7.	Being considered. Will be implemented in Phase III.
Continue to stay in touch with contractors about specific lighting technologies (T5s, T8 high bay lighting, LED screw-ins, LED exit signs, and occupancy sensors) as the market matures and prices continue to drop.	Implemented.
Explore new incentives for LEDs as replacements for linear fluorescent lamps.	Implemented.

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Prescriptive Equipment	
Consider strategies for providing more contractor support to improve awareness of the program and available rebates by creating a contractor-specific communications plan, providing equipment-specific technical training to contractors, providing educational materials for customers, and exploring a bonus or SPIF for contractors.	Will be implemented in Phase III. PPL will significantly improve the trade ally network in Phase III.
Conduct further research to determine manufacturers' interest in and the feasibility of offering a midstream or upstream incentive program in PPL Electric Utilities' service territory.	Will be implemented in Phase III.

2.6 FINANCIAL REPORTING

A breakdown of the Prescriptive Equipment Program finances is presented in Table 2-33.

Table 2-33: Summary of Prescriptive Equipment Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[1] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$41,542	$65,628
2	EDC Incentives to Participants	$16,623	$22,233
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$24,919	$43,395
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$5,517	$8,655
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[2]	$5,517	$8,655
8	Marketing[3]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[4] (Sum of rows 1, 5 and 11)	$47,059	$74,283
13	Total NPV Lifetime Energy Benefits	$68,728	$127,454
14	Total NPV Lifetime Capacity Benefits	$6,794	$11,384
15	Total NPV O&M Saving Benefits	($0)	($0)
16	Total NPV TRC Benefits[5]	$75,523	$138,838
17	TRC Benefit-Cost Ratio[6]	1.60	1.87

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

[1] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report.
[2] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[3] Includes the marketing CSP and marketing costs by program CSPs.
[4] Total TRC Costs includes Total EDC Costs and Participant Costs.
[5] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[6] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

ADDENDUM A. PARTICIPANT SURVEY ATTRITION AND FINAL DISPOSITION

Contact Instructions

PPL Electric Utilities provided survey contact instructions for conducting surveys. Customers cannot be contacted for a survey until a year has passed since they completed their last survey (with PPL Electric Utilities or Cadmus). They cannot be contacted for a survey if they have opted out of a survey or have asked not to be contacted again. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition for Standard Lighting Participants

Cadmus coordinated with PPL Electric Utilities' contractor to screen the sample and remove customer records called in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and those who requested not to be contacted again. Cadmus removed records with incomplete information. We excluded from this population any participants of the Custom Incentive and the Continuous Energy Improvement programs to reserve them for inclusion in the limited sample pools for these program-specific surveys.

This cleaning and survey sample preparation process reduced the available sample. Cadmus sent the remaining records to the survey subcontractor. Table 2-34 lists total number of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table 2-34: Prescriptive Lighting Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Population (number of rebates)	**2161**
Removed incomplete phone	10
Removed duplicate	1006
Removed inactive customer	48
Removed do not call	26
Removed in concurrent sample or in reserve	261
Removed completed survey in past year	128
Survey Sample Frame (sent to survey subcontractor)	**682**
Not attempted	**0**
Records Attempted	**682**
Non-working number	30
Wrong number, business	36
Language barrier	1
PPL Electric or market research employee	7
Cannot confirm equipment	8
Refusal	168
No answer/answering machine/phone busy	122
Non-specific or specific callback scheduled	189
Partial complete	61
Completed survey	**60**

Online Sample Cleaning and Attrition

Cadmus coordinated with PPL Electric Utilities' survey subcontractor to screen the sample provided by the ICSP and remove customer records contacted in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and those who requested not to be contacted again. Cadmus removed records with incomplete information and records that could not be matched to the projects in EEMIS. We excluded from this population any participants already selected for either standard lighting channel surveys and participants of the Continuous Energy Improvement and Custom Incentive programs.

As mentioned previously, multiple projects were completed by the same customer so we generated a final survey sample of unique decision-makers to ensure that no customer was contacted more than once for the online survey. This cleaning and survey sample preparation process reduced the available sample. Cadmus contacted all remaining records. Table 2-35 lists total number of records included in the contact list and the outcome (final disposition) of each record.

Table 2-35: Online Sample Attrition Table – Direct Discount Delivery Channel Participants

Description of Call Outcomes	Number of Records
Population (number of customers with valid e-mail addresses)	**139**
Removed because not in EEMIS	23
Removed because duplicate	38
Removed because in concurrent sample	2
E-mail Invitations Sent	**76**
Records Attempted	**76**
Undeliverable e-mail	14
Opted out	1
Remaining non-final records [1]	49
Completed survey	**12**
[1]These records were included in the sample frame but participants did not respond.	

Sample Cleaning and Attrition for Equipment Participants in Online Survey

Cadmus coordinated with PPL Electric Utilities' contractor to screen the sample and remove records for customer who completed a survey in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and those who opted out of online surveys. Cadmus removed duplicate records and records with incomplete information. We excluded from this population any participants already selected for either standard lighting or direct discount delivery channel surveys and participants of the Continuous Energy Improvement and Custom Incentive programs.

This cleaning and survey sample preparation process reduced the available sample. Cadmus sent e-mail invitations to all remaining records. Table 2-36 lists total number of records included in the contact list and the outcome (final disposition) of each record.

Table 2-36: Online Sample Attrition Table – Equipment Participants

Description of Call Outcomes	Number of Records
Population (number of rebates)	**9**
Removed because completed survey in last year	1
Removed because in concurrent sample	2
E-mail Invitations Sent	**6**
Records Attempted	**6**
Remaining non-final records [1]	3
Completed survey	**3**
[1]These records were included in the sample frame but participants did not respond.	

ADDENDUM B. LOGIC MODEL

The program theory for the Prescriptive Equipment Program can be summarized as follows:

> By providing a rebate for high-efficiency or ENERGY STAR-rated equipment (such as HVAC, lighting, and refrigeration equipment), the 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 and ENERGY STAR-rated equipment will further increase sales, achieving additional energy and demand savings.

The elements of the logic model are:

- **Activities the program undertakes** include management and strategic direction, the trade allies' support, marketing, rebate form submission, eligibility verification, education, the purchase and installation of equipment by the customer or by a contractor, and rebate processing and payment.
- **Outputs produced by program activities** include the number of marketing materials distributed, the number of customers submitting rebate forms, the number of customers verified as eligible, the number of products installed, and the number and amount of rebates paid.
- **Short-term outcomes** include increased program awareness, increased customer and trade ally awareness of energy-efficient equipment, and an increase in the installations of energy-efficient equipment. Rebated equipment is installed, leading to immediate energy and demand savings. Program effectiveness is confirmed through evaluation, measurement, and verification (EM&V).
- **Intermediate outcomes** of the program are a reduction in annual energy consumption and peak load, and lower electric bills for program participants.
- **Long-term outcomes** include PPL Electric meeting its plans for reducing energy consumption and peak demand.

ADDENDUM C. LIGHTING AND HVAC CONTRACTOR INTERVIEW FINDINGS

To:	PPL Electric EM&V
From:	Hope Lobkowicz and Anne West, Cadmus
Subject:	Lighting and HVAC Contractor Interview Findings on Market Effects
Date:	November 18, 2014

In September 2014, Cadmus completed 30 phone interviews with contractors participating in PPL energy efficiency programs. We spoke with 15 lighting contractors representing a mix of activity (eight represented a large portion of program savings between 1% and 8%, and seven represented a small portion between 0% and 1%.). We interviewed 15 HVAC contractors who sold ductless mini-split heat pumps or air source heat pumps and participated in the Residential Home Comfort Program. Although many of these contractors also reported having nonresidential customers, only one contractor we reached had actually sold rebated equipment to PPL's business customers in the past.[21]

This memo summarizes the objectives of this study and the major findings drawn from the interviews.

BACKGROUND AND METHODOLOGY

The primary purpose of the contractor interviews was to assess the market effects of PPL Electric's energy efficiency programs. "Market effects" are changes in the structure of a market or behavior of participants attributable to an energy efficiency incentive program.[22] Market effects also provide evidence that a market barrier has been partially or fully mitigated. To measure market effects, we asked contractors a series of questions about market conditions before and after the PPL Electric rebate program became available in 2009. Because we are lacking baseline information from the pre-2009 market, we asked contractors to think back to prior years before rebates were available. If a change occurred during this timeframe, we asked contractors to consider PPL Electric's influence on this change.

Finally, we asked if the current conditions (i.e., sales, promotional practices, quantities of equipment stocked) would remain the same if the rebates were no longer available next year. This question provided another perspective on the influence of the program rebates. This helps to determine whether a particular barrier has been mitigated, indicating a reduced need for future program intervention. We asked about the following market indicators:

1. Consumer attitudes toward energy efficiency
2. Promotional practices surrounding energy-efficient equipment options
3. Prices of equipment
4. Sales of equipment

---

21 No heat pumps were rebated for nonresidential customers in PY5.

22 Eto, Joseph, Prahl, Ralph, and Schlegel, Jeff. 1996. *A Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs.* Prepared for the California Demand-Side Management Committee.

5. Stocking practices
6. Business services and offerings

Cadmus gathered a significant amount of data about nine types of energy-efficient lighting equipment and three heat pump technologies (air source heat pumps, ductless mini-split heat pumps, and ground source heat pumps). Table 1 presents a snapshot of the changes in the market reported by contractors: whether they identified the PPL Electric program as influencing that change; and, whether the market conditions would remain the same in the absence of the program. These findings represent a simple majority. Later sections of this report present more detail on frequencies, metrics, and differences between technologies.

Table 1. Summary of Market Effects Determined by a Majority of Contractors

Market Indicator	Was there a Change in the Market since 2009/in Past 5 Years	Did PPL Electric Influence the Change*	Would Current Conditions Continue in Absence of Program
Lighting			
Consumer Attitudes	Yes	Yes	N/A**
Promotional practices surrounding EE	Yes	Yes	Yes
Prices	Yes	-	N/A**
Sales	Yes	Yes	No, sales would decrease
Stocking	Yes	-	Split: 3 of 7 contactors reported stocking would stay the same
Business services	-	-	Split: 3 of 6 contractors reported services would stay the same
Heat Pumps			
Consumer Attitudes	Yes	-	N/A**
Promotional practices surrounding EE	-	-	Yes
Prices	Yes	-	N/A**
Sales	Yes	-	Yes
Stocking	-	-	Yes
Business services	-	-	Yes

*As measured by an influence rating of 4 or higher on a scale of 1 through 5
**Contractors were not asked if prices and customer awareness would stay the same in the absence of the program because these market factors are outside of their control

In addition to assessing market effects and gathering market intelligence, the contractor interviews also covered market barriers, suggestions for improving the program, trade ally marketing practices, and overall satisfaction with PPL Electric.

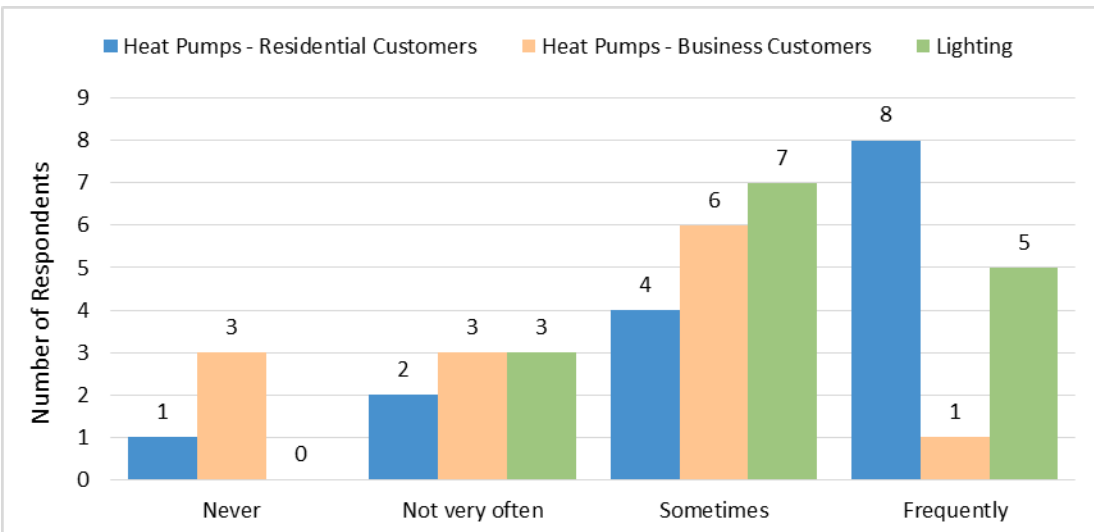
MARKET EFFECTS

Customer Attitudes toward Energy-Efficiency and Influence of the Rebates

Cadmus asked contractors several questions to gauge customer awareness and interest in energy-efficient lighting and heat pumps. Responses from contractors indicate that there is some demand for energy-efficient options in absence of the rebate program, yet, the availability of rebates still plays a role in the customer's final decision. This is true more so of lighting than heat pumps, as discussed below. A majority of contractors (93% of lighting contractors and 80% of HVAC contractors) reported that they thought customer awareness of energy efficiency has increased over the past five years. Two of the HVAC contractors who did not report increased awareness thought that customers still have a negative perception of the performance and comfort of heat pumps, and a third contractor reported that his service area has a very strong heat pump market with informed customers, and this had not changed significantly over time.

Nearly all respondents reported that they have had customers *already* interested in energy-efficient lighting and heat pumps before learning of the PPL Electric rebate, but HVAC contractors reported that this happened much more frequently among their residential customers than among business customers. A third of the lighting contractors (5 of 15) and just one HVAC contractor said this happened *frequently* among business customers (Figure 1). The survey question asked: *When shopping for lighting equipment/HVAC equipment, how often would you say that customers already know they want energy-efficient fixtures/heat pumps before they know about the PPL rebate?*

Figure 1. Customer Interest in Energy-Efficient Lighting and Heat Pumps Prior to Learning about PPL Electric Rebates



Source: C3. When shopping for lighting equipment/HVAC equipment, how often would you say that business/residential customers already know they want energy-efficient fixtures/heat pumps before they know about the PPL rebate? (n=15 lighting, n=15 HVAC)

Despite some level of existing demand for energy-efficient lighting, contractors also reported that the PPL Electric rebate often affects their customer's decision to move forward with a lighting retrofit project. In fact, ten out of 15 contractors estimated the rebate affects customer's decisions to move forward at least 80% of the time. Table 2 contains each contractor's estimate of how often the lighting rebate affects the customer's decision.

Table 2. Estimate of How Often the Lighting Rebates Affect Customer Decisions

How Often the Rebate Affects Customer Decision (Percentage of Time)	No. of Responses
100% of the time	1
90%	5
85%	2
80%	2
75%	1
70%	2
50%	1
25% of the time	1
Total	**15**
Source: C6. About what percent of the time do you estimate that the PPL rebate affects the customer's decision to move forward with the retrofit project? (n=15)	

The response was quite different for HVAC contractors. On average, HVAC contractors estimated the HVAC rebate affected residential customer's purchase decisions just 25% of the time. They estimated the rebate is less influential for business customers, affecting their purchase decision only 17% of the time, on average (Table 3).

Table 3. Estimate of How Often the Heat Pump Rebates Affect Customer Decisions

How Often the Rebate Affects Customer Decision (Percentage of Time)	No. of Responses (Residential Customers)	No. of Responses (Business Customers)
75% of the time	1	0
70%	1	1
50%	1	0
40%	1	1
30%	0	1
25%	1	0
20%	3	2
10%	4	1
5%	2	2
0% of the time	1	4
Total	**15**	**12**
Source: C6. About what percent of the time do you estimate that the PPL rebate affects the customer's purchase decision? (Residential n=15, Business n=12)		

These findings support the PY5 freeridership estimates calculated through self-report surveys. Although measured differently, the general trends between customer data and how contractors perceive the rebate's effectiveness were similar. Lighting contractors suggested that the rebate had a strong influence on the customer's decision, and the freeridership score for the Prescriptive Equipment lighting was 27%. HVAC contractors perceived little influence on customer decision-making, and the freeridership score for the equipment portion of the Residential Retail Program was 55%.

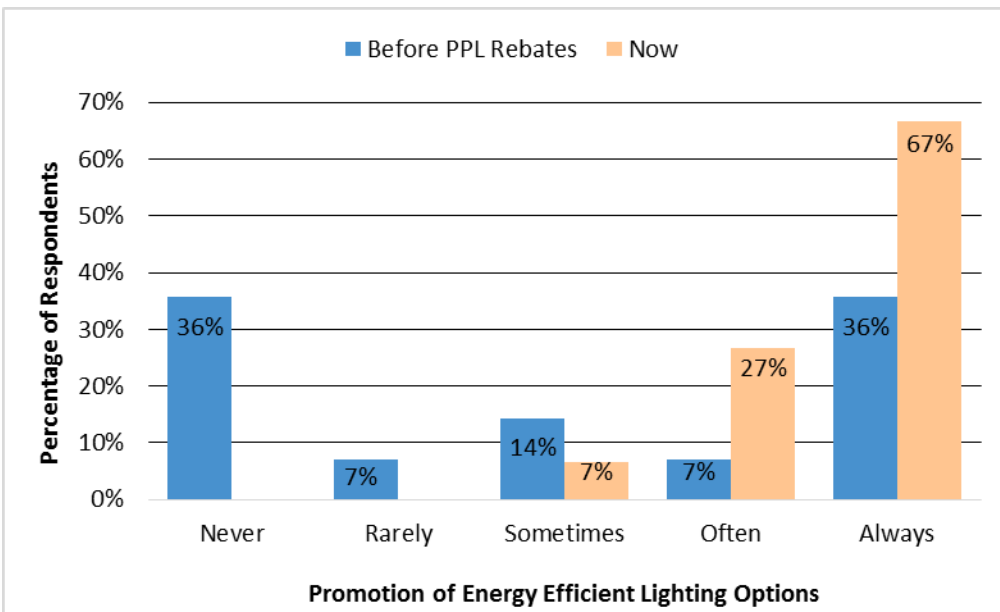
Promotional Practices

We asked contractors how often they promoted energy-efficient lighting and heat pumps to customers prior to the rebate program and since PPL Electric began offering rebates.[23] Again, we found differences in whether promotional practices had changed over time between lighting and HVAC contractors, with findings indicating that the availability of rebates has influenced the promotion of energy-efficient lighting much more so than heat pumps.

Prior to the availability of rebates, over one third of lighting contractors said they *never* promoted energy-efficient lighting, and less than half (6 of 14, or 43%) reported that they *always* or *often* did (Figure 2). This baseline of "energy efficiency promotion" prior to the program was significantly higher among HVAC contractors: 12 of 15, or 80% reported that they *always* or *often* promoted high efficiency heat pumps before the availability of rebates (Figure 3).

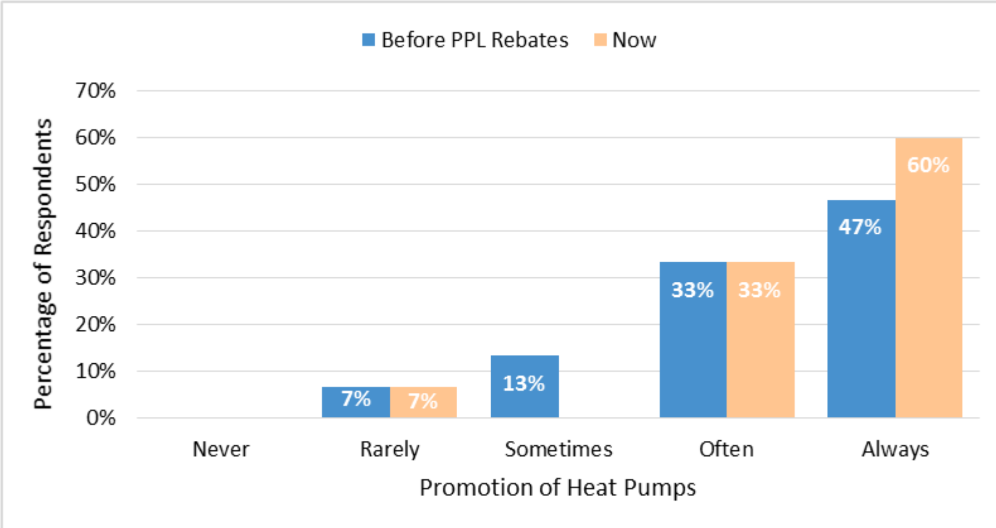
A large number of lighting contractors reported an increase in their promotion of energy-efficient options since the availability of the PPL Electric rebates: the percentage of contractors who promote energy-efficient options *often* grew by 20% and the percentage of those who promote them *always* grew by 31%. This shift was much less apparent for HVAC contractors; just 13% more contractors said they *always* promote heat pumps since rebates became available.

Figure 2. Promotion of Energy-Efficient Lighting – Now and Prior to Rebates



23 Respondents were provided with the example of HP T8s, T5s, or LEDs to define "efficient lighting."

Figure 3. Promotion of Heat Pumps – Now and Prior to Rebates



Sources: Question B11. "How often do you promote energy-efficient lighting/heat pumps to your customers?" (n=15 lighting, n=15 HVAC) Question B12. "And before PPL Electric rebates were available, how often would you say you promoted energy-efficient lighting/heat pumps to customers?" (n=14 lighting, n=15 HVAC)

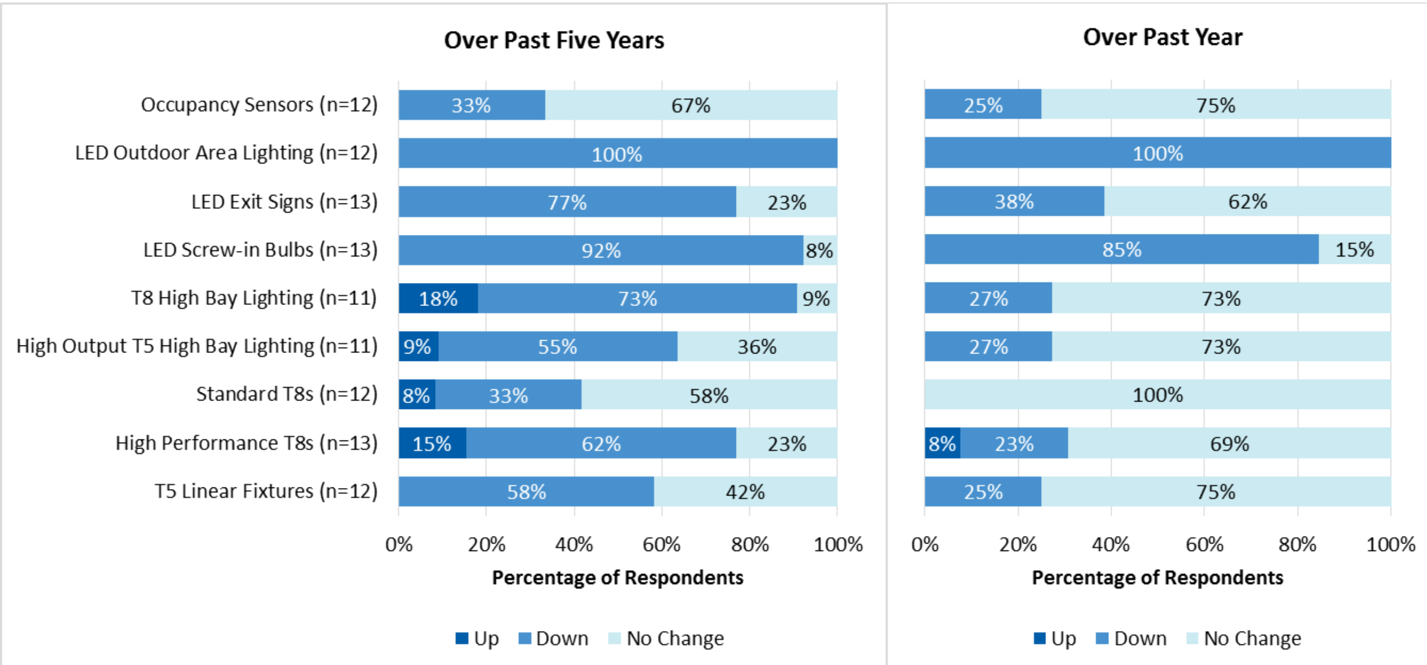
Cadmus asked contractors what influenced their decision to promote energy-efficient products to a greater degree since PPL Electric began offering their rebate program. Eight lighting contractors mentioned the rebates were the primary influence in changing how they promote energy-efficient lighting. One lighting contractor said that PPL Electric's program improved his education and knowledge, reporting that he was not aware of the energy-efficient options before getting involved with PPL Electric. Just four HVAC contractors mentioned the rebates influenced the change in how frequently they promote heat pumps. One HVAC contractor noted that the "*original rebates were much more effective at attracting customer interest in heat pumps, but now it's less of a help,"* referring to the rebate level.

Prices

Cadmus asked contractors if prices of various lighting and heat pump technologies increased, decreased, or stayed the same in the last year and over a period of five years. Figure 4 shows the percentage of lighting contractors who reported prices went up, down, or stayed the same, by lighting type. Figure 5 shows heat pumps.

A relatively small percentage of lighting contractors indicated prices *increased* for T8 high bay lighting, high output T5s, and HP T8s over the past five years. The majority of contractors reported that prices dropped for most technologies, with the exception of standard T8s and occupancy sensors (which contractors reported stayed the same). There was widespread agreement that prices decreased for LED outdoor area lamps and for LED screw in bulbs over the past five years as well as more recently, in the past year. Contractors were less likely to report recent drops in price for other lighting types like linear fluorescent fixtures and occupancy sensors.

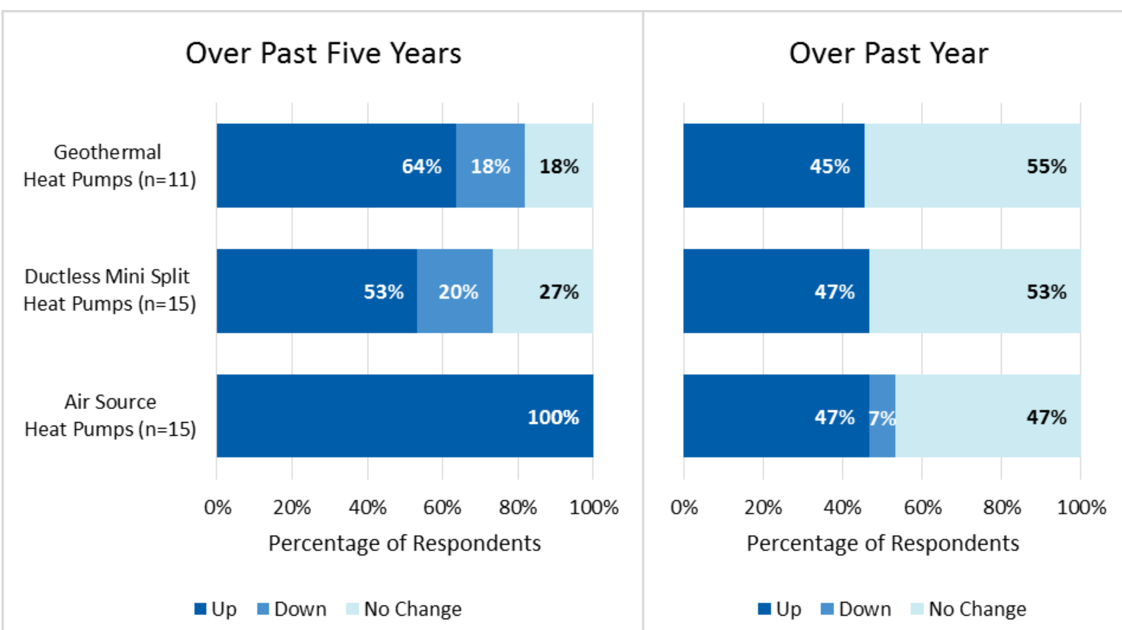
Figure 4. Percentage of Contractors Reporting Price Changes Over Time: Lighting



Source: Question D1_1. "Price change in past 5 years" and Question D1_2. "Price change in past year"

This was in stark contrast to what HVAC contractors reported about heat pumps. In fact, the majority of contractors stated that costs of all heat pump technologies had increased in the past five years, and nearly half of them reported that costs were still going up as recently as in the last year (Figure 5).

Figure 5. Percentage of Contractors Reporting Price Changes Past Five Years: Heat Pumps



Source: Question D1_1. "Price change in past 5 years" and Question D1_2. "Price change in past year"

The reasons that lighting contractors cited for the decrease in prices included:

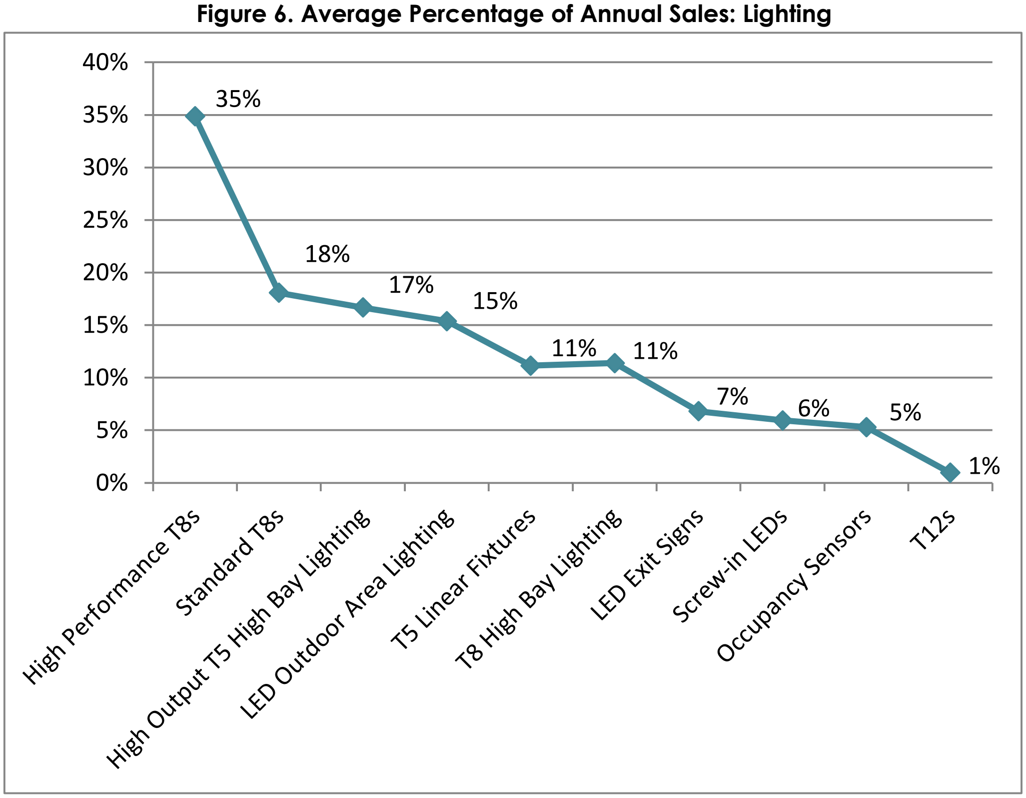
- Improved awareness of energy efficiency in the marketplace
- Increase in consumer demand
- Increased supply-side competition (specifically for LEDs)
- Improved technology (specifically for LEDs)
- Increased availability of LED replacement technology for fluorescents – specifically cited as a reason for decrease in T8 and HP T8 prices

Meanwhile, HVAC contractors attributed price increases to higher energy efficiencies of heat pumps (47%) or increased material costs (40%). Two contractors noted that improved technology or increased market competition decreased prices for ductless mini-splits and geothermal heat pumps in the past five years.

Sales – Lighting

Cadmus asked contractors to estimate their sales in the past year. High Performance T8s represented the largest share of sales (35%, on average), followed by Standard T8s, High Output T5 High Bay Lighting, and LED Outdoor Area Lighting (Figure 6). Only two contractors reported selling T12s: one contractor reported they accounted for 10% of annual sales; the other estimated that T12s comprised just 0.5% of annual sales.

Figure 6. Average Percentage of Annual Sales: Lighting



Thirteen of fifteen contractors reported that sales have changed since PPL began offering rebates in 2009. When asked if contractors could estimate the percentage increase, results were very high, with multiple contractors saying their sales had increased by 100% for various technologies. Table 4 lists the average reported increases in sales. No one reported a change in sales for standard T8s.

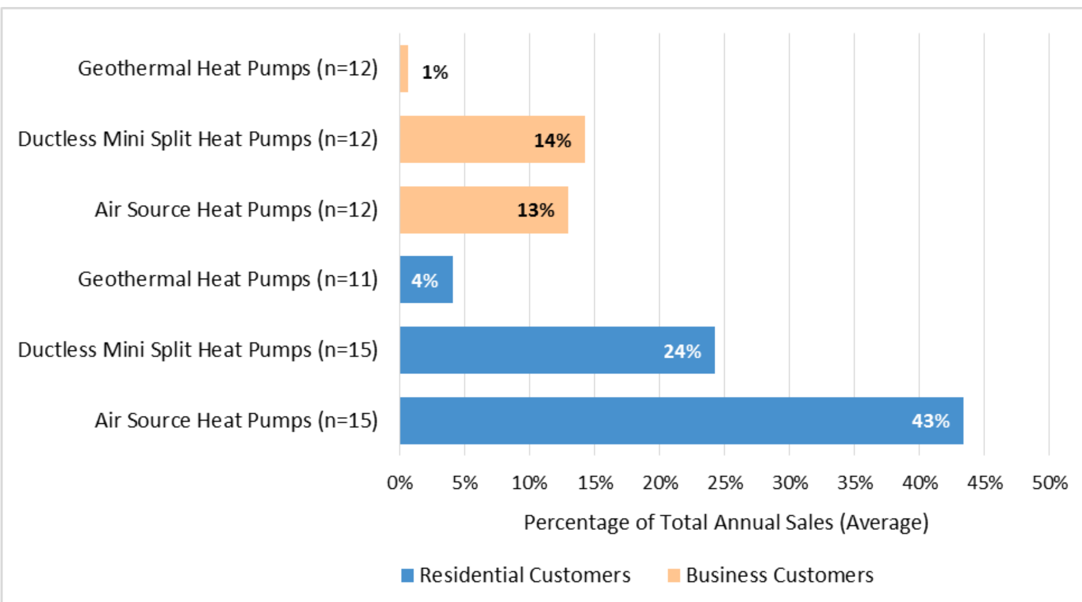
Table 4. Respondents' Reported Increase in Sales Since Rebate Introduction: Lighting

Lighting Type	Average Increase in Sales since 2009
LED Exit Signs (n=5)	96%
LED Outdoor Area Lighting (n=7)	96%
T5 Linear Fixtures (n=4)	95%
Occupancy Sensors (n=4)	95%
T8 High Bay Lighting(n=6)	82%
LED Screw-in Bulbs (n=8)	76%
High Performance T8s (n=9)	74%
High Output T5 High Bay Lighting (n=6)	73%
Standard T8s	0%

Sales – Heat Pumps

HVAC Contractors reported a much higher percentage of their annual sales came from heat pumps for residential customers compared to business customers (Figure 7). Within the business segment, ductless mini-splits and air source heat pumps occupied a similar share of the market. For residential customers, air source heat pumps represented the most sales.

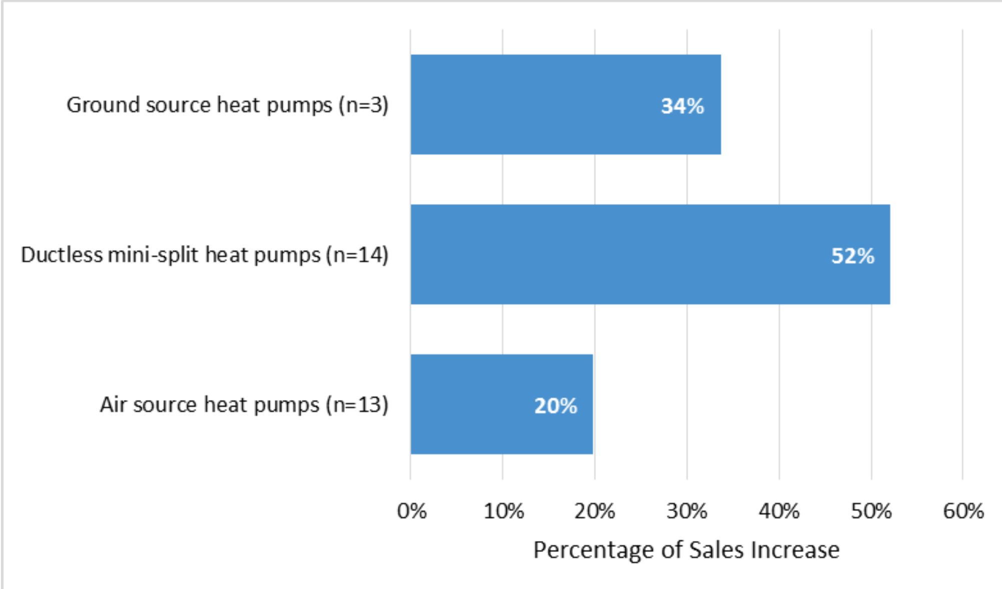
Figure 7. Average Percentage of Total Annual Sales: Heat Pumps



Source: Question D3a. "Of your total annual sales for residential customers in the past year, about what percentage were…?" Question D4a. "Of your total annual sales for business customers in the past year, about what percentage were…?"

Cadmus asked contractors whether their sales of heat pump technologies have changed since PPL began offering rebates in 2009 for air source heat pumps (ASHPs) and ground source heat pumps (GSHPs) and in 2010 for ductless mini-split heat pumps. Ductless mini-split heat pumps represented the greatest percentage increase in sales with fourteen out of fifteen contractors reporting increased sales on average of 52%. Figure 8 shows the average reported increases in sales for each technology type.

Figure 8. Respondents' Reported Increase in Sales since Rebate Introduction: Heat Pumps



Source: Question D5a. "PPL began offering rebates for air source heat pumps in 2009. Have you sales changed since that time?" Question D5b. "PPL began offering rebates for ductless mini-split heat pumps in 2010. Have you sales changed since that time? Question D5c. "PPL began offering rebates for ground source heat pumps for businesses in 2009. Have your sales changed since that time?"

Stocking Practices

Seven of fifteen lighting contractors reported that they increased the quantities of energy-efficient lighting equipment they stock since PPL Electric began offering rebates, and one HVAC contractor reported stocking more heat pumps. Lighting contractors reported stocking more:

- HP T8s (4 responses)
- LEDs (3 responses)
- T5s (2 responses)
- All products (2 responses)

Business Services and Offerings

Six lighting and two HVAC contractors reported that they changed the services or types of equipment offered to customers since PPL began offering rebates. Some lighting contractors reported expanding their product mix to include LED lighting and outdoor area lighting. One contractor mentioned adding a whole division for energy-efficient lighting, and another reported they began promoting program start ballasts. The two HVAC contractors said that they began offering higher-efficiency units with the availability of rebates.

PPL Electric Influence on the Changes in the Market

Cadmus asked contractors to rate the influence PPL Electric's rebate program on changes the respondents identified. Respondents used a scale from 1 to 5, with 1 meaning *no influence* and 5 meaning *extremely influential*. Table 5 and Table 6 show the average influence rating for each change in the market.

We note that contractors were only asked about the program's influence on the change in the market *if* they had previously reported a change, whether in prices, sales, offerings, stocking, promotional practices, or customer awareness. Therefore, the number for responses differs for each category and is denoted in the table row.

The shaded blue rows represent average influence ratings of four or higher, indicating strong PPL Electric influence.

Table 5. Average Influence of the PPL Electric Program on Market Change: Lighting

Change in the Market	Average Influence Rating
Price of T5 Linear Fixtures (n=7)	2.4
Price of High Performance T8s (n=9)	3.2
Price of Standard T8s (n=5)	3.0
Price of High Output T5 High Bay Lighting (n=6)	2.5
Price of T8 High Bay Lighting (n=10)	2.8
Price of LED Screw-in Bulbs (n=12)	3.2
Price of LED Exit Signs (n=11)	2.4
Price of LED Outdoor Area Lighting (n=12)	2.8
Price of Occupancy Sensors (n=4)	2.5
Sales of T5 Linear Fixtures (n=4)	4.8
Sales of High Performance T8s (n=9)	4.2
Sales of Standard T8s (n=6)	4.7
Sales of High Output T5 High Bay Lighting (n=6)	4.7
Sales of T8 High Bay Lighting (n=8)	4.5
Sales of LED Screw-in Bulbs (n=8)	4.5
Sales of LED Exit Signs (n=6)	4.7
Sales of LED Outdoor Area Lighting (n=8)	4.6
Sales of Occupancy Sensors (n=4)	4.8
Change in Company's Services or Equipment Offerings (n=6)	3.3
Change in Quantities of Equipment Stocked (n=8)	3.1
Change in Promotion of Energy Efficiency (n=13)	4.1
Change in Customer Awareness of Energy Efficiency (n=14)	3.9*
*Rounded to 4.0	

Table 6. Average Influence of the PPL Electric Program on Market Change: Heat Pumps

Identified Change	Average Influence Rating
The price of air source heat pumps (n=15)	1.8
The price of ductless mini split heat pumps (n=12)	2.3
The price of geothermal ground-source heat pumps (n=8)	1.4
Your sales of air source heat pumps (n=14)	1.9
Your sales of ductless mini split heat pumps (n=15)	2.7
Your sales of geothermal ground-source heat pumps (n=8)	1.5
The change in your company's service or equipment offerings (n=1)	2.0
The change in your promotion of energy efficiency (n=5)	3.2
The change in customer awareness of energy efficiency (n=14)	3.2

Permanency of Changes in the Marketplace

Among lighting contractors, responses regarding whether current market conditions would stay the same in absence of the program were somewhat divided, with the most agreement surrounding the impact of the no-rebate scenario on lighting sales. Most contractors were likely to say that their sales of various lighting technologies would drop without the rebates, but responses were more varied when it came to business practices, with respondents being less willing to say they would shift their business focus away from energy-efficient lighting. For heat pump equipment, the majority of contractors thought that their practices and sales would remain the same in the absence of the program. The following summary focuses on lighting.

- ***Sales.*** Most contractors reported that they expected sales of all types of efficient lighting equipment would decrease. Specifically, 12 of 15 (80%) contractors thought sales of High Performance T8s and High Output T5 High Bay Lighting would decrease. Nearly three-quarters (11 of 15, or 73%) of interviewed contractors reported their sales of LED Outdoor Area Lighting would decrease. Fewer contractors, yet still a majority, anticipated that discontinued rebates would result in lower sales of the other lighting technologies (occupancy sensors, LED exist signs, LED screw-in bulbs, and standard T8 lighting).
- ***Promotional practices.*** Cadmus asked contractors whether they would continue to promote energy-efficient lighting to the same extent if PPL rebates were no longer available next year. Just over half (8 of 15 contractors) reported they would continue promoting energy-efficient lighting to the same extent. Three of these contractors caveated that it would be more difficult to sell the job, and one contractor stated, *"some of our customers consider the rebates the make-or-break of whether a job gets approved (by decision makers)."*
- ***Stocking.*** Of the seven contractors who reported an increase in stocking quantities, four of these contractors reported they would not continue with current stocking practices in the absence of the PPL rebate program, while three said the quantities of equipment would stay the same.
- ***Business Services and Offerings.*** Of the six contractors who reported that they changed the services or types of equipment offered to customers, half (3) reported that their current services and types of equipment would remain the same in the absence of PPL rebates, and half (3) said they were unlikely to continue.

TRADE ALLY MARKETING

This section explores how contractors utilize the PPL Electric program to promote their equipment and services.

The most common ways that contractors reported marketing their business was word-of-mouth or customer referrals (this was true for both lighting and HVAC contractors). Lighting contractors reported relying also on cold calls or door-to-door marketing (7 responses), while a large number of HVAC contractors also said they used company advertising (12 responses). A small number of respondents reported customers learn about their services through PPL Electric's website (two lighting contractors and two HVAC contractors).

- ***Advertising as a PPL Electric Trade Ally***. Almost two thirds of the lighting contractors we spoke with (9 of 15) reported that they advertise their company as a PPL Electric trade ally, while just two of the fifteen HVAC contractors did so. Two lighting contractors who do not advertise as a PPL Electric trade ally indicated they do not do much marketing in general, and one reported they have only just started actively marketing their services. One contractor reported having customers nationwide and working with multiple utilities, and *"to put them all on some sort of advertisement would be extensive."*

- Some contractors said they were not aware they could advertise as a PPL Electric Trade Ally. This was true for just two lighting contractors who had completed a small number of projects, but nine HVAC contractors indicated they didn't know about the opportunity.
- ***Using PPL Electric Marketing Materials.*** Eight of 15 lighting contractors and one of 15 HVAC contractors reported using PPL Electric's marketing materials, such as brochures, postcards, logos, and other items on the PPL website. Cadmus asked the contractors to rank how often they use these materials. Of the lighting respondents, three reported they use them *frequently*, two use them *sometimes*, and three use them *rarely*. The HVAC respondent said he used them *frequently.*
- Most HVAC contractors reported not using the marketing materials because they *don't know about them* (6 responses or 43%), or they *don't have a need for them* (6 responses or 43%). Lighting contractors who reported they did not use PPL Electric's materials often said it just didn't fit into their business model to use printed materials or promote a specific utility program. Two contractors indicated they did not know about the marketing resources or where to access them.

MARKET BARRIERS

Cadmus asked contractors about the challenges related to both selling and procuring energy-efficient lighting and heat pumps.

Selling

Contractors reported that cost is the main market barrier to selling energy-efficient equipment to customers, followed by customer awareness of energy efficiency benefits. The barriers cited by respondents are listed in Table 7.

Table 7. Barriers to Selling Energy-Efficient Equipment

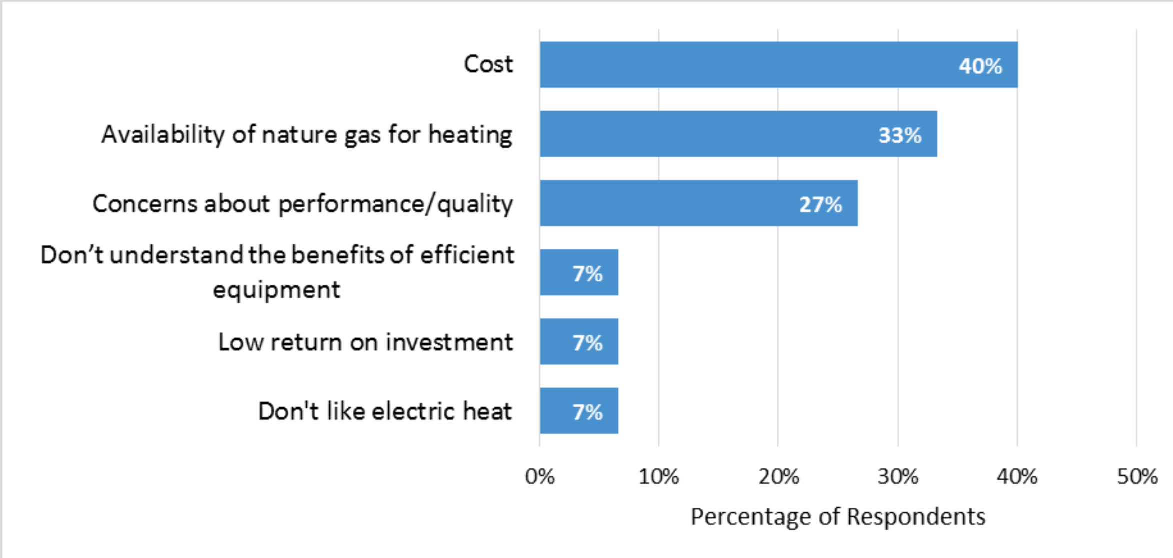
Market Barrier	Number of Responses – Lighting	Number of Responses - HVAC
Cost or return on investment	9	4
Awareness; education; understanding the benefits of EE	4	4
Finding time for the program (the audit and report)	1	-
Program pre-approval timelines	1	-
Lack of geothermal rebate for residential customers	-	1

We also asked the reasons why customers choose not to purchase or install energy-efficient options. Cost was mentioned fourteen out of fifteen times as the primary reason why customers will not move forward with an energy-efficient lighting project. One lighting contractor indicated that most of his customers "*try to hit a 2 to 3 year payback and they might not have the capital presently to invest in a lighting project*."

HVAC contractors also most commonly mentioned cost as a barrier to purchasing heat pumps, but they cited other challenges much more frequently than lighting contractors did. One contractor said that for his customers "*if natural gas is available, heat pumps are not cost-effective*." Another said, *"Customers are sometimes still misinformed on the performance and comfort level of modern heat pumps."*

Figure 9 shows the reasons that contractors reported customers did not purchase a heat pump.

Figure 9. Reasons Customers Do Not Purchase a Heat Pump



Source: Question C7. "If a customer chooses not to purchase a heat pump, what are the typical reasons?" Percentages may add up to more than 100% due to multiple mentions.

Buying

Fewer contractors noted challenges with procuring energy-efficient equipment from manufacturers. Three people said that LED product availability can be an issue, resulting in long lead times and delays. One person reported this used to be a larger issue, but was improving: *"With the LED market, 5 years ago, it was difficult getting things in a timely manner. A lot of things were coming from China and took a while to get. But now, most things are manufactured in the US and are easy to get."* A different person noted that a quarter of their equipment is still imported, and dealing with U.S. Customs is an issue. This person said, *"U.S. Customs. They can always be a challenge. About 25% of our equipment comes directly overseas to our warehouses; 75% from California."*

EXPERIENCE WITH PPL ELECTRIC

Lighting

Fourteen of fifteen contractors reported they have interacted with a PPL representative, and all indicated they were satisfied with their experience. Eight contractors expressed they were *very satisfied*, and the remaining six contractors were *somewhat satisfied*. Since becoming a PPL trade ally, two contractors reported their opinion of PPL Electric has *improved significantly*, seven indicated their opinion had *improved somewhat*, and five reported *no change*.

HVAC

Cadmus asked participating contractors in the Residential Home Comfort Program to describe their experience working with CLEAResult, the ICSP. Four of the seven contractors reported they were *very satisfied* or *somewhat satisfied*. One contractor reported they were *not too satisfied* because they had "poor implementation" and their software did not compare well with other options available. Two contractors thought they were participating contractors in the Home Comfort Program, but did not know the implementer CLEAResult.

Seven of the fifteen contractors reported they interacted with a PPL representative regarding their energy efficiency programs, and almost all (6 of 7) indicated they were satisfied with their experience. Two contractors expressed they were *very satisfied* and four contractors were *somewhat satisfied*. One contractor reported they were *not too satisfied* because "*the presentation that I went to didn't have information that pertained to our business."*

Since working with PPL through the rebate program, two contractors reported their opinion of PPL Electric has *improved significantly*, seven indicated their opinion had *improved somewhat*, five reported *no change*, and one reported *decreased slightly*. The contractor who reported his opinion had *decreased slightly* said, "*the rebate program was simple and easy to use, but it is difficult to get a hold of people at PPL who are knowledgeable*."

Suggestions for Overcoming Marketing Barriers and Improving the Program

Contractors had the following suggestions for PPL Electric:

- Increase rebate level (4 lighting, 9 HVAC)
  - *"(Increase the rebates) specifically for LED fixtures, because the price point is still a sticking point for customers."*
  - *"They (heat pump rebates) are just too low right now for them to have an impact."*
- Assist with advertising/promotion (3 lighting, 9 HVAC)
- Improve approval turn-around times (3 lighting)
  - *"Effective 6/1 this year, their turnaround time has been subpar (they've always been very good in the past)… since 6/1, the LED mapping really slows down how quickly we can get back to our customers. Anything we can do to speed things up as quick as possible is always in the best interest of the customer. When we have to tell a customer to wait a week or two weeks and delay the process, that's not always the best thing."*
- Expand program offerings, focus on next "tier" (2 lighting, 1 HVAC)
  - *"Offer rebates for some of the newer LED fixtures that are available (high bays, office lighting, stairwell lighting), some of the other utilities offer these."*
  - *"Get rid of the 15 SEER rebates and do more for the higher efficiency options, they weaken the program by cutting back on the high efficiency options."*
- Increase communication with contractors about incentives (2 lighting)
  - *"Let me know what's on the market so I can inform my customers about it. If I give my customers an informed response to their questions, if PPL gives me the knowledge, and if PPL were more involved with their contractors, I would be able to sell more. I can't remember the last time I got anything from PPL."*
- Change direct discount delivery limits (1 lighting)
  - *"They need to increase the kW [limit] for Direct Discount, which would increase the number of customers that qualify."*
- Add on-bill financing options (1 lighting)
  - Educate contractors on how to explain the benefits of energy efficiency (1 HVAC)

3 RESIDENTIAL RETAIL PROGRAM

The Residential Retail Program comprises two components, upstream lighting and rebated equipment. Both components are managed by one ICSP.

The upstream lighting component offers incentives to manufacturers to discount the price of energy-efficient screw-in LEDs sold in stores. The program also distributes information about energy-efficient lighting in brochures, online, and at participating retailers. The ICSP works directly with manufacturers and retail store channels to coordinate and track the sale of discounted bulbs.

The ICSP also makes CFL recycling bins and recycling educational materials available at participating retailers throughout the PPL Electric Utilities territory as well as in various municipal and community locations. PPL Electric Utilities posts these CFL-recycling locations on its website.

The rebated equipment component provides rebates directly to customers for energy-efficient refrigerators and heat pump water heaters. This component also includes efficient fossil-fuel water heaters eligible for rebates under the fuel-switching pilot (see Appendix K: Fuel-Switching Pilot Analysis: Electricity to Fossil Fuels. The ICSP provides educational and promotional materials to participating retailers and maintains a call and rebate-processing center.

The objectives of the Residential Retail Program are to:[24]

- Provide a mechanism for customers to easily obtain discounted ENERGY STAR®-qualified energy-efficient light bulbs (primarily CFLs in PY5 and only LEDs in PY6 and PY7) and efficient equipment sold in retail stores.
- Achieve widespread visibility through independent and regional retailers that carry the eligible ENERGY STAR® products.
- Develop and execute strategies aimed at transforming the market for ENERGY STAR®-qualified LEDs and equipment.
- Provide customers with the opportunity to recycle CFLs through retailers and municipalities and educate customers on proper recycling.
- Educate customers on new technologies for light bulbs, such as LEDs, and the impact the Energy Independence and Security Act (EISA) will have on energy-efficient light bulbs.
- Engage retailers by educating and training retail sales associates about the energy-efficient equipment.
- Provide a one-stop call and rebate processing center.
- Promote other PPL Electric Utilities energy efficiency programs.
- Obtain annual savings of approximately 186,000 MWh/yr from the lighting component of the program and 5,800 MWh/yr from the energy efficiency component.

[24] Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p. 47.

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

Table 3-1: Residential Retail Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000) [1]	Program Acquisition Cost [1], [2] ($/Annual kWh)	Cost of Conserved Energy[3] (TRC $/kWh)	Phase II Participants
Residential Retail – Equipment	4,583	4,728	4,701	0.61	N/A	N/A	N/A	N/A	11,685
Residential Retail – Upstream Lighting	137,208	138,595	137,076	0.72	N/A	N/A	N/A	N/A	386,809
Total	**141,791**	**143,323**	**141,777**	**0.72**	**3.75**	**$13,308**	**$0.09**	**$0.03**	**398,494**

[1] Expenditures are tracked at the program level, not by component.
[2]Total EDC Costs divided by first year kWh savings.
[3] Total TRC Costs divided by levelized lifetime kWh savings.

3.1 PROGRAM UPDATES

At the start of PY6, PPL Electric Utilities increased the rebate for refrigerators from the $25 offered in PY5 to $100, but it also required that to be eligible refrigerators must meet the more stringent ENERGY STAR "Most Efficient" or the Consortium for Energy Efficiency (CEE) Tier 3 criteria. However, within a few months of the start of the program year, the ICSP reported a large number of rejected refrigerator rebate applications and observed that customers, as well as participating retailer staff, were confused about and frustrated with the new requirements.

In response, PPL Electric Utilities decided to implement a tiered rebate by continuing to offer $100 for the most efficient models but retaining the original $25 rebate for ENERGY STAR base-tier models.

3.2 DEFINITION OF PARTICIPANT

Residential Retail Program participants for the rebated equipment component are defined by a unique job, or rebate application.

For the upstream lighting component, jobs are reported as weekly bulb sales, by product. Cadmus calculated the number of participants by dividing the total number of bulbs sold or distributed by a bulbs-per-participant estimate derived from general residential population survey respondents who reported having purchased LEDs. In PY6, Cadmus estimated that each participant purchased an average of 6.2 LEDs.

3.3 IMPACT EVALUATION GROSS SAVINGS

3.3.1 Reported Gross Savings

In Phase II, the Residential Retail Program reported energy savings of 141,791 MWh/yr and demand reduction of 16.69 MW, as shown in Table 3-2. The savings for the small commercial and industrial (small C&I) sector include adjustments to account for cross-sector sales in the upstream lighting portion of the program, as described in Appendix D: Residential Lighting Upstream Cross-Sector Sales.

Table 3-2: Phase II Residential Retail Reported Results by Customer Sector

Sector	Phase II Participants	Phase II Reported Gross Impact (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)	Incentives ($1000)
Residential	377,313	104,068	7.19	$6,861
Government/Nonprofit/Education	72	10	0.00	$3
Large C&I	1	0	0.00	$0
Small C&I	21,108	37,714	9.49	$746
Phase II Total	**398,494**	**141,791**	**16.69**	**$7,610**

Table 3-3b: Phase II Residential Retail Reported Results by Customer Sector & Component

Sector	Phase II Participants	Phase II Reported Gross Impact (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)
Residential – Equipment	11,553	4,554	0.45
Residential – Upstream Lighting	365,760	99,514	6.75
Small C&I – Equipment	59	20	-
Small C&I – Upstream Lighting	21,049	37,694	9.49
Government/Nonprofit/Education Equipment	72	10	-
Large C&I – Equipment	1	-	-
Phase II Total	**398,494**	**141,791**	**16.69**

The PY6 Residential Retail Program reported 3,481 equipment-rebate participants and an estimated upstream 173,399 lighting participants who purchased 1,069,869 discounted bulbs.[25] There were also 88 smart strips installed during PY5 but reported in PY6.

3.3.2 EM&V Sampling Approach

Cadmus used methods specific to each program component to review and adjust savings estimates. For the upstream lighting component, Cadmus conducted an audit of lighting manufacturer invoices and reviewed all database records. The invoice audit was conducted for the first time in PY6, partly in response to Cadmus' database review findings.

The rebated equipment measures were verified via desk audits of a simple random sample of rebate forms. Cadmus also used the ENERGY STAR- and CEE-qualified product lists to look up model-specific inputs and make adjustments to savings estimates based on either the 2013 or the 2014 Pennsylvania TRM, depending on the year within which the measure was installed.

25 This lighting participant estimate is based on the verified bulb count, divided by the PY6 bulbs-per-participant estimate of 6.17; therefore, the estimate differs slightly from the reported participant count shown in the portfolio-level tables.

Cadmus prorated the sample of 70 rebated equipment measures between refrigerators and heat pump water heaters based on reported energy savings, and it included seven extra records for the fuel-switching pilot measures. The PY6 sampling plan was designed to meet the target of 70 records with data from Q1 to Q3. Therefore, Cadmus did not request additional rebate forms from the ICSP from Q4.

Cadmus used the distribution of discounted bulbs, by manufacturer and retailer, to develop a strategic sample of manufacturer lighting invoices, but it also made sure to include a diversity of manufacturer and store invoices in the sample.

Cadmus did not conduct any verification activities for the 88 smart strips installed in PY5 and reported in PY6; it did review the installation-tracking workbook provided by the ICSP to compare the quantity with that reported in EEMIS.

The EM&V sampling strategy is summarized in Table 3-4.

Table 3-4: PY6 Residential Retail Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Upstream Lighting Manufacturer Invoice Audit	371	N/A	70	76	Impact; strategic sample
Rebated Equipment	3,401	90/10	70	77	Records review
Database Review (Lighting and Equipment)	Census	N/A	N/A	N/A	Impact; census *ex ante* adjustments
Program Total	**N/A**	**90/10**			

3.3.3 *Ex Ante* Adjustment Methodology and Findings

Cadmus adjusted the reported savings from EEMIS to align with assumptions specified in the 2014 or 2013 Pennsylvania TRM. These TRM *ex ante* adjustments modify the savings reported in EEMIS (when reported *ex ante* savings are placeholders) to reflect the specifications of measures. These adjustments are made to the population and account for differences among planning assumptions, the TRM assumptions, and specifications of the equipment rebated to participants. The results of these adjustments to the population are the adjusted *ex ante* savings used in the equation to determine the program's realization rate.

3.3.3.1 Rebated Equipment

Cadmus looked up specific model numbers for rebated measures, based largely on ENERGY STAR-qualified product lists, to assign the appropriate TRM deemed savings.

For refrigerators, Cadmus made *ex ante* adjustments to each record by looking up model numbers on lists retrieved from the ENERGY STAR and CEE websites. These lists contain estimates of annual energy consumption, as well as volume, which Cadmus used to compute energy savings, in accordance with the TRM. Cadmus used the TRM algorithms,[26] by configuration and model-specific volumes, to compute the baseline usage according to federal standard maximums, then subtracted each unit's annual energy

[26] Table 2-53, column 2, in the 2014 Pennsylvania TRM.

consumption from the calculated baseline, to compute *ex ante* adjusted energy savings. For models for which these data were not available, Cadmus used the Pennsylvania TRM (2013 or 2014) default savings, based on configuration lookups to a list maintained by Cadmus.

The federal efficiency standards for refrigerators changed on September 15, 2014. Because ENERGY STAR and CEE specifications are based upon the percentage of efficiency over the federal standard, this change affects the number of models that qualify for all designation tiers. However, the energy-savings assumptions based on these new standards take effect under the 2015 Pennsylvania TRM. Therefore, it is appropriate to use manufacturers' test data, provided in current or historical qualified product lists, and the TRM baseline algorithms, as described above, to determine energy savings for models installed during PY6.

For heat pump water heaters, Cadmus verified the energy factor and tank size associated with the model number (according to the ENERGY STAR Qualified Product List) to determine the correct level of savings that should be applied (according to the 2014 Pennsylvania TRM). Cadmus confirmed that all 844 records reported in PY6 were for heat pump water heaters with an energy factor greater than or equal to 2.3.

Savings for units with installation dates in PY5 are subject to the 2013 Pennsylvania TRM protocol and are deemed (1,698 kWh and 0.156 kW per heat pump water heater). Savings for units installed in PY6 are based on the 2014 Pennsylvania TRM algorithm, dependent on both energy factor and tank size:

$$\Delta kWh = \left(\frac{1}{EF_{Base}} - \frac{1}{EF_{Proposed} * 0.84}\right) * 3018.0$$

$$\Delta kW_{peak} = \Delta kWh \text{ X } 0.00008294$$

Ex ante reported savings for units installed in PY6 are based on an energy factor of 2.3 and on tank size. In addition, some EEMIS-calculated savings values for heat pump water heaters were incorrect (prior to a correction made in March 2015). Because Cadmus determined both energy factor and tank size, these adjustments increased the savings for units installed in PY6 by approximately 4%.

3.3.3.2 Upstream Lighting

Cadmus reviewed the quarterly EEMIS extracts from PPL Electric Utilities, which contain inputs provided by the ICSP. Bulb type, wattage, lumens, and baseline wattage—along with assumptions deemed by the 2014 or 2013 Pennsylvania TRM, such as in-service rate, hours of use, and coincident peak factor—are used to compute energy and demand savings. Cadmus reviewed inputs such as measure wattage and lumens for reasonability and consistency across multiple records for the same product for the census of records.

Because records reported in PY6 Q1 are for bulbs sold in PY5 and PY6, Cadmus applied the savings algorithms, and baseline-wattage tables from the 2013 Pennsylvania TRM or the 2014 Pennsylvania TRM, depending on the sales date of each specific record.

For bulbs sold in PY5, Cadmus used the 2013 Pennsylvania TRM, Table 3-69: "Baseline Wattage by Lumen Output," to assign baseline wattages to all bulbs (except reflector bulbs) based on the reported lumens for each bulb record. For reflector lamps, Cadmus used Table 3-81 from the 2013 Pennsylvania TRM LED protocol.

For bulbs sold in PY6, Cadmus used the 2014 Pennsylvania TRM Table 2-74: “Baseline Wattage by Lumen Output for General Service Lamps (GSL)” for A-Line bulbs and Table 2-75: “Baseline Wattage by Lumen Output for Specialty Lamps” for candelabra and globe bulbs. Cadmus used text strings from the “Bulb Type” field in EEMIS to categorize bulbs. For reflector lamps, the baseline wattage reported in EEMIS (the manufacturer-rated equivalent wattage) was used, rather than the default table, per the instructions in the 2014 Pennsylvania TRM.

After applying baseline wattages as described, Cadmus used the MEASUREWATTAGE field in the EEMIS extract to compute an evaluated wattage delta for each record for use in the TRM savings algorithm specific to the program year for each record.

As shown in Table 3-5, Cadmus applied sector and program year-specific hours of use, coincidence factor, in-service rate, and interactive effect assumptions to the reported records to compute adjusted savings. The small C&I sector hours of use and coincidence factor assumptions are weighted values, based on mapping PPL Electric Utilities’ small commercial customer records to building types provided in the TRM protocol. The small C&I in-service rate is based on the PY6 small commercial customer survey.

Table 3-5. PY6 Reported and Adjusted Savings, by Quarter and Sector

Quarter	TRM Year	Sector	Qty	HOU	ISR	CF	IE (kWh/KW)	Reported Gross MWh	Reported Gross MW [1]	Adjusted *Ex Ante* MWh	Adjusted *Ex Ante* MW [2]
PY6Q1	2013	Residential	95,263	2.8	95%	0.05	N/A	4,292	0.210	4,240	0.207
PY6Q1	2013	Small C&I	12,990	8.79	89%	0.62	N/A	1,564	0.390	1,701	0.329
PY6Q1	2014	Residential	74,427	2.8	97%	0.091	-6%/+12%	2,490	0.276	2,552	0.271
		Small C&I	10,149	8.79	89%	0.62	+12%/+34%	901	0.232	1,194	0.276
PY6Q2		Residential	187,436	2.8	97%	0.091	-6%/+12%	6,648	0.737	6,759	0.717
		Small C&I	25,560	8.79	89%	0.62	+12%/+34%	2,407	0.619	3,163	0.731
PY6Q3		Residential	270,681	2.8	97%	0.091	-6%/+12%	9,394	1.041	9,494	1.007
		Small C&I	36,911	8.79	89%	0.62	+12%/+34%	3,401	.874	4,443	1.027
PY6Q4		Residential	337,927	2.8	97%	0.091	-6%/+12%	11,794	1.307	11,995	1.273
		Small C&I	46,081	8.79	89%	0.62	+12%/+34%	4,270	1.098	5,614	1.298
Program Total			**1,097,425**	**N/A**				**47,160**	**6.784**	**51,156**	**7.136**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.

[2] *Ex ante* gross demand reductions include T&D losses.

HOU = hours of use; ISR = in-service rate; CF = coincidence factor; IE = interactive effect

3.3.4 *Ex* Post Adjustment Methodology and Findings

3.3.4.1 Rebated Equipment

Cadmus verified rebated equipment by randomly sampling records and reviewing the associated rebate forms and documentation (invoices; Air Conditioning, Heating, & Refrigeration Institute [AHRI] certificates) obtained from the ICSP. Cadmus did not find any errors in its sample of rebate forms for refrigerators or heat pump water heaters nor any incorrect quantities in EEMIS. Therefore, Cadmus did not make any *ex post* adjustments to these measures in PY6.

For fuel-switching pilot measures, eligibility for electricity savings is based on conversion from a standard electric water heater. Cadmus reviewed the rebate forms to ensure the customer indicated replacing an electric water heater. Of the seven forms reviewed, Cadmus found one customer who indicated the existing equipment was not electric and one customer who left this box blank.

Cadmus planned to verify the fuel type of the replaced equipment during its fuel-switching pilot analysis survey, which included participants from both the Residential Retail and the Residential Home Comfort programs. It attempted to contact all eight of the Residential Retail fuel-switching participants; unfortunately, in spite of multiple attempts, none were reached to complete surveys. Therefore, Cadmus made *ex post* adjustments by assigning zero savings to the two records it reviewed for which it was unable to verify the type of fuel replaced. Cadmus calculated a 72% realization rate based on the seven records reviewed and applied this to the savings for the one Q4 record not reviewed, for which the replacement field was blank in both EEMIS and the ICSP's data extract.

3.3.4.2 Upstream Lighting

To determine if bulb quantities in the EEMIS extracts were correct, Cadmus reviewed quarterly reports and monthly invoice summaries prepared by the ICSP and compared the quantities, by bulb type, to those reported in EEMIS. Cadmus also reviewed the per-bulb retail prices and incentive levels for reasonability in preparation for its econometric study. During this review, Cadmus discovered some inconsistencies in pricing data for the same product and some unreasonable promotional prices. The ICSP confirmed that some stock keeping units (SKUs) had been associated with incorrect pack sizes in its database. Because the unit quantities reported by manufacturers are for pack units, the ICSP multiplies these by bulbs-per-pack inputs to translate manufacturer-reported units into a total number of bulbs. Therefore, incorrect pack sizes result in errors in reported quantities and per-unit pricing data. The ICSP conducted its own internal audit, corrected the errors resulting from this issue, and sent Cadmus updated reports, which Cadmus used to confirm corrections to the discrepancies it had discovered during the manufacturer invoice audit and *ex post* adjustment process.

Cadmus upstream lighting manufacturer invoice audit consisted of reviewing bulb model numbers, packs, units, and total incentive amounts to ensure consistency between the manufacturer invoices and the ICSP's invoice summaries. Incorrect pack sizes resulted in overstated quantities for a small number of records; therefore, Cadmus audited a strategic sample of invoices rather than a random sample, as described in Section 3.3.2. Cadmus also verified, through Internet research, the pack sizes for 96% of SKUs treated as multi-packs.

Cadmus made *ex post* adjustments to the records affected by incorrect bulbs-per-pack inputs. Cadmus could confirm or correct the overwhelming majority of bulbs shown as multi-packs. The strategic sample uncovered no data discrepancies of a different nature that would result in incorrect quantities or savings assumptions. Therefore, the review and adjustments are considered comprehensive.

Cadmus used the ICSP's updated report—and an additional measure-level adjustment for the one SKU that was not corrected in the updated report—to compute a realization rate for each job, by dividing each job's total corrected quantity by the total quantity reported in EEMIS. Applying these rates to the record-level quantities from EEMIS data resulted in the total *ex post* verified savings for PY6.

3.3.4.3 Combined Results

The evaluation results for both program components, by measure, are shown in Table 3-6 and Table 3-7.

Table 3-6: PY6 Residential Retail Summary of Evaluation Results for Energy[1]

Stratum	PYTD Reported Gross Impact (MWh/yr)	PYTD Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	PYTD Verified Gross Energy Savings (MWh/yr) [2]	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
ENERGY STAR Refrigerators	303	268	100%	268	0	0.%
Fuel Switching Water Heaters	26	26	72%	19	0.67	14.73%
Heat Pump Water Heaters	1,482	1,524	100%	1,524	0	0%
Smart Strips	16	16	91%	15	N/A	N/A
Upstream Lighting	47,160	51,156	97%	49,638	0.74	12.00%
Program Total	**48,987**	**52,990**	**97%**	**51,463**	**0.94**	**11.57%**

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

Table 3-7: PY6 Residential Retail Summary of Evaluation Results for Demand

Program	PYTD Reported Gross Demand Savings [1] (MW)	PYTD Adjusted *Ex Ante* Demand Savings [2] (MW)	Demand Realization Rate (%)	PYTD Verified Gross Demand Savings [2] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
ENERGY STAR Refrigerators	0.035	0.03454	100%	0.03454	0	0%
Heat Pump Water Heaters	0.128	0.14192	100%	0.14192	0	0%
Fuel Switching Water Heaters	0.002	0.00247	71%	0.00175	0.70	15.49%
Smart Strips	0.001	0.00124	92%	0.00113	N/A	N/A
Upstream Lighting	6.784	7.73047	98%	7.57858	0.74	12.00%
Program Total	**6.949**	**7.911**	**98%**	**7.758**	**0.95**	**11.72%**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex Ante* and Verified gross demand reductions include T&D losses.

3.4 IMPACT EVALUATION NET SAVINGS

Cadmus conducted an analysis to determine net savings for the Residential Retail Program. Net savings are determined only for future program planning purposes. Phase II energy savings and demand reduction compliance targets are met using verified gross savings.

3.4.1 Net-to-Gross Ratio Methodology for Rebated Equipment

The methods used to determine net savings for downstream programs were defined by the SWE, including instructions provided in the Evaluation Framework and Guidance Memos. Cadmus typically determines net savings by assessing freeridership and spillover.

For the rebated equipment component of the Residential Retail Program, Cadmus included freeridership and spillover ratio estimates, in accordance to the SWE's net-to-gross guidelines, which relies on self-report survey information from participating customers. Table 3-8 summarizes the sampling strategy for the rebated equipment participant survey.

Table 3-8: PY6 Residential Retail Sampling Strategy NTG Research—Rebated Equipment

Stratum	Stratum Boundaries	Population Size	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
Residential Retail Equipment Participants	Participants who installed a rebated measure in PY6	1,405	0.5	90/10	150	150	62%

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completes.

The net-to-gross results for the rebated equipment component of the program are shown in Table 3-9. Although the survey sample sizes to compute the PY6 freeridership estimates were not designed to produce statistically valid results at the product level, we noted that the estimated freeridership level for respondents who purchased refrigerators was 65% (n=75), close to the PY5 estimate of 67%, compared to 39% (n=75) for respondents who purchased heat pump water heaters (HPWHs). Surprisingly, the estimated freeridership level for participants who received a $100 rebate (64%; n=45) was only slightly lower than for those who received a $25 rebate (67%; n=30).

Table 3-9: PY6 Residential Retail Summary of Evaluation Results for NTG Research—Rebated Equipment

Target Group or Stratum (if appropriate)	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Residential Retail Equipment	0.43[1]	0.03	0.60	0.051	9%

[1] Survey sample sizes were determined for the program but not designed to assess individual measures offered in the program. Therefore, measure level assessments of freeridership are for information purposes and are not designed to determine statistical significance. Freeridership was estimated for the heat pump water heater and refrigerator equipment measures, 39% and 65%, respectively. These estimates were weighted by the survey sample-verified program kWh savings. This method ensures that respondents who achieved higher energy savings through the program measures are given a greater influence on the measure level freeridership estimate than those respondents who achieved lower energy savings. The measure level freeridership estimates were then weighted by the measure's *ex post* kWh program population savings to arrive at the final equipment stratum freeridership estimate of 43%.

3.4.2 Net-to-Gross Ratio Methodology for Upstream Lighting

The methods used to determine net savings for upstream programs were discussed in ongoing meetings with the NTG working group, led by the SWE, and attended by the EDCs and their EM&V CSPs. These group discussions, and memos issued by the SWE on the subject, presented a number of approaches to determine net savings and market effects of upstream lighting programs. Developing an EDC-consistent method and net-to-gross protocols for upstream lighting is difficult for several reasons, including, for example, the difficulty identifying purchasers of bulbs discounted in the upstream program—whether by store intercept studies or general population surveys; the lack of sales data in the market as a whole (particularly nonparticipating retail stores) and the proprietary nature of these data; and the difficulty of collecting all program data to confidently estimate price response and sales lift attributable to the program.

The SWE team, the EDCs, and their EM&V CSPs determined that there is not one single method that can reliably estimate net savings for upstream lighting program. Because it is difficult the assess, the SWE suggested the EDCs collect data for a number of market progress indicators, in addition to other evaluation activities and analyses planned to assess the upstream lighting programs. During the March 2015 meeting with the SWE's NTG working group, the SWE and EDCs agreed that one analysis method alone cannot fully demonstrate the net effects of an upstream lighting program, and that multiple methods and perspectives are needed to tell a more robust story about the market effects of upstream programs, and in PPL Electric's case, their contribution to the market's transition from CFLs to LEDs.

Cadmus conducted several analyses designed to assess market effects of the upstream lighting component of the Residential Retail Program. These are discussed in detail in section 3.6 of this chapter, Process Evaluation for Upstream Lighting. Activities included:

- Price Response Demand Modelling (discussed below and in 0)
- Act 129 cross-program participant surveys (n=300)
- General residential population surveys (n=301)
- General small business population surveys (n=385)
- Lighting manufacturer interviews (n=8)
- Longitudinal shelf-stocking study (n=37 stores)

3.4.2.1 Demand Elasticity Model Estimates of Freeridership

To estimate freeridership for the Residential Retail Program's upstream lighting component, Cadmus conducted demand elasticity modeling using bulb sales information from the ICSP. Lighting products that incur price changes and promotion over the program period provide valuable information regarding the correlation between sales volume and prices. Using price elasticity to estimate freeridership is the same principle applied in the willingness-to-pay analyses using self-report survey responses as in Phase I. However, rather than relying on self-report data, elasticities are based on actual observed changes in purchasing behavior in response to program activity. Cadmus conducted demand modeling to determine freeridership in PY5.

All available data were used for this analysis in PY6. Overall the model relied on products with price variation that accounted for 61% of total lamp sales in PY6.[27]

[27] Products with no price variation provide no information to quantify the relationship between sales and price and are therefore not included.

Table 3-10: PY6 Residential Retail Sampling Strategy NTG Research—Upstream Lighting

Stratum	Stratum Boundaries	Population Size	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample
Residential Retail Upstream Lighting Program Component	All available data	All records	N/A	N/A	N/A	N/A	N/A
Upstream Lighting Component	All available data	All records	N/A	N/A	N/A	N/A	N/A

Table 3-11: PY6 Residential Retail Summary of Evaluation Results for NTG Research—Upstream Lighting

Target Group or Stratum (if appropriate)	Freeridership Estimated from Demand Elasticity Model	Estimated Participant Spillover	NTG Ratio Estimated from Demand Elasticity Model	Observed Coefficient of Variation or Proportion	Relative Precision
Upstream Lighting Component	Preliminary - 48%	0%	52%	0.22	34%
			Adjusted - 75%		

The estimated freeridership from the demand elasticity model was 48% for the upstream lighting component as a whole. This means that the program effectively doubled the number of LEDs sold in the service territory in PY6, selling just over one million LEDs.

The results of the elasticity model suggest that freeridership varies by retail channel,[28] with Do-It-Yourself (DIY) store shoppers being least price sensitive (or the prices are already competitive), and Mass Market and Club stores are more price sensitive. The model estimated freeridership to be roughly 14% for big box stores, roughly 40% for club stores, and roughly 58% for DIY stores. The differences may be due to differences in customer demographics, and the size of price discounts offered in the stores. (See Appendix E: Demand Elasticity Study for a discussion of methodology and findings.)

The net-to-gross estimate in Table 3-11 reflects only one analysis, the demand elasticity model. This estimate determined from the elasticity model is more accurately a net-of-freeridership estimate as the model does not account for spillover or market effects. Therefore the estimate is likely the floor, or lower limit, of the net-to-gross ratio for the program as there are additional effects of the program that are influencing the efficient lighting market more broadly.

Additionally, as discussed further in Appendix E, data anomalies and lack of data regarding merchandising and promotional activities limited the analysis. Because the impact of merchandising is substantial, Cadmus will work with the ICSP to improve data tracking for subsequent program years.

This demand elasticity study found higher levels of freeridership in PY6 for LEDs than the model estimated for CFLs in PY5: 16% freeridership. Considering this is the first year for LEDs, data issues with the demand model, no estimate of nonparticipant spillover, and the preponderance of evidence from the upstream

28 The individual estimated coefficients – elasticities by channel as well as displays – and model results are presented in detail in Appendix E.

lighting market effects studies discussed in the next sections, Cadmus concludes the net-to-gross ratio estimate is too low. We propose the NTGR is more likely about 75%. The freeridership and NTGR estimates will be updated in PY7 and the first year of Phase III as more data on the LED market becomes available.

3.4.2.2 Upstream Lighting Market Effects

It is important to reiterate, however, that the econometric analysis cannot capture market effects or spillover. It is very likely that utility sponsored upstream lighting programs are accelerating the rate at which customers are converting to LEDs and the rate at which the market for LEDs is maturing. This could be especially true for PPL Electric Utilities, which transitioned from offering discounts for CFLs in Phase I and PY5 to discounting only LEDs by the beginning of PY6.

The preponderance of evidence, discussed in more detail in Section 3.6 of this chapter, suggests that PPL Electric's financial incentives to discount the price are helpful in transitioning the market to LEDs. For example, manufacturers consistently indicate that utility incentives are instrumental in LEDs' acceptance in the market. Both manufacturers and customer self-report willingness to pay responses indicate there is a threshold price at which LEDs are much more likely to be considered. Current research indicates that there are two thresholds, one at $10 per lamp, and one at $5 per lamp.

Market progress indicators assessed a number of LED attributes in addition to willingness to pay. Customers are satisfied with the light quality of LEDs. With all of the customer engagement and events to educate customers about choosing the right lamp or color temperature, it is possible, if not likely, that many of the 2015 freeriders were converts in 2014 or repeat customers in 2015.

Additionally, the impact of displays estimated by the model suggests that, on average, off-shelf placement increases sales by 67%. This specific impact is captured in the econometric model, however, successful merchandising and customer acceptance of LEDs likely influence merchandising decisions more broadly. For example, one major retailer completely reorganized their lighting aisle in early PY6 to feature LEDs at the front of the aisle. Although there is no way to quantify the influence of the program, the fact that, with utility incentives, many general purpose LEDs are selling below the $5 per lamp threshold could be one of the factors influencing the retailer's decision to feature LEDs.

Respondents to the general residential population survey (n=301), as well as the surveys conducted with the Residential Behavior and Education treatment group (n=361) and the control group (n=180) all indicated recent purchase of some type of screw in bulb (65% of general residential survey population). Nearly the same percentage of treatment and control group respondents to the Residential Behavior and Education survey reported purchasing CFLs and LEDs (treatment group: 63% LEDs and 64% CFLs; control group: 60% LEDs and 61% CFLs). However, due to differences in the design and delivery of survey questions, it is likely that the Residential Behavior and Education survey respondents were referring to the purchase of general screw in bulbs, rather than differentiating between technology types. If that is the case, a small percentage actually purchased an LED; the general residential population survey indicated 16% of respondents purchased a screw-in LED.

Although the general population survey found residential customer' purchases holding steady, Cadmus found that small businesses are increasing their LED purchases. Small businesses reported they care most about energy use and cost, and indicated a greater willingness to pay for LEDs than seen in the PY5 surveys.

The longitudinal shelf stocking study shows a significant drop in LED prices, at both participating and nonparticipating retailers, between 2014 and 2015. LED prices, as expected, were lower at participating retailers, but the drop in prices between the years was actually more dramatic at nonparticipating retailers. Still, the average price of general service LED at a nonparticipant store, at over $14, was still out of the range most respondents indicated a willingness to pay.

Addendum G of this chapter shows total bulb sales from a high of 2.7 million CFLs in PY2 to 1.5 million in PY5. In PY6, about 1 million LEDs were discounted. Clearly, customers buy large numbers of screw-in bulbs. Surveys and interviews indicated that in the absence of affordable LEDs, customers are more likely to revert to halogens than CFLs.

A number of conclusions and recommendations offered in section 3.7 of this chapter address findings related to the upstream lighting market effects studies.

3.5 Process Evaluation For Rebated Equipment

3.5.1 Research Objectives

The purpose of the process evaluation was to assess, and provide recommendations for improving, the program's effectiveness in achieving its objectives, which are to:

- Achieve widespread visibility through independent and regional retailers that carry the eligible ENERGY STAR products.
- Engage retailers by educating and training sales associates about the program-rebated energy-efficient equipment.
- Provide a one-stop call and rebate processing center that will also promote other PPL Electric Utilities energy efficiency programs.

Cadmus designed the process evaluation activities to assess:

- Effectiveness encouraging customers to install energy-efficient products
- Customer satisfaction
- Opportunities and barriers to promoting optimal participation
- Possible program enhancements

3.5.2 Evaluation Activities

For the equipment component of the Residential Retail Program, the PY6 process evaluation activities are listed here and discussed in the next section on methodology. These activities were consistent with those outlined in the PY6 EM&V Plan, with the exception of the cross-program participant survey, which was not specifically part of the evaluation plan for this program but was part of a portfolio-level analysis.

- Program staff and implementer interviews (n=2)
- Participant surveys (n=150)
- Cross-participant surveys (n=66)[29]
- Interviews with licensed plumbers or contractors (n=9)

[29] The cross-program survey included participants of the Residential Retail, Residential Home Comfort, and Appliance Recycling programs. Cadmus completed 300 cross-program surveys but are only discussing the results from the Residential Retail program in this report.

- Database and quality assurance/quality control (QA/QC) review of records

The sampling strategy for the Residential Retail Program is presented in Table 3-12.

3.5.3 Methodology

3.5.3.1 Program Staff and Implementer Interviews

Cadmus interviewed Residential Retail Program managers from PPL Electric Utilities and the ICSP to gain a thorough understanding of the program process for the current year and to discuss their perspectives about processes that are working well as well as areas experiencing challenges.

3.5.3.2 Participant Surveys

Cadmus conducted surveys with Residential Retail Program participants who installed their equipment and received a rebate in PY6. The primary purpose was to assess customer satisfaction, the effectiveness of the program, freeridership, and to support an analysis of fuel-switching behavior (heat pump water heater rebates). We prorated according to the targets shown above in Table 3-12 (on next page).

The sample excluded customers who had completed a survey in the past year (as required by PPL Electric Utilities) or requested not to be contacted. It also excluded any participants of the new homes component of the Residential Home Comfort Program to reserve them for inclusion in the limited sample pool for that program-specific survey. From this sample frame, Cadmus selected a simple random sample (probability sampling).

The participant pool and survey sample were screened to determine whether customers applied for more than one rebate and which products were rebated. If records indicated multiple products were rebated, the product with the largest claimed savings was the focus of the survey.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

Cadmus fielded the participant surveys during May, June, and July of 2015.

3.5.3.3 Cross-Participant Survey

Cadmus conducted a cross-program survey in PY6 that targeted customers participating in one of these general residential rebate programs—Appliance Recycling, Residential Home Comfort (equipment, weatherization, and audit), and Residential Retail (heat pump water heaters only). A total of 66 surveys were completed with participants of the Residential Retail Program.

Table 3-12: PY6 Residential Retail Equipment Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or Cv in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percentage of Sample Frame Contacted [1]	Evaluation Activities
PPL Electric Utilities Program and CSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, Impact, Program Staff Interview, Census
Residential Retail Equipment Participants	Participants who installed a rebated measure in PY6	1,405	0.5	90/10	150	1,190 [2]	150	74%	Process, impact, participant survey, simple random sample
Cross-Program Survey	Residential Retail Participants (Q1-Q2) [3]	2,731	0.5	90/10	300 [4]	706 [5]	66	95%	Process, estimate low income participation, residential program participants, probability sample, simple random sample
Heat Pump Water Heater Installer Interviews	Water heater installers or sales staff	Unknown	N/A	N/A	10-15	75 [6]	9	100%	Process, market effects, strategic sample

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews.
[2] We removed 215 because they were duplicates, were included in other sample frames, were inactive customers, were incomplete records, completed a survey in the past year, or requested not to be contacted.
[3] Cross-program survey included participants of the Residential Retail, Residential Home Comfort, and Appliance Recycling programs. Cadmus completed 300 cross-program surveys but the results in this table and report reflect only those records and surveys completed for the Residential Retail Program.
[4] We completed surveys within all three programs until we reached the overall goal of 300.
[5] We selected a random sample of 1,004 records and removed 298 because they were duplicates, were included in other sample frames, were inactive customers, were incomplete records, completed a survey in the past year, or requested not to be contacted.
[6] We removed 27 because the phone number was missing or incomplete or was a duplicate retailer.

The primary purpose of this cross-program survey was to obtain a preliminary estimate of low-income participation in programs that are not specifically targeting this sector (i.e., programs that do not require income verification). We excluded only those customers who participated in surveys within the last year or who requested not to be contacted. From this sample frame, we selected a random sample (probability sampling), but we did not stratify the sample by program. Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by applying random sampling whenever possible and using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

Although the primary purpose of the survey was to estimate low-income participation, we used the opportunity to gather additional data such as program satisfaction, energy efficiency behaviors, and challenges, the findings for which are aggregated with the Residential Retail Program participant survey results and summarized in this report.

Cadmus fielded the phone surveys during March and April 2015.

3.5.3.4 Water Heater Installer Interviews

During the months of June and July, 2015, Cadmus interviewed nine water heater installers in PPL Electric Utilities' service territory to learn if new outreach strategies that targeted professional water heater installers could increase purchases of heat pump water heaters in Phase III.

Cadmus used existing program data to obtain contacts for plumbers who installed a rebated heat pump water heater, regardless of whether they work for a participating retailer. We refer to these respondents as participants. The sample of nonparticipating general plumbers was created by conducting an Internet map search for licensed plumbers within PPL Electric Utilities' service territory. For nonparticipating water heater installers, Cadmus created two sample pools—general plumbers and plumbers who specifically promote the installation of heat pump waters heaters.

Our sampling strategy was not designed to provide statistically representative findings, and it is subject to potential bias. Additional information about dialing rules, attrition, and final disposition of the sample is in Addendum B. Water Heater Installer Interviews.

3.5.3.5 Database and Records Quality Control Review

Cadmus reviewed and verified the rebated equipment measures via desk audits of a simple random sample of rebate forms. We also used the ENERGY STAR- and CEE-qualified product lists to look up model-specific inputs and make adjustments to savings estimates based on either the 2013 or the 2014 Pennsylvania TRM, depending on the year within which the measure was installed. A more detailed description of our sampling and methodology can be found in Section 3.3 of the impact report.

Table 3-13: Database and Records Review

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Rebated Equipment	3,401	90/10	70	77	Records review
Database Review (Lighting and Equipment)	Census	N/A	N/A	N/A	Impact; census *ex ante* adjustments
Program Total	**N/A**	**90/10**			

3.5.4 Achievements Against Plan

Table 3-14 contains the Residential Retail Program's planned energy savings and incentives and the progress on these. PPL Electric Utilities' EE&C Plan did not separate the annual plan for the upstream lighting component from the equipment component; therefore, the table provides planned and achieved savings for the program as a whole.

Table 3-14: Residential Retail Program Savings[1]

	PY5 Verified	PY6 Only			Phase II: PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	90,314	50,180	51,463	103%	191,861	141,777	74%
MW[2]	8.92	9	7.758	86%	35.45	16.678	47%
Participants	8,204	N/A	3,481	N/A	N/A	11,685	N/A

[1] Planned savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table E6, p.56. The table includes both equipment and upstream lighting.
[2] Planned and verified MW savings include line losses.

The Residential Retail Program achieved 103% of its planned PY6 MWh savings, based on verified gross savings. It achieved 86% of the planned MW, based on verified gross savings. Although there is no Phase II compliance target for MW, Cadmus notes that the discrepancy between the achieved percentage of planned MWh and achieved percentage of planned MW is due to the fact that the planned MW savings are based on end-use load profiles, not the coincidence factors deemed in the Pennsylvania TRM.

3.5.5 Program Delivery

The ICSP manages the processing of rebate applications and provides promotional materials to participating retailers. However, participants may purchase eligible equipment from any retailer, not just participating retailers. According to program staff, during PY6 the Residential Retail Program was delivered effectively and efficiently and the ICSP met its program goals and forecast sales. Cadmus found some issues related to the eligibility criteria and rebate levels for ENERGY STAR refrigerators that led to confusion and dissatisfaction on the part of some participants, as discussed in Program Satisfaction.

3.5.5.1 Logic Model

During PY5, Cadmus developed a logic model and process flow maps for the Residential Retail Program. At the end of PY6, we reviewed the logic model to determine if the program had changed and found that the model is still applicable to the program process in PY6. Additional information can be found in Addendum C. Logic Model.

3.5.5.2 Key Performance Indicators

Aside from planned savings, PPL Electric Utilities and the ICSP do not currently track or have specific non-energy savings goals or metrics. Program staff reported that one of the internal metrics it is monitoring involves engaging an ample distribution of retailers, by both geography and retail channels. The ICSP is working with a data visualization tool to help it identify and expand the geographic coverage of participating retailers.

3.5.6 Participant Profile

Of the products reported and rebated in PY6,[30] 467 were ENERGY STAR refrigerators, 429 were ENERGY STAR Most Efficient or CEE Tier 3 refrigerators, and 538 were heat pump water heaters.

Ninety-five percent of heat pump water heater survey respondents (n=108) and 84% of refrigerator respondents (n=106) live in a detached, single-family home. Only 4% of heat pump water heater respondents said they live in an attached or row house, compared to 12% of refrigerator respondents. Ninety-seven percent of survey respondents own their own home (n=216).

3.5.7 Satisfaction

3.5.7.1 Program Satisfaction

Overall satisfaction with the rebated equipment component was high in PY6, with 69% of all survey respondents (n=216, including participants from the cross-program survey) saying they were *very satisfied* and 25% saying they were *somewhat satisfied* with their overall experience.

The majority of Residential Retail Equipment survey respondents (77%, n=150) said they were *very satisfied* with the equipment they purchased (16% said they were *somewhat satisfied)*. These metrics are similar to those in PY5, when 75% of respondents said they were *very satisfied* and 22% were *somewhat satisfied.*

Table 3-15 contains the satisfaction findings of various aspects of the rebate component among refrigerator and heat pump water heater purchasers.

3.5.7.2 Reasons for Dissatisfaction

Survey respondents said they were *dissatisfied* (n=92, less than *very satisfied)* because rebates took too long (25%), the rebate involved a cumbersome or back-and-forth process (26%), or they received conflicting information regarding qualification requirements (11%).

Responses from PY6 participants indicated an increase in rebate processing times over PY5; almost one-third of respondents (n=150) said they waited more than eight weeks to receive a rebate, compared to 11% in PY5. Cadmus compared these customers' reported processing times against the dates provided in tracking data from the Energy Efficiency Management Information System (EEMIS); although about half of these rebates did appear to have taken more than six weeks, some appeared to have been processed more quickly than customers reported. However, this could be due to the fact that the ICSP "resets" the received date when an application is returned to a customer because it lacks the required information.

[30] Total quantities and savings reported in PY6 include equipment installed in PY5; the participant survey and analysis focuses on participants who installed rebated equipment in PY6.

Table 3-15: Satisfaction with Rebates

Product	Rebate Amount			Rebate Form			Ease of Rebate Process		
	Very Satisfied	*Somewhat Satisfied*	*Not too or Not at all Satisfied*	*Very Satisfied*	*Somewhat Satisfied*	*Not too or Not at all Satisfied*	*Very Satisfied*	*Somewhat Satisfied*	*Not too or Not at all Satisfied*
ENERGY STAR Refrigerator (n=30)	40%	33%	24%	53%	20%	14%	70%	20%	10%
Most Efficient or CEE Tier 3 Refrigerator (n=45)	69%	20%	7%	60%	31%	2%	69%	22%	6%
heat pump water heater (n=75)	69%	27%	1%	64%	23%	5%	59%	23%	13%
Source: Question G1 b-d: "How satisfied were you with..."									

3.5.7.3 Satisfaction with PPL Electric Utilities

Overall satisfaction with PPL Electric Utilities as a provider of electric service was high. Eighty-five percent of respondents (n=216) rated their satisfaction as eight or higher (on a scale of 1 through 10), which is similar to findings in previous years (81% rated PPL Electric Utilities as 8 or higher in PY5). Five percent rated PPL Electric Utilities as seven, and 10% gave a rating of six or lower.

Thirty-three percent of respondents (n=216) said their opinion of PPL Electric Utilities improved at least *somewhat* after participating in the program (27% said *somewhat* and 6% said *very)*. Respondents who received a rebate for a heat pump water heater (n=108) were more likely to report an improved opinion of PPL Electric Utilities (38% said their opinion of PPL improved at least *somewhat*) than those who received a rebate for an ENERGY STAR or ENERGY STAR Most Efficient (24% and 27%, respectively) refrigerator.[31]

3.5.8 Marketing and Outreach

3.5.8.1 PPL Electric Utilities and ICSP Marketing

With approval from PPL Electric Utilities, the ICSP plans, creates, and implements marketing activities and materials that are specific for the equipment component of the Residential Retail Program. Marketing materials include posters to display at participating retailers and "ribbons" on refrigerators to indicate which models are eligible for incentives and describing the incentive levels.

Customer feedback, as reported by the ICSP and observed in survey findings by Cadmus, indicates some inconsistency in the information displayed by retailers and in the rebate customers actually received. In addition, the ICSP reported that some staff at participating retailers were still confused about which models met the criteria for higher rebate tiers.

Although most respondents who purchased a refrigerator (68%, n=75) said they knew that some ENERGY STAR models were labeled or designated Most Efficient or Tier 3, the majority (77%, n=75) said they did

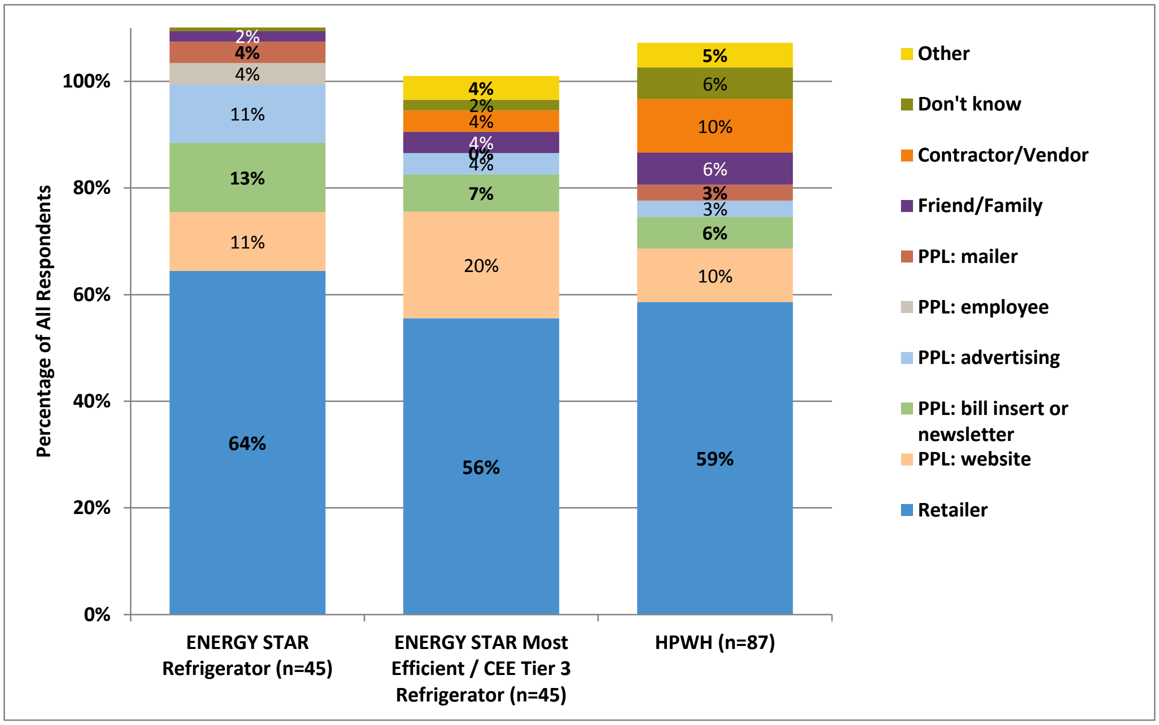
31 This difference is statistically different at 90% confidence.

not know that PPL Electric Utilities offered different rebate amounts for different levels of energy efficiency. Only 39% (n=75) said they knew what rebate amount the model they purchased qualified for. Of these, 83% (n=29) learned of the rebate amount from retail floor staff or a sticker on the unit, and 14% learned from PPL Electric Utilities' website link to the ENERGY STAR-qualified product list. About half of the respondents who purchased a base tier refrigerator (48%, n=23) said they did not get the amount they expected.

3.5.8.2 Program Awareness

The majority of participants (60%, n=178) learned about the Residential Retail Program through a retailer, as shown in Figure 3-1. Only 10% of heat pump water heater participants (n=87) said they heard about the rebate from a contractor. These findings are similar to those in PY5.

Figure 3-1: How Respondents Learned about the Residential Retail Equipment Program

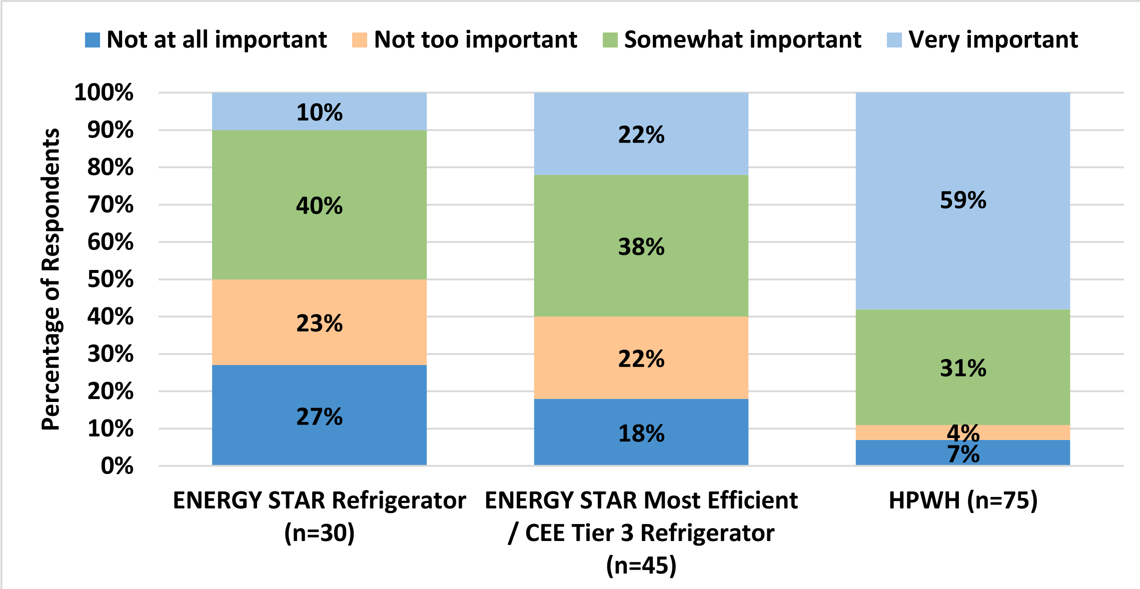


Source: Question B1: "How did you learn about PPL Electric Utilities' Residential Retail Program? Was it from PPL Electric Utilities, from a contractor or retailer, from a friend or family member or some other way?" This was a multiple-response question so the number of distinct responses add up to more than 100%.

3.5.9 Influence of Rebate

When asked how important getting the rebate was to their decision to install their equipment, 59% of respondents who purchased heat pump water heaters (n=75) said it was *very important*, compared to 22% who received a rebate for a higher-tier refrigerator (n=45) and only 10% who purchased a base-tier refrigerator (n=30). Figure 3-2 shows the importance of the rebate in customers' decisions to install new equipment.

Figure 3-2. Influence of Rebate



Source: Question G5: "When you were considering the purchase of your ___, how important was getting the $ AMT rebate from PPL Electric Utilities in your decision to install the ___? "

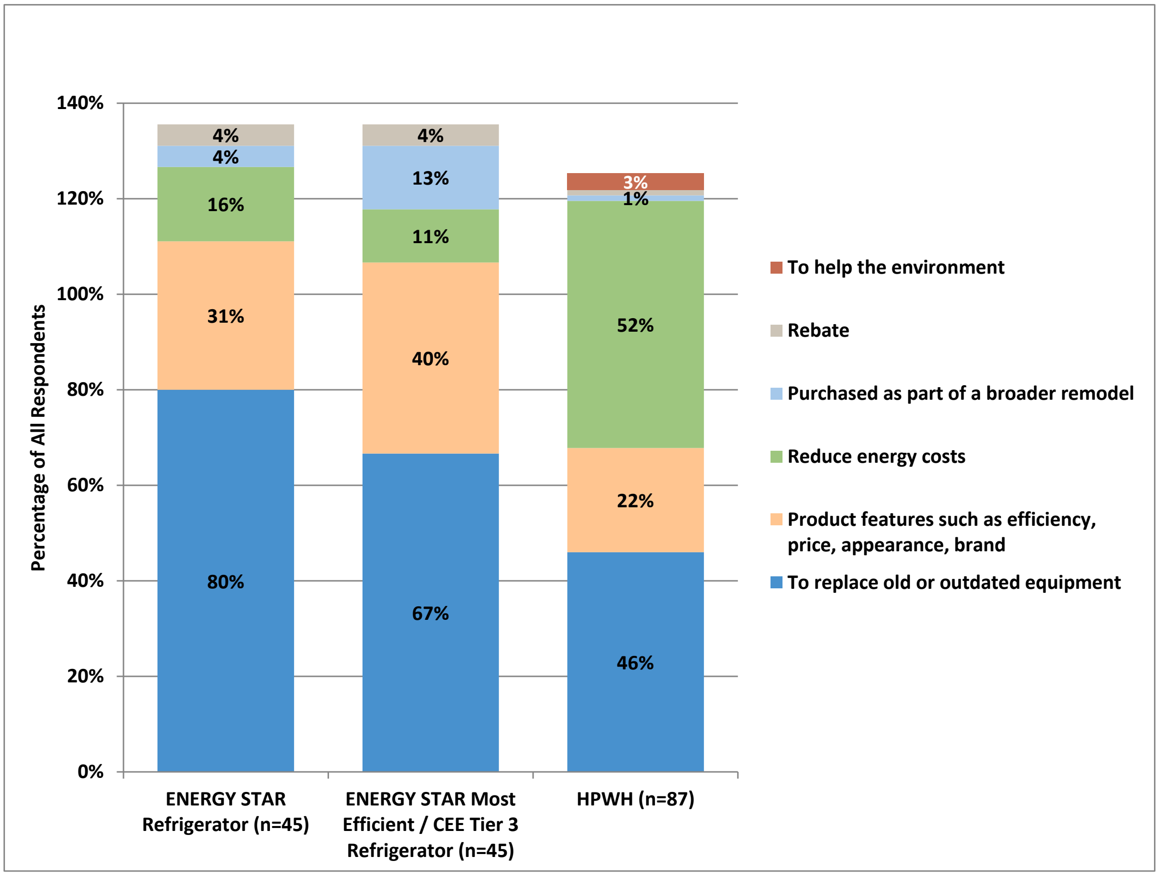
Although the survey sample sizes to compute the PY6 freeridership estimates were not designed to produce statistically valid results at the product level, we noted that for respondents who purchased refrigerators, the estimated freeridership was 65% (n=48), close to the PY5 estimate of 67%. For respondents who purchased heat pump water heaters, the estimated freeridership was 39% (n=75). Surprisingly, the estimated freeridership level for participants who received a $100 rebate (64%, n=30) was only slightly lower than for those who received a $25 rebate (67%, n=18).[32]

3.5.10 Purchase Decisions

Cadmus asked respondents why they purchased their rebated equipment; more respondents who purchased refrigerators (n=90) said they were replacing old equipment or chose the equipment based on its features than did respondents who purchased heat pump water heaters (n=87), who more commonly said they wanted to reduce energy costs. Respondents who chose the higher-efficiency refrigerators (n=45) appeared to be more inclined to look at product features (these models tend to be high-end and expensive with more features) than those who chose a base-tier refrigerator who were more likely to say they were simply replacing existing equipment. Figure 3-3 shows the reasons respondents purchased equipment.

[32] This difference is not statistically significant at 90% confidence.

Figure 3-3: Reasons Respondents Purchased Equipment

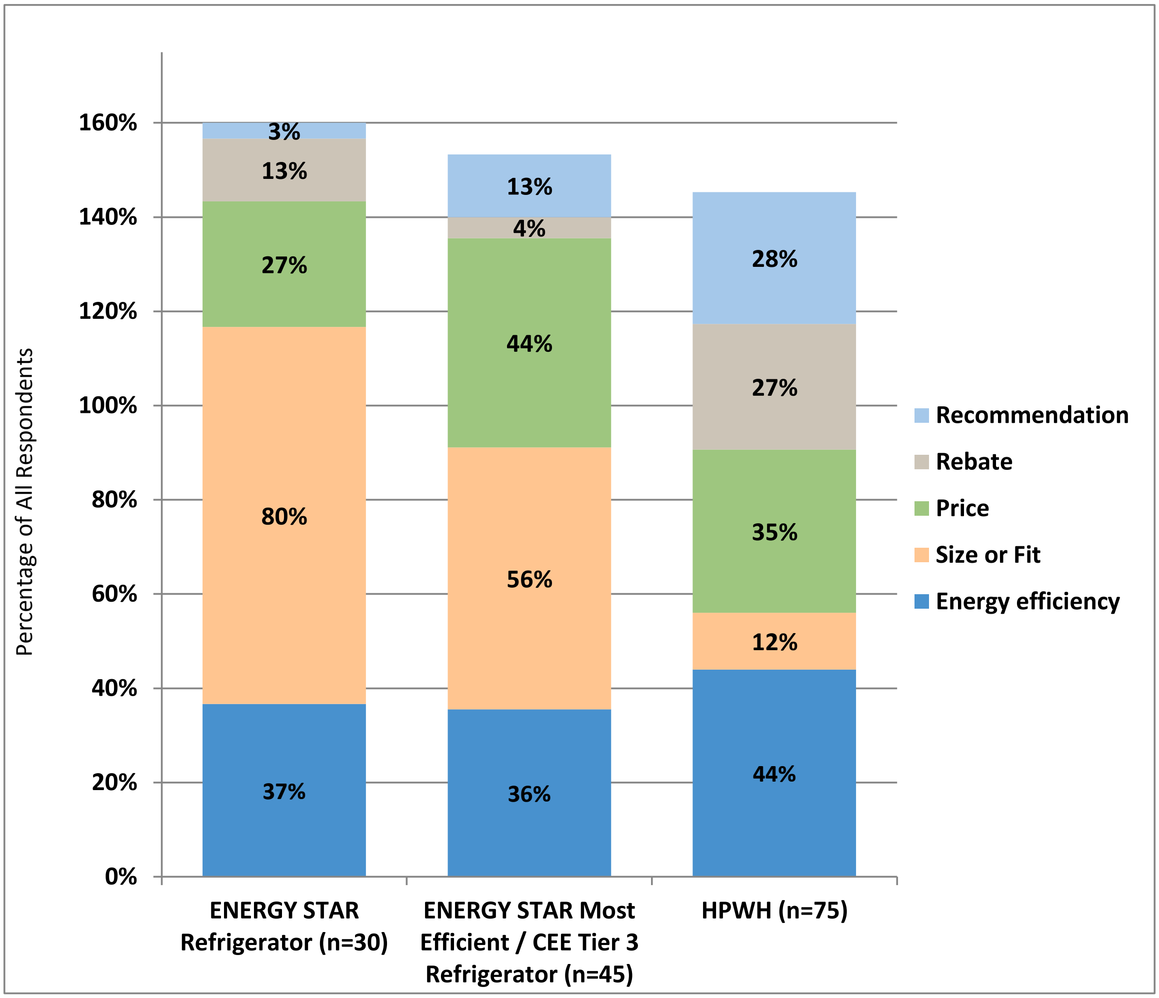


Source: Question D1 “What were the major reasons you purchased the __”? This was a multiple-response question so the number of distinct responses add up to more than 100%.

Respondents answered a question about why they purchased a specific model. The most common response from participants who purchased refrigerators regarded size or fit. Notably, respondents who purchased the most efficient refrigerators were not more concerned with energy efficiency or the rebate.

Respondents who purchased heat pump water heaters most commonly cited energy efficiency, followed by price, and the rebate. The five most commonly cited reasons are shown in Figure 3-4.

Figure 3-4: Five Most Common Reasons for Choosing Equipment Model

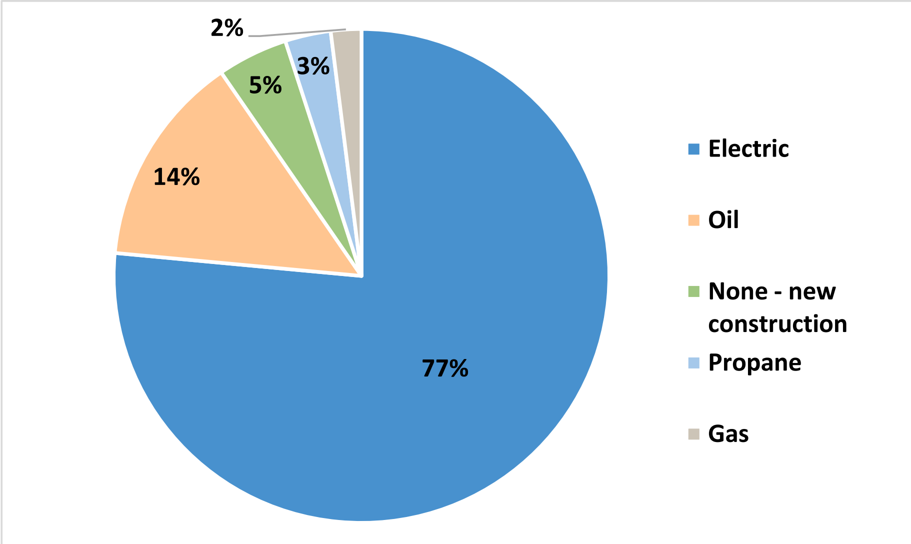


Source: Question D2. What were the top three reasons why you chose the exact model of the ____?

3.5.10.1 Heat Pump Water Heater Replacements

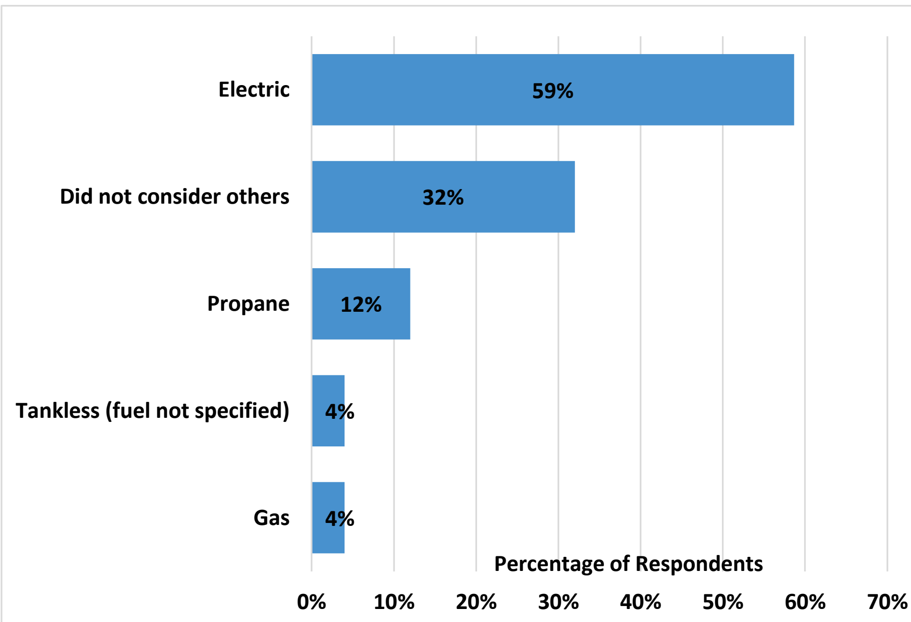
Although only 10% of respondents who purchased heat pump water heaters (n=87) learned about the program from a contractor or installer, when asked if a contractor or plumber recommended the installation, 23% said one did. The majority (77%, n=108) replaced an electric water heater, as shown in Figure 3-5. Although 14% replaced an oil water heater, none of these respondents said they considered an oil heater as a replacement option, as shown in Figure 3-6.

Figure 3-5: Types of Water Heaters Replaced with a Heat Pump Water Heater



Source: Question D4. "What type of water heater did your heat pump water heater replace? (n=108)"

Figure 3-6: Other Water Heater Options Considered by Heat Pump Water Heater Purchasers



Source: Question D3a. "What other types of water heaters did you consider?" (n=75)

Eighty-five percent of heat pump water heaters (n=75) were installed in basements.[33] Only 7% were installed in utility rooms and 5% were installed in garages.

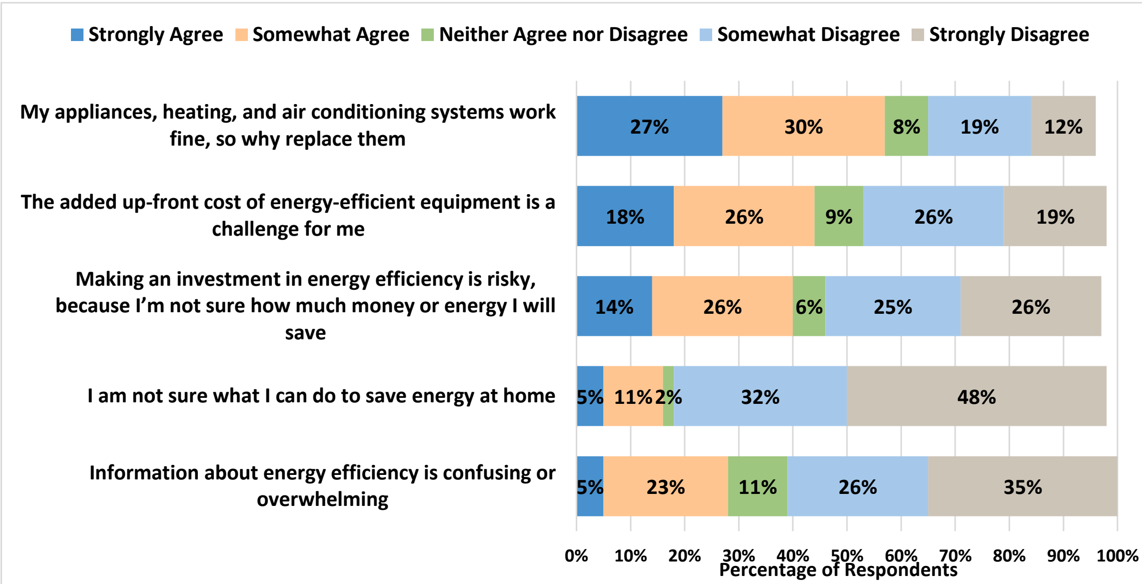
---

33 Cadmus did not ask participants to specify whether basements were conditioned or unconditioned.

3.5.11 Energy Efficiency Knowledge and Challenges

Respondents answered questions about whether they agreed or disagreed (*strongly, somewhat,* or *neither*) with hypothetical scenarios that people might face when purchasing new appliances or considering energy-efficient improvements to their home. Respondents were split on whether they agreed with statements regarding investments or choices to replace equipment, but they tended to disagree with statements implying lack of knowledge about energy efficiency. Their responses are presented in Figure 3-7.

Figure 3-7: Respondents Reactions to Scenarios Regarding Energy Efficiency Purchases or Improvements



Source: Question J10 "I'm going to read a list of scenarios that people might face when purchasing new appliances or considering energy-efficient improvements to their home. The first statement is___" (n=216).

3.5.12 Water Heater Installer Interview Findings

Most of the water heater installers who were not affiliated with a participating retailer were not aware of PPL Electric Utilities' rebate program. These nonparticipants did not sell many heat pump water heaters and also tended to be less educated about the technology. However, most thought they could sell more heat pump water heaters with a direct incentive, indicating they are open to changing their standard practice.

Respondents from participating retailers sell a substantial number of heat pump water heaters and are enthusiastic about them. They actively market both PPL Electric Utilities' rebate and heat pump water heater technology in general as an energy and cost-saving investment.

Seven of the nine total respondents (affiliated or not with a participating retailer) saw the potential for increasing demand for heat pump water heaters in the near future. In general, respondents agreed that educational efforts would help customers quantify financial savings.

These findings indicate a likely benefit from expanding outreach efforts to independent contractors or installers and nonparticipating plumbing companies. Complete findings are included in Addendum B. Water Heater Installer Interviews.

3.5.13 Market Effects

"Market effects" are changes in the market or behavior of participants attributable to an energy efficiency incentive program.[34] An assessment of a program's effect on the market can provide evidence that a market barrier has been partially or fully mitigated.

To understand whether this program is contributing to the market transformation for heat pump water heaters, we interviewed retailers and installers about their standard practice selling the equipment. This estimates a baseline against which to measure change in future years. Noted in the prior section and in Addendum B, retailers are beginning to sell heat pump water heaters, and those who are promote the program and rebate. However, the technology is still relatively new to the market and retailers. Purchasers who were surveyed indicated energy efficiency is an important factor in decision making and rebates are important. These findings indicate PPL Electric Utilities' rebates and education are important factors to move the market.

PPL Electric Utilities continues to offer rebates for energy-efficient refrigerators, even as the standards for EnergyStar and most efficient refrigerators continue to increase. Survey respondents indicated size and fit were the most important factors in their decisions, the rebate was not very important, and that they learned about rebates from retailers. Additionally, freeridership is relatively high for purchasers of both the rebate tiers. These findings suggest the market for highly efficient refrigerators is transforming. PPL Electric Utilities' rebate may not be instrumental in encouraging customers to buy more efficient refrigerator than they originally planned.

3.6 PROCESS EVALUATION FOR UPSTREAM LIGHTING

3.6.1 Research Objectives

The purpose of the process evaluation was to assess, and provide recommendations for improving, the program's effectiveness in achieving its objectives, which are to:

- Provide a mechanism for customers to easily obtain discounted ENERGY STAR®-qualified energy-efficient LEDs and efficient equipment sold in retail stores
- Achieve widespread visibility through independent and regional retailers that carry eligible ENERGY STAR products
- Develop and execute strategies aimed at transforming the market for ENERGY STAR-qualified LED bulbs and equipment
- Educate customer on proper disposal of CFLs and give them opportunities to do so
- Educate customers on new lighting technologies, such as LEDs

Cadmus designed the process evaluation activities to effectively assess:

- Awareness of energy-efficient light bulbs
- Level of environmentally sound disposal behavior
- Purchases of energy-efficient lighting
- Customer satisfaction and decision-making
- Opportunities and barriers

---

34 Eto, Joseph, Prahl, Ralph, and Schlegel, Jeff. 1996. *A Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs.* Prepared for the California Demand-Side Management Committee.

- Possible program enhancements

3.6.2 Evaluation Activities

The PY6 process evaluation activities for the upstream lighting component of the Residential Retail Program are listed here, summarized in Table 3-16 and Table 3-17, and discussed in the next section on Methodology. These activities were consistent with those outlined in the PY6 EM&V Plan, with the exception of the cross-program participant survey, and the lighting manufacturer audit component of the database QA/QC review, which was an additional enhancement.

- Act 129 cross-program participant surveys (n=300)
- General residential population surveys (n=301)
- General small business population surveys (n=385)
- Program staff and implementer interviews (n=2)
- Lighting manufacturer interviews (n=8)
- Shelf-stocking study (n=37 stores)
- Database and quality assurance/quality control (QA/QC) review of records
- Econometric modeling of price elasticity

3.6.3 Methodology

Cadmus' methodology for the PY6 process evaluation included interviews to gather high-level perspectives from program staff about the Residential Retail Program and from lighting manufacturer representatives about the lighting market. We conducted general population surveys with the residential and small commercial populations; these surveys included questions designed to identify likely participants (bulb purchasers) and nonparticipants. We also conducted surveys with known Act 129 residential program participants, where, in addition to other metrics, we collected data related to lighting purchases and perspectives.

We collected quantitative data by conducting a shelf-stocking study and econometric modeling to help us characterize the lighting market. We also thoroughly reviewed the data sources and supporting documentation, via a database review and lighting manufacturer invoice audit, to ensure data were accurate and to identify possible improvements in the data handling or quality assurance process.

3.6.3.1 Program Staff and Implementer Interviews

Cadmus interviewed PPL Electric and the ICSP's Residential Retail Program managers to gain a thorough understanding of the program process for the current year and to discuss their perspectives on processes that are working well or any areas where they had experienced challenges.

Table 3-16: PY6 Residential Retail Lighting Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percentage of Sample Frame Contacted[1]	Evaluation Activities
PPL Electric Program and CSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, Impact, Program Staff Interview, Census
Residential	General Population	2,140,376	0.5	90/10	300	21,790	301	17%	Process, impact, general population survey, probability sample, simple random sample
Small Business	General Population, specified rate class	238,839	0.5	90/10	385	52,770	385	13%	Process, impact, general population survey, probability sample, simple random sample
Cross-Program (Appliance Recycling, Residential Home Comfort, and Residential Retail)	Act 129 Participants	11,152	0.5	90/10	300	3,083	300	96%	Process, estimate low income participation, residential program participants, probability sample, simple random sample
Lighting Manufacturers Survey	Lighting Manufacturers Representatives	29	N/A	N/A	10	29	8	100%	Process, market effects, strategic sample

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews.

3.6.3.2 Lighting Manufacturer Interviews

Interviews with lighting manufacturers can provide insight into how utility programs and incentives are affecting the efficient lighting market. Such metrics add to the preponderance of evidence that upstream lighting programs have an effect on the manufacture and prices of bulbs and contribute to market transformation. To that end, Cadmus conducted interviews with lighting manufacturers to discuss the trend in sales of CFLs and LEDs and the influence of discounts provided through utility-sponsored programs on their decisions to manufacture ENERGY STAR-certified CFLs and LEDs.

Cadmus collaborated with other Pennsylvania electric distribution companies (EDCs) and their evaluators. We drafted the interview guide, which the EDCs and the SWE reviewed. Cadmus and PPL Electric compiled an initial list of contacts, based on previously established relationships, and requested additional contributions from other EDCs and the SWE (systematic sample). Three EDCs provided additional contact information. Cadmus contacted, via phone and e-mail, each of the 29 firms on the compiled list and completed eight interviews with a mix of current and former incentive-program partners and non-partners. Our findings are detailed in Addendum E. Lighting Manufacturer Interviews, and contribute to the discussion of MPIs in this report.

3.6.3.3 General Residential Population Survey

The program's primary target audience was residential customers. However, because incentives are paid directly to manufacturers, the actual participants are not known. In addition, because signage varies by retailer, customers are not always aware they are purchasing a program-discounted bulb. Therefore, Cadmus conducted a general-population survey of all of PPL Electric's residential customers. We excluded from this population any participants of the new homes component of the Residential Home Comfort Program and the Residential Retail Program to reserve them for inclusion in the limited sample pools for these program-specific surveys. We also excluded any customers who had completed a survey in the past year (as required by PPL Electric) or requested not to be contacted.

From this sample frame, Cadmus selected a simple random sample (probability sampling). Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by applying random sampling whenever possible and using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

The purpose of the survey was to ask questions about recent bulb purchases. A general population survey allowed us not only to identify likely program participants and the rate of participation but also to track market progress indicators (MPIs) and willingness to pay (WTP) and to compare the perspectives and demographics of people who have purchased or used LEDs and people who have not.

3.6.3.4 Small Business Cross-Sector Sales Survey

Similar to the residential survey Cadmus conducted a general-population survey with a random sample of small commercial customers, the survey's target audience. Although the survey's primary purpose was to inform our PY6 cross-sector sales analysis, we also collected data on MPIs and WTP and compared these commercial data to similar data collected from residential customers.

The population for this survey included all customers classified as "small commercial" in PPL Electric's customer database. We excluded any with rate codes associated with larger general service customers because they are not likely to be representative. We also excluded participants of the Custom Incentive

Program, the non-lighting component of the Prescriptive Equipment Program, and the Continuous Energy Improvement Program to reserve these customers for inclusion in the limited sample pools for these program-specific surveys. We also excluded any customer who had completed a survey in the past year or requested not to be contacted.

From this sample frame, Cadmus selected a simple random sample of customers (probability sampling). Because we assumed businesses would vary by type and size and by the personnel capable of answering questions about the business's lighting purchases, we took additional steps to ensure that respondents who completed surveys adequately represented the small commercial population. These steps included examining the distribution of respondents by rate code, SIC code, and annual energy consumption (an assumed proxy for size).

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

3.6.3.5 Cross-Program Participant Survey

Cadmus conducted an additional cross-program survey in PY6 that targeted customers participating in one of these general residential rebate programs—Appliance Recycling, Residential Home Comfort (equipment, weatherization, and audit), and Residential Retail (heat pump water heaters only). The primary purpose of this cross-program survey was to obtain a preliminary estimate of low-income participation in programs that are not specifically targeting this sector (i.e., programs that do not require income verification). We excluded only those customers who had participated in surveys within the last year or who requested not to be contacted. From this sample frame, we selected a random sample (probability sampling), but we did not stratify the sample by program. In the following discussion of the process evaluation, we refer to these respondents as "Act 129 participants." Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by applying random sampling whenever possible and using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

Although the primary purpose of the survey was to estimate low income participation, we used the opportunity to gather additional data such as these metrics related to upstream lighting—LED awareness, LED satisfaction, and willingness to pay for LEDs.

Table 3-16 above lists the survey-sampling strategy for the Residential Retail program for PY6. Additional information about dialing rules, attrition, and final disposition of the sample is in this program's chapter, Addendum D. Participant Survey Attrition and Final Disposition. Cadmus fielded the phone surveys during March and April 2015.

3.6.3.6 Database Review and QA/QC of Records

In PY6, Cadmus conducted two data review processes—a census database review and an audit of lighting manufacturer invoices. Cadmus conducted the invoice audit for the first time in PY6, partly in response to our database review findings.

Cadmus reviewed the quarterly Energy Efficiency Management Information System (EEMIS) extracts from PPL Electric, which contain inputs provided by the ICSP. Bulb type, wattage, lumens, and baseline wattage—along with assumptions deemed by the Pennsylvania Technical Reference Manual (TRM), such as in-service rate (ISR), hours of use (HOU), and coincident peak factor (CF) —are used to compute energy and demand savings. Cadmus reviewed inputs such as product wattage and lumens for reasonability and consistency across multiple records for the same product for the census of records.

To determine if bulb quantities in the EEMIS extracts were correct, Cadmus reviewed quarterly reports and monthly invoice summaries prepared by the ICSP and compared the quantities, by bulb type, to those reported in EEMIS. Cadmus also reviewed the per-bulb retail prices and incentive levels for reasonability in preparation for our econometric study.

Cadmus designed and conducted the manufacturer invoice audit, which consisted of reviewing bulb model numbers, packs, units, and total incentive amounts to ensure consistency between the manufacturer invoices and the ICSP's invoice summaries. Because identified errors in pack size resulted in overstated quantities in a small number of records, Cadmus audited a strategic sample of invoices rather than a random sample. We also verified pack sizes through internet research.

3.6.3.7 Shelf Stocking Study

A shelf stocking study—in which technicians collect data regarding the number, types, and pricing of screw-in lighting products displayed on shelves at retail locations in PPL Electric's service territory—provides metrics on the availability and pricing of efficient lighting and other information about market effects.

To support PPL Electric's planning and program design activities, Cadmus designed and conducted a longitudinal shelf stocking study. During spring 2014 and spring 2015, we visited 37 stores in two rounds of site visits, involving 26 participating stores and 11 nonparticipating stores. The study assessed trends in screw-in lighting technology stocking practices and pricing for LED, CFL, halogen, and incandescent lamps. Addendum G. Shelf Stocking Study provides additional detail about the methodology and findings.

3.6.3.8 Demand Elasticity Study

Cadmus is conducting demand modeling using data from EEMIS supplemented with marketing event information provided by the ICSP. We will use this study to estimate the responsiveness of consumers to changes in bulb pricing and program marketing activities. This study's primary purpose is to compute freeridership (and a net-to-gross ratio) for the upstream lighting component of the Residential Retail Program by estimating the increase in bulb sales attributable to PPL Electric's program.

However, it is important to note that using pricing and sales data offers an additional perspective on consumer behavior and the effectiveness of program activities that is less subjective than the self-report data collected through consumer surveys and the perspectives of lighting manufacturer representatives.

See Appendix E: Demand Elasticity Study for a discussion of methodology and findings.

Table 3-17: Additional Process Evaluation Activities

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Shelf Stocking Study	379 participant stores, nonparticipating stores unknown	N/A	37	37	Process, market effects, strategic sample, participant and nonparticipant stores, stratified by channel
Manufacturer Invoice Audit	371	N/A	70	76	Impact; strategic sample
Database Review	Census	N/A	N/A	N/A	Impact

3.6.4 Achievements Against Plan

Table 3-18 contains the program's planned energy savings and incentives and the progress on these. Cadmus will update verified savings values in the annual report.

Table 3-18: Residential Retail Upstream Lighting Program Savings[1]

	PY5 Verified	PY6 Only			Phase II: PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned	Verified	Percentage of Planned
MWh/yr	90,314	50,180	49,638	99%	191,861	137,076	71%
MW[2]	8.92	9	7	78%	35.45	16.18	46%
Participants	219,174	N/A	167,635	N/A	N/A	386,809	N/A

[1] Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table E6, p.56.
[2] Planned and verified MW savings include line losses.

The upstream lighting component of the Residential Retail Program came within 1% of its planned PY6 MWh savings, based on verified gross savings. It achieved only 78% of the planned savings for MW, based on verified gross savings. Although there is no Phase II compliance target for MW, Cadmus suggests PPL Electric review the per-bulb assumptions used in forecasting demand savings.

3.6.5 Program Delivery

According to program staff, during PY6 the upstream lighting component was delivered effectively and efficiently and the ICSP was able to meet its program goals and forecast sales accurately. Cadmus has identified some room for improvement in data quality assurance to facilitate accurate and efficient tracking and verification and possible expansion of outreach and educational efforts (presented in the Conclusions and Recommendations section of this chapter).

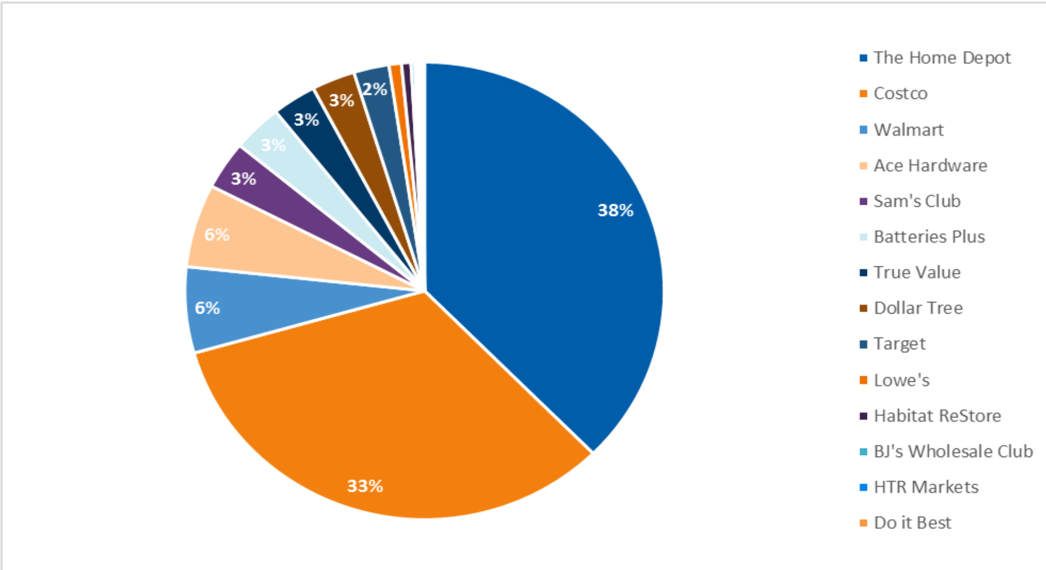
3.6.5.1 Logic Model

During PY5, Cadmus developed a logic model and process flow maps for the Residential Retail Program. These can be found in Addendum C. Logic Model. At the end of PY6, we reviewed the logic model to determine if the program had changed from the description in the Phase II EE&C Plan and found that the model is still applicable to the program process in PY6.

3.6.5.2 Key Performance Indicators

Aside from the planned savings, PPL Electric and the ICSP do not currently track or have specific non-savings goals or metrics. Program staff reported that the objectives of the program include engaging an ample distribution of retailers, by both geography and retail channels, increased awareness and adoption of LEDs by customers, reduced retail prices of LEDs, awareness of PPL Electric's bulb subsidies, and responsible disposal of CFLs. The ICSP is working with a data visualization tool to help it identify and expand the geographic coverage of participating retailers. The PY6 distribution of bulb sales, by retailer, is shown in Figure 3-8.

Figure 3-8: Distribution of Bulbs Sold, by Retailer



Source: EEMIS data with corrected bulb quantities.

3.6.5.3 Program Updates

Program changes in PY6 were:

- Shifted to incentives for LED only (eliminated CFL incentives)
- Increased incentives for LEDs
- Expanded CFL recycling bin locations; bins are now available in municipal or community locations, rather than exclusively at participating retailers
- Eliminated general bulb giveaways
- Eliminated community events (fairs, sporting events, etc.)
- Increased store events to replace community events

According to the ICSP, community events are less effective if there is no bulb giveaway; this was the reason for eliminating community events in favor of increasing the presence at retail stores, where ICSP staff can educate customers shopping for bulbs. In PY7, PPL Electric and the ICSP are planning a low-income LED giveaway, in which approximately 45,000 LEDs will be mailed to low-income customers who have been identified through the Low-Income Energy-Efficiency Behavior & Education Program.

PPL Electric has started making CFL recycling bins available at various municipal and nonprofit locations. The ICSP reported that, by March 2015, it had placed bins in 60 additional nonretail locations, with a goal of attaining 100 by the end of Phase II, and that local municipalities are enthusiastic about CFL recycling.

3.6.6 Data Quality

In PY6, Cadmus identified an issue with bulb types in both the ICSP's reports and the EEMIS extract. We found that the same product was shown with multiple bulb types and was often not consistent with the more detailed product descriptions. We brought this to the attention of PPL Electric, and the ICSP corrected the issue in its database; however, it was too late to correct the data that had already been uploaded into EEMIS. Therefore, Cadmus implemented an alternative process using ICSP data to incorporate the correct bulb types into the data we use to compute savings and for reporting.

We discovered some inconsistencies in pricing data for the same product and some unreasonable promotional prices. We had several discussions with the ICSP; it confirmed that some stock keeping units (SKUs) had been associated with incorrect pack sizes in its database, resulting in errors in reported quantities and per-unit pricing data. The ICSP conducted its own internal audit, corrected these errors, and sent Cadmus an updated report for the first quarter of PY6 along with a listing of the affected SKUs. The ICSP stated it found no data problems in subsequent quarters.

Because the pack size issue that resulted in overstated quantities affected a small number of records, Cadmus decided to audit a strategic sample of invoices rather than a random sample. We selected a sample from each quarter by choosing the invoices for the largest number of bulbs and also some smaller invoices to ensure we covered each manufacturer and retailer combination. We also verified, through either Internet research or data indicated on manufacturer invoices, that the pack size for 89% of the SKUs shown in the ICSP's reports were multi-packs. We noted any SKUs that appeared to be a multi-pack, based on the manufacturers' invoice description or model number, but were shown as single packs in the ICSP's reports.

Following Cadmus' audit, the ICSP determined that corrections to its database affected subsequent quarters in PY6 so it sent an updated report with job numbers that Cadmus could link to data from EEMIS extracts and to updated invoice summaries. We consolidated these reports and reviewed them to ensure consistency with our findings. We also used the updated ICSP data to make final adjustments to PY6 EEMIS data for our impact evaluation.

3.6.7 Participant Profile

Using data collected in the general population residential survey (n=301), Cadmus established a profile of customers purchasing LEDs in the upstream lighting component of the Residential Retail Program. Of the residential respondents who have purchased or used LEDs (n=93), the majority (74%) live in single-family detached residences and 8% and 12%, respectively, live in multifamily apartments or attached houses. Only 3% live in manufactured or mobile homes. About a quarter of respondents who have purchased or used LEDs (n=93) have a bachelor's degree, another quarter have a two-year or technical degree, 11% have an advanced degree, and about a third have a high school diploma.

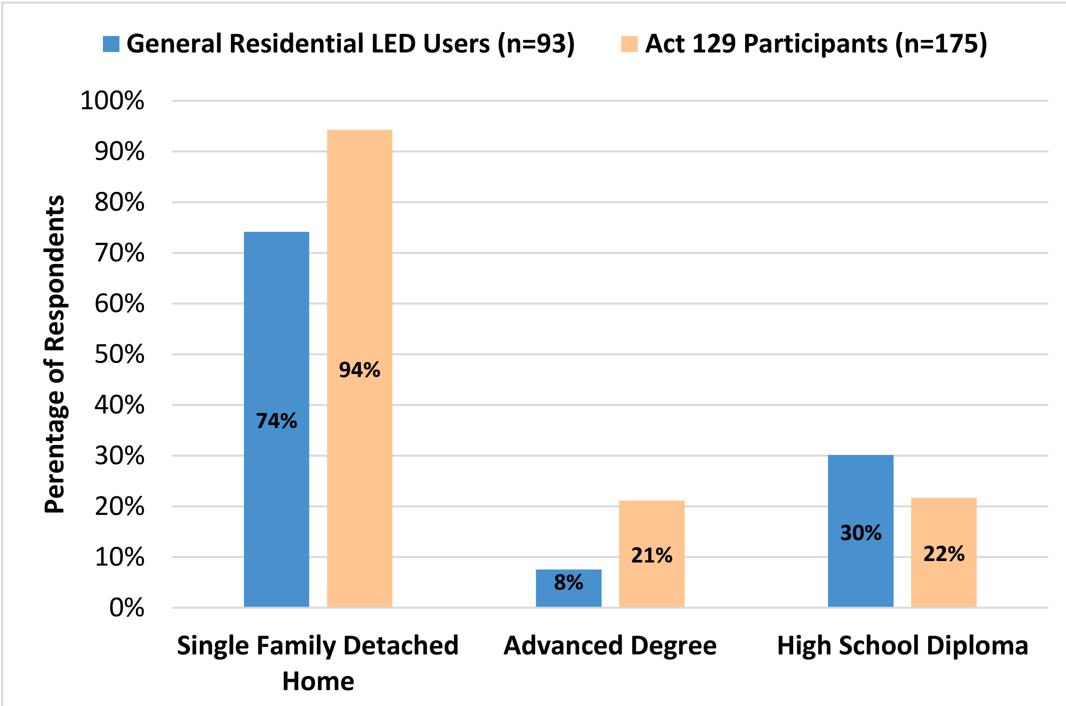
Unlike in PY5, there was no significant difference in age, education, or level of income among general population residential respondents who had used LEDs and those who had not.[35]

In contrast to the general population, 94% of the Act 129 participants who have installed LEDs (n=175) live in a single-family, detached home, and twice as many have an advanced degree. About the same percentage as the general population (n=93) who have purchased or used LEDs have technical or four-year degrees, and fewer have only a high school diploma. The majority of respondents in both groups (respondents who disclosed their age from both groups, n=254) are over the age of 45; more than 45% range in age from 45 to 65 years old.

35 Differences are not significant based on a t-test at 90% confidence.

Within both the general residential population and the Act 129 participants, there was no significant difference in age, education, or level of income among respondents who had used LEDs and those who had not.[36] Figure 3-9 illustrates the differences between these two respondent groups.

Figure 3-9. Demographic Differences Between LED Users



Source: General Population Survey Question L1 and Act 129 Cross-Program Survey Question N1, "What type of residence do you live in?"

3.6.8 Market Progress Indicators and LED Purchasing Patterns

3.6.8.1 Market Progress Indicators

When surveying the Act 129 participants (through the cross-participant survey), the residential general population, and the small business general population, Cadmus measured these market progress indicators—awareness of LEDs, likelihood to purchase LEDs in the future, experience using LEDS, and willingness to pay for LEDs. This section discusses differences among respondent groups and, where possible, changes over time. We conducted t-tests on differences in means (p values are shown in parenthesis to indicate statistically significant differences).

Awareness of LEDs. Act 129 participants were significantly more aware of LEDs than were the small business and residential general population survey groups ($p < 0.05$).

- 96% (n=300) of Act 129 participants were aware of LEDs
- 85% (n=385) of general population small businesses were aware of LEDs
- 79% (n=301) of general population residents were aware of LEDs

[36] Differences are not significant based on a t-test at 90% confidence.

Act 129 participants were also more likely to have seen LEDs for sale at retail stores (90%, n=300) versus 71% (n=301) of the general population residential group ($p < 0.05$) and more aware that PPL Electric discounts the bulbs (23%, n=300) versus 11% (n=301) of the general population residents ($p > 0.05$). However, small business respondents (n=385) were the most educated group about the upstream discount, with 28% reporting that they knew PPL Electric provided funding to reduce the cost of LEDs.

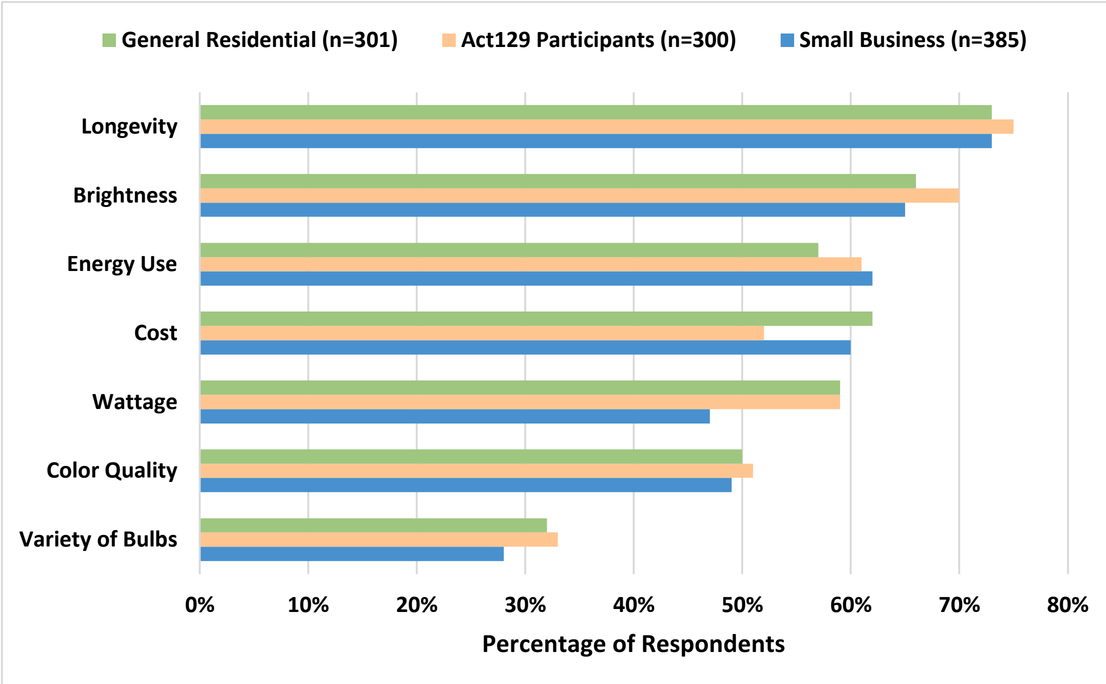
Purchasing Likelihood and Decision-Making Factors. Act 129 participants (n=300) said they were more likely to install LEDs in the next year than were either the small business (n=385) or the residential general population (n=301); 57% said *very likely* versus 33% of the general residential population (n=301) and 42% of small business customers (n=385) ($p < 0.05$).

Cadmus asked respondents how likely they were to purchase LEDs in the next 12 months and why. For the responses *not too* or *not at all likely* to purchase LEDs, the most common reason given by general residential population (n=301) was that they cost too much. A few indicated they already had purchased LEDs or had existing stock of other bulbs, and some said they did not like LEDs.

When making a purchasing decision, bulb longevity, brightness, and energy use (in this order) are more important to respondents than cost (Figure 3-10). This ranking is based on aggregated responses from participants in Act 129 programs (n=300) and the general residential and small business populations (combined n=986). Across the various decision possibilities that Cadmus asked respondents to consider, responses were remarkably similar among Act 129 participants (n=300) and the general residential and small business populations (combined n=986), showing convergence on key preferences when looking for light bulbs. However, there were some notable differences:

- Small business customers (n=385) and general residential population (n=301) care more about bulb cost, with 60% and 62% of these respondents ranking cost as *very important*, respectively, than Act 129 participants (52%, n=300). This difference is statistically significant ($p < 0.05$).
- Energy use was more important to small businesses (n=385) than cost by a small margin. This was not true for the general residential population (n=301) —more ranked the cost of bulbs as *very important* versus energy use (62% versus 57%, respectively). However, the typically cost-conscious general population still placed more importance on bulb quality characteristics such as brightness and longevity than on cost.

Figure 3-10: Importance of Various Bulb Traits, by Consumer Group



Source: Questions J1a-g, "When buying light bulbs, how important is…" Responses from the Act 129 cross-participant survey, general residential population survey, and general small business survey (n=986)

3.6.8.2 LED Purchasers, by Sector

Approximately 65% of residential respondents (n=301) reported purchasing screw-in bulbs, and 16% had purchased LEDs (from any source) within the last six months, roughly the same percentage as in the previous year. In contrast, more small business respondents (n=385) reported having purchased LEDs this year than last year (23% in PY6 versus 11% in PY5). Slightly less than half of small business respondents purchased any screw-in bulb. Of the Act 129 participants surveyed (n=300), 79% said they purchased bulbs in the last six months; 45% reported they had purchased LEDs.

In the PY6 surveys, Cadmus asked small business and residential respondents about all screw-in bulb purchases; in PY5, we asked residential customers only about CFLs and LEDs. Table 3-19 shows the percentages of respondents who purchased lamps, from any source, by technology type.

Table 3-19: Percentage of Respondents Purchasing Bulbs in Past Six Months

Customer Base	N	Year	LEDs	CFLs	Incandescent or Halogens	Any Screw-In Bulb
Small Business General Population	385	PY6	23%	20%	12%	49%
	392	PY5	11%	21%	21%	44%
Residential General Population	301	PY6	16%	29%	26%	65%
	301	PY5	17%	45%	Unknown	
Act 129	300	PY6	45%	33%	21%	79%

More small business respondents purchased LEDs in PY6 than in PY5, and fewer purchased incandescent or halogen bulbs, but about as many purchased CFLs. Significantly fewer residential customers, however, purchased CFLs, but more did not purchase LEDs. Although we do not know the reported percentage of residential customers who purchased incandescent or halogen bulbs in PY5, it is reasonable to assume, given that approximately the same proportion of customers purchased some type of screw-in bulb in both years (as is the case with small business customers), that residential customers are turning back to the lower-priced halogen bulbs, as suggested by lighting manufacturer representatives.

3.6.8.3 LED Pricing

Cadmus asked general residential and small business respondents who had *either* recently purchased or reported having ever used LEDs what price they paid for the bulb they purchased most recently.[37] We asked program participants only what price they paid if they purchased LEDs in the past six months. Both small business and general residential respondents reported having paid an average of $13 for a single LED. Act 129 participants recalled paying an average price under $10, close to the $11 average reported by general residential customers who purchased an LED within the last six months. These results are likely a reflection of the rapidly falling prices for LEDs.

Cadmus' shelf-stocking analysis illustrated the significant drop in LED prices, at both participating and nonparticipating retailers, between 2014 and 2015. We observed that LED prices, as expected, were lower at participating retailers, but the drop in prices between the years was actually more dramatic at nonparticipating retailers. Still, the average price of a general-service LED at a nonparticipant store, at over $14, was still out of the range most respondents indicated a willingness to pay. Table 3-20 shows the average price, by bulb type, at both participating and nonparticipating retailers.

Table 3-20: LED Prices by Category and Participant and Nonparticipant Retailers [1]

Category	Average Price per Bulb Participant			Average Price per Bulb Nonparticipant		
	Round One	Round Two	Percentage Change	Round One	Round Two	Percentage Change
General Service	$10.12	$7.47	-26%	$33.36	$14.28	-57%
Recessed Lighting	$33.03	$23.82	-28%	N/A	$22.53	N/A
Reflector/Flood	$23.38	$13.15	-44%	$41.10	$22.68	-45%
Specialty	$10.55	$8.70	-17%	N/A	$10.97	N/A
[1] For more information, see Addendum G. Shelf Stocking Study in this report.						

PPL Electric's program bulbs, especially the most common general-service bulbs, sold for well within the range most respondents indicated they would be willing to pay for an LED. The average price and incentive levels of program bulbs sold during PY6, weighted by the number of bulbs sold, are shown in Table 3-21.

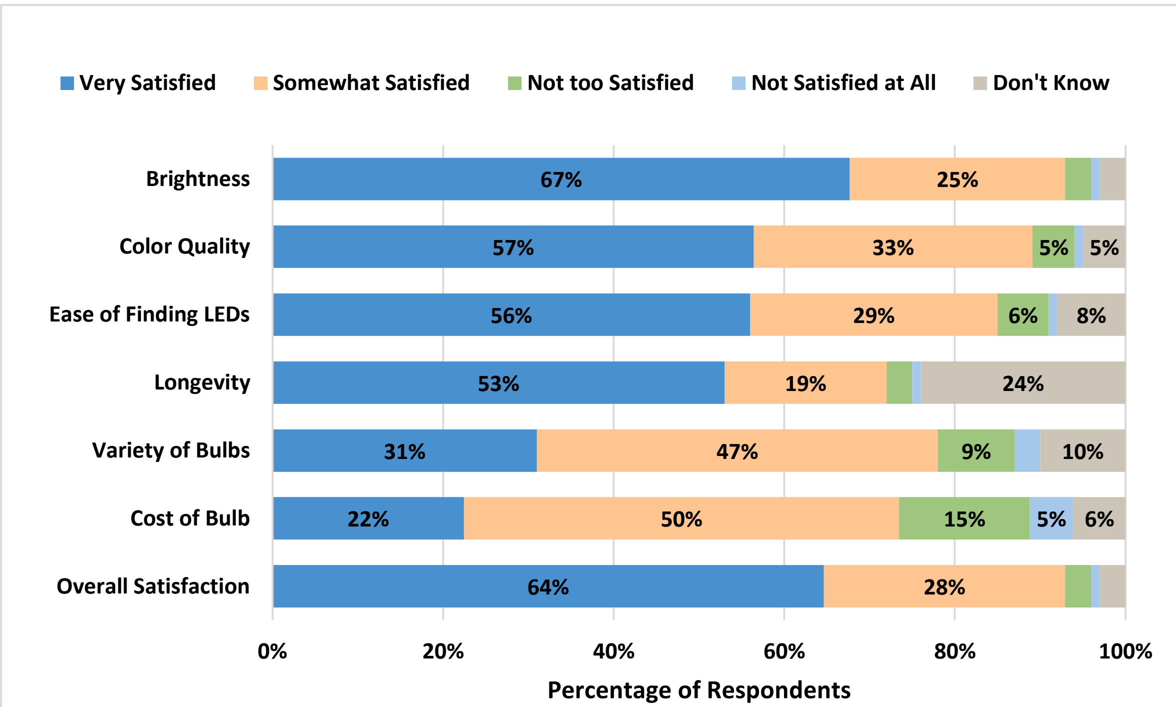
37 Note that we did not ask customers to specify what type of LED they purchased. A-line or reflector/flood, which are significantly more expensive.

Table 3-21: PY6 Program Bulb Pricing

Bulb Type	Percentage of Program Bulbs Sold	SKUs	Average Retail Price	Average Incentive	Average Promotional Price
Candelabra	7%	45	$ 9.32	$ 4.22	$ 4.85
Exempt (3-Way)	0%	1	$ 21.97	$ 7.00	$ 14.97
Globe	5%	19	$ 7.25	$ 4.21	$ 2.90
GSL	55%	107	$ 10.60	$ 4.71	$ 5.32
Reflector	33%	121	$ 14.34	$ 7.21	$ 6.70
Source: EEMIS data with corrected bulb quantities and pricing from updated ICSP report.					

User Experience with LEDs. Most respondents across all groups were satisfied with their LEDs. Figure 3-11 presents the combined satisfaction across groups with various bulb traits. The majority, or 92%, were happy with the LED they installed (64% being *very satisfied* and 28% *somewhat satisfied*). Respondents were most satisfied with the brightness of the bulbs, followed by color quality, ease of finding LEDs to purchase, and longevity. Respondents were least satisfied with the cost of the bulb.

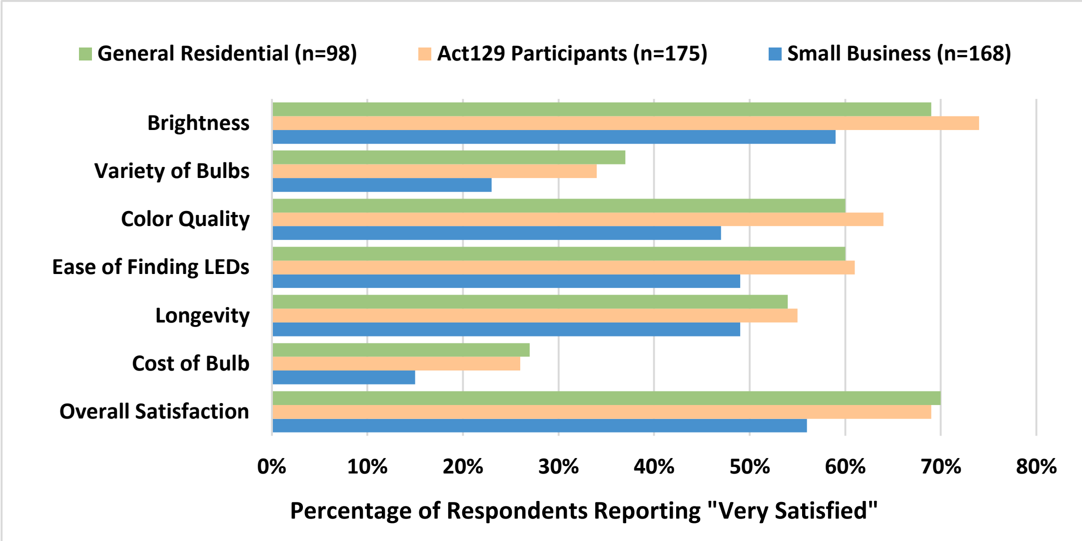
Figure 3-11: Satisfaction with Various LED Traits Among All Consumer Groups



Source: Questions J2,J3a-f, "How satisfied were you with the screw-based LEDs you installed in terms of…"; Responses from the Act 129 cross-participant survey, general residential population survey, and general small business survey (n=986). NOTE: Segments in the bar graph with no data label represent 3% or fewer of the responses.

Interestingly, there were consistent differences between residential and small business respondent groups. The small business respondents were consistently less likely to be *very satisfied* with any bulb trait than either the residential general population respondents or the Act 129 respondents, as shown in Figure 3-12. These differences were statistically significant for every trait except bulb longevity.

Figure 3-12: Satisfaction with Bulb Traits by Respondent Group



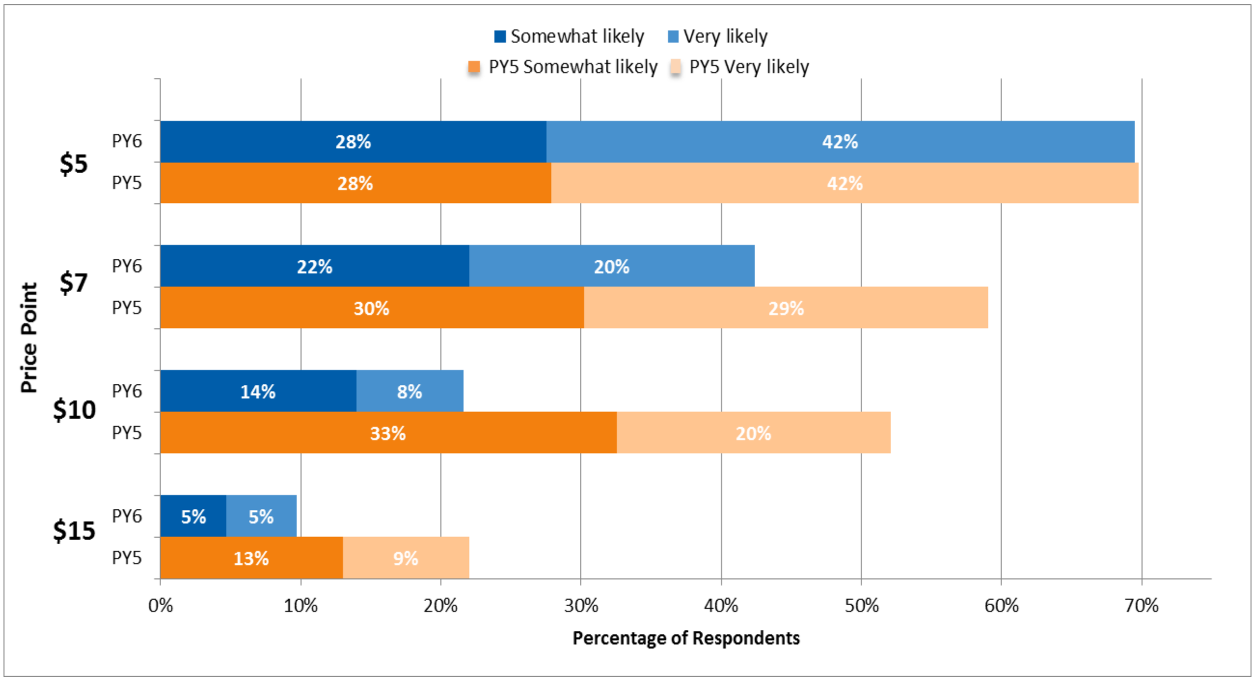
Source: Questions J3a-f, "How satisfied were you with the screw-based LEDs you installed in terms of…"

3.6.8.4 Willingness to Pay

As in PY5, general population residential customers indicated price sensitivity to hypothetical price points of \$5, \$10, \$7, and \$15. However, although residential customers were about equally willing to pay \$5 for an LED in PY6 and PY5, they appeared to be less likely to pay \$7 or more in PY6 than they were in PY5. The percentages of residential customers who reported they were *somewhat* or *very likely* to pay for an LED at different prices points in PY5 and PY6 are shown in Figure 3-13.[38]

[38] During its survey review, the SWE recommended that Cadmus add questions about how many LEDs customers would purchase at each price point; however, Cadmus did not add these questions due to survey length and so that results were comparable to PY5.

Figure 3-13: Residential Customers' Willingness to Pay for LEDs: PY5 and PY6 Comparison

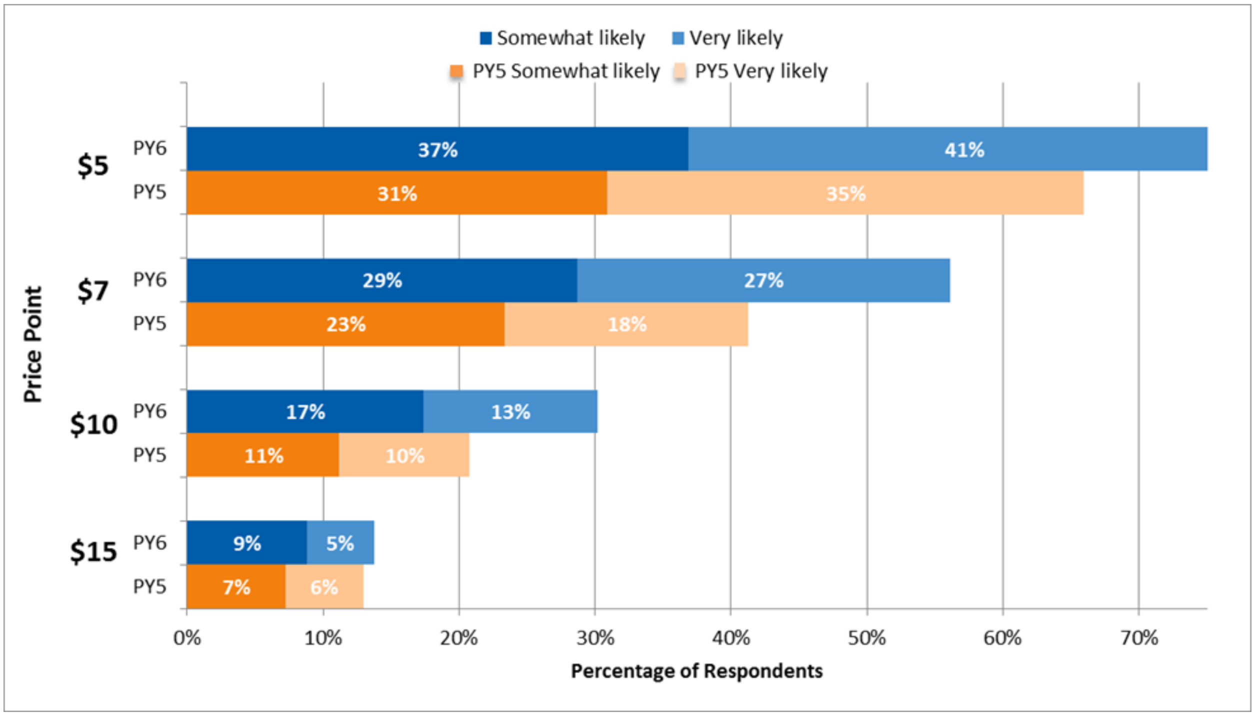


Source: PY6: Questions F11, F15, F16, and F17, "Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-based LED cost $5, how likely would you be to purchase the LED instead of a CFL?" (n=236); PY5: Questions F15, F16 & F17, "If the LED cost $5/$8/$10 less [than $15], or $10/$7/$5, how likely would you be to purchase the LED?" (n=215)

Conversely, small business respondents indicated a higher willingness to pay in PY6 than in PY5 at all price points (Figure 3-14). We found that small business respondents were also more likely to pay for bulbs than the general residential population, which was a reversal from last year's findings (Figure 3-15). This finding is also interesting considering that, as we reported above, small business customers were less likely to be *very satisfied* with various bulb traits than were residential customers. Act 129 participants' willingness to pay was similar to that of small business customers.

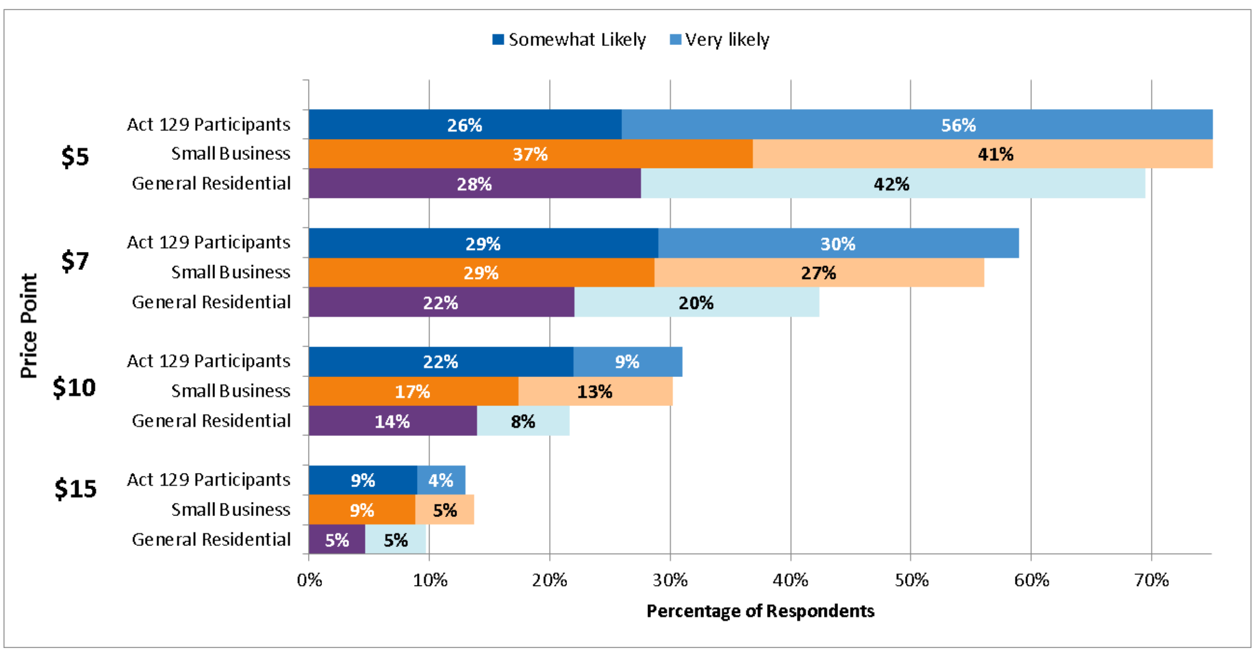
Cadmus noted that, among the Act 129 participants, Residential Home Comfort Program participants were more willing to pay $5 for an LED than Appliance Recycling Program or Residential Retail Program participants (Residential Home Comfort n=146, Appliance Recycling n=81, Residential Retail n=61; $p < 0.05$).

Figure 3-14: Small Business Customers' Willingness to Pay for LEDs



Source: Questions A7, A9, A10 & A11, "Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-based LED cost $5, how likely would you be to purchase the LED instead of a CFL?" (n=328)

Figure 3-15: Willingness to Pay, by Respondent Group

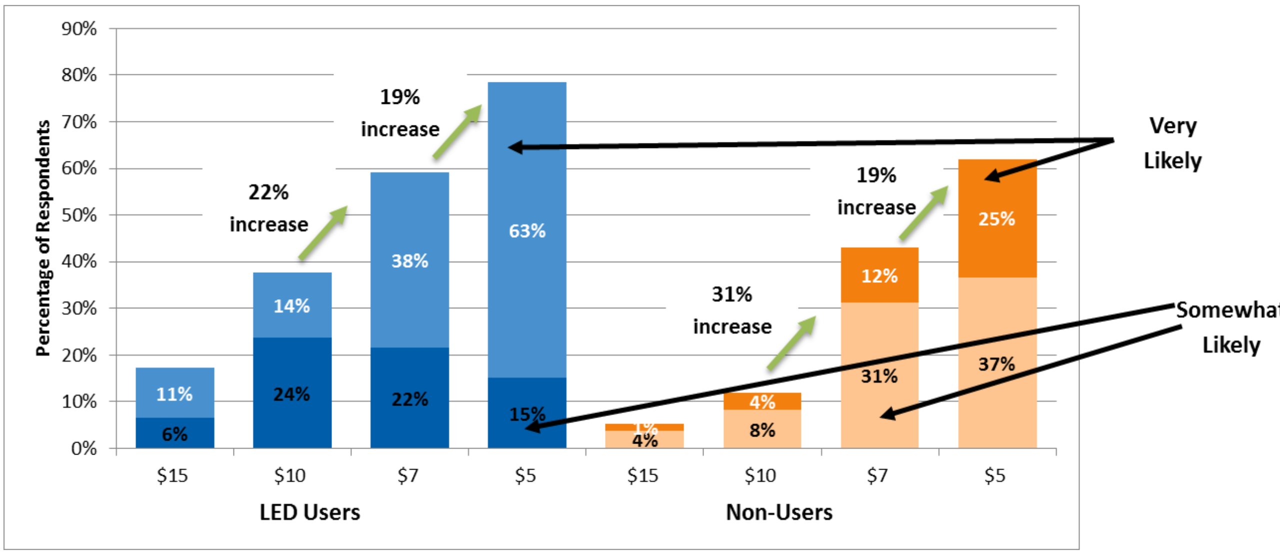


Source: "Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-based LED cost $5, how likely would you be to purchase the LED instead of a CFL?" (Small Business n=328, Residential n=236, Act 129 Participants n=288)

Differences between LED Users and Non-Users. Similar to PY5, there is a marked difference in willingness to pay between general residential respondents who had used LEDs and those who had not. The largest jump in willingness to pay occurred in general residential non-users, between price points of $10 and $7.

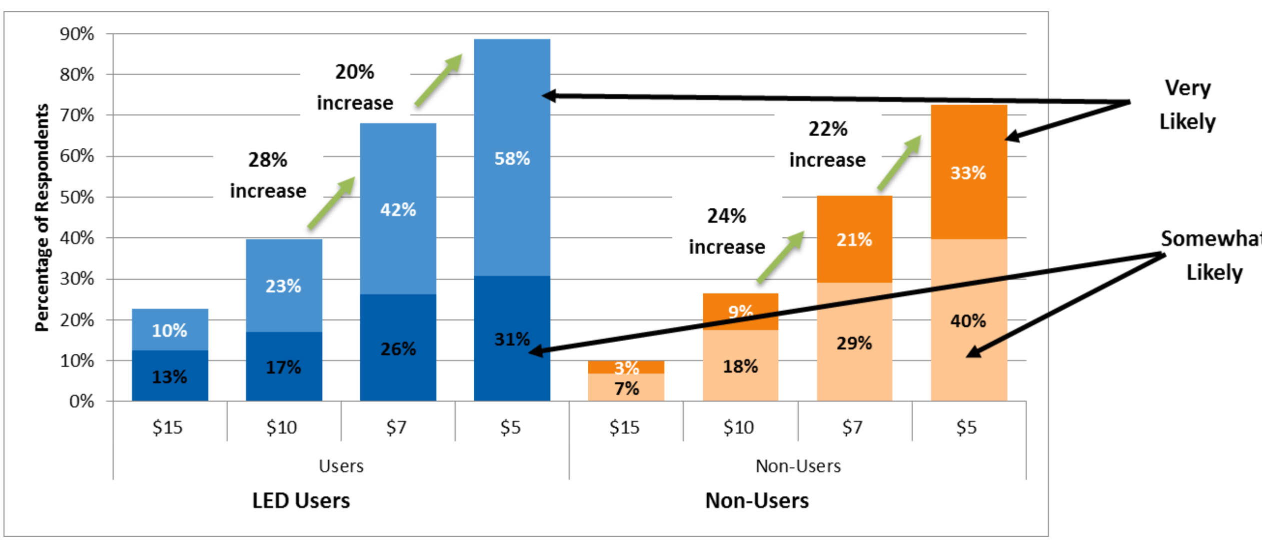
Figure 3-16, Figure 3-17, and Figure 3-18 show users' willingness to pay for LEDs for the general population, small business, and program participants, respectively. These figures show the percentages of respondents who were *somewhat* or *very likely* to purchase an LED at various price points, similar to the previous figures, but break the respondents into groups. The "Users" are respondents who either recently purchased or had ever used an LED; "Non-Users" are the remaining respondents who were aware of LEDs. The percentage increases indicated in the figures represent the increase in *total likelihood* (sum of *somewhat and very likely)* as the hypothetical prices decreased.

Figure 3-16: General Residential LED Users vs. Non-Users Willingness to Pay



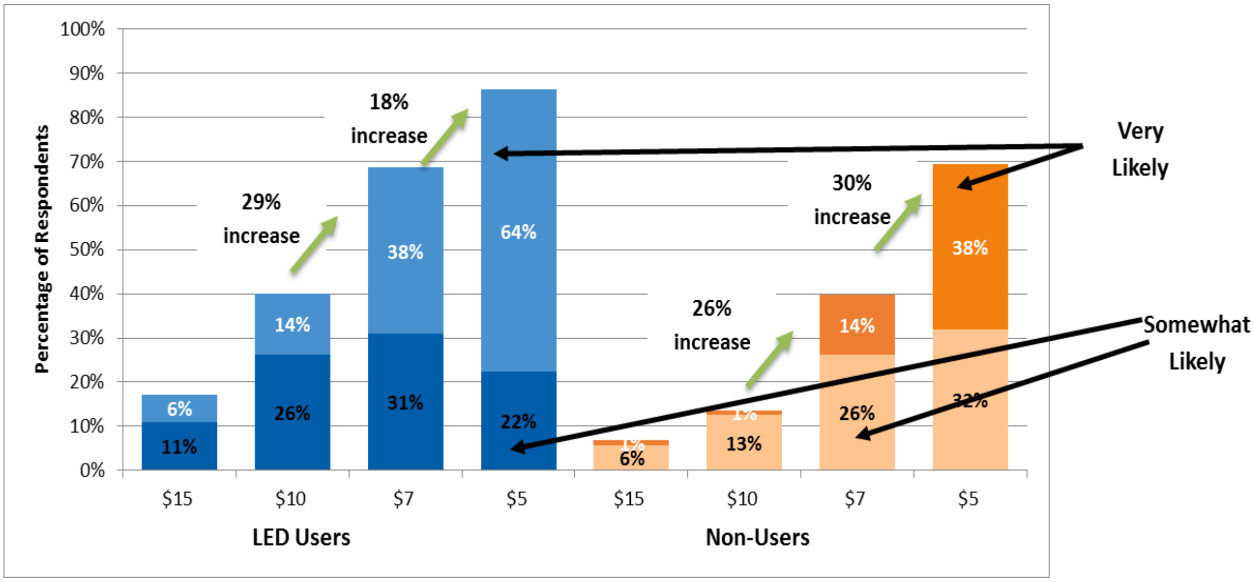
Source: Questions F11, F15, F16, and F17, "Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-based LED cost $5, how likely would you be to purchase the LED instead of a CFL?" (n=93 users and 134 non-users)

Figure 3-17: Small Business LED Users vs. Non-Users Willingness to Pay



Source: Questions A7, A9, A10 & A11, "Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-based LED cost $5, how likely would you be to purchase the LED instead of a CFL?" (n=88 users and 234 non-users)

Figure 3-18: Program Participants Users vs. Non-Users Willingness to Pay

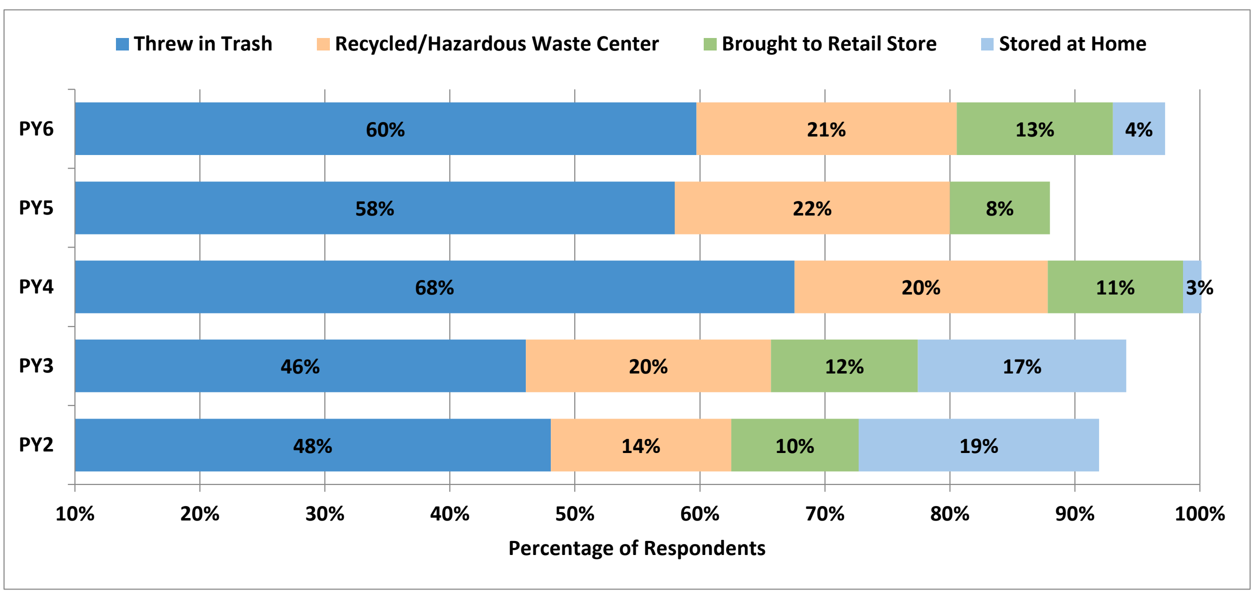


Source: Questions I5, I6, I7 & I8 "Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-based LED cost $5, how likely would you be to purchase the LED instead of a CFL?" (n=175 users and 88 non-users)

3.6.8.5 CFL Disposal

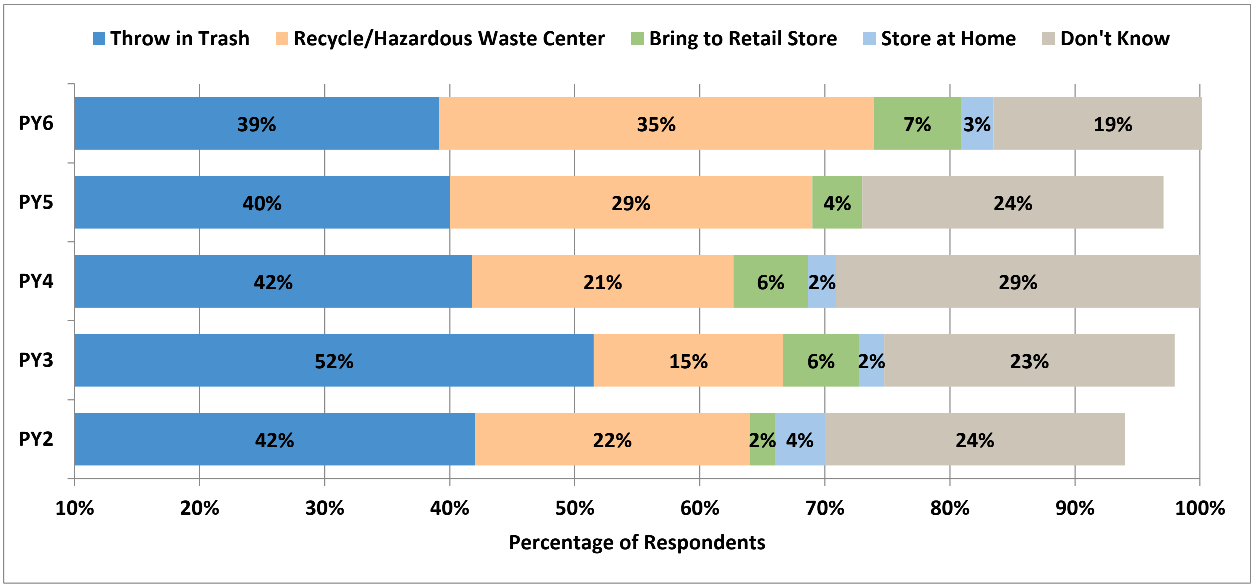
Of the 187 residential respondents who had used CFLs, 72 (39%) said they had disposed of any CFLs in the past 12 months. Over half of these respondents, or 60%, said they threw the CFLs in the trash. We asked those who had not, or were not sure whether they had disposed of a CFL, hypothetically, how they would do so. Less than 40% said they would throw a CFL in the trash, and more said they would dispose of CFLs by taking them to a recycling center or a retail store. Nineteen percent said they were unsure of how they would dispose of a CFL. These patterns are similar to patterns in previous years, as shown in Figure 3-19 and Figure 3-20.

Figure 3-19: Reported Disposal Behavior



Source: (PY6) Question H2 "How did you dispose of the CFL?" (n=72)

Figure 3-20: Hypothetical Disposal Behavior



Source: (PY6) Question H3 "If you were to dispose of a CFL, how would you do so?" (n=115)

Only 12% of residential respondents said they knew that PPL provided recycle bins, and about half of these 22 respondents had actually seen bins in the last six months.

Responses to disposal questions by small business respondents were similar to those of residential customers. Approximately half of residential customers and over 60% of small business customers said they had no concerns about the disposal of CFLs.

3.6.9 Market Effects

3.6.9.1 Shelf Stocking Study

Cadmus observed an increase in the presence of LED and halogen general-service bulbs in both participant and nonparticipant stores. General-service CFLs increased only in nonparticipants stores. The change we observed in participant stores is probably the result of PPL Electric's upstream lighting LED incentives. Lighting manufacturers hypothesized that, as the price difference between CFLs and LEDs shrinks, consumers will certainly prefer and choose to purchase LEDs. In contrast, both participant and nonparticipant stores are moving from CFL to LED technology for specialty and reflector/flood bulbs. This is consistent with a lighting manufacturer representative's suggestion that retailers are devoting more shelf space for specialty bulbs and LEDs, which tend to be more versatile than CFLs.

The observed price decrease for LEDs appears to correlate with increased shelf space compared to CFLs. Lighting manufacturers thought CFL socket saturation is unlikely to increase—and may decrease over the next few years as LEDs come down in price—because many consumers never liked CFLs. Manufacturers also suggested that many consumers who purchased CFLs would not have purchased them for market price and that halogens would be the market leader in the absence of utility incentives, especially for consumers who are looking for the cheapest bulbs.

3.6.9.2 Lighting Manufacturer Interviews

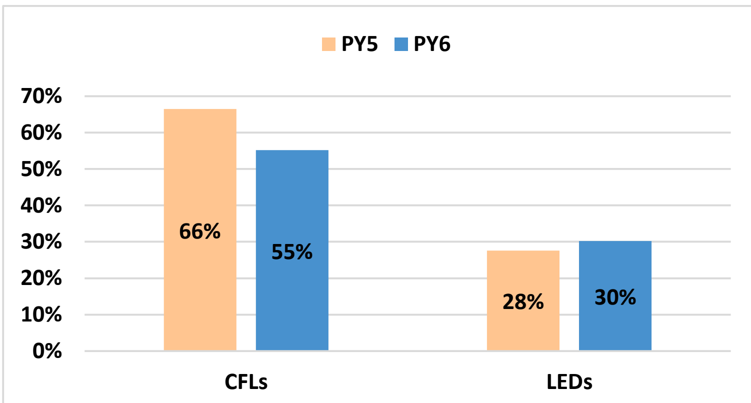
Although few lighting manufacturer respondents were willing or able to give specific, quantitative estimates or predictions of past or future trends in CFL and LED sales, most seemed willing to speak openly about their perceptions of the current and future lighting market. The strongest themes were that utility-program incentives, as well as educational and promotional efforts, had a dramatic effect on the speed at which LED sales have increased recently and that consumers prefer and will more quickly adopt LEDs than CFLs, eventually squeezing CFLs out of the market as LED prices come down.

They suggested that the market would naturally transform because utility incentives contribute to both competition and economies of scale and support the competitiveness of ENERGY STAR-certified bulbs, which are superior in quality and preferred by some major retailers. These factors contribute to market transformation in the long run, but in the short run, incentives are making LEDs competitive with EISA-compliant halogens, which are still the cheapest bulbs in the absence of subsidies.

3.6.9.3 General Residential CFL and LED Saturation and Use

Fewer than 30% of respondents to the general residential population survey (n=301) said they were currently using LEDs, approximately the same proportion as in PY5 (Figure 3-21). However, fewer said they were currently using CFLs. This is consistent with the trend we observed in residential respondents' reported purchasing behavior.

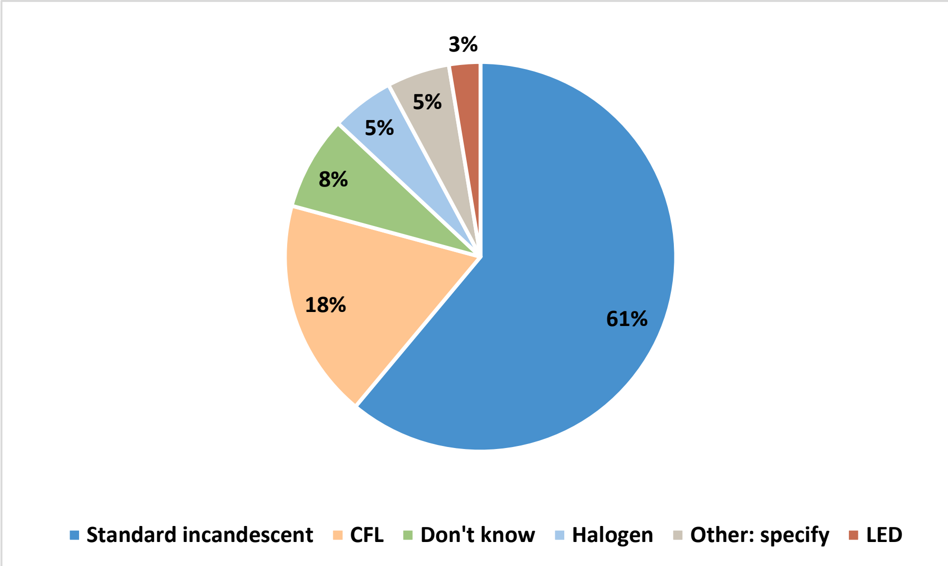
Figure 3-21: Percentage of Respondents Using CFLs and LEDs



Source: Question E9. Are you currently using any screw-based LEDs inside or outside your home? (n=301)

The majority of respondents who currently had LEDs installed (and remembered how many; n=77) said that the LEDs replaced standard incandescent bulbs (Figure 3-22). Only 18% said that the LEDs replaced CFLs.

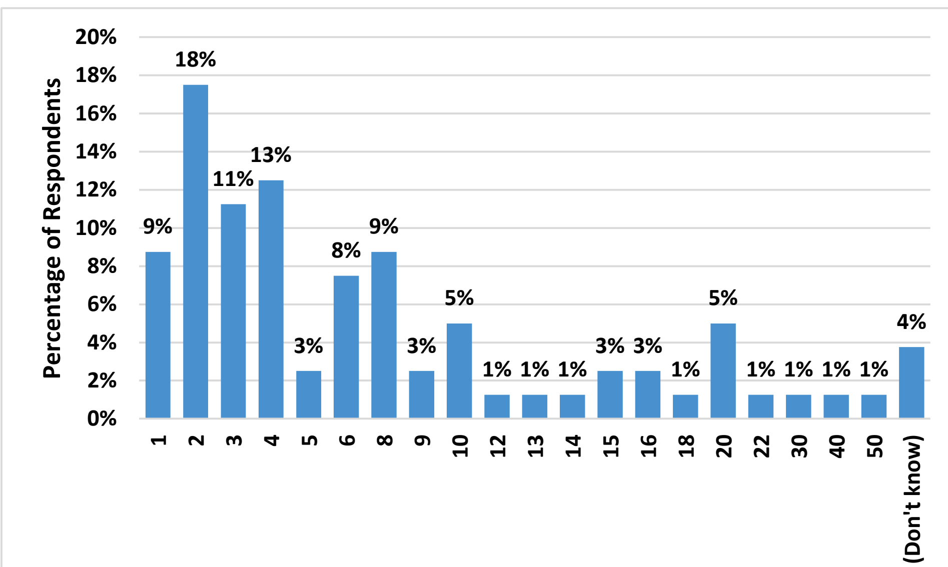
Figure 3-22: Type of Bulbs Installed LEDs Replaced



Source: E13. What kind of light bulbs did the LED bulbs replace? (n=77)

Of the respondents who had at least 1 LED installed (n=80), most had fewer than five installed. Figure 3-23 shows the distribution of responses regarding the number of LEDs currently installed.

Figure 3-23: Number of LEDs Currently Installed



Source: E11. Approximately, how many screw-based LEDs are installed inside and outside your home right now? (n=80)

3.6.10 Satisfaction with PPL Electric

Overall satisfaction with PPL Electric as a provider of electric service was high. Seventy-five percent of general residential customers (n=301) rated their satisfaction as eight or higher (on a scale of 1 through 10), which is similar to findings in previous years. Ten percent rated PPL Electric as 7, and 13% gave a rating of 6 or lower.

3.6.11 Energy Efficiency Knowledge, Challenges, and Actions

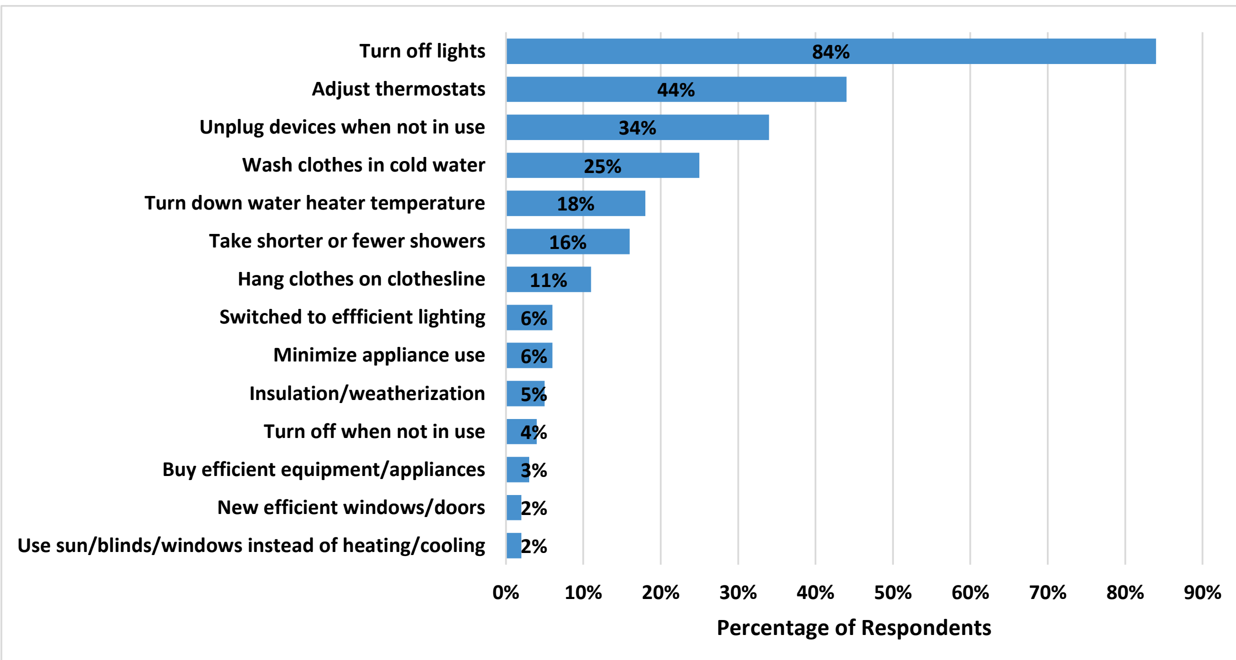
3.6.11.1 Knowledge About Ways to Save Energy

Cadmus asked general residential respondents (n=301) to rate their current knowledge about ways to save energy in their home.[39] The majority (61%) rated themselves *somewhat knowledgeable*. About equal numbers of respondents, 18%, said they were either *very* or *not too* knowledgeable, and only 3% said they were *not at all* knowledgeable.

3.6.11.2 Steps to Save Energy

The vast majority of general residential respondents (93%) said they take steps to save energy at home on a regular basis. Figure 3-24 shows the steps respondents say they take regularly.

Figure 3-24: Steps Respondents Take to Save Energy



Source: Question J3 “What steps do you take [to save energy at home]?” (n=281)

3.7 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, Cadmus presents its conclusions for PY6 for lighting and suggests that PPL Electric consider these recommendations in PY7.

Conclusion

PPL Electric Utilities implemented the higher-tier refrigerator rebate of $100 in PY6 to encourage customers to purchase the most efficient equipment available but also to inhibit freeridership. Although the $100 rebate influenced customers’ purchase decision more than the $25 base-tier rebate, freeridership in PY6 was still high for both tiers. In addition, the tiered rebate system caused confusion and disappointment (with the rebate amount) for some customers.

---

39 Cadmus did not ask Act 129 participants or small commercial customers the same questions about energy efficiency education or behavior.

Recommendation
Refrigerators offer relatively low savings for the rebate amount (especially the higher-tiered models) and for the program's total savings. Also, freeridership appears unchanged by the higher rebate. Although refrigerators are a commonly purchased appliance, the benefit from increasing the number of participants may not offset customers' confusion and dissatisfaction with the eligibility requirements. Therefore, it may be worthwhile for PPL Electric Utilities to consider replacing this product with another that is more likely to have impact on savings and customer satisfaction, and one where rebates assist customers to purchase products of increased energy efficiency.

Conclusion
PY6 rebate-processing times have not improved over PY5. Thirty-six percent of heat pump water heater and 33% of base-tier refrigerator participants said it took more than eight weeks to receive a rebate check. The rate in PY5 was 13% for heat pump water heaters and 7% for refrigerators. However, participants' reporting of processing times were sometimes inconsistent with tracking data for receipt and invoice dates. The ICSP replaced its rebate processing contractor in PY7 and will monitor processing times.

Conclusion
Findings from interviews with water heater installers indicated potential for increasing participation by reaching out to independent contractors or installers and nonparticipating plumbing companies. These nonparticipants could benefit their customers and encourage adoption of heat pump water heater technology simply by being made aware of PPL Electric Utilities' rebate program and from education about the technology. At least initially, they may be motivated by some type of SPIF, or incentive, for installing heat pump water heaters. They may also benefit from educational materials or simple examples illustrating investment payback time that could be passed along to their customers.

Recommendation
PPL Electric Utilities could consider working with the ICSP to explore ideas for marketing campaigns to reach and educate water heater installers. For example, the ICSP might distribute marketing or educational materials to installers listed by state licensing boards. Another possibility is to contact distributors and use their existing marketing channels to distribute such materials. One-on-one meetings may be the most efficient way to educate installers.

Conclusion
General population surveys indicate potential for increased adoption of LEDs by general residential customers, who were more likely to report having purchased halogen or incandescent bulbs than LEDs, even though fewer are purchasing CFLs. Conversely, more small business customers are purchasing LEDs and fewer appear to be purchasing halogen or incandescent bulbs; however, the number purchasing CFLs has not changed since PY5. This suggests that small business customers who previously purchased incandescent or halogen bulbs are now purchasing LEDs.

Although we do not have year-over-year data regarding how many residential customers purchase any screw-in bulbs (halogen or incandescent bulbs, specifically), it is reasonable to conclude that approximately the same proportion of residential customers purchased some type of bulb as in the previous year, as we see with commercial customers. Therefore, because the same number of residential customers are purchasing LEDs, and fewer are purchasing CFLs, the customers who purchased CFLs in the past are likely now purchasing halogens, currently the lowest-cost bulbs in PPL Electric's service territory, as observed in our shelf-stocking study.

PPL Electric's program has sold more than 1 million LEDs, and is on track to meet its planned sales for Phase II. Increased outreach is unlikely to be necessary in PY7; however, it is important to understand customer purchasing patterns and the effects of program bulb pricing, in order to monitor the market during Phase III.

As substantiated by Cadmus' shelf-stocking study, as well as interviews with lighting manufacturers, LED prices have dropped rapidly and significantly over the past year, partly due to utility incentives, which has helped propel market adoption. However, LEDs are still more expensive than CFLs or than halogens that are compliant with EISA. Lighting manufacturers stated that, in the absence of utility discounts, low-cost halogen bulbs would become the market leader and that utility efforts to educate customers are indispensable to market transformation.

Most customers indicated a willingness to pay between $5 and $7 for an LED. However, it is still unclear when more residential customers will begin purchasing LEDs in response to the recently lowered prices, as small business customers have done.

Although appreciative of the lifespan and brightness of LEDs, customers are still sensitive to prices, especially general residential customers and customers who have not yet used LEDs. Therefore, educational efforts on lifecycle costs may be the key to hastening increased market adoption of LEDs.

Recommendation
Cadmus will continue to research changes in purchasing behavior in its PY7 general residential population survey. Specifically, we will again ask questions regarding LED purchases, price paid, and hypothetical willingness to pay. In addition, we suggest adding questions to assess customers' perceptions of current pricing for LEDs, as well questions regarding where customers typically purchase bulbs for their households. Responses will help us determine the rate at which customers become aware of price changes and identify possible gaps in program retail channel distribution.

Additionally, PPL Electric could consider exploring ways to educate customers on the benefits of LEDs. Specifically, PPL Electric could focus on education efforts regarding the cost-effectiveness, from the consumer's perspective, of efficient bulbs over their halogen counterparts. For example, a simple graphic demonstrating the cost-effectiveness, or pay-back time in months or years, could show the benefit of investing in a discounted LED over a lower-priced halogen bulb. Manufacturers lauded utility incentive programs for their education programs, which are designed to encourage consumers to think of bulb purchases as cost-saving investments rather than simply expenses, and dissuade them from always looking for the lowest-priced bulbs. This suggests that these efforts have been and can continue to be effective in changing consumer behavior.

Conclusion
The majority of general residential survey respondents who were aware of LEDs (n=236) are willing to pay $5 for one (42% were *very likely* and 28% *somewhat likely*). However, those who reported having recently purchased an LED and who recalled the price they paid (n=23) said they paid more than $10, including the subset of these who reported having purchased bulbs from a participating retailer (n=20). This average price recalled by customers who purchased LEDs was significantly higher than the current promotional prices of program bulbs. Throughout PY6, PPL Electric's standard A-lamp program bulbs have been selling for between $5 and $6 throughout PY6; however, it is possible that customers recall purchases made prior to PY6. Therefore, the fact that we did not observe a measureable increase in residential customers purchasing LEDs could be due to a lag between recent price changes and customers' purchasing behavior.

Conclusion
The price response (demand modelling) analysis of the program's LED data indicated retailer's promotional marketing such as displays or off-shelf placement increases sales.

Recommendation

This suggests another opportunity for the program. PPL Electric and the ICSP could work with retailers to utilize product placement as a lower cost mechanism for generating sales lift rather than more aggressive incentives throughout the year.

Conclusion

The price response (demand modelling) analysis found lesser levels of freeridership in big box stores and higher levels in DIY stores. There may be an opportunity to increase the numbers of discounted LEDs in stores other than the DIY channels.

Recommendation

PPL Electric could consider ways to organize their program to decrease freeridership by focusing on products or channels with lower freeridership. However, there may be a trade-off between gross savings and net-to-gross as DIY shoppers may more likely be small business customers which have higher hours of use and higher savings than residential customers. Therefore, one option may be to increase overall sales by retaining the level of LEDs discounted in DIY stores and increasing the number of discounted LEDs in other channels.

Conclusion

Although falling LED prices, partly due to utility incentives, are likely to propel market adoption, according to lighting manufacturer representatives, LEDs are still substantially more expensive than both CFLs and Energy Independence and Security Act (EISA)-compliant halogen bulbs. We also observed, in our shelf-stocking study, that the CFLs that no longer receive incentives are also substantially more expensive than halogen bulbs. Assuming there are still a significant number of consumers who will look for the least expensive bulb, there may still be a place for incentives for CFLs in an upstream lighting program, where the utility wishes to discount CFLs. PPL chooses to discount LEDs; therefore, educating the customer about the financial benefits of LEDs could encourage customers to purchase LEDs.

Conclusion

CFL disposal behavior remains relatively unchanged from prior years, with over half of customers disposing of CFLs in the trash, in spite of more recycling bins in diverse locations. Many customers (52%, n=187) are still unconcerned about improper disposal of CFLs (or do not know that CFLs should not be thrown in the trash) and it is unclear what is required to encourage more people to properly dispose of CFLs.

Recommendation

In its PY7 customer survey, Cadmus could include questions to help determine if making bins available at popular locations such as grocery stores would change consumers' behavior.

3.7.1 Status of Recommendations for Program

Table 3-22 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 3-22: Residential Retail Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Residential Retail Program	
Consider replacing refrigerators with another product that is more likely to have impact on savings, can benefit from rebates, and increase customer satisfaction.	Being considered for Phase III.
Work with the ICSP and Cadmus to explore ideas for marketing campaigns to reach and educate water heater installers to stock and promote heat pump water heaters.	Will be implemented in Phase III with an enhanced trade ally network.
Continue to research changes in residential customer purchasing behavior with regard to LEDs, in preparation for optimal program impact in Phase III.	Implemented.
For Phase III, consider developing marketing for the general residential population (bill inserts, etc.) that highlights the promotional price of discounted LEDs.	Implemented.
Work with retailers to utilize LED product placement as a lower cost mechanism for generating sales lift (rather than more aggressive incentives throughout the year) and to reduce freeridership.	Will be implemented in Phase III.
Consider ways to organize the program to decrease LED freeridership by focusing on products or channels with lower freeridership.	Will be implemented in Phase III.
Use customer surveys to explore ways to encourage CFL recycling.	Will be implemented in Phase III.

3.8 FINANCIAL REPORTING

A breakdown of the Residential Retail Program finances is presented in Table 3-23.

Table 3-23: Summary of Residential Retail Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$18,901	$21,727
2	EDC Incentives to Participants	$5,003	$7,233
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$13,898	$14,494
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$3,078	$5,467
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$3,078	$5,467
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$12	$11
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$21,991	$27,204
13	Total NPV Lifetime Energy Benefits	$41,164	$78,142
14	Total NPV Lifetime Capacity Benefits	$3,098	$4,205
15	Total NPV O&M Saving Benefits	$10,335	$19,539
16	Total NPV TRC Benefits[4]	$54,596	$101,885
17	TRC Benefit-Cost Ratio[5]	2.48	3.75

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

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report.

ADDENDUM A. PARTICIPANT SURVEY METHODOLOGY

Dialing Instructions

PPL Electric Utilities provided dialing instructions for conducting surveys. Customers cannot be contacted within a year of the last time they completed a survey (with PPL Electric Utilities or Cadmus). Any customer who has requested to be removed from the sample frame for any survey cannot be contacted again. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Prior to the start of survey data collection, Cadmus coordinated with PPL Electric Utilities' survey subcontractor to screen the sample and remove records of any customers who were called in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) or who requested not to be contacted again. Cadmus removed records with incomplete information. As mentioned previously, initial sample preparation also excluded program participants of the Residential Home Comfort, New Homes program.

For the cross-program survey, Cadmus selected a simple random sample of all remaining records and sent them to the survey subcontractor. Table 3-24 lists total number of records submitted to the survey subcontractor and the outcome (final disposition) of each record for the cross-program survey.

For the program-specific survey, Cadmus selected and sent all remaining records to the survey subcontractor. Table 3-25 lists total number of records submitted to the survey subcontractor and the outcome (final disposition) of each record for the program-specific survey.

Table 3-24: Cross-Program Sample Attrition

Cross-Program: Residential Retail Participants	
Description	**Count**
Total population (number of participants Q1-Q2)	**2,731**
Random sample selection	**1,004**
Removed incomplete or bad phone number, inactive customer, completed survey in past year, on "do not call" list, selected for a different survey, duplicate contact	298
Sent to Survey Subcontractor	**706**
Records Not Attempted [1]	**35**
Records Attempted	**670**
Nonworking number	28
Business/wrong number	9
Refusal	204
Language barrier	1
Ineligible; PPL Electric Utilities or market research employment	9
Ineligible; did not participate in program	11
No answer/answering machine/phone busy	223
Nonspecific or specific callback scheduled	101
Partially completed survey	18
Completed survey [2]	**66**

[1] These records were not needed because the overall survey target for the cross-program survey was reached before they were attempted.
[2] The survey target for the cross-program survey was 300 and was not stratified by program (Appliance Recycling, Residential Home Comfort, and Residential Retail).

Table 3-25: Survey Sample Attrition

Residential Retail Equipment	
Description	**Count**
Total population (number of rebate participants)	**1405**
Removed inactive customer	39
Removed contacted in past year	61
Removed do not call	2
Removed in concurrent sample	103
Removed duplicate	4
Removed incorrect sector	6
Sent to Survey Subcontractor	**1190**
Records Not Attempted [1]	**312**
Records Attempted	**878**
Nonworking number	31
Business/wrong number	15
Refusal	222
Language barrier	1
Ineligible; PPL or market research employment	17
Ineligible; didn't participate in program	1
No answer/answering machine/phone busy	244
Nonspecific or specific callback scheduled	175
Partially completed survey	22
Completed survey	**150**

[1] These records were not needed because the survey target was reached before they were attempted.

ADDENDUM B. WATER HEATER INSTALLER INTERVIEWS

INTRODUCTION

During the months of June and July, 2015, Cadmus interviewed nine water heater installers in PPL Electric Utilities' service territory.

Objectives

The objectives of this research were to learn if new outreach strategies, targeted toward professional water heater installers, could increase purchases of heat pump water heaters in Phase III. Cadmus' PY5 Residential Retail Program participant survey suggested that most participants who received a rebate for a heat pump water heater learned about PPL Electric Utilities' rebate program through retailers. Assuming plumbers are often the first point of contact for residential customers who need to replace a water heater, Cadmus suspected this marketing channel may be underused. The interviews were designed to investigate the perspectives of installers about the program's influence on demand for heat pump water heaters. Additionally, we gathered perspectives regarding the potential for increased use of heat pump technology in the near-future market for residential water heating.

The findings from these interviews were intended to be qualitative and are not statistically representative of all water heater installers in PPL Electric Utilities' service territory.

Audience

The interview targeted licensed plumbers or contractors who install residential water heaters. However, during efforts to reach potential respondents, we expanded the pool to include sales people. They are often the first point of contact at participating retailers and give advice and guide customers' purchase decisions.

Participants are defined as contractors who Cadmus determined had installed a rebated heat pump water heater (they may or may not be aware of the fact that their customer received a rebate from PPL Electric Utilities).

Nonparticipants are contractors who advertise as general plumbers in PPL Electric Utilities' service territory or that they offer heat pump water heaters; they may or may not have installed a rebated heat pump water heater.

Key Findings

Key findings based on the interviews were:

- Installers and salespeople from participating retailers were very enthusiastic about the program and rebates, and they sold a significant number of heat pump water heaters.
- Awareness was low among nonparticipants, and they did not sell many heat pump water heaters.
- Participants did not think a salesperson or installer incentive would help sell more heat pump water heaters if it were in lieu of a customer rebate.
- Nonparticipants did think an incentive to salespeople and installers would encourage them to sell more heat pump water heaters.
- Most installers saw a potential for an increase in heat pump water heater installations in the future.
- The general consensus among installers is that educational efforts will help customers.

Sampling Methodology

Cadmus used existing program data to obtain contacts for plumbers who installed a rebated heat pump water heater, regardless of whether they work for a participating retailer. We used copies of rebate applications (collected for PY5 and PY6 impact evaluations) to obtain names and phone numbers of installers referenced on invoices submitted as supporting documentation. We refer to these respondents as participants.

The sample of nonparticipating general plumbers was created by conducting an Internet map search for licensed plumbers within PPL Electric Utilities' service territory. For nonparticipating water heater installers, Cadmus created two sample pools—general plumbers and plumbers who specifically promote installation of heat pump waters heaters. The number of respondents interviewed, by respondent group, is shown in Table 3-26.

Table 3-26: Completed Interviews

Respondent Group	Source	Population	Sample Pool Size	Contacts Attempted	Not Attempted (No Phone Number, Duplicate Retailer, etc.)	Interviewed
Participants	Installer contacts taken from PPL rebate forms used in the impact evaluation (reported in EEMIS)	138	38	13	25	3
Nonparticipants	Internet search for installers in PPL Electric Utilities' territory	Unknown	28	26	2	5
Nonparticipant specifically advertising heat pump water heater installation	Internet search for installers in PPL Electric Utilities' territory	Unknown	9	9	0	1
Other	Receptionist who passed along feedback from installers	N/A	N/A	N/A		1
Total						**10**

Incentives

To encourage participation and compensate respondents for their time, Cadmus offered $100 gift cards for completion of an interview, estimated to take approximately thirty minutes. We increased the amount of the gift card from the initial $50 when scheduling interviews with busy installers became challenging.

Respondent Profile

Respondents from the participant group all worked for appliance retailers that participate in PPL Electric Utilities' program. Two of the five nonparticipant respondents were independent contractors, and three worked for plumbing companies. One respondent was from a company specifically advertising heat pump water heater installations in Bethlehem, Pennsylvania.

FINDINGS

Willingness to Participate in the Interview

During the interview scheduling process, Cadmus found that water heater installers are very busy and can be difficult to reach directly. We left several messages that did not result in returned calls, and some installers we did reach were unwilling to commit to a 30-minute interview even after we increased the incentive from a $50 to a $100 gift card. It did seem, however, that respondents from the participant group, all from participating retailers, were somewhat easier to reach, and all were enthusiastic about PPL Electric Utilities' rebate program. Although our sampling strategy was not designed to provide statistically representative findings, it is worth stating that participants' responses indicated they benefit from PPL Electric Utilities' program with increased sales of heat pump water heaters, which represent a significant proportion of their water heater sales.

Awareness and Promotion of PPL Electric Utilities' Rebate

As expected, all three participating retailer respondents were aware of PPL Electric Utilities' rebate, and all said they *always* tell customers about it. They also said the rebate was *very important* to customers' decisions to purchase heat pump water heaters; two said the rebate's reduction in payback time on customers' investments was a key deciding factor.

Only two of the six nonparticipants were aware of the rebate, and they said they did not tell prospective customers about it.

- One of the two respondents said he would bring up the rebate if a customer specifically asked about heat pump water heaters, but said he did not think heat pump water heaters made sense for most of his customers because *"…you're trading BTUs in your house where the heat pump water heater is located for BTUs in the water and you're not savings as much as what you might think."*
- The other said he did not install many heat pump water heaters because *"it has to be the perfect situation for a heat pump water heater to be appropriate."* He also said the rebate was not important at all to customers' decisions and that it was *"just convenient."*

Surprisingly, the respondent from the company advertising heat pump water heater installations said he was *not aware* of the rebate, but later in the interview he did mention PPL Electric Utilities' bill inserts.

The "other" respondent, a receptionist who passed along feedback from installers, said that "*the heat pump water heater program is in its infancy stage in the Harrisburg area, so we haven't really dealt with it."* She said they have had only one or two customers in the last three years install a heat pump water heater.

Heat Pump Water Heater Installations, Brand Preferences, and Recommendations

All respondents from participating retailers said they mostly sell electric water heaters; the two who estimated the proportion of total sales said approximately 70% to 80% of the electric water heaters sold were heat pump water heaters. One said there is very little demand for gas water heaters because gas service is sparse in his area.

Conversely, the highest estimate from nonparticipants for heat pump water heaters was 5% of sales and they said fuel types ranged between 30% and 60% electric and 30% and 50% gas. One nonparticipant said 10% of the water heaters he sells are oil-fueled. Two others said 10% and 20% are propane water heaters.

All three participant respondents said GE was a brand they carried and recommended; one said he was exclusively a GE dealer. One respondent said he only sold GE heat pump water heaters but sold other brands of traditional water heaters. All of the participants favored heat pump water heaters; one said he recommended a traditional tank if the customer did not want to go with a heat pump water heater, because he has had *"lots of complaints"* about tankless water heaters. Another said he asked first about fuel and recommended the GE Geospring heat pump water heater if the customer had electric fuel. He would sometimes convince a customer using propane to switch to a heat pump water heater but said that switching from natural gas to a heat pump water heater was a harder sell because the efficiency gain was not as dramatic.

The nonparticipants' recommendations were based either on existing fuel type or were specifically in favor of natural gas, either tank or tankless. None of the nonparticipants said they typically recommend heat pump water heaters. One said he did not recommend heat pump water heating because he *"does not see many houses with heat pump heating,"* indicating a lack of understanding that a heat pump water heater is independent of the heating system.

Discounting and Marketing Practices

The three participant respondents said they *sometimes* offered discounts on heat pump water heaters; two of these said the margins for heat pump water heaters were already slim. No nonparticipants offered discounts specifically for heat pump water heaters. Only one respondent (a participant) had heard of a manufacturer that offered a rebate for heat pump water heaters; he said GE occasionally offered a *"buy-in"* promotion for dealers.

All three participant respondents said their companies' marketing was influenced by PPL Electric Utilities' rebate; only one nonparticipant said his company mentions the rebate in advertisements.

Demand for Heat Pump Water Heaters

The three participant respondents reported they had seen an increase in demand for heat pump water heaters since 2010, and they thought both the rebate and the federal tax credit had *a lot* of influence on this increase. One said changes to the federal regulations covering water heater efficiency (in effect as of April, 2015 and covered in March by local news media) had affected customers' awareness of heat pump water heaters as an efficient alternative.

Only one of the nonparticipants noticed an increase in demand for heat pump water heaters (he said he had received more questions about them, although he reported having done very few installations), and he attributed *some* influence to both PPL Electric Utilities' rebate and the federal tax credit.

Factors Important to Customers, Level of Knowledge about Energy Efficiency

When asked which factors were most important to customers looking to replace a water heater, seven of the nine total respondents said energy efficiency and five said purchase price. Four also said either reliability or a warranty and two said size. These are summarized in Figure 3-25.

Figure 3-25: Factors Important to Customers, as Cited by Installers or Sales Staff

Source: Question F3. "Based on what you have heard from customers, what are the most important factors in deciding which type of water heater to install?"

Two of the three participant respondents said that customers *often* ask about the energy use of water-heating options, and one said *always*. Only one of the nonparticipants said customers *often* ask about this; four nonparticipants said *sometimes* and one said *never*.

The nine respondents were equally split about how well informed their customers were about the effect their water heater has on their energy use and energy bills *(very, not very,* or *somewhat informed)*. Two of the three participants said *very informed;* but the one who said *not very informed* also said his customers were very informed by the time they left his store. Four of the six nonparticipants thought their customers where *somewhat informed;* one each said *very* and *not very informed.*

The nine respondents agreed educational materials or marketing would help customers better understand how much energy or money could be saved by choosing energy-efficient appliances. One said that more point of purchase (POP) materials would be helpful in big box stores where salespeople are not as educated. One said educating customers in advance of their need to purchase a water heater is key, because if the customer is in a hurry, he or she will not want to take the time to figure out if new technology will work. Another said that direct mail (bill stuffers) was the best way to get information to customers and suggested that some contractors will hesitate to recommend new technology to customers because they *"prefer to stick with the old equipment."*

Installers' Perspectives on Heat Pump Water Heater Technology, Future Potential

When asked about the benefits of heat pump water heater technology over traditional electric-resistance water heaters, all three participants and two of the six nonparticipants cited *energy efficiency*, although one of these two qualified his response by mentioning that the price was significantly higher than traditional electric. Two of the nonparticipants said they did not know enough about heat pump water heaters to answer the question, and one suggested that customers save money by combining water and space heating. One nonparticipant said that a heat pump water heater only makes sense if there is excess heat where the unit is installed.

When asked if there were circumstances under which they would NOT recommend a heat pump water heater, their most common reason (five respondents) was *lack of space* in the room where the unit would be installed. Two respondents said a high demand for hot water would result in switching a hybrid unit to the standard electric mode, reducing or eliminating energy savings. One said noise, although another said noise was not a problem. One thought the heating system was a factor, and another suggested that heat pump water heaters do not work well in unconditioned basements. Another said that *"most circumstances"* are not right for heat pump water heaters, yet when asked if he thought there was potential for an increase in heat pump water heater installations in the next two years in PPL Electric Utilities' service area, he, and six other respondents, said *yes*.

Not surprisingly, price was commonly mentioned (five respondents) as a barrier to increasing market share. Other barriers were ambient air temperature (one respondent), lack of recovery time (two respondents), a lack of qualified maintenance technicians (one respondent), and lack of education on the part of customers, who will tend to simply replace what they already have (one respondent).

When asked about emerging technologies in water heating, three respondents mentioned tank-less systems; one each mentioned solar, "Smart" controls, and water softeners. Two said they did not see any emerging technologies, aside from heat pumps, and another suggested that existing technologies would simply become more efficient.

Rebates and Incentives

All three participants, and one nonparticipant, said that rebates paid directly to customers were more effective than an incentive for installers. However, four of the six nonparticipants said they would be encouraged to sell more heat pump water heaters if they had a direct incentive to do so. The three participants said that more marketing assistance or materials from PPL Electric Utilities would be helpful; one said it *"would be cool to see PPL come out and say we want you to buy this water heater."* This respondent also suggested that PPL Electric Utilities could provide retailers with rebate forms on tear-off pads so they would not have to download and print them and said he often fills out the form for the customer and provides it with the receipt.

SUMMARY

Water heater installers who are not affiliated with a participating retailer are less aware of PPL Electric Utilities' rebate program and tend to be less educated about heat pump water heater technology. Although only the respondents from participating retailers said they sold a substantial number of heat pump water heaters and were enthusiastic about them, most of the nine respondents saw a potential for an increase in demand for heat pump water heaters in the near future. The fact that the majority of nonparticipants thought they could sell more heat pump water heaters with a direct incentive indicates they are open to changing their standard practice. Respondents, in general, agreed that educational efforts would help customers quantify financial savings. These findings indicate a likely benefit from expanding outreach to independent contractors or installers and nonparticipating plumbing companies.

ADDENDUM C. LOGIC MODEL

A program's theory informs its development and implementation as well as its evaluation. A program logic model identifies the relationships between activities and expected results. Because typical logic model design makes the underlying theory explicit, logic models are useful tools for implementers and evaluators.

A summary of the program theory for the Residential Retail Program includes:

- **Residential Lighting Component.** By using various program delivery mechanisms and educating customers about lighting options, PPL Electric Utilities encourages its customers to purchase new ENERGY STAR-qualified CFLs (PY5) and LEDs and install them as replacements for inefficient incandescent bulbs, thereby reducing demand and producing energy savings. By placing recycling buckets and educational materials in retail and community or municipal locations, the program will encourage customers to dispose of CFLs in an environmentally sound manner.
- **Residential Efficient Equipment Component.** By providing rebates for high-efficiency or ENERGY STAR-rated equipment (such as refrigerators and heat pump water heaters), the program will increase market saturation and acceptance of high-efficiency equipment. Customers will learn about energy benefits and achieve energy savings and demand reduction by installing qualifying equipment.

Elements within the logic model include:

- **Activities the program undertakes** include trade ally recruitment and coordination; price negotiations for bulk purchases of bulbs; marketing and outreach to customers; dissemination of program materials; distribution of no-cost bulbs to customers; recycling of used CFLS; rebate form submission; eligibility verification; customer education; equipment purchases by the customer; and rebate processing and payment.
- **Outputs produced by program activities** include informed and active trade allies and community organizations; marketing materials; promotional campaigns; and program-discounted LEDs. Measureable outputs include: the number and distribution of participating retailers, the number of discounted bulbs purchased, the number of customers receiving equipment rebates, the number of efficient equipment products purchased (both total quantity and number of different models), and the number and amount of rebates paid.
- **Short-term outcomes** include promotional campaigns to educate customers about energy-efficient lighting; increased LED availability; increased customer demand for LEDs; reduced retail prices for program-discounted LEDs; increased customer and trade ally awareness of energy-efficient equipment, and increased installations of energy-efficient equipment. Distributing upstream and giveaway bulbs and incentivizing efficient-equipment purchases leads to immediate energy and demand savings when these items are installed.
- **Intermediate outcomes** include increased customer familiarity and comfort with energy-efficient light bulbs and appliances, which leads to more efficient equipment installations. Installations result in more energy and demand savings; reduced LED and efficient equipment manufacturing costs due to economies of scale and technological improvements; reduced LED market pricing due to competition from incentivized bulbs; and more efficient and effective program implementation resulting from the continuous evaluation feedback.
- **Long-term outcomes** include customers thinking of LEDs and efficient appliances as standard equipment (i.e., transformation of the light bulb and appliance markets); and substantial energy savings and demand reduction, with a planned program savings of 191,861 MWh/yr and 35.45 MW through the end of PY7 and beyond.

ADDENDUM D. PARTICIPANT SURVEY ATTRITION AND FINAL DISPOSITION

SURVEY METHODOLOGY

Dialing Instructions

PPL Electric has provided dialing instructions for conducting surveys. Customers cannot be contacted for a telephone survey until a year has passed since they completed their last survey (with PPL Electric or Cadmus). Customers who have requested not to be contacted again are also removed from the sample frame. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Cadmus coordinated with PPL Electric's survey subcontractor to screen the sample and remove any records of customers who had been called in the past year (whether for a Cadmus survey or a PPL Electric survey) or requested not to be contacted again. We also removed records with incomplete information and participants reserved for another survey, as described above.

Cadmus selected a simple random sample of all remaining records and sent them to the survey subcontractor. Table 3-27, Table 3-28, and Table 3-29 lists total number of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table 3-27: Survey Sample Attrition Table for Act 129 PY6 Participants

Description	Count
Total Population (Number of Participants)	**11,152**
Random Sample Selection	**4,716**
Removed incomplete or bad phone number	2
Removed inactive customer	442
Removed completed survey in past year	277
Removed because on do not call list	2
Removed because selected for other survey	874
Removed because duplicate	36
Sent to Survey Subcontractor	**3,083**
Records Not Attempted [1]	**133**
Records Attempted	**2,948**
Nonworking number	94
Business/wrong number	60
Refusal	887
Language barrier	3
Ineligible; PPL or market research employment	34
Ineligible; did not participate in program	38
No answer/answering machine/phone busy	990
Nonspecific or specific callback scheduled	464
Partially completed survey	78
Completed Survey	**300**

[1] These records were not needed because the survey target was reached before they were attempted.

Table 3-28: Survey Sample Attrition Table for General Population Residential Customers

Description	Count
Total Population (Number of Customers)	**2,140,376**
Random Sample Selection	**40,000**
Removed because bad or incomplete phone	1,913
Removed because duplicate	756
Removed because inactive customer	15,227
Removed because contacted in past year	223
Removed because selected for a different study	91
Sent to Survey Subcontractor	**21,790**
Records Not Attempted [1]	**18,095**
Records Attempted	**3,695**
Nonworking number	456
Business/wrong number	148
Refusal	1,214
Language barrier	30
Ineligible; PPL or market research employment	41
Ineligible; not PPL customer	0
No answer/answering machine/phone busy	934
Nonspecific or specific callback scheduled	451
Partially completed survey	120
Completed Survey	**301**

[1] These records were not needed because the survey target was reached before they were attempted.

Table 3-29: Survey Sample Attrition Table for General Population Small Business

Description	Count
Total Population (Number of Customers)	**256,317**
Removed because of rate codes	17,478
Adjusted Population (Number of Small Business Customers)	238,839
Random Sample Selection	**124,122**
Removed because bad or incomplete phone	6,393
Removed because duplicate	39,793
Removed because inactive customer	23,537
Removed because contacted in past year	1,456
Removed because PPL facility	22
Removed because not valid address	151
Sent to Survey Subcontractor	**52,770**
Records Not Attempted [1]	**45,769**
Records Attempted	**7,001**
Nonworking number	934
Business/wrong number	940
Refusal	2,141
Language barrier	39
Ineligible; PPL or market research employment	33
Ineligible; not PPL customer	73
No answer/answering machine/phone busy	1,020
Nonspecific or specific callback scheduled	1,252
Partially completed survey	184
Completed Survey	**385**
[1] These records were not needed because the survey target was reached before they were attempted.	

ADDENDUM E. LIGHTING MANUFACTURER INTERVIEWS

During the months of November and December 2014, Cadmus interviewed eight representatives of lighting manufacturers. The objectives of these interviews were to assess:

- The influence of Pennsylvania's utility-sponsored manufacturer buy-down programs on the diversity, quantities, and pricing of energy-efficient bulbs as well as on customer awareness and decisions to purchase energy-efficient bulbs
- Whether manufacturers discount LEDs only through utility-sponsored programs or whether they also discount non-program LEDs
- How manufacturers think their businesses would be affected if the Pennsylvania EDCs stopped discounting, or increased the discounts on, energy-efficient bulbs
- How manufacturers think their businesses would be affected if utilities across the United States stopped discounting, or increased the discounts on, energy-efficient bulbs
- Manufacturers' expectations about LED saturation and ability to fill sockets
- Proportions of bulb sales

Key findings and predictions from the interviews with eight manufacturers include:

- Utility programs have had a profound effect on the market for emerging technologies in lighting.
- Market effects are due to both incentives and utility-provided education for consumers.
- In the absence of utility programs, incandescents, and now EISA-compliant halogens, would be the market leaders.
- Utility programs were more effective than EISA in changing consumer behavior.
- CFLs will be replaced by LEDs as LEDs come down in price.

Methodology

Cadmus conducted structured interviews with lighting manufacturers to discuss the trend in sales of CFLs and LEDs and the influence of discounts provided through utility-sponsored programs. We collaborated with other Pennsylvania electric distribution companies (EDCs) and their evaluators, then drafted the interview guide, which the other EDCs and SWE reviewed. Cadmus and PPL Electric compiled the contact list and requested contacts from other EDCs. Cadmus administered the revised guide, calling each of the 29 firms on the compiled list.

This was not a structured survey. We developed a structured interview guide to help us ask specific questions consistently and guide the flow of discussions. However, respondents were encouraged, and tended to, speak freely on topics introduced by our questioning. This type of dialogue often diverges from the planned order, as well as from comprehensiveness, of the specific questions asked. The nature of these interviews and time constraints meant that not every interviewee was specifically asked (or specifically answered) every question in our interview guide. Therefore, mentions of responses by specific numbers of people—only one or two people, for example—should not be interpreted as proportional results, unless stated otherwise.

Respondent Profile

The contacts developed by Cadmus and provided by the Pennsylvania EDCs, and subsequently interviewed by Cadmus, were current and former partners and non-partners in the upstream lighting component of the Residential Retail Program, as shown in Table 3-30.

Table 3-30: Contacts, by Partner Status

<table>
<tr><th>Partner Status</th><th>PPL</th><th>Duquesne</th><th>First Energy Utilities</th><th>PECO</th><th>Interviewed</th></tr>
<tr><td>Current Partners</td><td>11</td><td>16</td><td>6</td><td>5</td><td>3</td></tr>
<tr><td>Former Partners</td><td>9</td><td>3</td><td>1</td><td rowspan="2">Unknown</td><td>3</td></tr>
<tr><td>Non-Partners</td><td>9</td><td>10</td><td>22</td><td>2</td></tr>
<tr><td>Total</td><td colspan="4">29</td><td>8</td></tr>
</table>

Half of the representatives of the manufacturers we interviewed were in general sales or marketing roles, and half focused on utility programs or on retailers participating in utility programs.

All but one of the manufacturers represented by those interviewed make both CFLs and LEDs. The one exception makes fixtures or integrated LED decorative products but not stand-alone bulbs. Four make exclusively CFLs and LEDs (not halogen or incandescent bulbs) and three make all types of general-service bulbs. A summary of bulbs made by respondents is shown in Table 3-31.

Table 3-31: Bulbs Manufactured by Respondents

Bulbs Manufactured	Number of Respondents	Exclusively CFL/LED
General-Service CFLs and LEDs	7	4
General-Service Halogens	3	N/A
No Screw-In Bulbs	1	N/A

Firms range in size from 35 to 400 employees. The majority have been making CFLs for at least 20 years; most only started making LEDs more recently, in the last two to ten years, although one has been making LEDs since 2000.

Effects of Pennsylvania Utility Programs on Business

The general consensus among respondents was that utility programs have had a profound effect on the market for emerging technologies in lighting, first for CFLs and now for LEDs. They said this effect is due to incentives bringing price points down and to utility-provided education about energy-saving technologies designed to make customers think of efficient lighting as a cost-saving investment rather than to seek only the lowest price for bulbs. Several respondents suggested that, in the absence of utility programs, incandescents, and now EISA-compliant halogens, would be the market leaders, based solely on price, and that LED sales would revert to being limited to first-adopter purchases.

One respondent mentioned that a cut in funding in Pennsylvania in 2011 reduced the number of program-discounted bulbs and so significantly affected sales of spiral and reflector CFLs significantly that sales have yet to regain the same volume.

Another respondent suggested that utility programs were more effective than EISA in changing consumer behavior. Utilities make it more affordable to adopt a new technology and support marketing and education efforts. Another respondent estimated that its CFL sales would have been 75% lower in the absence of the program.

Most respondents made some mention of greater product diversity due to incentives. One said that specialty CFLs were being phased out in favor of LEDs, which fit a wider variety of sockets and are an increased presence on store shelf space. Another said that, initially, LEDs had a real presence only in big-box or club stores and took longer to reach other categories of retail but also that the traditional supply chain tends to lock in older products, whereas utility programs allow for "drop-ship" promotions that allow manufactures to put the most advanced products in stores.

Three mentioned retailer participation in the promotion of energy-efficient products; two suggested that retailers were motivated by an increase in sales volume, whereas one suggested that the incentive model does not really motivate floor staff to sell efficient products because light bulb sales are a small fraction of total retail sales.

Impact of EISA and Role of Compliant Replacements

Three respondents mentioned that the initial impact of EISA resulted in a surge in orders for incandescent bulbs. Most said that price is a big driver for sales and that utility programs helped move CFLs and LEDs. Several mentioned that without utility incentives, halogens would still be the market leader, because many consumers would not have ever purchased a CFL for the market price.

One respondent mentioned customer confusion due to EISA, and several praised utility programs for educating consumers about energy-efficient alternatives to traditional incandescent bulbs.

One respondent suggested that EISA had nothing to do with the move toward energy-efficient bulbs, which this respondent believed was completely market-driven, but that the recent increase in LED sales made it look that way.

A common theme was the prediction that CFLs will be replaced by LEDs, as LEDs come down in price. One even mentioned that no one wants bare spiral CFLs and that these do not sell outside of [stores such as] Walgreens. Another said something very similar—in all but bottom-end channels, price-wise (Dollar Tree, Walgreens), CFLs will go away quickly. When asked if they thought customers would stop buying CFLs if and when LEDs cost the same, one said yes, because LEDs last longer, and one said that customers want something that looks more like an incandescent and do not like factors such as the mercury in CFLs, so it would make sense for them to choose LEDs.

Emerging Technology

When asked about emerging technologies that may play a role in lighting in upcoming years, two respondents mentioned LED tubes and four mentioned smart technology or remote or interactive controls. Of the four who mentioned smart technology, two spoke of it as a potentially significant trend or game-changer for energy efficiency, while the other two were dubious about its value.

Low-End Prices for CFLs and LEDs

With incentives, bare spiral CFLs can be sold for under \$1 for a four-pack. Without rebates, quoted prices for CFLs ranged from about \$5 to \$8. Rebated, standard A-line LEDs sell for as low as \$4. Without rebates, ENERGY STAR-certified LEDs bottom out between \$9 and \$12. One respondent predicted that, by next year, LEDs could sell for as low as \$15 for a three-pack, without incentives.

Discounting Practices

Although responses were sparse to questions about discounting practices, there was not a strong indication that manufacturers further discount bulbs already discounted through utility programs. One respondent specifically said that, for the most part, there is one national retail price. Another stated that margins are already thin, but that they may offer additional discounts if they can guarantee large volumes of sales. Two said that additional discounting can be achieved indirectly, by taking incentives off of the wholesale price, further reducing the manufacturers' margin.

Change in CFL and LED Sales Over Past Two Years

Of the five respondents who commented about trends in CFL sales over the past two years, three reported a significant drop-off, with one also stating that sales initially spiked with incentives but then leveled off. The other two respondents said that CFL sales had not changed much. When answering these questions, only one respondent offered a quantitative estimate, which was that CFL sales went from 90% to 20%.

Responses regarding trends in LED sales over the past two years were less specific. One said the company was "just on the cusp" of LED sales. Another said the company had no program bulbs in Pennsylvania yet, but did in other states, and that LED sales were up about 35% over two years ago. Two other respondents simply said that LEDs were starting to compete with CFLs.

Future CFL Socket Saturation

Most respondents agreed that CFL socket saturation is not likely to increase beyond the roughly 30% suggested by industry research. Only one said that CFL use would increase as regular incandescents disappear but added the caveat that LEDs could compete, thus staving off any increase in CFL saturation. The rest agreed that CFL saturation would either not change or decrease and several mentioned common reasons (light quality, slow to come on, mercury) that consumers do not really like CFLs.

ENERGY STAR® Certification

Half of the manufacturers reported that 100% of the LED bulbs they sell in the United States are ENERGY STAR-certified. Most mentioned that the eligibility for rebates was a major influence in seeking ENERGY STAR certification; the cost of certification was mentioned as a factor, but opinions differed as to whether the cost was directly related to the testing and certification process or indirectly related due to the costs of making products that meet the specifications. One said that more bulbs in the United States than in Canada are ENERGY STAR-certified because the Canadian incentive structure is different (i.e., not based on ENERGY STAR certification). Another said that non-ENERGY STAR products sell more in non-utility incentive areas because they are cheaper. Another suggested that, in the absence of utility programs, the proliferation of sub-par, non-ENERGY STAR products could hurt the industry, similar to the way problems with early CFLs contributed to their relatively poor reputation amongst consumers.

SUMMARY

Although few respondents were willing or able to give specific, quantitative estimates or predictions of past or future trends in CFL and LED sales, most seemed willing to speak openly about their perceptions of the current and future lighting market. The strongest themes were that utility-program incentives, as well as educational and promotional efforts, had a dramatic effect on the speed at which LEDs sales have increased recently and that consumers prefer and will more quickly adopt LEDs than CFLs, eventually squeezing CFLs out of the market as LED prices come down.

They suggested that the market would naturally transform because utility incentives contribute to both competition and economies of scale and support the competitiveness of ENERGY STAR-certified bulbs, which are superior in quality and preferred by some major retailers. These factors contribute to market transformation in the long run, but in the short run, incentives are making LEDs competitive with EISA-compliant halogens, which are still the cheapest bulbs in the absence of subsidies.

ADDENDUM F. LOGIC MODEL

A program's theory informs its development and implementation as well as its evaluation. A program logic model identifies the relationships between activities and expected results. Because typical logic model design makes the underlying theory explicit, logic models are useful tools for implementers and evaluators.

A summary of the program theory for the Residential Retail Program includes:

- **Residential Lighting Component.** By using various program delivery mechanisms and educating customers about lighting options, PPL Electric encourages its customers to purchase new ENERGY STAR-qualified CFLs (PY5) and LEDs and install them as replacements for inefficient incandescent bulbs, thereby reducing demand and producing energy savings. By placing recycling buckets and educational materials in retail and community or municipal locations, the program will encourage customers to dispose of CFLs in an environmentally sound manner.
- **Residential Efficient Equipment Component.** By providing rebates for high-efficiency or ENERGY STAR-rated equipment (such as refrigerators and heat pump water heaters), the program will increase market saturation and acceptance of high-efficiency equipment. Customers will learn about energy benefits and achieve energy savings and demand reduction by installing qualifying equipment.

Elements within the logic model include:

- **Activities the program undertakes** include trade ally recruitment and coordination; price negotiations for bulk purchases of bulbs; marketing and outreach to customers; dissemination of program materials; distribution of no-cost bulbs to customers; recycling of used CFLS; rebate form submission; eligibility verification; customer education; equipment purchases by the customer; and rebate processing and payment.
- **Outputs produced by program activities** include informed and active trade allies and community organizations; marketing materials; promotional campaigns; and program-discounted LEDs. Measureable outputs include: the number and distribution of participating retailers, the number of discounted bulbs purchased, the number of customers receiving equipment rebates, the number of efficient equipment products purchased (both total quantity and number of different models), and the number and amount of rebates paid.
- **Short-term outcomes** include promotional campaigns to educate customers about energy-efficient lighting; increased LED availability; increased customer demand for LEDs; reduced retail prices for program-discounted LEDs; increased customer and trade ally awareness of energy-efficient equipment, and increased installations of energy-efficient equipment. Distributing upstream and giveaway bulbs and incentivizing efficient-equipment purchases leads to immediate energy and demand savings when these items are installed.
- **Intermediate outcomes** include increased customer familiarity and comfort with energy-efficient light bulbs and appliances, which leads to more efficient equipment installations. Installations result in more energy and demand savings; reduced LED and efficient equipment manufacturing costs due to economies of scale and technological improvements; reduced LED market pricing due to competition from incentivized bulbs; and more efficient and effective program implementation resulting from the continuous evaluation feedback.
- **Long-term outcomes** include customers thinking of LEDs and efficient appliances as standard equipment (i.e., transformation of the light bulb and appliance markets); and substantial energy savings and demand reduction, with a planned program savings of 229,274 MWh/yr and 39.89 MW through the end of PY7 and beyond.

ADDENDUM G. SHELF STOCKING STUDY

INTRODUCTION

As part of research activities for PPL Electric's Phase II Residential Retail Program, Cadmus conducted a longitudinal shelf stocking study in two rounds of site visits to 37 stores during the spring of 2014 and spring of 2015. The study was designed to help inform the Act 129 planning and program design activities through these objectives:

- Assess trends in screw-in lighting technology stocking practices for LED, CFL, halogen, and incandescent lamps
- Compare stocking and pricing practices in different stores for LED lighting technologies
- Compare changes in lighting technology offerings by manufacturer

Cadmus' analysis involved several metrics, which required consistent protocols for both rounds of data collection. Using the experience of our first round, we made only minor revisions to the data collection protocols for the second round.

Findings from lighting manufacturer interviews,[40] completed by Cadmus in early 2015, add additional insights to the study.

TERMINOLOGY

Table 3-32 is a glossary of key terminology used in the shelf stocking study.

Table 3-32: Shelf Stocking Study Glossary

Term	Definition
Bulb	Individual bulb within a bulb pack having a unique stock keeping unit (SKU)/model number and store
Bulb Category	Bulbs are categorized into one of these four bulb technologies: **General service lamps** are medium screw based bulbs that are not globe, bullet, candle, flood, reflector, or decorative shaped. These bulbs encompass both twist/spiral and A-lamp bulbs. **Specialty bulbs** include candelabra base, globe, bullet and shapes other than A-lamp bulbs. **Reflector/flood bulbs** are reflector (directional) bulbs. **Recessed lighting packs** are screw-in downlights.
Bulb Pack	Package or a set of bulbs with a unique stock keeping unit (SKU) and/or make and model number at a given store.
Geographic Designation	Urban or rural, based on 2013 U.S. Census Bureau definitions[1]
Nonparticipating Store	Stores that do not sell PPL Electric's program-incentivized bulbs and do not have an active contract with Ecova, the program implanter, are nonparticipating stores.
Pack Face	Bulb package facing the consumer (i.e., the visible pack[s] adjacent to the aisle). Depth or total number of packs does not factor into this number. Cadmus used pack faces as the primary unit of analysis when reporting this study's findings. Figure 3-26 presents examples of pack faces.
Participating Store	Stores that sell PPL Electric's program-incentivized bulbs and have a contract with Ecova, the program implanter, are participating stores.
Program Bulb	Bulbs or bulb packs advertised as PPL program bulbs.[2]

40 See Addendum B, "Lighting Manufacturer Interview Findings."

Term	Definition
Retail Channel	Retailers are assigned to one of the following categories: home improvement, mass merchandise, membership club, hardware, discount chain, or grocery.
Retailer	Chain or franchise involved in the study
Round One	First round of store visits completed in the spring of 2014.
Round Two	Second round of store visits completed in the spring of 2015.
Shelf Location	Location designations include shelf, end-cap, and aisle display.
Shelf Space	Number of pack faces will serve as the primary proxy for measuring shelf space.
Store	Individual retail establishment or individual store visited by a field technician
Technology Type	Bulbs will be designated as one of these bulb technology types: incandescent, halogen, CFL, or LED.

[1] The Census Bureau identifies two types of urban areas. Urbanized areas are defined as areas of 50,000 or more people; urban clusters have at least 2,500 but less than 50,000 people. Rural encompasses all population, housing, and territory not included within an urban area. Cadmus included both urbanized areas and urban clusters in the definition of "urban." More information can be found at https://www.census.gov/geo/reference/urban-rural.html
[2] Cadmus did not cross-check data collected in the field with program data provided by PPL Electric and the ICSP for this study.

Figure 3-26 shows examples of pack faces. We counted each bulb pack facing the consumer as one pack face, regardless of its size, the number of bulbs in the pack, or the bulb type. Pack faces offer the best available proxy for shelf space (area) dedicated to each bulb type. The number of pack faces by bulb pack is a good indication of available products and proportion of anticipated sales; store managers decide which bulbs to market and dedicate shelf space accordingly.

The photo on the right in Figure 3-26 shows a shelf-stocking practice featuring a variety of pack faces, indicating this store intends to market a wide variety of bulb types. The photo on the left shows an end-cap stocked with 16 pack faces of a unique bulb pack. From this stocking pattern, we determined that the intent of the store was to present four rows of four pack faces to customers.

Figure 3-26: Pack Face Examples

Figure 3-27 illustrates the complexity of counting and documenting pack faces. The left photo is an example of the extent of the variety and number of bulbs that can be found at a single store. The right photo shows a common situation where bulbs are stocked in various areas of a store instead of one consolidated lighting section. Regardless of the shelving practices, Cadmus inspected and documented pack faces located throughout each store.

Figure 3-27: Example of Bulbs Locations and Size of Shelf Space

SAMPLING PLAN SUMMARY

Cadmus visited 37 stores in March 2014 (round one) and again in March 2015 (round two). We stratified the store sample by retail channel (home improvement, mass merchandise, hardware, discount chain, and grocery) and geography (urban, rural) to generate a well-rounded sample of lighting technologies, availability, and price in PPL Electric's service territory. Where possible, we visited the same stores to obtain the most accurate comparison of the light bulb market between study years. However, in some cases, we added alternate stores to best fit with the original sample frame because the first-round stores opted out of the second round or the store was no longer participating in PPL Electric's program.

Table 3-33 lists the number of completed store visits, along with the retail channel and store, for both rounds of the shelf stocking study.

Table 3-33: Distribution of Store Samples in Round One (2014) and Round Two (2015) [1]

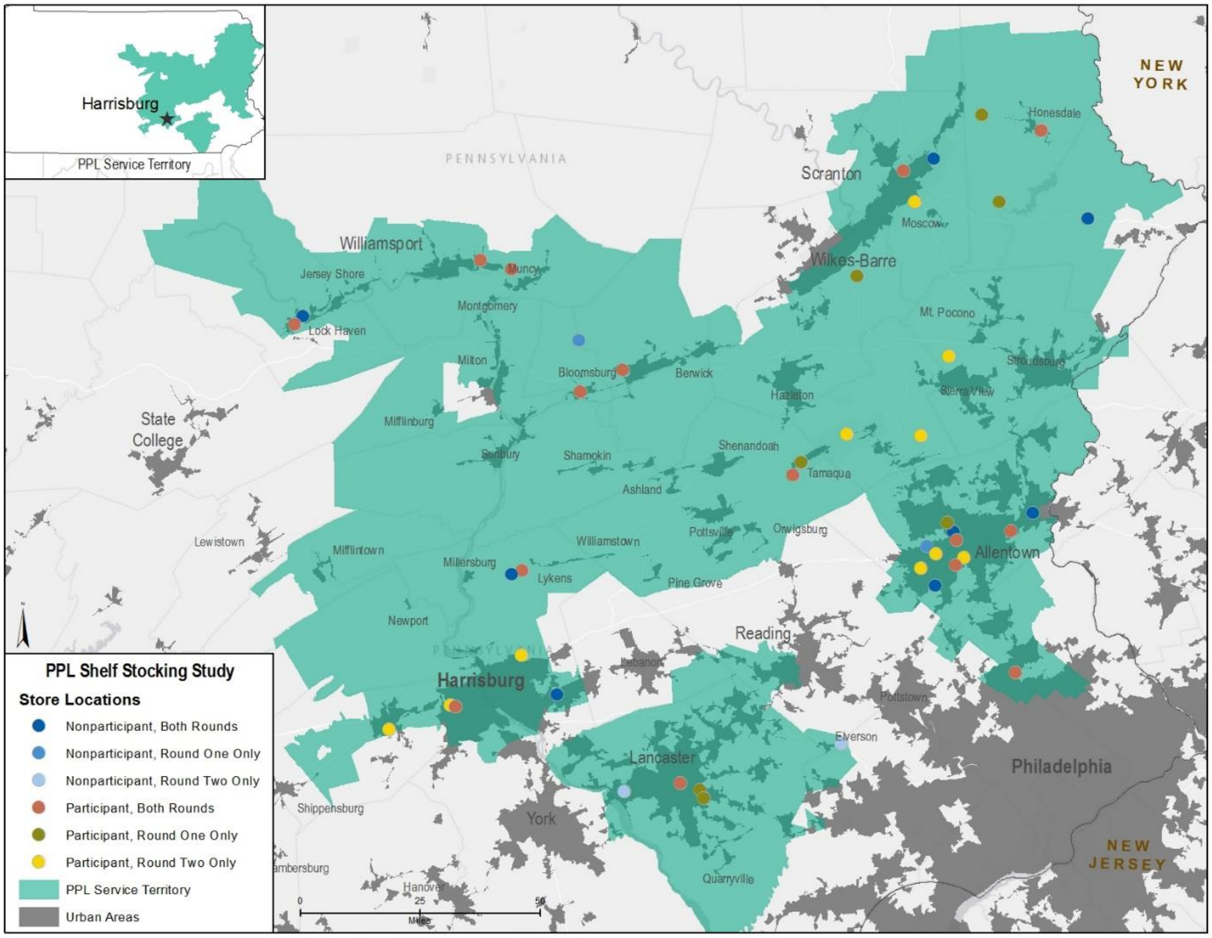
Retail Channel	Participating Stores	Completed Store Visits	Nonparticipating Stores	Completed Store Visits
Home Improvement	The Home Depot	8	No comparable stores	None
Mass Merchandise	Walmart	8	Kmart	2
Membership Club	Sam's Club, Costco	2	No comparable stores	None
Hardware	Ace Hardware, True Value	3	Do It Best, 84 Lumber (2014), Ace Hardware/True Value (2015)	5
Discount Chain	Dollar General (2014), Family Dollar (2015)	2	Dollar Tree	2
Grocery	Weis Markets (2014), Wegmans (2015)	3	IGA, ShurSave	2
Total		**26**		**11**

[1] Replaced and alternate stores are distinguished with a participant year next to their name; all other stores were visited during both rounds of the study.

Participating stores had contracts with Ecova (PPL Electric's upstream lighting program administrator, or ICSP) and sold bulbs for which PPL Electric provided discounts. Nonparticipating stores did not have contracts with the ICSP and therefore did not sell program-discounted bulbs.

Figure 3-28 shows the locations of participant and nonparticipant stores visited during round one of the shelf stocking study.

Figure 3-28: Shelf Stocking Study Store Locations



DATA COLLECTION SUMMARY

The shelf stocking study assessed changes in availability, characteristics, and pricing of incandescent, halogen, CFL, and LED lighting technologies, with a focus on 40W to 150W bulbs equivalent to pre-Energy Independence and Security Act (EISA) bulbs. The residential lighting section of the 2014 Pennsylvania Public Utility Commission (PUC) Technical Reference Manual (TRM) provides baseline bulb wattages by lumens, shape, and EISA qualifications.[41] The TRM separates bulbs into three bulb

---

[41] Pennsylvania Public Utility Commission. *2014 TRM Annual Update Final Order.* Available online: http://www.puc.pa.gov/pcdocs/1262306.docx

categories—general service lamps (GSLs), specialty bulbs, and reflector/flood bulbs.[42] Cadmus used these TRM definitions to inform its data collection methodology and analysis approach:

- GSLs are medium screw-based bulbs that are not globe, bullet, candle, flood, reflector, or decorative shaped. These bulbs do encompass both twist/spiral and A-lamp bulbs.
- Specialty bulbs include candelabra base, globe, bullet, and shapes other than A-lamp bulbs.
- Reflector/flood bulbs are reflector (directional) bulbs.

We also included LED-recessed lighting fixtures in general market characterizations. Three-Way Lamps later in this report summarizes information about three-way bulbs and program bulbs found outside of the defined lumen ranges of the study.

Table 3-34: Data Collection Design for GSLs

TRM 2014				Technology Types Collected			
Bulb Technology	Pre-EISA Wattage	Min Lumens	Max Lumens	Incan-descents	Halogens	CFLs	LEDs
General Service Lamps (GSL)	150	2,000	2,600	X	X	X	X
	100	1,600	1,999	X	X	X	X
	75	1,100	1,599	X	X	X	X
	60	800	1,099	X	X	X	X
	40	450	799	X	X	X	X
	25	310	449				

Table 3-35: Data Collection Design for Specialty Bulbs [1]

TRM 2014				Technology Types Collected			
Bulb Technology	Pre-EISA Wattage	Decorative Lumens	Globe (G) Lumens	Incan-descents	Halogens	CFLs	LEDs
Specialty Bulbs	150	-	1100-1300			X	X
	100	-	650-1099			X	X
	75	-	575-649			X	X
	60	500-699	500-574			X	X
	40	300-499	350-499			X	X
	25	150-299	250-349				
	25	90-149	-				
	25	70-89	-				

[1] The study did not collect data on incandescent or halogen specialty or reflector/flood bulbs. Cadmus focused on GSLs, which made up 91% of the bulbs incentivized through PPL Electric's upstream lighting program in PY5 Q1 and Q2. Retailer-imposed in-store time constraints also affected the decision to limit data collection. In round two, we collected the number of pack faces for incandescent and halogen specialty and reflector/flood bulbs to allow for proportional comparisons.

42 Cadmus used tables 2.74, 2-75, and 2-76 of the 2014 TRM to guide data collection activities.

Table 3-36: Data Collection Design for Reflector/Flood Bulbs

TRM 2014				Bulb Types			
Bulb Technology	Pre-EISA Wattage	Min Lumens	Max Lumens	Incan-descents	Halogens	CFLs	LEDs
Reflector/ Flood	All	All	All			X	X

For each unique pack face, Cadmus collected data on bulb category, bulb type, base type, model number, shelf stocking unit (SKU) (for LED bulbs only), price, shelf location, three-way bulb designation, ENERGY STAR certification, and the presence of PPL Electric promotional signage. We designed the data collection instruments to inform these metrics:

- Counts of incandescent, halogen, CFL, LED pack faces, bulb packages, and bulbs
- Price information for incandescent, halogen, CFL, LED bulb packages
- Counts of PPL- incentivized pack faces advertised in stores
- Shelf space dedicated to incandescent, halogen, CFL, and LED technologies

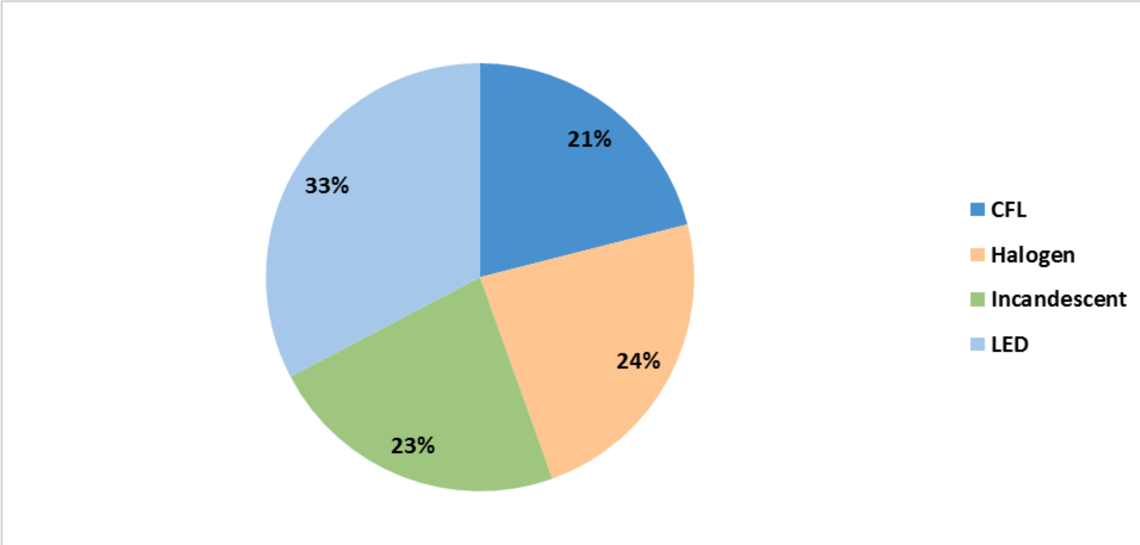
The data fields collected during round one (2014) and round two (2015) were identical with the following exceptions:

- These data elements were not collected in round two: SKU for non-program bulbs, lifetime, and color temperature recorded on bulb packaging.
- Physical shelf space was not measured. Cadmus believes that the number of pack faces provides a proxy for shelf space. The number of technology pack faces by bulb pack provides a good indication of available products and the proportion of anticipated sales since store managers must decide which technologies to market and to dedicate sufficient shelf space.
- Additional data were collected in round two to allow for proportional comparisons by technology. In particular, we collected the number of pack faces (but not additional details) for incandescent, halogen specialty, incandescent, and halogen reflector/flood bulbs.
- During round two, we crosschecked LED SKU/model numbers against a list of program bulbs by stores (from program data provided by Ecova for Q1 to Q3) and noted whether bulbs were on the program bulb list.

Round Two Technology Types

Cadmus determined the distribution of GSL, specialty, and reflector/flood bulbs by lighting technology during round two, as shown in Figure 3-29.

Figure 3-29: Round Two Percentage of Weighted Pack Faces by Technology



Because data for incandescent and halogen specialty and reflector/flood bulbs were not collected in round one, direct high-level comparisons encompassing these bulb categories cannot be provided between data collection rounds.

Table 3-37 provides a breakout by bulb category and technology type.

Table 3-37: Round Two Pack Faces by Category and Technology Type

Category	Technology Type	Percentage of Total Weighted Pack Faces
GSL	Incandescent	2%
	Halogen	11%
	CFL	15%
	LED	17%
Reflector/Flood	Incandescent	10%
	Halogen	10%
	CFL	4%
	LED	9%
Specialty	Incandescent	11%
	Halogen	2%
	CFL	2%
	LED	2%
Recessed Lighting	LED	4%
Total		**100%**

GSLs make up close to half of the light bulb market (45%), followed by reflector/flood bulbs (33%) and specialty bulbs (17%). Incandescents make up almost a quarter of the total light bulb market share (23%), although they consist mainly of reflector and specialty bulbs. Halogen pack faces make up 23% of the market share, CFLs 21%, and LED 28%.

DATA ANALYSIS FINDINGS

Cadmus compared data from both rounds to determine any changes occurring in the lighting market in PPL Electric's service territory. We compared lighting technologies and the three most common bulb categories—GSL, specialty, and reflector/flood bulbs.[43] For the GSL analysis, we reviewed changes between all bulb technologies. For specialty and reflector/flood bulbs, we focused on changes between CFL and LED technologies.

Additionally, we have included findings from interviews with lighting manufacturer interviews about changes in the lighting market.[44]

General Study Characteristics

Cadmus completed 74 store visits. Table 3-38 lists selected metrics from data collected throughout the shelf stocking study.

Table 3-38: Sample Characteristics for Round One and Round Two Store Visits

Sample Characteristics	Round One Quantity	Round Two Quantity
Total Stores Visited	**37**	**37**
Participating Stores Visited	26	26
Nonparticipating Stores Visited	11	11
Total Pack Faces Recorded	**6,767**	**8,187**
Pack Faces Recorded at Participating Stores	6,256	7,456
Pack Faces Recorded at Nonparticipating Stores	511	731
Pack Faces Recorded at Urban Stores	5,972	7,432
Pack Faces Recorded at Rural Stores	795	755
Pack Faces Advertised as Program Bulbs	**622**	**635**

To allow for meaningful comparisons between stores, the shelf stocking analysis normalized data using sampling weights for each year. To appropriately weight the observed sample data by retail channel, Cadmus used the distribution of PPL Electric's participating stores as a proxy for the distribution of the overall population of stores within its territory and created weights to normalize the stratified sample according to this assumed distribution.

Weights are determined by store type (retail channel) and urban/rural designations. For example, if urban discount chains made up 25% of the stores in PPL Electric's territory but only 5% of stores of the sample, the retail channel stratum would be given a weight of 5, meaning observations from this retail channel would be counted as if they were five times as prevalent in our data. This ensures that, when computing

43 Changes in the lighting market in PPL Electric's territory probably result from recent changes in EISA standards, PPL program incentives, and other market forces, including the market adoption of new technologies. It is important to note that the shelf stocking study's scope was not to determine a quantifiable cause and effect relationship between market influences and changes in the market. Any noted comparisons or differences found between study years are qualitative observations. We designed the sample to reflect the primary delivery channels and urban and rural settings. We did not design the study to meet parameters that provided statistically significant results.

44 See Addendum B, "Lighting Manufacturer Interview Findings."

averages or proportions, the observations were represented according to the assumed true distribution of stores by retail channel.

Shelf Space (Pack Faces)

As stated previously, we compared the number of pack faces to the proportion of shelf space dedicated to each unique bulb pack. Using this metric, we determined changes in the percentage of shelf space dedicated to incandescent, halogen, CFL, and LED bulb types by bulb categories.

Cadmus observed a change in the distribution of GSL technologies between study rounds. EISA standards,[45] fully in effect as of 2014, eliminated the manufacture of most traditional (non-halogen) GSL incandescent bulbs. During round one, we observed a large number of incandescent bulbs, probably because retailers were allowed to deplete their incandescent inventories. In one year, the observed presence of incandescent pack faces dropped from 45% to 4%. In addition, we observed halogen and LED bulb pack faces increase their presence by 15% and 22%, respectively, between both rounds. CFL bulbs maintained a similar market presence, increasing 4% between rounds. The changes in GSL shelf space between study rounds are shown in Figure 3-30.

Figure 3-30: Percentage of Weighted Pack Faces of GSL Bulbs by Technology Type

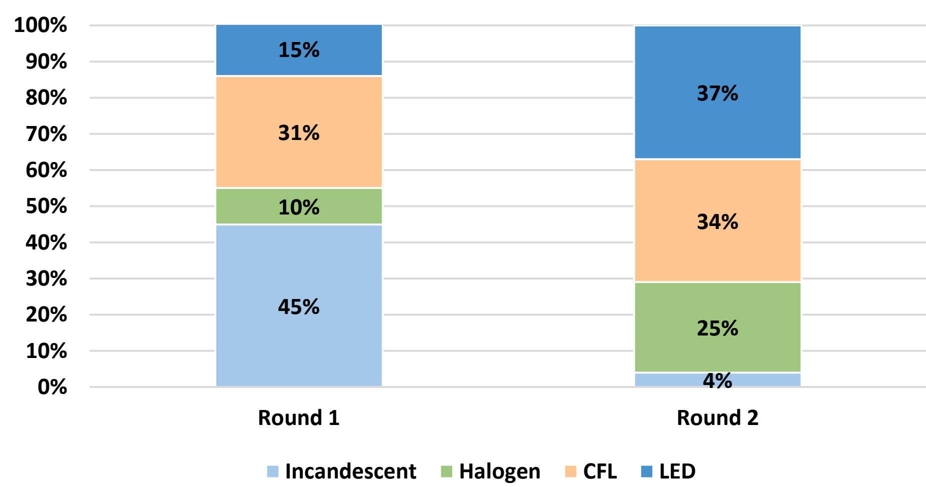
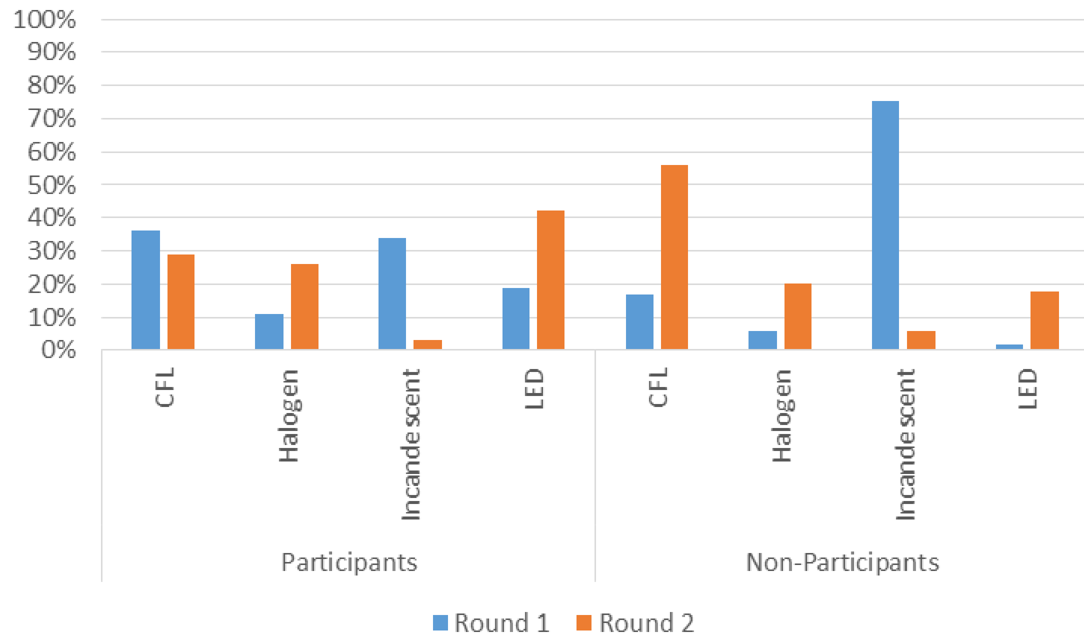


Figure 3-31 illustrates changes in proportions of shelf space between stores participating in PPL Electric's upstream lighting program and nonparticipants.

45 LED Lighting Facts. "The Energy Independence and Security Act (EISA) of 2007." Available online: http://www.lightingfacts.com/Library/Content/EISA

Figure 3-31: Comparison of Percentage of Weighted Pack Faces of GSL Bulbs by Technology, Participant and Nonparticipant Stores

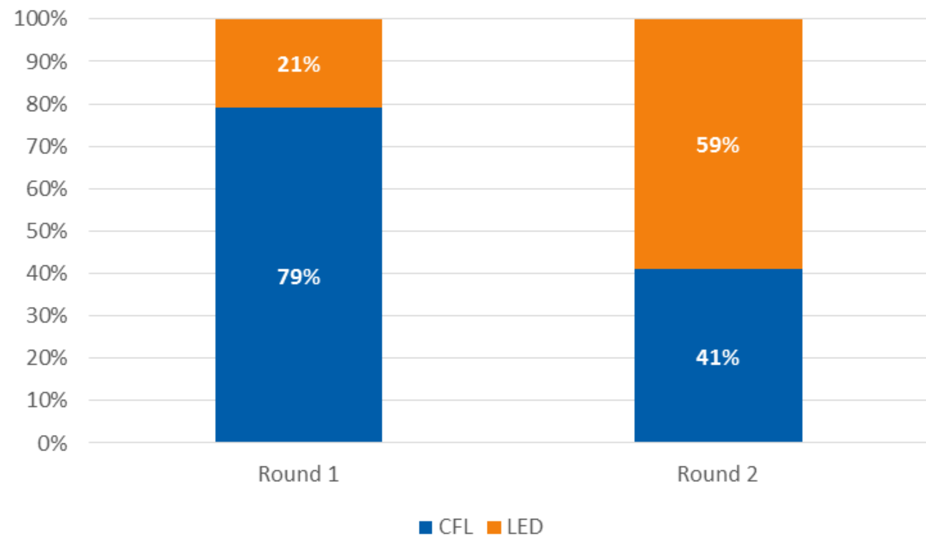


Incandescent and halogen bulb proportions decreased between round one and round two in both participant and nonparticipant stores. The proportion of CFL shelf space increased at nonparticipant stores while decreasing at participant stores.[46] LEDs increased shelf space at both participant and nonparticipant stores.

Cadmus also compared specialty and reflector/flood CFL and LED pack face distributions between study rounds. Since EISA standards affected only a small portion of all specialty bulbs and exempted common reflector/flood lamp types, the changes in shelf space proportions are more likely due to program influences and market adoption of new technologies. Figure 3-32 and Figure 3-33 illustrate changes between study rounds for specialty and reflector/flood bulbs, respectively.

46 Possibly influenced by PPL Electric's decision to halt upstream CFL incentives in favor of LEDs, beginning in June 2014.

Figure 3-32: Percentage of Weighted Pack Faces of Specialty Bulbs by Technology



Between round one and round two, specialty and reflector/flood technologies shifted from a majority of CFL bulbs to a majority of LED bulbs (Figure 3-33 and Figure 3-34). Whereas in round one, LEDs comprised 49% of observed reflector pack faces, LEDs comprised 69% in round two; specialty LEDs shifted even more dramatically, from 21% to 59%.

Figure 3-33: Percentage of Weighted Pack Faces of Reflector/Flood Bulbs by Technology

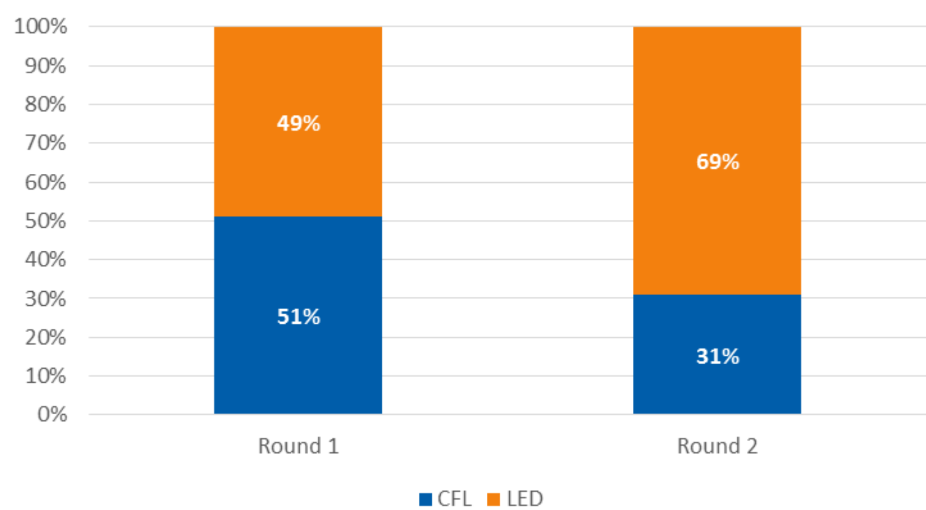
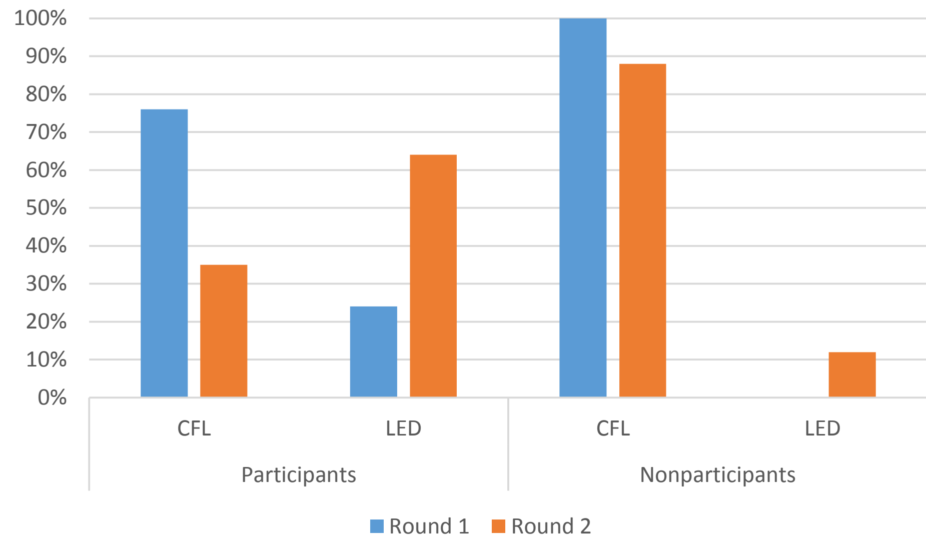


Figure 3-34: Percentage of Weighted Pack Faces of Specialty Bulbs by Bulb Type Participants vs. Nonparticipants



Price

Cadmus reviewed price changes in PPL Electric's lighting market focusing on price changes for all GSL technology types and for CFL and LED specialty and reflector/flood bulbs. We grouped bulbs into "like for like" categories to determine price changes in bulb types by technology (e.g., change in average price for GSL bulbs by technology between the two rounds). We also investigated differences in bulb pricing between participating and nonparticipating stores. All price comparisons exclude lamps with three-way functionality, which are discussed in "Three-Way Lamps" later in this report.

Cadmus reviewed changes in proportions and bulb prices between ENERGY STAR and non-ENERGY STAR bulbs. Some lighting manufacturers commented that low quality bulbs can enter the market at cheap price points,[47] but these ultimately hurt acceptance of new technologies because they result in poor experiences for consumers. Since ENERGY STAR requires high standards of quality through product testing, the different prices and proportions between ENERGY STAR and non-ENERGY STAR CFL and LED bulbs can provide insights about product mixes in the efficient light bulb market during the study period.

All prices are weighted by the sampling weights for each store type and the number of pack faces (combination of weights). The pack faces are used as weights to represent sales volume so that the average pack face-weighted prices are a proxy for the average sales-weighted price of a bulb sold through a particular store.

Figure 3-35 shows the average price per bulb in 2014 and 2015 for various bulb types. The price of LEDs decreased across all categories by roughly 25%—the largest for reflector/flood bulbs (43%) and the smallest for specialty bulbs (17%). General service bulbs and recessed lighting decreased by 26% and 28%, respectively.

---

47 See Addendum B, "Lighting Manufacturer Interview Findings."

CFL prices stayed relatively unchanged from one year to the next, probably because PPL Electric's incentives for CFLs had largely been phased out when we collected data for round one.[48] Therefore, the prices we observed can reasonably be assumed to be the retail price of CFLs for which there were no PPL program incentives.

Incandescent prices increased substantially for GSLs, (167%), probably because EISA regulations phased out lower wattage bulbs between the two years. Halogen GSLs decreased slightly in price (17%).

Figure 3-35: Average Price per Bulb, by Year, Technology, and Category

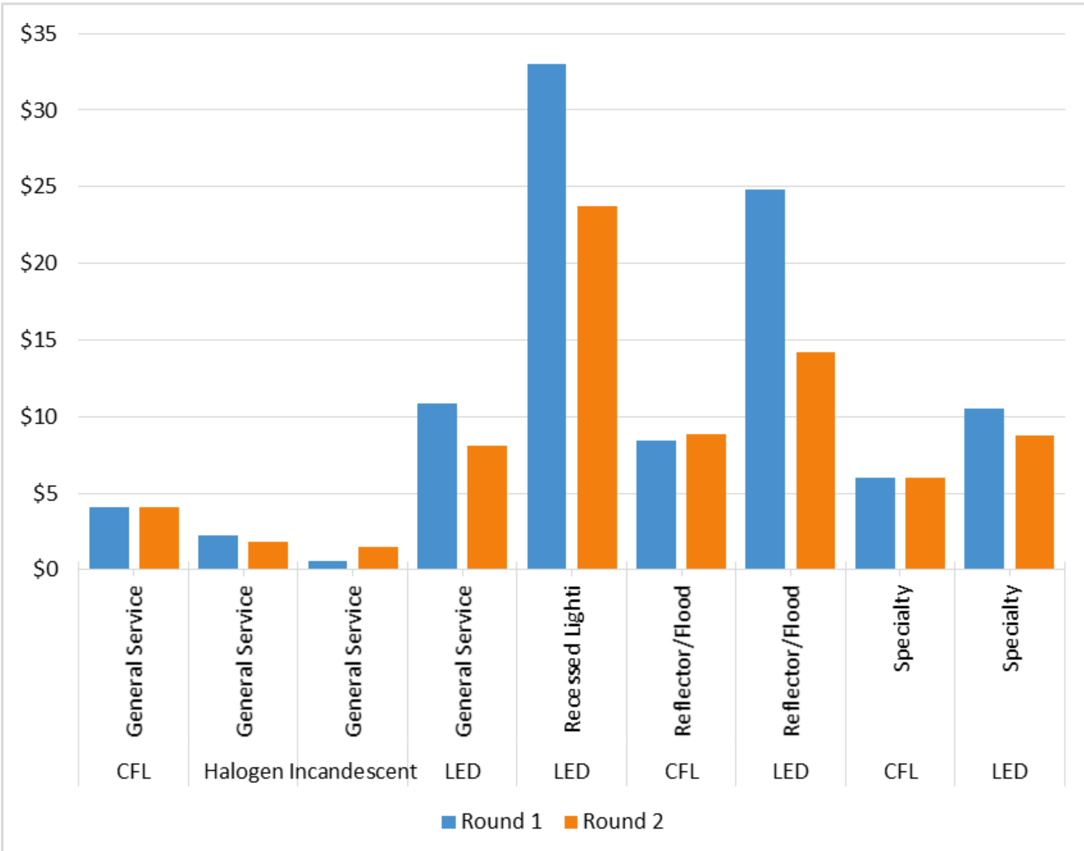


Table 3-39 lists the average bulb prices for each bulb technology type within each retail channel. These prices aggregate participating and nonparticipating retailers in each retail channel and aggregate bulbs by technology. Because of this aggregation, comparisons between retail channels will not control for differences in product mix. For example, downlights and specialty LEDs are much more common at hardware or home improvement retailers but are more expensive than GSLs, which increases the average per-bulb price. Subsequent tables show more granular price data.

48 See Upstream Lighting Program Phase Out of CFLs.

Table 3-39: Average Bulb Price by Retail Channel and Technology

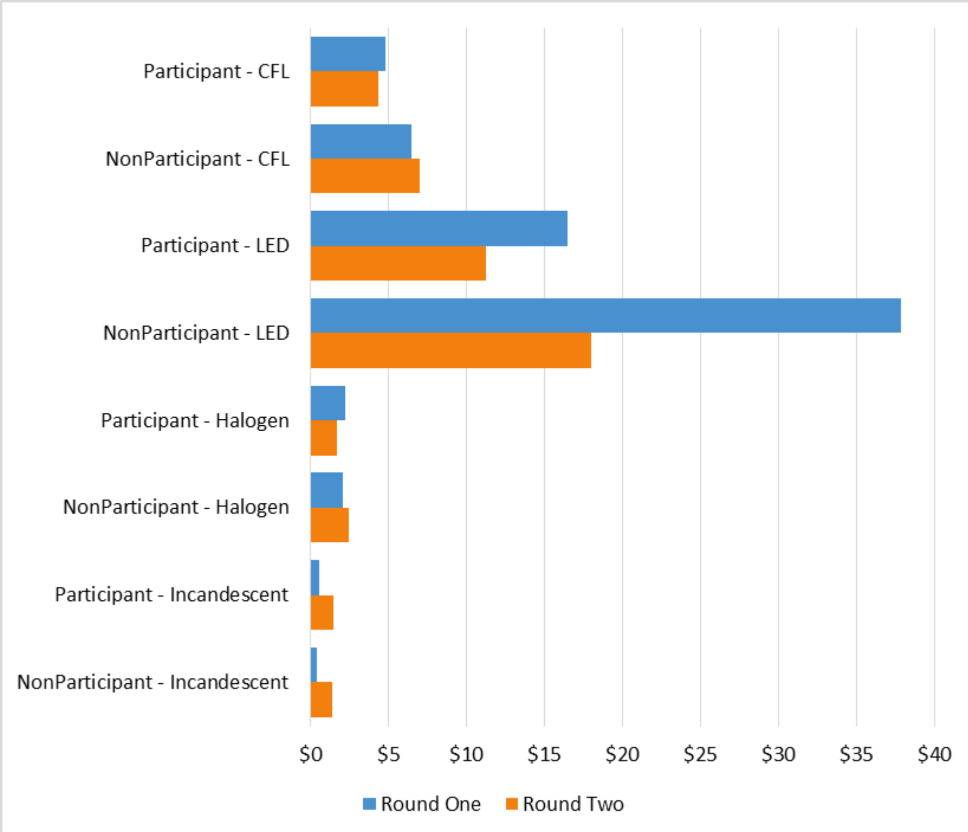
Retail Channel	Technology	Weighted Average Price Per Bulb	
		Round One	Round Two
Discount Chain	CFL	$2.68	$5.03
	Halogen	$1.75	$1.66
	Incandescent	$0.36	N/A
	LED	N/A	$3.23
Grocery	CFL	$7.60	$4.88
	Halogen	$3.08	$1.72
	Incandescent	$0.85	$0.92
	LED	$11.49	$10.11
Hardware	CFL	$6.00	$6.65
	Halogen	$2.61	$2.12
	Incandescent	$0.85	$1.05
	LED	$17.25	$13.20
Home Improvement	CFL	$4.63	$3.97
	Halogen	$2.19	$2.11
	Incandescent	$0.66	$1.93
	LED	$17.99	$13.06
Mass Merchandise	CFL	$4.19	$3.89
	Halogen	$1.70	$1.57
	Incandescent	$0.58	$2.88
	LED	$17.05	$10.15
Membership Club	CFL	$1.80	$1.95
	Halogen	$1.33	$1.33
	LED	$12.47	$6.40

Figure 3-36 shows prices in each of the two years and for the participant and nonparticipant stores. The figure shows a similar pattern as above—that is, incandescent bulb prices have increased over time.

CFL prices and halogen prices stayed relatively constant with the average price per bulb for both technologies lower at participating retailers. This is probably because the participating retailers are primarily big-box, volume retailers that offer lower prices in general.

In all retail channels but membership club, CFL prices are still substantially higher than halogen prices.

Figure 3-36: Average Bulb Price by Technology and Participant and Nonparticipant Stores



LED prices dropped at both participating and nonparticipating retailers; the drop was considerably larger in nonparticipating stores. LED prices are shown in Table 3-40.

Table 3-40: LED Prices by Category and Participant and Nonparticipant Retailers

Category	Average Price per Bulb Participant			Average Price per Bulb Nonparticipant		
	Round One	Round Two	Percentage Change	Round One	Round Two	Percentage Change
General Service	$10.12	$7.47	-26%	$33.36	$14.28	-57%
Recessed Lighting	$33.03	$23.82	-28%	N/A	$22.53	N/A
Reflector/Flood	$23.38	$13.15	-44%	$41.10	$22.68	-45%
Specialty	$10.55	$8.70	-17%	N/A	$10.97	N/A

The LED product mix did not change substantially for either participant or nonparticipant retailers and does not explain the dramatic drop in prices in nonparticipant stores from 2014 to 2015. However, other factors could explain the price drop for LEDs at nonparticipating. For example:

- The number of LED products in nonparticipating stores was relatively small—20 LED products in round one and 45 in round two. By comparison, we collected prices at participating retailers for 678 LED products in 2014 and 1,529 LED products in 2015.
- New LED brands have entered the market. For both participating and nonparticipating stores, the number of LEDs essentially doubled from one year to the next. This could mean that manufacturers

are introducing additional products because they are scaling up production or new entrants to the market are increasing competition and price pressure.

- Price pressure may be due to the incentives provided for products sold through PPL Electric's upstream lighting program. Lighting manufacturers also suggested this and were adamant that utility incentive programs have a profound effect on the market for LED lighting.[49] However, due to limitations of this analysis, we cannot determine if, or to what extent, this may be a factor.

Table 3-41 compares the average price per bulb by category for CFLs and LEDs.

Table 3-41: Average LED and CFL Price by Technology

Category	Average Price per Bulb – Round One		Average Price per Bulb – Round Two	
	CFL	LED	CFL	LED
General Service	$4.11	$10.85	$4.06	$8.06
Reflector/Flood	$8.47	$24.85	$8.88	$14.23
Specialty	$6.00	$10.55	$5.98	$8.75

In 2015, the price difference between CFLs and LEDs decreased substantially across all bulb categories. Although CFL prices remained largely unchanged, LED prices decreased, making LEDs more price competitive. In 2015, the price of reflector and GSL LEDs is 150% to 200% of the price of a comparable CFL; in 2014, LEDs cost 250% to 300% more than CFLs.

Table 3-42 compares the average price per bulb for all four types of GSLs. LEDs are still the most expensive technology at twice the price of a CFL and approximately four times the price of halogens, but their price appears to be coming down while CFL prices remain relatively constant. Halogen prices decreased 17% from 2014 to 2015, less than the 25% decrease in LEDs prices.

Table 3-42: Average Price for General Service Lamps by Technology

Technology Type	Average Price per Bulb	
	Round One	Round Two
CFL	$4.11	$4.06
Halogen	$2.24	$1.85
Incandescent	$0.55	$1.47
LED	$10.85	$8.06

Table 3-43 compares the prices for ENERGY STAR-certified bulbs to non-ENERGY STAR bulbs.

49 See Addendum E. Lighting Manufacturer Interviews.

Table 3-43: 2015 Price per Bulb – ENERGY STAR and Non-ENERGY STAR Bulbs

Technology Type	Technology Type	Average Price per Bulb - Round Two	
		ENERGY STAR	Non-ENERGY STAR
CFL	General Service	$3.10	$4.97
	Reflector/Flood	$7.46	$7.79
	Specialty	$5.25	$5.18
LED	General Service	$6.00	$11.30
	Recessed Lighting	$23.37	$30.97
	Reflector/Flood	$11.13	$17.80
	Specialty	$7.51	$9.94

Manufacturers reported that cheaper, lower quality bulbs can enter the market and leave consumers with a bad impression of new technologies, which in turn slows acceptance into the market. We found no instances where non-ENERGY STAR products were significantly cheaper. In fact, in nearly all locations, the ENERGY STAR products were less expensive than the non-ENERGY STAR. However, we were not able to control for program incentives (only ENERGY STAR-certified bulbs qualify for program incentives); therefore, we cannot test price difference absent program incentives.

On the other hand, this comparison was limited to 2015 observations, when PPL Electric was not offering incentives for CFL bulbs. As Table 3-43 shows, ENERGY STAR general service CFLs were still cheaper than non-ENERGY STAR CFLs. Reflectors and specialties were very similar in price, which suggests that the ENERGY STAR designation is not an important factor in determining price. Our observation is inconsistent with suggestions made by lighting manufacturers that, in the absence of utility programs, the less expensive, non-ENERGY STAR products would be more price-competitive.

Manufacturers

Cadmus examined the number of manufacturers in 2014 and 2015, within each technology type and lumen type, as shown in Table 3-44. We expected that as EISA standards take effect we would see fewer incandescent manufacturers in 2015. We did observe this decrease at both participating and nonparticipating retailers.

Table 3-44: Count of Unique Manufacturers by Technology, Year, Participant and Nonparticipant Retailers

Technology Type	Lumen Type	Participant Stores		Nonparticipant Stores	
		Round One	Round Two	Round One	Round Two
CFL	General Service	12	12	6	9
	Reflector/Flood	7	7	6	6
	Specialty	4	6	3	3
Halogen	General Service	7	9	6	6
Incandescent	General Service	8	4	6	4
LED	General Service	12	13	5	5
	Recessed Lighting	10	11	N/A	1
	Reflector/Flood	10	12	5	6
	Specialty	6	9	N/A	1

We also looked at changes in the number of LED and CFL manufacturers from 2014 to 2015. The green colored cells in Table 3-44 highlight increases in the observed numbers of manufacturers in each category.

With PPL Electric discontinuing incentives for CFLs in PY5, we expected there would be differences in the number of CFL manufacturers, but this was not the case. We observed more specialty CFL manufacturers in participating stores in 2015, more GSL CFL manufacturers in nonparticipating stores, but no observed decreases in the overall number of CFL manufacturers. This suggests that, although we observed fewer pack faces in 2015 as incandescent lamps become less available, CFLs remain a viable option.

We also observed an increase in the number of manufacturers producing LEDs across all categories in participating retailers. For nonparticipating retailers, however, we did not collect data for specialty LEDs or recessed lighting in 2014 and cannot make a comparison. However, we saw little change in the number of manufacturers of GSL LEDs and reflector LEDs.

The change observed in participating retailers may be that smaller manufacturers can enter the market because PPL Electric's incentives allow them to market their products at a competitive price point. However, this may also be due to market maturation as the cost of LED production decreases.

SUMMARY

Cadmus observed both participant and nonparticipant stores moving from CFL to LED technology for specialty and reflector/flood bulbs. The change we observed in participant stores is probably the result of PPL Electric's upstream lighting LED incentives. Lighting manufacturers hypothesized that, as the price difference between CFLs and LEDs shrinks, consumers will certainly prefer and choose to purchase LEDs.[50]

For specialty and reflector/flood bulbs, market adoption is occurring in both participant and nonparticipant stores. This observation is consistent with a suggestion made by a representative of a lighting manufacturer that retailers are devoting more shelf space for specialty bulbs to LEDs, which tend to be more versatile than CFLs.[51]

The observed price decrease for LEDs appears to correlate with increased shelf space compared to CFLs. Lighting manufacturers thought CFL socket saturation is unlikely to increase—and may decrease over the next few years as LEDs come down in price—because many consumers never liked CFLs. Manufacturers also suggested that many consumers who purchased CFLs would not have purchased them for market price and that halogens would be the market leader in the absence of utility incentives, especially for consumers who are looking for the cheapest bulbs.

Although falling LED prices, partly due to utility incentives, are likely to propel market adoption, LEDs are still substantially more expensive than both CFLs and EISA-compliant halogen bulbs. We also observed that the CFLs that no longer receive incentives are also substantially more expensive than halogen bulbs. Assuming there are still a significant number of consumers who will tend to look for the least expensive bulb, there may still be a place for incentives for CFLs in an upstream lighting program.

Alternatively, PPL Electric could focus on education efforts specific to the cost-effectiveness, from the consumer's perspective, of efficient bulbs over their halogen counterparts. Manufacturers lauded utility incentive programs for their education programs, which are designed to encourage consumers to think of lighting choices in terms of long-term cost savings rather than simply looking for the lowest-priced bulbs, suggesting that these efforts have been and can continue to be effective.

---

[50] See Addendum E. Lighting Manufacturer Interviews

[51] See Addendum E. Lighting Manufacturer Interview

THREE-WAY LAMPS

Lamps with three-way functionality were excluded from the analysis because they were exempt from EISA standards and are not included in the TRM tables. However, because three-way lamps still offer savings potential for PPL Electric, Cadmus collected data to compare prices of three-way lamps.

Table 3-45 shows the average price-per-bulb by technology and lumen category. Prices changed relatively little for CFLs. LEDs decreased by $3 per bulb, a decrease of 15% from 2014 to 2015. Incandescent lamps and halogen lamps were not included because we collected no pricing data for either technology in round 1.

Table 3-45: Average Price-per-Bulb by Year, Technology, and Category – Three-Way Lamps

Technology Type	Category	Weighted Average Price Per Bulb	
		Round One	Round Two
LED	General Service	$19.97	$16.97
CFL	General Service	$12.37	$12.70
CFL	Reflector/Flood	$8.99	N/A

UPSTREAM LIGHTING PROGRAM PHASE OUT OF CFLS

Figure 3-37 shows the proportion of CFL vs. LED program bulb sales, by month, for bulbs sold in PY5 (including bulbs sold in PY5 but reported in PY6). March 2014, when Cadmus staff were collecting data for Round one of the shelf stocking study, was the first month where LED sales were higher than CFL sales.

Figure 3-37: PPL Electric Upstream Lighting Program Bulbs Sold in PY5

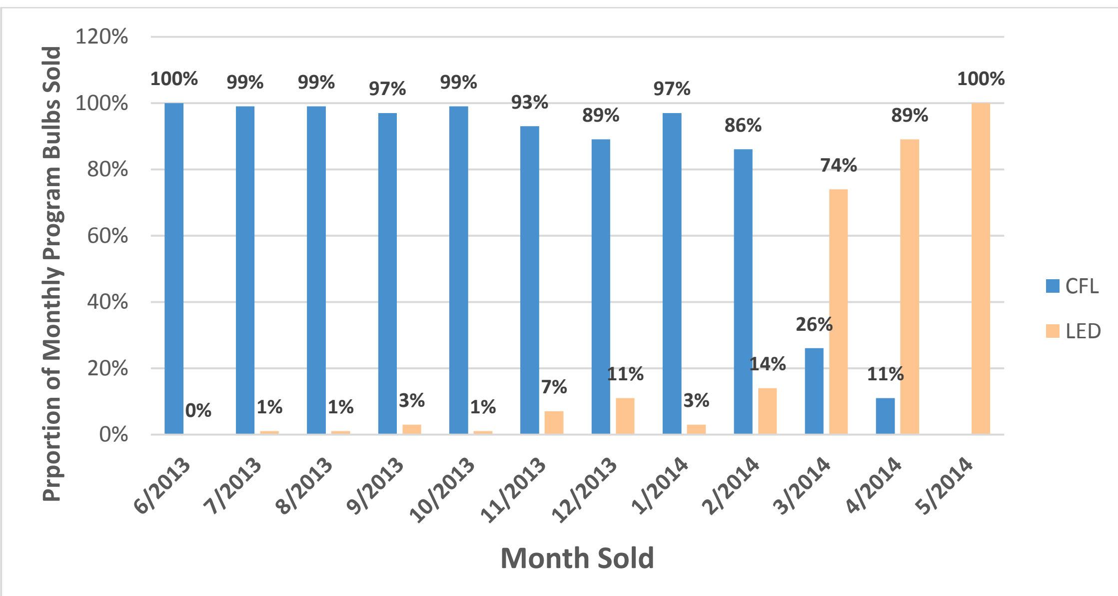
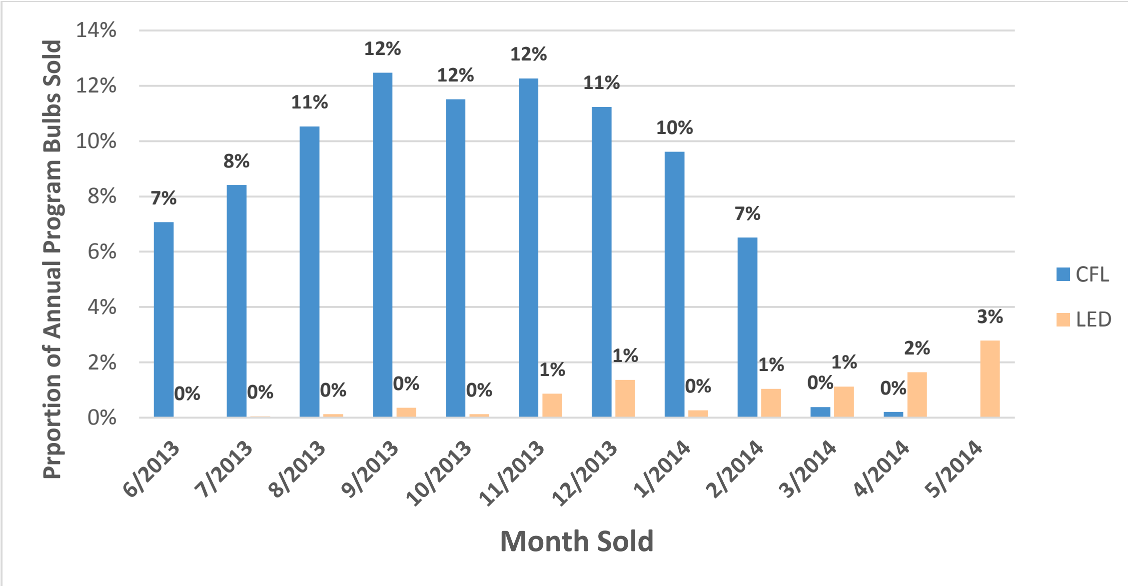


Figure 3-38 shows the monthly sales as a proportion of the annual sales (with annual sales representing 100% of sales). There were very few program bulbs sold in March 2014 (less than 2% of annual program bulb sales) as the program wound down for the year.

Figure 3-38: PPL Electric Upstream Lighting Program Bulbs Sold in PY5, Annual Distribution



ADDENDUM H. ADDITIONAL DATA FROM GENERAL RESIDENTIAL SURVEY AND REPORTED PROGRAM BULB SALES

The following content was provided to Navigant in May 2015 to support Duquesne's Delphi panel study to inform their estimates of net-to-gross for upstream lighting. The general residential population survey data included here is as provided to Navigant; the bulb sales data have been updated to include PY6 Q4 and take into account corrections to EEMIS data provided by the ICSP.

General Residential Population Survey Data

How satisfied were you with the CFLs you installed?	**N**	**187**
		Respondents who have used CFLs
	Very satisfied	70
		37%
	Somewhat satisfied	81
		43%
	Not too satisfied	29
		16%
	Not satisfied at all	7
		4%
	Don't know	-
		-
How satisfied, in general, were you with the screw-based LEDs you installed?	**N**	**90**
		Respondents who have used LEDs
	Very satisfied	64
		71%
	Somewhat satisfied	17
		19%
	Not too satisfied, or	3
		3%
	Not satisfied at all?	1
		1%
	Don't know	3
		3%
	Refused	2
		2%

		% of N	**N**	**Definition of N**
Likelihood to buy LEDs in next 12 months	Very likely	33%	236	Respondents who were aware of LEDs
	Somewhat likely	40%		
	Not too likely	14%		
	Not at all likely	9%		
	Don't know	3%		

			Response to Likelihood question		
Follow-up question:		**N**	Somewhat likely	Not too likely	Not at all likely
Why are you [Somewhat/Not too/Not at all] likely to install screw-based LEDs in your home in the next 12 months?	**Base**	**149**	**94**	**34**	**21**
	Costs too much	**50**	22	17	11
		34%	*23%*	*50%*	*52%*
	Don't like them	**14**	3	8	3
		3%	*3%*	*24%*	*14%*
	Don't fit	**2**	-	1	1
		1%	-	*3%*	*5%*
	Not familiar enough with them	**15**	12	1	2
		10%	*13%*	*3%*	*10%*
	I don't expect to have to replace any bulbs	**25**	19	4	2
		7%	*20%*	*12%*	*10%*
	Like LEDs	**5**	5	-	-
		3%	*5%*	-	-
	Am interested in being energy efficient	**11**	11	-	-
		7%	*12%*	-	-
	Already use them	**5**	1	2	2
		3%	*1%*	*6%*	*10%*
	Interested in learning more/ trying them	**10**	10	-	-
		7%	*11%*	-	-
	OTHER	**5**	3	1	1
		3%	*3%*	*3%*	*5%*
	Don't know	**16**	12	3	1
		11%	*13%*	*9%*	*5%*
	Refused	**-**	-	-	-
		-	-	-	-

Specific reasons for choosing to purchase LEDs	**N**	**61**	*Multiple-response question; responses add up to > 100%
	Reduce energy costs	21	34%
	They last a long time	14	23%
	Wanted to try them/new product	2	3%
	Dislike CFLs/they are better than CFLs	2	3%
	To help the environment	1	2%
	Size or Fit	1	2%
	Recommendation	1	2%
	Brand	1	2%
	Cost	3	5%
	No specific reason	5	8%
	Other: specify	15	25%
	Don't know	2	3%

	N	84	Definition of N: Respondents currently using LEDs (regardless of when purchased)
Approximately, how many screw-based LEDs are installed inside and outside your home right now?	0	4	5%
	1	7	8%
	2	14	17%
	3	9	11%
	4	10	12%
	5	2	2%
	6	6	7%
	8	7	8%
	9	2	2%
	10	4	5%
	12	1	1%
	13	1	1%
	14	1	1%
	15	2	2%
	16	2	2%
	18	1	1%
	20	4	5%
	22	1	1%
	30	1	1%
	40	1	1%
	50	1	1%
	(Don't know)	3	4%

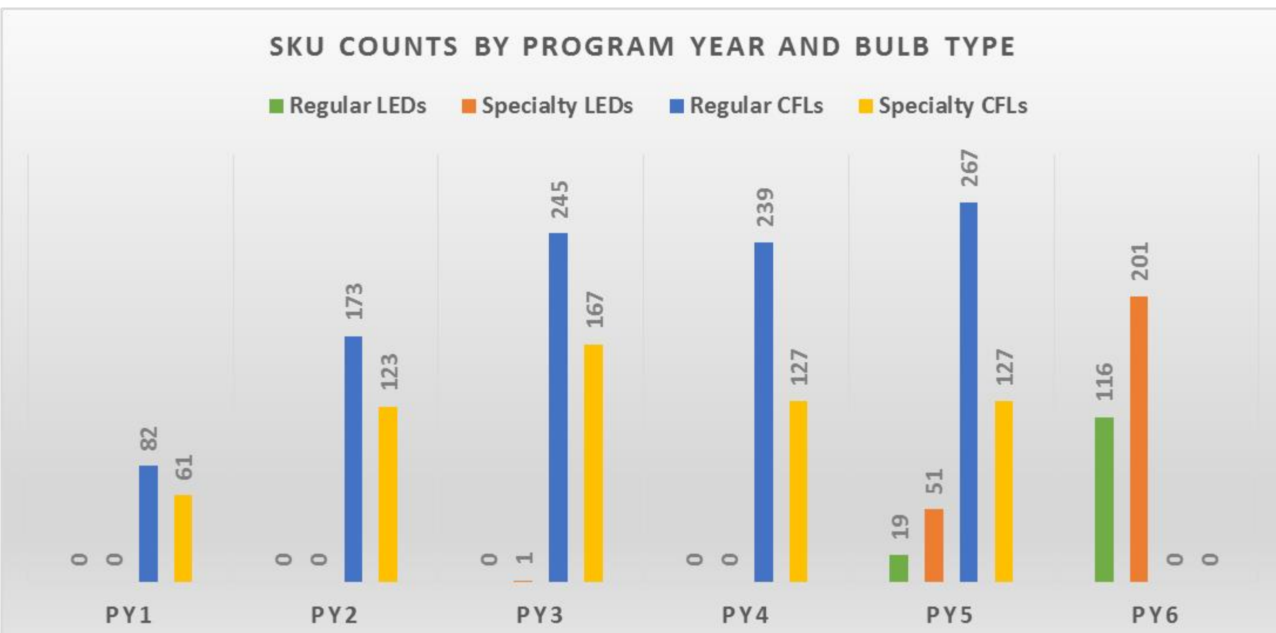
	N	77	Definition of N: Respondents who have LEDs currently installed
What kind of light bulb(s) did the screw-based LED bulb(s) you installed replace?	CFL	14	18%
	Don't know	6	8%
	Halogen	4	5%
	LED	2	3%
	Other: specify	4	5%
	Standard incandescent	47	61%

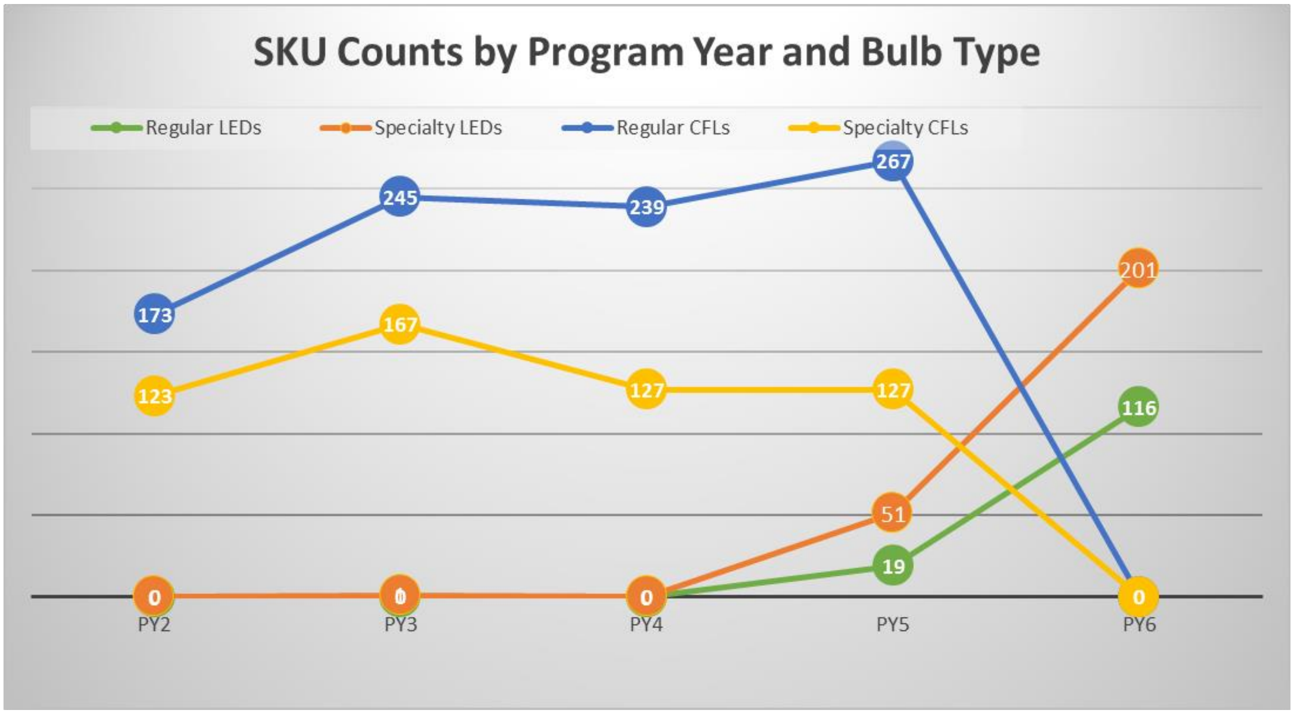
About how many of the light sockets in your home currently have CFLs in them?	**N**	**166**	**Definition of N:** Respondents currently using CFLs
	None of them	4	
		2%	
	A few of them	68	
		41%	
	About half of them	36	
		22%	
	A lot of them	36	
		22%	
	All of them	22	
		13%	
	(Don't know)	-	
		-	
	(Refused)	-	
		-	

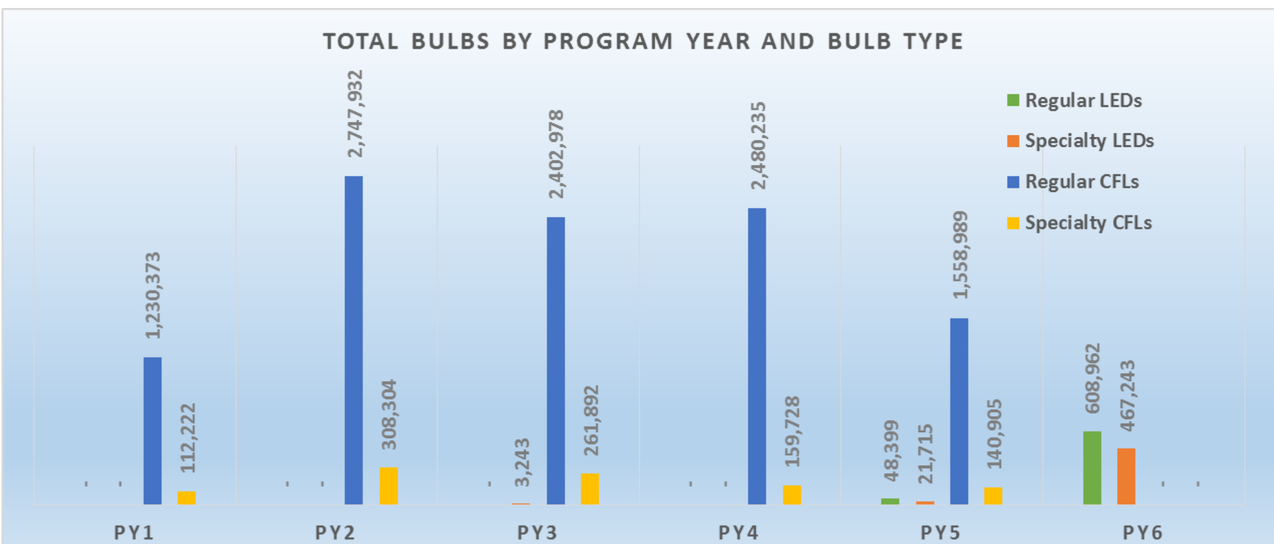
Why did you stop using CFLs?	**N**	**18**	**Definition of N:**
		100%	***Respondents who have used CFLs but are not currently using CFLs***
	Other	3	
		17%	
	Burned out	1	
		6%	
	Broke/stopped working	-	
		-	
	Bulb was too bright	-	
		-	
	Bulb was not bright enough	6	
		33%	
	Delay in light coming on	2	
		11%	
	Did not work with dimmer/3-way switch	1	
		6%	
	Didn't fit properly	1	
		6%	
	Stuck out of fixture	-	
		-	
	Light color	2	
		11%	
	Too expensive	-	
		-	
	Concerned about mercury	3	
		17%	
	Replace LEDs for better efficiency	2	
		11%	
	Don't know	2	
		11%	
	Refused	-	
		-	

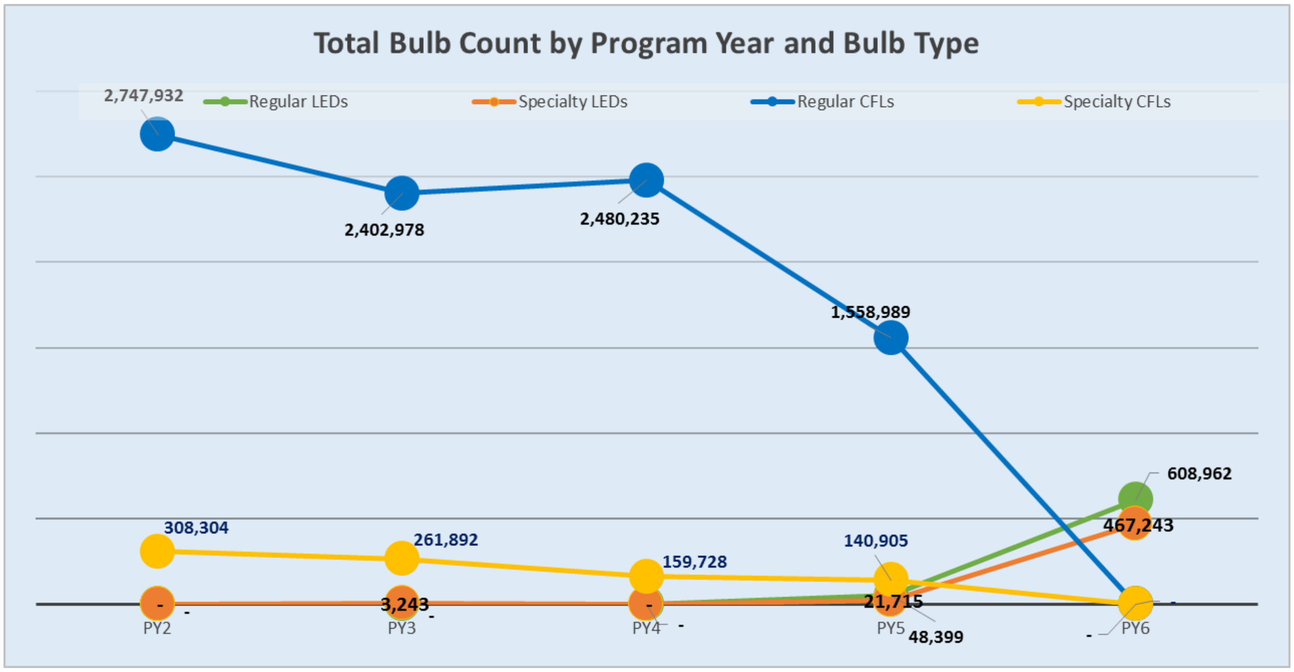
Why did you stop using screw-based LEDs?	**N**	**5**	**Definition of N:**
		100%	***Respondents who have used LEDs but are not currently using LEDs***
	(Burned out)	1	
		20%	
	(Broke/stopped working)	-	
		-	
	(Bulb was too bright)	-	
		-	
	(Bulb was not bright enough)	-	
		-	
	(Didn't fit properly)	-	
		-	
	(Light color)	-	
		-	
	(Too expensive)	2	
		40%	
	(Other: specify)	-	
		-	
	(Don't know)	2	
		40%	
	(Refused)	-	
		-	

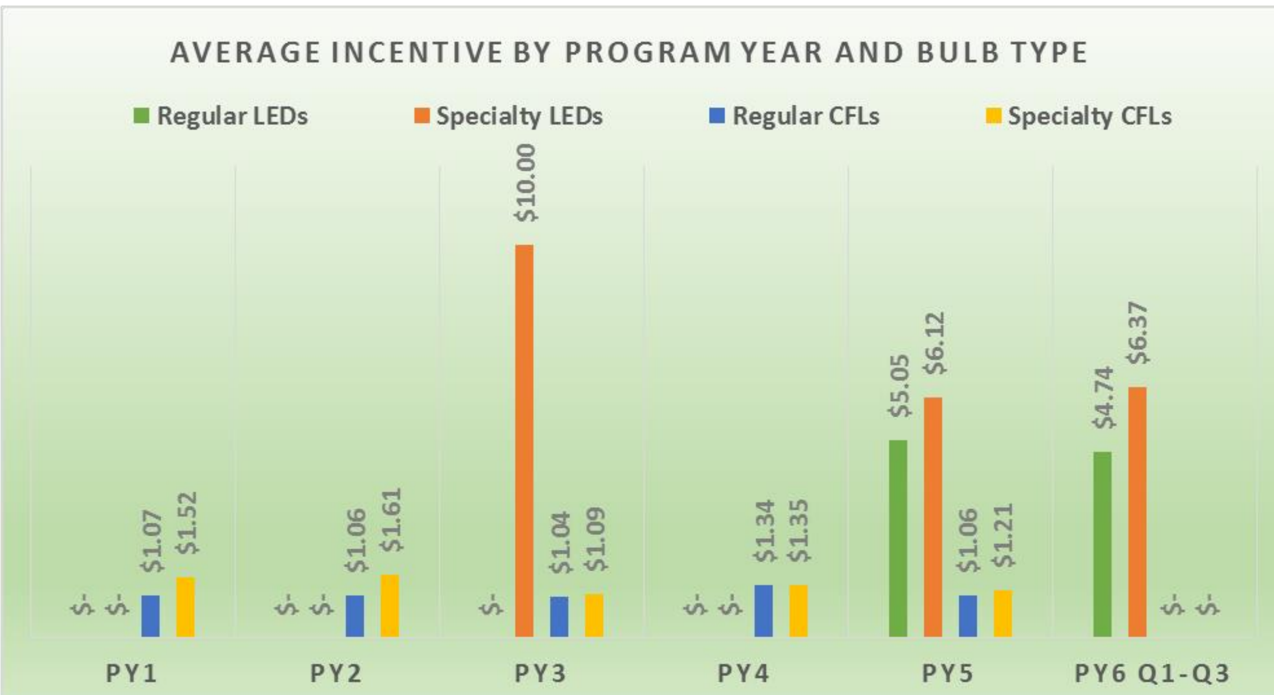
Program Bulb Sales Data

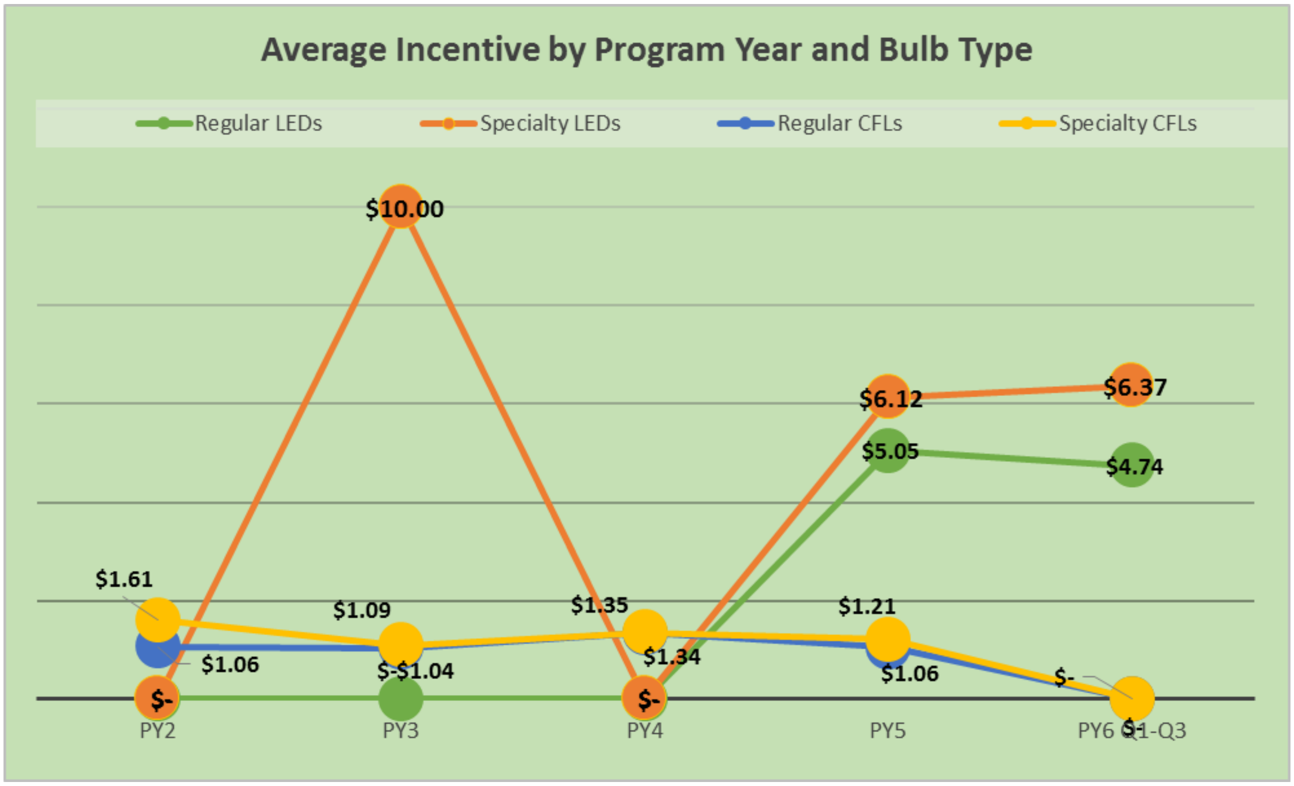



SKU Counts by Program Year and Bulb Type
Regular LEDs
Specialty LEDs
Regular CFLs
Specialty CFLs
173
245
239
267
123
167
127
127
201
116
51
19
0
0
0
0
PY2
PY3
PY4
PY5
PY6


TOTAL BULBS BY PROGRAM YEAR AND BULB TYPE
Regular LEDs
Specialty LEDs
Regular CFLs
Specialty CFLs
1,230,373
112,222
2,747,932
308,304
3,243
2,402,978
261,892
2,480,235
159,728
48,399
21,715
1,558,989
140,905
608,962
467,243
PY1
PY2
PY3
PY4
PY5
PY6


Total Bulb Count by Program Year and Bulb Type
Regular LEDs
Specialty LEDs
Regular CFLs
Specialty CFLs
2,747,932
2,402,978
2,480,235
1,558,989
608,962
467,243
308,304
261,892
159,728
140,905
3,243
21,715
48,399
PY2
PY3
PY4
PY5
PY6


AVERAGE INCENTIVE BY PROGRAM YEAR AND BULB TYPE
Regular LEDs
Specialty LEDs
Regular CFLs
Specialty CFLs
$- $- $1.07 $1.52
$- $- $1.06 $1.61
$- $10.00 $1.04 $1.09
$- $- $1.34 $1.35
$5.05 $6.12 $1.06 $1.21
$4.74 $6.37 $- $-
PY1
PY2
PY3
PY4
PY5
PY6 Q1-Q3


Average Incentive by Program Year and Bulb Type
Regular LEDs
Specialty LEDs
Regular CFLs
Specialty CFLs
$10.00
$6.12
$6.37
$5.05
$4.74
$1.61
$1.09
$1.35
$1.21
$1.06
$-
$-$1.04
$1.34
$1.06
$-
$-
$-
PY2
PY3
PY4
PY5
PY6 Q1-Q3

4 CUSTOM INCENTIVE PROGRAM

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

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

To qualify, commercial and industrial customers are required to submit documentation that their proposed efficiency upgrades pass the program's cost-effectiveness threshold. For PY6, preapproval was required prior to equipment purchase. PPL Electric Utilities reimburses the customer following successful implementation of a cost-effective project, and the reimbursement may vary by the type or size of the equipment, system, or improvement.

An ICSP, DNV GL Energy Services USA, Inc., manages the program and handles application intake, assesses eligibility, and calculates project energy savings and incentives.

The objectives of the Custom Incentive Program are to:[52]

- Encourage PPL Electric Utilities customers to install high-efficiency custom projects. In PY5, custom could include any projects not included in PPL Electric Utilities' Prescriptive Equipment Program. Starting in PY6, only projects that are not included in the Pennsylvania TRM are eligible.
- Encourage qualifying equipment repairs and optimization and operational or process changes that reduce electricity consumption.
- Encourage a whole-facility approach to energy efficiency.
- Increase customer awareness of the features and benefits of electric energy-efficient equipment.
- Increase the market penetration of high-efficiency equipment.
- Support emerging technologies and non-typical efficiency solutions in cost-effective applications.
- Encourage advanced energy efficiency strategies required for certification by national market transformation programs such as Leadership in Energy and Environmental Design (LEED), Architecture 2030, ENERGY STAR® Buildings, or Energy Policy Act of 2005 (EPAct) tax credits.
- Promote other PPL Electric Utilities energy efficiency programs.
- Achieve approximately 96 completed projects through 2016, with a total reduction of approximately 8,500 MWh/yr (small C&I customers).

---

52 Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, pp.120, 137, and 155.

- Achieve approximately 111 completed projects through 2016, with a total reduction of approximately 34,000 MWh/yr (large C&I customers).
- Achieve approximately 26 completed projects through 2016, with a total reduction of approximately 20,000 MWh/yr (GNI customers).

An executive summary of Phase II program metrics by sector is presented in Table 4-1.

Table 4-1: Phase II Custom Incentive Executive Summary by Customer Sector

Sector	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost ($/Annual kWh)	Cost of Conserved Energy[1] (TRC $/kWh)	Phase II Participants
Government/ Nonprofit/Education	1,796	1,796	1,595	N/A	N/A	$438	$0.27	$0.18	13
Large C&I	21,078	21,078	20,707	N/A	N/A	$2,289	$0.11	$0.05	50
Small C&I	5,204	5,204	4,986	N/A	N/A	$1,020	$0.20	$0.04	62
Total	**28,079**	**28,079**	**27,288**	**0.47**	**1.39**	**$3,747**	**$0.14**	**$0.05**	**125**

[1] Total TRC Costs divided by levelized lifetime kWh savings.

4.1 PROGRAM UPDATES

For PY6, the program implemented these two changes:

- Products found in the 2014 Pennsylvania TRM that may have been eligible for a prescriptive incentive were no longer accepted into the custom program (e.g., variable frequency drives [VFDs] on motors).
- Preapproval for projects was required prior to the purchase of equipment, rather than prior to installation as in PY5.
- The PY6 incentive cap was based on the total project cost, rather than the incremental project cost as in PY5.
- For the total resource cost testing that established project eligibility, the incremental cost was still used to determine overall project cost-effectiveness.

4.1.1 Definition of Participant

A PY6 participant is defined as a custom project that received an incentive payment between June 1, 2014, and May 31, 2015. Projects for which customers submitted an application during this time period but did not receive an incentive are not counted as participants in PY6. It is possible for an individual customer to have multiple participating projects. Typical custom projects may take more than a quarter to complete.

4.2 IMPACT EVALUATION GROSS SAVINGS

4.2.1 EM&V Sampling Approach

To evaluate savings for the Custom Incentive Program, Cadmus defined projects as large stratum and small stratum. Projects in the large stratum were identified during the application process as expecting savings greater than 500,000 kWh/yr. Projects that expected savings below the 500,000 kWh/yr threshold were assigned to the small stratum.

Table 4-2 shows the sampling parameters for PY6. The achieved precision for the program level results are in compliance with the Evaluation Framework requirements to meet 85/15 levels of confidence and precision at the program level. The large stratum savings make up 71% of the reported savings for PY6 and all projects were verified with 100% realization rate (precision is not applicable). The small stratum savings are known with less precision (21%), but in PY6 they represent only 29% of the reported savings. Therefore, the sample exceeded the requirements of 85/15 at the program level, with 5% precision at the 85% confidence level.

Table 4-2: PY6 Custom Incentive Program Sampling Strategy

Stratum	Population Size[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Small	57	85/15	10	10	Site Visits, impact
Large	12	N/A[2]	Census	12	Site Visits, impact
Program Total	**69**	**85/15**		**22**	

[1] The population size is based on the number of jobs that contributed to reported savings in PY6. The total number of projects created in PY6 is 101 including those still in progress and those that have been since cancelled.
[2] This evaluation included the census of program participants in the large stratum. As a result, the savings estimate in this stratum is not subject to sampling error. The Cv and confidence and precision do not apply to the large stratum.

Small Stratum: Cadmus selected a sample of 10 small stratum projects participating from Q1 through Q3 for verification at the close of Q3 of PY6 and verified their savings and determined a realization rate. This realization rate was then applied to the entire small stratum population.

For the 10 small stratum projects selected into the verification sample, Cadmus prepared the site-specific measurement and verification plan (SSMVP). Pre-installation inspections are not possible for small stratum projects because they cannot be selected into the sample until after they are installed and an incentive is paid. Cadmus conducted post-installation inspections and verified savings for the sample of 10 small stratum projects. Cadmus calculated the realization rate as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

Large Stratum: The ICSP informed Cadmus after receiving an application for a project likely to fall into the large stratum. The SSMVP was typically prepared in coordination with the ICSP. Cadmus then evaluated these large stratum projects at a high level of rigor, often collecting pre-installment measurements so there was no duplication of effort by customers, the ICSP, and trade allies. Cadmus generally conducted pre-installation inspections for all large stratum projects. There were exceptions made for the baseline visit in cases where the ICSP did not inform Cadmus until after the measure was installed. This occurs when initial savings estimates are low but the ICSP's estimate of project savings increases as more is learned about the project or the project scope changes. New construction projects also did not receive a baseline inspection since there was no existing condition.

Cadmus collected data to verify the savings for the entire population of the large stratum projects during a site visit. PPL Electric Utilities based the incentive payment upon the verification report, so the realization rate is 100% for these large stratum projects.

4.2.2 Custom Incentive Program Project Details

PPL Electric Utilities paid incentives for a total of 69 projects in the Custom Incentive Program in PY6— 12 large stratum and 57 small stratum. These projects were finalized (paid) during the program year. The number of projects initiated during the program year, is determined by the number of projects that had applications submitted from June 1, 2014, through May 31, 2015, is indicated in by sector in Table 4-3.

Table 4-3: Projects Initiated in PY6 by Sector

Sector	Projects Initiated in PY6
Government/Nonprofit/Education	9
Large C&I	31
Small C&I	61
Program Total	**101**

The size of incentivized projects has varied from program year to program year. Table 4-4 lists the average project size for all program years, both Phase I and Phase II:

Table 4-4: Average Project Size by Program Year

	Phase I				Phase II		Average
	PY1	PY2	PY3	PY4	PY5	PY6	
Average kWh Saved	55,731	309,722	931,091	647,902	96,321	317,311	542,007
Average kW Saved	4.16	35.81	106.48	70.33	8.19	35.58	60.45
Projects	**1**	**54**	**107**	**112**	**56**	**69**	**67**

The average project size can be highly dependent on relatively few projects. For example, the average project size in PY3 is 50% higher than it otherwise would have been based on one large project with verified savings greater than 33,000,000 kWh. For Phase II, PY5 average kWh saved per project was relatively low because of the lack of large stratum projects paid during that program year. Similarly, there was only one project in PY1. Thus, Program Years 2, 4, and 6 are the most representative of the long term average.

Custom Program project incentives are limited to either 50% of the total project cost, or $500,000, whichever is less. The Phase 2 incentives as a percentage of verified measure costs have been consistent, varying from 20% to 22%.

Table 4-5: Project Costs vs. Incentives

Program Year	Cost Capped Projects	Maximum Incentive Projects	Verified Measure Cost	Total Incentives	Incentives as Percent of Verified Measure Cost
PY5	13	0	$1,525,727	$336,397	22%
PY6	11	0	$8,372,297	$1,654,125	20%

For all verified projects in the sample, Cadmus created a final savings calculation in accordance with the site-specific measurement and verification plan (SSMVP) and documented the findings in a project verification report that included any deviations from the project's SSMVP. Verified savings for most custom projects were derived from metered data collected by the customer, the ICSP, or Cadmus.

4.2.3 Summary of Evaluation Results

As can been seen in Table 4-6 and Table 4-7, the realization rates for energy and demand savings were higher for large strata projects (100%) than for small-strata projects (81% energy, 80% demand). The total program realization rate for energy savings was 94% for energy and 95% for demand in PY6.

Table 4-6: PY6 Custom Incentive Summary of Evaluation Results for Energy [1]

Stratum	PYTD Reported Gross Impact (MWh/yr)	PYTD Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	PYTD Verified Gross Energy Savings (MWh/yr) [2]	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Large	16,515	16,515	100%	16,515	0	N/A
Small	6,655	6,655	81%	5,380	0.30	21%
Program Total	**23,170**	**23,170**	**94%**	**21,894**	**N/A**	**5%**

[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] No *ex ante* adjustments were made. Reported *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding

Table 4-7: PY6 Custom Incentive Summary of Evaluation Results for Demand

Program	PYTD Reported Gross Demand Savings [1] (MW)	PYTD Adjusted Ex-Ante Demand Savings [2] (MW)	Demand Realization Rate (%)	PYTD Verified Gross Demand Savings [2] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Large	1.892	1.97559	100%	1.97559	0	N/A
Small	0.703	0.74264	80%	0.59442	0.36	30%
Program Total	**2.595**	**2.718**	**95%**	**2.570**	**N/A**	**7%**

[1] Reported Gross Demand reductions do not include T&D losses.
[2] Adjusted Ex Ante and Verified Gross Demand reductions include T&D losses.

4.2.4 Summary of Site Visits

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

Cadmus found a variety of discrepancies during the on-site inspections but no sites were classified as having “failed.” For small stratum projects, Cadmus found that operating parameters were typically somewhat different than were assumed by the ICSP. For large stratum projects, Cadmus typically conducted the inspection with the ICSP and calculated verified savings based on the inspection results. The inspections found nothing unexpected for the custom projects in this program.

There was no consistent source of discrepancies between reported and verified savings. The ICSP generally determined the ex-ante savings with an appropriate level of effort.

Table 4-8 summarizes the number of site visits planned, conducted, and the nature of discrepancies.

Table 4-8: PY6 Custom Incentive Program Summary of Site Visits

Program	Measure	Inspection Firm	Number of Inspections Planned	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
Custom	All Verified Custom Projects	EM&V CSP	34	34	10	Varies; typically updated with site-specific data or through M&V

Sources of discrepancy between reported savings and verified savings vary depending on the project. Large stratum projects did not have discrepancies since Cadmus was involved with the project as soon as identified for the large stratum, and reported and verified savings were equal. Small stratum projects may have had discrepancies between reported and verified savings because Cadmus used more rigorous EM&V methods than the ICSP (e.g., the ICSP annualized the average kWh saved between the baseline and post metering periods while Cadmus used a regression that annualized the baseline and post energy to yearly production or typical weather); Cadmus used site-specific data that was not available to the ICSP (e.g., the ICSP relied on short term post-installation trending while Cadmus collected longer term post-installation trending more representative of operation); and/or the baseline for savings changed if the existing equipment was past its useful life or had failed (e.g., replacing an in-situ baseline of equipment well past useful life with code minimum efficiency or industry standard equipment).

4.3 Impact Evaluation Net Savings

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

4.3.1 Net-to-Gross Ratio Methodology

For the Custom Incentive Program, Cadmus estimated freeridership and spillover in accordance to the SWE net-to-gross guidelines, which uses self-report survey information from participating customers.

4.3.2 Net-to-Gross Ratio Sampling

Cadmus conducted a telephone survey of Custom Incentive Program participants in PY6, surveying 13 unique PY6 participants representing 15 projects. Net-to-gross analysis was based on 15 projects.

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

- Identify unique decision-maker phone numbers and contact information.
- Remove accounts contacted in the past 12 months for a PPL Electric Utilities or Cadmus survey effort.
- Remove accounts with in-progress, reserved, or cancelled Custom Program projects.

After completing these steps, the final sample contained 30 unique decision-makers.

Table 4-9: PY6 Custom Incentive Program Sampling Strategy for NTG Research

Stratum	Stratum Boundaries	Population Size[1]	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Number of Records Selected for Sample Frame[2]	Achieved Sample Size[3]	Percent of Sample Frame Contacted to Achieve Sample[4]
Participants	**Telephone**	**59**	**0.5**	**85/15**	**15**	**30**	**15**	**100%**

[1] Represents number of paid projects.
[2] We removed 29 records from the population because they were inactive, duplicates, participated in survey in the last year or were selected for a different survey project.
[3] Thirteen unique respondents completed surveys about 15 facilities.
[4] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete surveys.

4.3.3 Net-to-Gross Ratio Findings

4.3.3.1 Freeridership

In PY6, surveys with 13 respondents representing 15 properties indicated 61% freeridership. Two respondents surveyed each accounted for two separate properties and the survey effort collected information for each individual property. The overall PY6 freeridership is weighted by each surveyed property's verified kWh savings to ensure that respondents whose properties achieved higher energy savings through participation have greater influence on the final freeridership estimate than those properties who achieved lower energy savings.

Table 4-10: Custom Incentive Program Summary of Evaluation Results for NTG Research

Stratum	Number of Survey Respondents	Verified Savings Represented	Estimated Freeridership[1]	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
PY5 Sample	11	1,474,508	0.45	0.00	0.55	0.120	22%
PY6 Sample	13	2,934,016	0.61	0.00	0.39	0.117	21%
Combined PY5/PY6	**24**	**4,408,524**	**0.55**	**0.00**	**0.45**	**0.098**	**17%**

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

The surveys in PY5 with 11 respondents indicated 45% freeridership and in PY4, with 61 PY3 and PY4 participants, indicated 48% freeridership.

The type of projects that survey respondents implemented has differed between program years. For example, the percentage of compressed air projects increased from 9% of all Custom projects in PY5 to 29% in PY6; refrigeration projects increased from 20% in PY5 to 34% in PY6; HVAC projects increased from 5% of the total in PY5 to 17% in PY6; equipment upgrades decreased from 32% in PY5 to none in PY6. Therefore the variability of project types can have an impact on freeridership especially because the number of unique customers and completed surveys is low. Most survey respondents in PY6 completed compressed air or HVAC projects. Notably, in PY6 the percentage of compressed air projects among survey respondents was 47% (7 out of 15) while in PY5 this was 9% (1 out of 11).

When survey respondents in PY5 and PY6 are combined to increase the sample size and to account for project variability, the resulting savings weighted estimate of freeridership is 55%. This is likely a more applicable estimate of freeridership for the program.

As discussed in PY5, one factor influencing freeridership may be the participant's decision-making process. Decision-making for custom projects can be complex, involve several actors, and span a significant period of time. In these cases, decisions may be made at various levels within a company and the program's influence may not be known by the people directly responsible for completing the program's project application. Similarly, the program may have influenced participants' decisions in the early stage, such as inviting a contractor to conduct a study, but then be forgotten or not considered later when final approval is given for the capital project.

Because the project pipeline shows there are enough projects to reach planned Phase II energy savings, PPL Electric and the ICSP are doing minimal marketing and outreach. This lower level of outreach and the fact that over half (8 out of 15 properties in the PY6 survey) indicated their company would have been *very likely* to complete the project without the incentive from PPL Electric suggests that the program is attracting customers who are already interested in energy efficiency when they design projects and utilize the program incentive after they have made the decision to install energy-efficient equipment. One company with 100% freeridership said they design projects for locations in multiple states to fit their business needs and then look for incentives or rebates to reduce the overall cost of the project.

Contractors and design engineers can influence decision making and should be considered as a factor when assessing freeridership. The three contractors and design engineers Cadmus interviewed represent 4 projects with freeridership scores over 50%. They report that they design projects to obtain maximum efficiency regardless of the availability of incentives. They said that without the incentive from PPL Electric they would not have changed the design of the project but they thought the incentive provided additional motivation for their customers to implement the project the way it was designed. Customers may not realize the influence of the program on their project but the program is influencing the way contractors and design engineers market the project to their customers.

4.3.3.2 Spillover

Two PY6 respondents reported installing other energy-efficient equipment since participating in the program where their participation in the PPL Electric Custom Incentive program was very influential on their decision to purchase the items. One respondent replaced 200 metal halide fixtures with fluorescent fixtures and the other respondent reporting installing three variable speed drives (VSDs). Although there are potential energy savings associated with these actions, Cadmus is qualitatively reporting these findings.

4.4 PROCESS EVALUATION

4.4.1 Research Objectives

The process evaluation examined how the program is operating compared to its intended design, and identified any gaps between expected outcomes and actual results. The main issues in the Custom Incentive Program concerned communications, administrative efficiency, administrative response, delivery infrastructure, technical support, and customer response.

4.4.2 Evaluation Activities

For the Custom Incentive Program, the PY6 process evaluation activities were:

- Participant surveys (n=15 unique participants representing 17 properties)[53]
- Partial participant surveys (n=5)
- Interviews with program and ICSP staff (n=2)
- Consulting firm interviews (n=3)
- Database and quality assurance/quality control (QA/QC) review of records

The research activities were consistent with the evaluation plan except that Cadmus completed quarterly customer satisfaction surveys using an online tool. In PY5, Cadmus conducted these surveys via telephone with a sample of participant decision-makers. In PY6, Cadmus completed online customer satisfaction surveys and also conducted telephone surveys with participants to assess net-to-gross ratios.

Cadmus did not conduct a benchmarking review in PY6 because the topics of research were included in the PY5 benchmarking study.

Table 4-11 summarizes the survey sampling strategy for the Custom Incentive Program for PY6.

4.4.3 Methodology

4.4.3.1 Interviews with Program and ICSP Staff

Cadmus conducted interviews with the program managers at PPL Electric Utilities and the ICSP in March and April 2015. The interviews focused on key performance indicators, program design changes, and implementation successes and challenges.

4.4.3.2 Participant Surveys

Cadmus conducted surveys with participants using two different methodologies to increase participation and sample size. Customers answered questions about program satisfaction using an online survey tool. Respondents also answered questions to inform the net savings analysis through a telephone survey. Ten of the 15 unique participants (representing 12 properties) completed both the online and telephone survey. Of the remaining five survey respondents, three completed only the telephone survey and two completed only the online survey. Cadmus fielded the online customer satisfaction surveys during June and July 2015 and the telephone net-to-gross surveys with participant in July 2015.

For the online survey, Cadmus coordinated with the ICSP to obtain a list of completed projects. Cadmus removed records that were not included in the EEMIS database of paid custom projects as well as those who participated in a survey in the past year or were included in another survey sample frame.

For the telephone participant survey sample frame, Cadmus removed records for projects that were not paid, were listed as inactive in the EEMIS database of paid custom projects along with those who participated in a survey in the past year or were included in another survey sample frame. In some instances, multiple custom projects were completed by the same customer.

[53] Ten of these respondents (12 properties) completed both the online and telephone survey questions, while three completed (3 properties) only the telephone survey, and two completed (two properties) only the online survey. The questions addressing net savings were administered to the 13 unique respondents (15 properties) who completed the telephone survey.

In some instances for both survey groups, multiple custom projects were completed by the same customer. This required that Cadmus generate a final survey sample of unique decision-makers to ensure that no customer was contacted more than once for the same survey. The final survey sample, contained all unique decision-makers from the participant group. More details about sample attrition and the outcome of each record are contained in Addendum A. Participant Survey Methodology.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they were implemented consistently. Cadmus attempted to reach all unique customers that participated in the Custom Incentive program. We attempted to call respondents multiple times over several days at different times of the day and scheduled callbacks when possible. All respondents with e-mail addresses also received an initial survey invitation and two reminder e-mail invitations. The response rate (50%; 15 of 30) is reasonable (and higher than for other surveys), therefore we assumed that any possible nonresponse bias would have minimal impact.

4.4.3.3 Partial Participant Surveys

The purpose of this survey was to determine why customers started the application process but did not receive a rebate (the project was cancelled) and to determine what PPL Electric Utilities could change to encourage them to participate in the program. Cadmus fielded the interviews during July 2015.

Cadmus coordinated with PPL Electric Utilities to obtain a list of partial participants. We removed any customers that were included as part of the participant sample frame and any customers who did not receive approval because the project was included in the TRM and could receive a rebate in another PPL Electric Utilities program. In some instances, multiple custom projects were started or completed by the same customer. This required generating a final survey sample of unique decision-makers to ensure that no customer was contacted more than once for the same survey. The final survey sample contained all unique decision-makers from the partial participant group.

A detailed methodology is included in Addendum B. Partial Participant Survey Methodology.

4.4.3.4 Consulting Firms Interviews

Cadmus asked program participants what or who had provided the most assistance in the design of their project. Two respondents named consulting firms. Cadmus conducted interviews with consulting firms to gather information about how much influence the program had on the way engineers design projects for the program participants. We contacted both firms in August 2015. Cadmus contacted an additional contractor provided by the ICSP in September 2015.

Table 4-11: PY6 Custom Incentive Program Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Population Frame Contacted[1]	Evaluation Activities
PPL Electric Utilities Program and ICSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, Impact, Program Staff Interview, Census
Participants	Online	75	N/A	N/A	Census	40 [2]	15 [3]	100%	Process, Participant Survey, Census
	Telephone	59 [4]	0.50	85/15	15	30 [5]		100%	Process, Impact, Participant Survey, Census
Partial participants	Telephone	34	N/A	N/A	5	15 [6]	5	100%	Process, Partial Participant Survey, Census
Consulting Firms	Consultants provided by participants	3	N/A	N/A	3	3	3	100%	Process, Consulting Firm Interview, Census
Program Total		**173**			**25**	**90**	**25** [6]		

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews

[2] We removed 35 records from the population because they were not in EEMIS, were duplicates, participated in survey in the last year or were selected for a different survey project.

[3] Between both online and telephone methodologies, we competed surveys with 15 unique respondents representing 17 facilities. Ten of these completed the telephone and online questions, two completed the online questions only, and three completed the telephone surveys only. The questions addressing net savings were administered to the 13 unique respondents (15 properties) who completed the telephone survey.

[4] This represents projects not unique contacts. It does not include participants who were not paid in PY6.

[5] We removed 29 records from the population because they were inactive, duplicates, participated in survey in the last year or were selected for a different survey project.

[6] We removed 19 records from the population because they participated in survey in the last year, included in other survey sample frames, or contained invalid reasons for being ineligible for the project.

4.4.3.5 Database and Records Quality Control Review

As part of the evaluation, Cadmus obtained the project files for all large stratum and those included in the small stratum. No separate database review was conducted. Project files were generally consistent with entries in EEMIS and included sufficient information to facilitate project evaluation. Table 4-12 summarizes the sampling methodology of this review.

Table 4-12: Custom Incentive Process Evaluation Database Review

Stratum	Population Size	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Used For Evaluation Activities (Impact, Process, NTG)
Large Stratum	12	N/A	Census	12	Process, Impact
Small Stratum	57	80/20	10	10	Process, Impact
Program Total	**69**	**85/15**	**22**	**22**	

4.4.4 Achievements Against Plan

Table 4-13 contains the program's plans for energy savings and incentives and the program's progress.

Table 4-13: Custom Incentive Program Savings

	PY5 Verified	PY6 Only			Phase II: PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	5,394	34,301	21,894	64%	62,793	27,288	43%
MW	0.48	5.62	2.57	46%	10.30	3.05	30%
Participants [2]	56	N/A	69	N/A	233	125	54%

[1] Planned savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table N6, p. 126, Table P6, p. 144, and Table Q6, p. 154.
[2] Beginning in PY6 Q1, the methodology for counting participants for the C&I Custom Incentive Program changed. The participant count is now based on the number of jobs contributing to reported savings for the specified period, as opposed to the number of projects created in that period.

There are several possible reasons why the program did not reach its planned MWh and MW savings for PY6. These include:

- Several projects submitted applications in PY5 and PY6 but were not completed within either program year.
- Products verified with lower than expected savings from initial reservations (for large stratum projects) and lower than reported (for small stratum projects).

The program achieved 43% of the Phase II planned savings through PY6. The current queue of projects, including those that have been reported through PY7 Q1, appear sufficient to achieve Phase II planned savings. When the verified savings from PY5 and PY6 are combined with the reported PY7 Q1 savings and the ICSP estimates for the remainder of PY7, not including currently waitlisted projects, the program is expected to reach 100% of the planned energy savings and 51% of the planned demand savings for Phase II.

Table 4-14: Phase II Predicted Energy Savings

	PY5 [1]	PY6 [1]	PY7 [1]	Phase II Totals	Phase II Goals
Savings (MWh/yr)	5,394	21,894	35,366	62,655	62,793
Capacity Savings (MW)	0.48	2.57	2.22	5.27	10.30
Percent of Phase II kWh Plans	9%	35%	56%	100%	-
Percent of Phase II kW Plans	5%	25%	22%	51%	-

[1] Savings listed for PY5 and PY6 are the Gross Verified Savings, while PY7 Savings are the Reported for PY7Q1 and ICSP estimates for PY7 Q2-Q4 (not including currently waitlisted projects)

4.4.5 Program Delivery

Overall the Custom Incentive Program ran smoothly in PY6. Based on current projects and robust pipeline estimates for PY7, the program is expected to achieve its Phase II savings targets.

Customers are engaged with the program. According to the ICSP, no week has passed without at least one application for a Custom Incentive Program project.

Communication with customers has been working well. For example, one customer provided positive feedback to the PPL Electric Utilities program manager about a preliminary site visit from the site-specific measurement and verification plan (SSMVP) CSP for a combined heat and power project. The customer said the visit was useful to determine which projects the company could complete to improve its energy usage.

Although the program has been running smoothly, a few minor challenges exist. Some customers did not realize how much time, effort, and cost was involved to complete a project. The ICSP continually works with customers to align their expectations with the program requirements. To help explain processes and requirements, the ICSP and PPL Electric Utilities designed a "Welcome Kit," available online. Six survey respondents were aware of it, but only three used it. The ICSP said some customers commented that the information in the welcome kit regarding the steps and timeline involved with the application was useful and that this has helped improve customer expectations.

4.4.5.1 Logic Model

Cadmus reviewed the logic model at the end of PY6 and determined that the program was implemented as described. See Addendum C. Logic Model at the end of this report.

4.4.5.2 Key Performance Indicators

In addition to energy savings targets, PPL Electric Utilities said the only other key performance indicator is that 80% of customers (n=16) report they are very satisfied with the program (rating satisfaction as a 8, 9, or 10 on a 10 point scale). This goal is measured through the survey question, *"Thinking about your overall experience with the program, how would you rate your satisfaction using a 1 to 10 scale where 10 means* outstanding *and 1 means* unacceptable*?"*

Overall, 75% of program participants rated their satisfaction as an 8, 9, or 10. The program fell short of the overall 80% target. Participants suggested improvements, such as increased responsiveness to questions and reduced delays. These are discussed in more detail in the section Satisfaction.

Additionally, PPL Electric Utilities and the ICSP monitor other metrics—the number of applications received, the number of preapproved projects, the number of projects paid, and the number of projects expected to be paid in the following months. There are no goals for these metrics but they are reviewed at least monthly.

PPL Electric Utilities has some other internal goals. One is to enter an approved application in the Energy Efficiency Management Information System (EEMIS) database within three to five days of receiving the initial approved application. Another is to approve projects for payment within one to two days of receiving the final application packet. These goals are not specifically tracked.

The ICSP monitors the time it spends reviewing an application before preapproval. It tries to complete the process as soon as possible and also tries to issue payment within 21 days of approval. Neither of these is tracked as a key performance indicator.

4.4.6 Participant Profile

Of 59 projects completed and paid in PY6, 34% (n=59) were refrigeration projects, 29% were compressed air projects, 17% were HVAC projects, 7% were process projects,[54] 3% were electric distribution upgrade projects, and 10% were other types of projects such as pool cover, storage tank insulation, new building, and battery chargers.

Over half of survey participants (59%, n=17) have participated in the Custom Incentive Program before. Six out of 15 participants and two out of five partial participants describe their company as manufacturing. Four out of 15 participants and one out of five partial participants represent educational institutions. The remaining companies represent other industries such as grocery, warehouse, distribution, aerospace, telecommunications, printing, and offices.

Over half of survey respondents (65%, 10 of 15 participants and three of five partial participants) said the heated and cooled space of their facilities was over 100,000 square feet. Fifty percent of these participants said the facility has more than 50 employees.

4.4.7 Satisfaction

Cadmus asked questions about satisfaction with the application process, program requirements and process, ICSP, PPL Electric Utilities, and the program overall in both the online and telephone surveys. Results are reported in this section. Because respondents could skip questions if they did not want to answer them; not all respondents provided an answer to every question. Some questions were included only in the online survey or in the telephone survey so the number of participants responding varies by question.

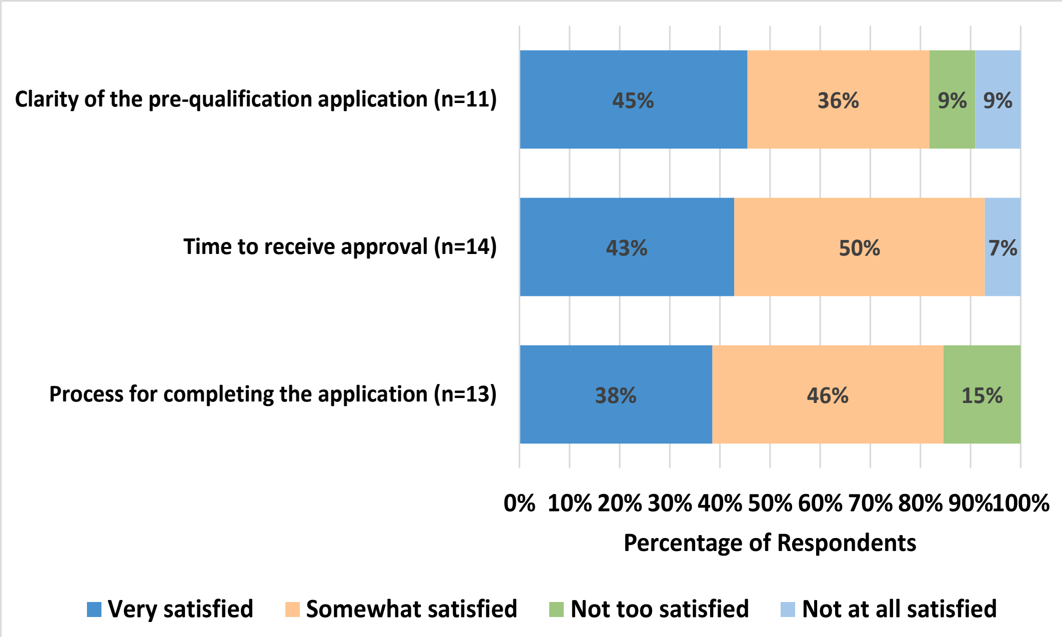
4.4.7.1 Application Process

Participants

Most respondents were *very* or *somewhat satisfied* with each aspect of the application process (Figure 4-1). One was not satisfied because the PPL Electric Utilities representative changed several times and each time the respondent had to restart the process. The other was not satisfied because he did not receive approval quickly and the ICSP was not responsive to his e-mailed questions.

54 Projects include magnetic bearing compressor, VFD's on CRAC cooling units, raw water pump refurbishment, VFD condenser, VFDs/motors (Glacier II), and blower VFD upgrade.

Figure 4-1: Satisfaction with Application Process



Source: Survey question E1, "Please rate your satisfaction with the following:"

Eight respondents (n=13) reported they received approval in less than four weeks, one received approval between four and six weeks, one between seven and eight weeks, and three did not know when they received approval. The percentage of respondents who said it look less than four weeks to receive approval improved in PY6 to 62% (n=13) compared to PY5 when 55% said this (six out of 11).

Three respondents (n=13) encountered delays during the application process. One said there were too many delays between each step, one said the PPL Electric Utilities representative changed several times and that created delays, and one could not start the internal purchase order process until the preapproval letter was received and this caused a delay in starting the project.

Partial Participants

All of the partial participants (n=5), except for one who did not complete the application, said they were *very satisfied* with the process. One suggested that PPL Electric Utilities could provide an example of the method for calculating the energy savings that would be used to score and approve the project. This partial participant was not aware of the online "welcome kit" and may not have realized this information was already available.

Consulting Firms

All three of the consulting firms completed the application for the customer and were involved in preparing the SSMVP. They said the application and the SSVMP processes were clear. Two of the firms worked with the ICSP and said the ICSP was very responsive and could not think of any way to improve the experience.

Lighting Projects

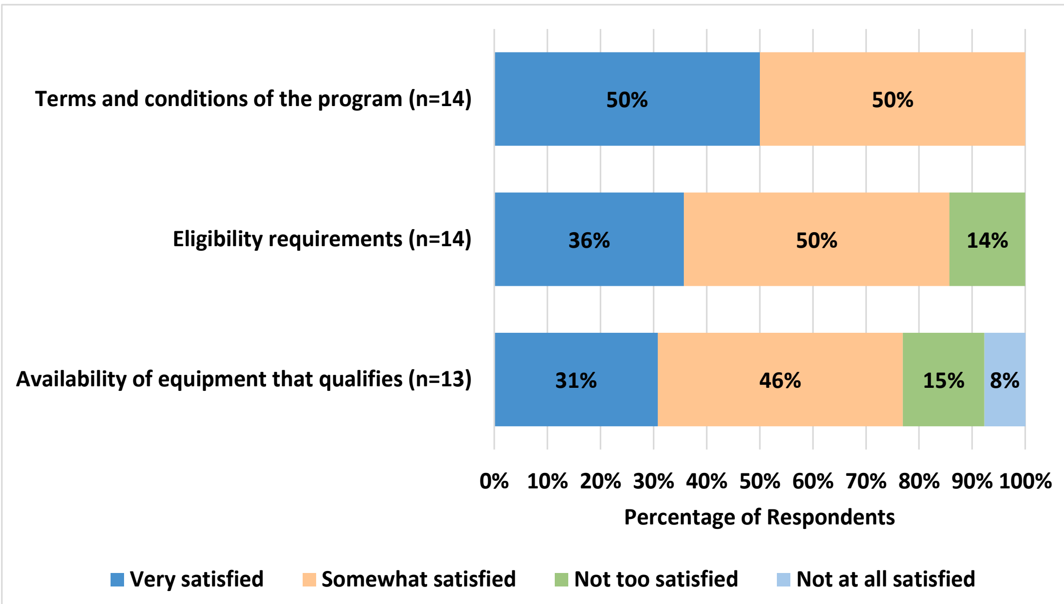
Five out of 13 respondents installed lighting and applied for a rebate from PPL Electric Utilities in PY6. Of these five, one said the application was *very easy* to complete, three said it was *somewhat easy*, and one said it was *somewhat difficult*.

4.4.7.2 Program Requirements and Process

Respondents answered questions about their satisfaction with the program requirements and process. They were most satisfied with the terms and conditions of the program and least satisfied with the availability of eligible equipment that qualified for a rebate (Figure 4-2).

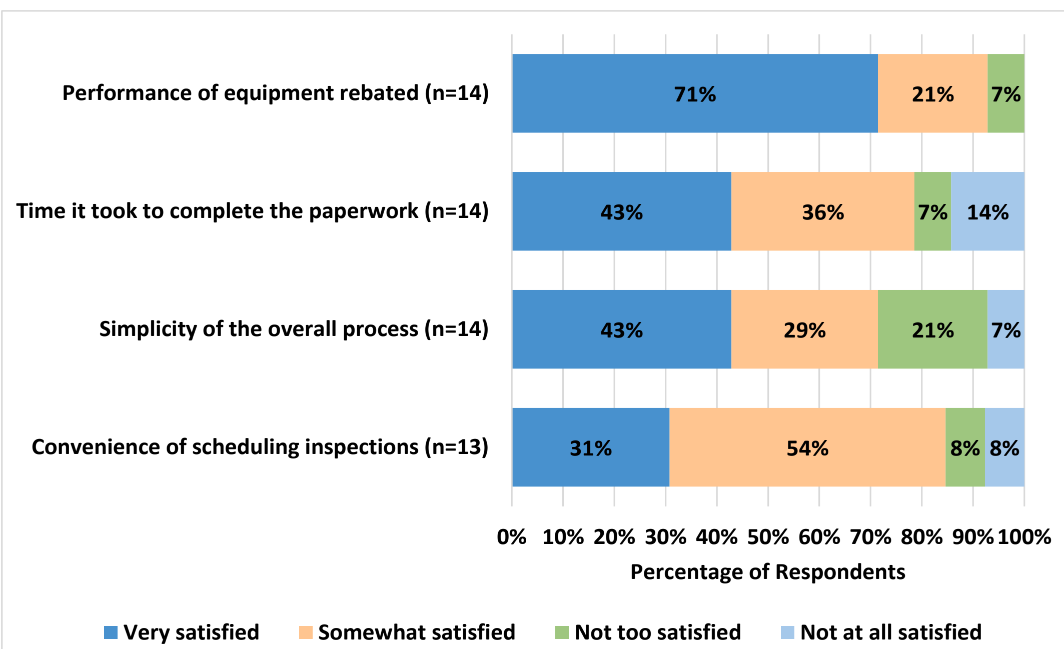
Overall, respondents were *very satisfied* with the equipment they installed and least satisfied with the convenience of scheduling inspections (Figure 4-3). A majority of respondents (69%, n=13) said the final energy and cost calculations were *very* or *somewhat easy* but one said it was *not too easy* and two said it was *not easy at all*. One did not know because he was not involved in the process.

Figure 4-2: Program Requirement Satisfaction



Source: Survey question E1, "Please rate your satisfaction with the following:"

Figure 4-3. Process Satisfaction



Source: Survey question E1, "Please rate your satisfaction with the following:"

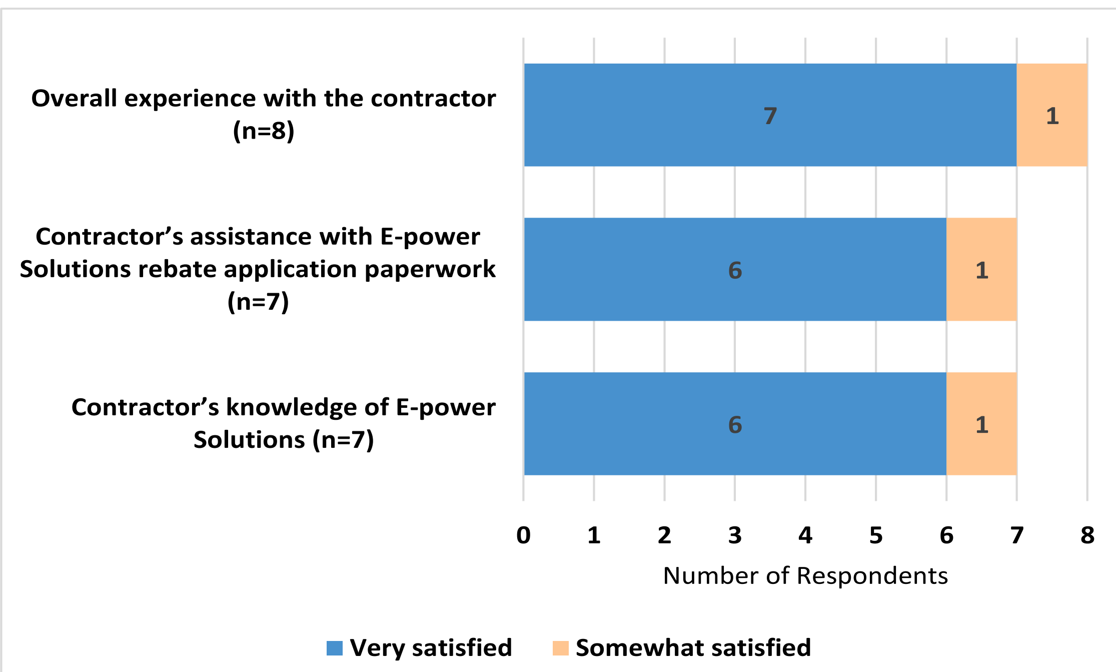
Respondents provided comments about what made it challenging ("them" and "they" refers to the ICSP):[55]

- *"We used an engineer to do calculations but we got different information so we had to do both heat and cooling load on both buildings. There was a cost for the engineer to provide us with the information they needed."*
- *"I mailed them the data and they said they didn't receive it. They called me with questions after I had sent the data and I told them to check the data. It took over a year from the time we submitted the first application until we received the rebate check. In fact, I also had to follow-up with them about the check and track it down."*
- *"Being a compressed air project, we needed pre-air audits. They didn't like the baseline results so we had to run the audits again and had to hire a third party."*
- *"It was challenging and we relied heavily on the contractor."*
- *"We set data loggers to do the calculations and it just took time."*

4.4.7.3 Satisfaction with Contractor

Nine respondents (n=14) said the project was installed by a contractor. Overall, respondents were satisfied with their contractor (Figure 4-4).

Figure 4-4: Satisfaction with Contractor



Source: Survey question F2, "How satisfied are you with the following items regarding the contractor who installed or implemented your project?"

55 Cadmus specifically asked three respondents about what was difficult. Two other respondents commented, so these are also included.

4.4.7.4 Overall Satisfaction

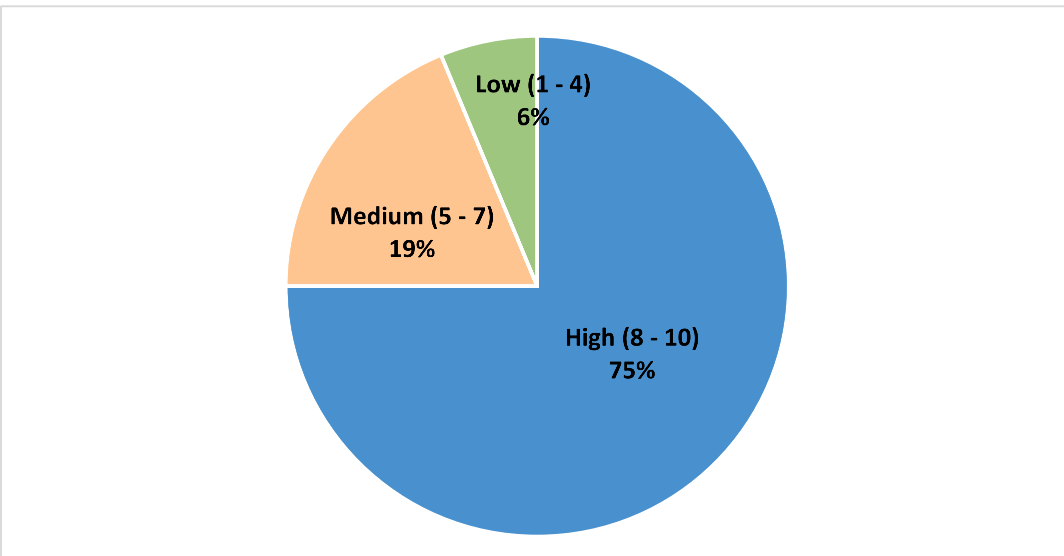
Participants

Overall, most participants are satisfied with the Custom Incentive Program (Figure 4-5). Seventy-five percent rated their satisfaction as high (rated 8, 9, or 10).[56]

Respondents who rated their overall satisfaction as lower than 8 were asked to provide comments about how PPL Electric Utilities and the ICSP could improve their satisfaction. The respondents reported that:

- Online submittal form did not work and they had to follow up with the ICSP several times over the course of the project.
- More rebates should be available for nonprofit organizations.
- Inspections were completed over a month after the project was finished.
- The project was audited, which caused a delay.
- Money should be shifted from commercial to industrial projects when the incentive cap for industrial has been reached.

Figure 4-5: Overall Program Satisfaction



Source: Survey question, "Thinking about your overall experience with the program, how would you rate your satisfaction using the same 1 to 10 scale where 10 means "outstanding" and 1 means "unacceptable"? (n=16) one person said they did not know and was removed from the base.

Partial Participants

Four out of the five partial participants rated their satisfaction with the program as an 8 or higher.[57] One respondent rated satisfaction as a 5, dissatisfied because he or she was encouraged to apply but that the

56 Using a 1 to 10 scaled where 10 means *outstanding* and 1 means *unacceptable.*

57 Using a 1 to 10 scaled where 10 means *outstanding* and 1 means *unacceptable.*

results that disqualified the project seemed arbitrary. This respondent suggested that PPL Electric Utilities provide better guidelines about how to determine if a project will qualify before submitting the application.

Consulting Firms

Overall, all three consulting firms were satisfied with the program. One said it used the incentive to push customers in the right direction so they are more interested in higher-efficiency projects. Another one said that the incentive was beneficial to companies when discussing project potential with upper management.

Satisfaction with PPL Electric Utilities

Overall satisfaction with PPL Electric Utilities as a provider of electric service was good. Twelve out of 18 survey respondents (67%, participants n=13 and partial participants n=5) rated their satisfaction as 8 or higher.[58] Satisfaction has increased since PY5, when seven out of 13 (54%) rated their satisfaction as 8 or higher.

Nine out of 13 participants said they had recommended the program to colleagues, which indicated they were satisfied with the program and wanted to share the benefits with others.

When asked if their opinion of PPL Electric Utilities had changed since participating in the Custom Incentive Program, 10 respondents out of 17 (participants n=12 and partial participants n=5) said their opinion had not changed. Three said their opinion had *improved significantly,* and two said it had *improved somewhat.* One respondent said it had *decreased somewhat,* and one said it had *decreased significantly*; however, these respondents did not indicate why.

4.4.8 Marketing and Outreach

4.4.8.1 PPL Electric Utilities and ICSP Marketing

Overall, very little marketing and outreach is needed to promote the program because participation has been on track to meet energy savings plans. When outreach is necessary to increase participation, the ICSP focuses its activities on sectors that need additional support. It has set up meetings and webinars with contractors to discuss projects and present case studies as examples of successful projects.

PPL Electric Utilities has also hosted meetings at regional home or trade shows to discuss the program. It also asks its account managers to reach out to customers to consider possible custom projects.

PPL Electric Utilities and the ICSP developed the welcome kit to inform customers about the application process, materials needed, and the timeline. Eight out of 18 survey respondents (participants n=13 and partial participants n=5) were aware of the welcome kit, and five of these (three participants and two partial participants) had used the kit. Three participants said its most useful aspects were the checklist and the online application. The two partial participants used the kit to complete the application but one said it was difficult to tell how the project would be judged and if the application would be accepted.

Because the program is on track to reach Phase II targets, neither PPL Electric Utilities nor the ICSP anticipate any changes to the marketing and outreach approach in PY7.

---

[58] Using a 1 to 10 scaled where 10 means *outstanding* and 1 means *unacceptable.*

4.4.8.2 Participant Program Awareness

Participants and partial participants mainly learned about the program through a contractor or direct mail from PPL Electric Utilities (Table 4-15).

Table 4-15: Program Awareness

Response	Participants (n=12)	Partial Participants (n=5)
Most common	PPL Electric Utilities or E-power Solutions website (7 responses)	Contractor (4 responses)
Second most common	Key account manager (6 responses)	Direct mail (1 response)
Third most common	Contractor (5 responses)	No others identified

4.4.8.3 Consulting Firm Program Awareness

All of the consulting firms (n=3) were aware of the program prior to working with the customers. Two firms said the customer was not aware of the PPL Electric Utilities incentive program when the consulting firm was hired and the other firm did not know if the customer was aware. All of the firms told the customer about the incentives offered through PPL Electric Utilities' Custom Incentive Program.

4.4.9 Equipment Purchase

During the telephone surveys, Cadmus asked participants about the equipment they purchased and installed. The most common reasons participants purchased the equipment was to reduce energy costs and save money (7 responses) and to replace old or outdated equipment (6 responses). The most common reason for choosing the exact model of equipment was because it was recommended (5 responses). Other reasons were energy efficiency, brand, ease of maintenance, design flexibility, equipment standardization between plants, and purchasing the most advanced technology.

Ten facilities (n=15) replaced equipment. Of these, two respondents said the equipment had failed and was not working, three said the equipment had problems but was still working, and five said the equipment was in working condition with no problems. Four of the respondents said the equipment was scheduled for replacement before their company decided to participate, and nine said it was not. One did not know and one said the question was not applicable because it was new construction.

Nine out of 13 participants said their contractor, vendor, or distributor provided the most assistance in designing their energy efficiency project.

4.4.10 Program Influence on Purchase

4.4.10.1 Participants and Partial Participants

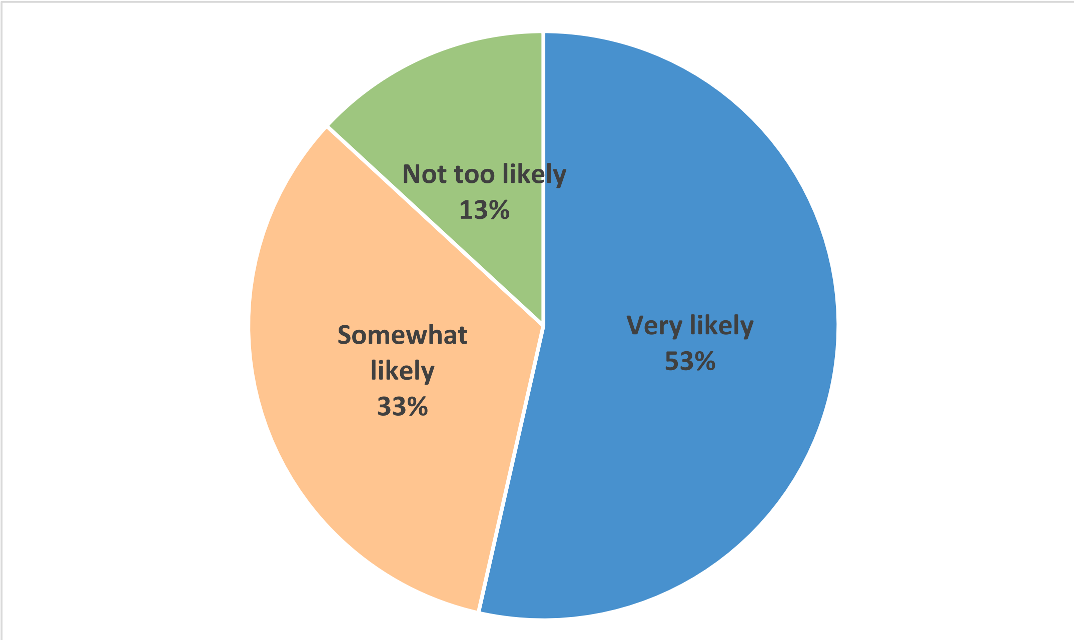
A majority of participants would have paid the full cost to complete the exact same project at the same time without the rebate from PPL Electric Utilities (Figure 4-6). According to participants (n=15) and partial participants (n=5), the preapproval process had no impact on their decision to proceed with the project.

4.4.10.2 Consulting Firms

All three of the consulting firms said the program did not impact the way they designed the project but said it helped confirm to the customers that the project design was useful. None of the consulting firms would have changed the way it designed the project if the incentive had not been available.

All of the respondents said when designing projects they look for ways their customers can get incentives. They always mention the program if it applies to the project they are designing or equipment they are recommending.

Figure 4-6: Likelihood to Complete Project Without Rebate from PPL Electric Utilities



Source: Telephone Survey Question G8, "How likely is it that your business would have paid the full cost to complete the exact same project at the same time without the rebate from PPL Electric Utilities?" (n=15)

4.4.11 Challenges

4.4.11.1 Partial Participants

Two partial participants (n=5) did not participate in the program because their project did not pass the total resource cost test. One said the return on investment was not high enough, one said the corporate office did not approve the capital expenses, and one said the company decided to wait a few years until it could replace the equipment instead of getting an incentive to upgrade existing equipment to be more energy efficient.

The partial participants faced challenges when purchasing new equipment and considering energy-efficient improvements. We asked them if certain scenarios were challenging:

- Finding low cost improvements is a challenge. Three out of five partial participants either *strongly* or *somewhat agreed* with the statement, *"My company has made all the energy efficiency improvements we can without a substantial investment."*
- Partial participants said that energy efficiency is a consideration when evaluating return on investment. All of the partial participants said they either *somewhat* or *strongly disagree* with the statement, *"Proposed capital upgrades must meet a certain return on investment and energy efficiency is not a major consideration when determining the ROI."*
- Partial participants did not think corporate decision-making was a challenge. All said they *strongly* or *somewhat disagree* with the statement, *"Decisions about equipment upgrades are made at the corporate level, and we don't have much input at this facility indicating that facilities are able to provide input into equipment upgrades."*

- Overall, partial participants did not think making energy efficiency upgrades was cost-prohibitive or an inconvenience. Four out of five said they *somewhat* or *strongly disagreed* with the statement, *"Making energy efficiency upgrades to this facility is cost-prohibitive."* All five said they *strongly* or *somewhat agreed* with the statement, *"Making upgrades at our facility is too much of an inconvenience."*

4.4.11.2 Consulting Firms

One consulting firm said the most challenging aspect was getting sufficient detailed production data. The other said the biggest challenge was project phasing. For example, *"When you work with schools, projects are difficult because of the timing and it does not always work well with the way the project is set up."* One said the waitlist will make it more difficult to convince people to implement the most energy-efficient projects since there is no guarantee of an incentive.

4.4.12 Future Implementation

Cadmus asked partial participants if they completed the project as planned (without participating in the Custom Program) and two said they did. The other three did not implement the project. One of these three partial participants said the company had no plans to implement the project in the future, one did not know if the project would be implemented, and one said the project would be implemented in the future but did not know when.

4.4.13 Benchmarking Against Other Programs

Cadmus planned to benchmark this program against other programs with equipment preapproval. However, benchmarking in PY5 included this information so there was no need in PY6.

4.5 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, we suggest PPL Electric Utilities consider the following recommendations in PY7.

Conclusion
PPL Electric Utilities has taken steps to reduce freeridership with required application preapproval, but there may still be room to reduce freeridership. Custom projects however, are not like typical prescriptive projects. Often times, facility energy managers, consultants, or a utility's key account manager assist the commercial customer to identify energy efficiency opportunities. For example, in Phase I, PPL Electric assisted businesses with technical assessments; in PY5, PPL employed outreach specialists who informed customers about rebate programs but did not provide technical assistance.

Recommendation
Although the calculated freeridership estimate for the program likely overstates the actual freeridership due to measurement challenges discussed in this report, we suggest that PPL Electric continue to work to reduce the program freeridership. For example, the ICSP's could work together to document the role of the program and its influence on the customer's decisions to participate. Additionally, in PY7, in preparation for Phase III, Cadmus will conduct additional benchmarking research to investigate eligibility requirements of other custom programs and specific types of custom projects (such as compressed air programs and data centers) that may be used to control freeridership. Cadmus and PPL could explore options for, and the feasibility of, means for the Custom program to offer dedicated, ongoing support to large business customers; incentive mechanisms designed to drive customers to install higher efficiency equipment; and/or bonuses or tiered rebates for increasing energy savings and projects with multiple measures.

Conclusion
One of the key performance indicators is achieving 80% customer satisfaction. In PY6, 75% of participants reported they were satisfied.[59] Generally, respondents were satisfied with the program but there were some challenges regarding responsiveness and program timelines.

Recommendation
There are several ways customer satisfaction may be improved:

- The ICSP could consider ways to improve clarity and timeliness of response to customers' questions by responding immediately to all questions and, if unable to answer the question during this initial response, advise the customer when to expect a response. It could also consider tracking such questions and answers to determine if the response is timely and if any additional information should be added to the list of frequently asked questions included with the application.
- The ICSP could continue to encourage applicants to review the information in the welcome kit as they are completing their application and follow up on any questions or concerns. Even though each project timeline is different, PPL Electric Utilities may want to review the online tools to determine if they need more clarity around the approximate timing of each step in the process.

Conclusion
Participation may be limited because, during the application process, customers have difficulty determining if a project will qualify for the program. One of the partial participants was encouraged to apply but the project did not pass the total resource cost test. This partial participant did not understand the process used for determining eligibility and said the results seemed arbitrary.

Conclusion
Final energy and cost calculations can be challenging for customers. Two respondents said they needed to hire a third party to provide data for calculations; this added costs and created more delay on finalizing the project and receiving the rebate.

Recommendation
Although the welcome kit specifies the data that may need to be collected and reported, PPL Electric Utilities and the ICSP could consider explaining more clearly the possibility of needing to hire a third party to provide pre- and/or post-installation data. This information could be added to the welcome kit and/or the preapproval letter.

[59] Rated their satisfaction as 8, 9, or 10 on a 1 to 10 point scale, where 10 means *outstanding* and 1 means *unacceptable.*

4.5.1 Status of Recommendations for Program

Table 4-16 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 4-16: Custom Incentive Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Custom Incentive Program	
Continue to work to reduce the program freeridership; Cadmus and PPL Electric could explore options for the Custom program to offer dedicated, ongoing support to large business customers.	Will be implemented in Phase III.
Consider ways to improve responsiveness to customers questions such as tracking the questions and answers to determine if the response is timely.	Will be implemented in Phase III.
Add more detail to online tools regarding the amount of time each step in the participation process may take.	Will be implemented in Phase III.
Revise program materials to mention that a third-party may be needed to assist or supply pre and post verification data.	Will be implemented in Phase III.

4.6 FINANCIAL REPORTING

A breakdown of the Custom Incentive Program finances is presented in Table 4-17.

Table 4-17: Summary of Custom Incentive Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$8,372	$9,268
2	EDC Incentives to Participants	$1,345	$1,512
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$7,027	$7,756
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$1,431	$2,026
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$1,431	$2,026
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$1,837	$1,699
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$11,640	$12,993
13	Total NPV Lifetime Energy Benefits	$14,084	$16,687
14	Total NPV Lifetime Capacity Benefits	$1,224	$1,342
15	Total NPV O&M Saving Benefits	($0)	($0)
16	Total NPV TRC Benefits[4]	$15,308	$18,029
17	TRC Benefit-Cost Ratio[5]	1.32	1.39

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

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

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

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

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

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

[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report

ADDENDUM A. PARTICIPANT SURVEY METHODOLOGY

Contact Instructions

PPL Electric Utilities provided contact instructions for conducting surveys for the Custom Incentive Program. Customers cannot be contacted for a survey until a year has passed since they completed their last survey (with PPL Electric Utilities or Cadmus). They cannot be contacted for a survey if they have opted out of a survey or have asked not to be contacted again. Telephone survey calls cannot take place on Sundays or national holidays.

Online Sample Cleaning and Attrition

Cadmus coordinated with PPL Electric Utilities' survey subcontractor to screen the sample provided by the ICSP and remove the records of customers contacted in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and who requested not to be contacted again. Cadmus removed records with incomplete information and records that could not be matched to the projects paid in EEMIS. We excluded from this population any participants already selected for the Prescriptive Equipment Program standard lighting channel surveys and participants of the Continuous Energy Improvement Program.

In the Custom Incentive Program, multiple custom projects were completed by the same customer so we generated a final survey sample of unique decision-makers to ensure that no customer was contacted more than once for the online survey. This cleaning and survey sample preparation process reduced the available sample. Cadmus contacted all remaining records. Table 4-18 lists the total number of records included in the contact list and the outcome (final disposition) of each record.

Table 4-18: Online Sample Attrition Table

Description of Call Outcomes	Number of Records
Population	**75**
Removed because not in EEMIS	**8**
Removed because duplicate	**14**
Removed because completed in past year	**1**
Removed because selected for concurrent sample	**12**
Survey Sample Frame (sent to survey subcontractor)	**40**
Records Attempted	**40**
Nonworking number	1
Started survey but did not finish	5
Remaining non-final records [1]	22
Completed survey	**12**

[1] These records were included in the sample frame but participants did not respond to the e-mail invitation.

Telephone Sample Cleaning and Attrition

Cadmus coordinated with PPL Electric Utilities' survey subcontractor to screen the sample and remove customer records called in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and those who requested not to be contacted again. Cadmus removed records with incomplete information.

In some instances, multiple custom projects were completed by the same customer. This required generating a final survey sample of unique decision-makers to ensure that no customer was contacted more than once for the same survey. This cleaning and survey sample preparation process reduced the available sample. Cadmus contacted all remaining records. Table 4-19 lists total number of records included in the contact list and the outcome (final disposition) of each record.

Table 4-19: Telephone Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Population (number of projects)	**59**
Removed because completed survey in past year	1
Removed because duplicate contact	17
Removed because selected for previous survey activities	3
Removed because account not active	8
Selected Interview Sample Frame	**30**
Not attempted [1]	**0**
Records Attempted	**30**
Refusal	1
No answer/answering machine/phone busy	14
Completed survey [2]	**15**

[1] These records were not needed because the interview target was reached before they were attempted.
[2] Telephone surveys were completed about 15 properties with 13 unique respondents.

ADDENDUM B. PARTIAL PARTICIPANT SURVEY METHODOLOGY

Contact Instructions

The contact instructions for this population is the same as the participant population described in Addendum A.

Sample Cleaning and Attrition

Cadmus received a list from PPL Electric Utilities of customers who began the application process but did not submit a final application. We coordinated with PPL Electric Utilities' survey subcontractor to screen the sample and remove customer records called in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and those who requested not to be contacted again. Cadmus removed records with incomplete information. As mentioned previously, we removed customers if they were included as part of the participant sample frame. We also removed customers who did not receive approval because the equipment proposed for rebate was included in the 2014 Pennsylvania TRM. In some instances, multiple custom projects were started or completed by the same customer. This required generating a final survey sample of unique decision-makers to ensure that no customer was contacted more than once for the same survey.

Cadmus contacted all remaining records. Table 4-20 lists total number of records and the outcome (final disposition) of each record.

Table 4-20: Partial Participant Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Population (unique decision makers)	**34**
Removed in concurrent sample	1
Removed in participant list	1
Removed completed survey in past year	11
Removed invalid reason for cancellation (equipment not eligible)	6
Survey Sample Frame (sent to survey subcontractor)	**15**
Not attempted [1]	**0**
Records Attempted	**15**
Non-working number	1
Wrong number	1
Do not remember submitting application	4
Refusal	1
No answer/answering machine/phone busy	3
Completed Survey	**5**

[1] These records were not needed because the survey target was reached before they were attempted.

ADDENDUM C. LOGIC MODEL

The program theory for the Custom Incentive Program is:

> By providing financial incentives, the program will lead to the installation of custom, high-efficiency equipment that would not have been installed in the absence of the program. It encourages equipment repairs and optimization, and operational or process changes that reduce electricity consumption. In so doing, the program increases the market penetration of high-efficiency equipment and supports emerging technologies, non-typical efficiency solutions, and products that require custom savings protocols (not covered in the TRM) in cost-effective applications. The program helps consumers save on their utility bills. The participation experience helps increase customer awareness of the features and benefits of electric energy-efficient equipment and processes.

The program logic model highlights the key program features, indicating the program goals, inputs, processes, and expected outcomes. Program inputs are funding and other support from PPL Electric Utilities program and Key Account staff, and the expertise of trade allies. The logic model elements are as follows:

- **Activities the program undertakes** include program implementation, technology assistance to customers and trade allies, marketing and outreach, processing applications, development of quality control (QA/QC) and evaluation, measurement and verification (EM&V) processes, and processing incentive payments.
- **Outputs produced by program activities** include informed and active trade allies, marketing materials, incentives paid, and rebate application and processing/payment systems.
- **Short-term (one year) outcomes** include increased customer and trade ally awareness of the program and its energy-efficient options. Rebated equipment, once installed, provides immediate energy savings and demand reduction. Incentives are processed. Program effectiveness is confirmed through EM&V and QC.
- **Intermediate outcomes (two to three years)** include experience and feedback that leads to updated programs, additional marketing and equipment installations, and continued energy and demand savings. With experience, some products no longer need to be treated as custom and can be rebated as prescriptive products. Customers experience lower electric bills. Customers and trade allies are more aware of PPL Electric Utilities programs.
- **Long-term outcomes (four to seven years)** include increases in PPL Electric Utilities' knowledge and experience operating this type of program. PPL Electric Utilities achieves long-term energy savings and demand reductions, transforming the market to improve energy efficiency. Environmental benefits are achieved.

5 APPLIANCE RECYCLING PROGRAM

PPL Electric Utilities' Appliance Recycling Program (ARP) offers a financial incentive and the free pick-up and recycling of operating-but-inefficient refrigerators, freezers, and room air conditioners. The program's overarching goal is to prevent the continued operation of older, inefficient appliances. Refrigerators and freezers must be 10 to 30 cubic feet in size to qualify for the program, and both primary and secondary refrigerators and freezers are eligible. Room air conditioners are picked up with a refrigerator or freezer but are not picked up as a stand-alone service. Eligible appliances must be plugged in and functioning at the time of pick-up. Table 5-1 shows the appliance eligibility parameters and incentive amounts.

Table 5-1: Eligible Appliances and Incentives

Appliance	Eligibility Rating	Incentive
Refrigerator	Working unit; ≥ 10 cubic feet and ≤ 30 cubic feet	Between $25 and $50
Freezer	Working unit; ≥ 10 cubic feet and ≤ 30 cubic feet	Between $25 and $50
Room Air Conditioner	Working unit	Between $10 and $25

The Appliance Recycling Program's ICSP, JACO Environmental, confirms that the units are operational upon pick-up. The ICSP disposes of participating units in an environmentally responsible manner. This involves removing hazardous materials from the refrigerant and foam insulation (e.g., chlorinated fluorocarbons), preparing the refrigerant for reclamation, and recycling other materials (e.g., metal and plastic).

The program is also available to nonresidential PPL Electric customers with a working, residential-grade refrigerator, freezer, or room air conditioner. The ICSP tracks the customer sector using the customer account number and address on the application, which is tied to a rate code that identifies the customer sector. PPL Electric reports units, savings, and costs allocated to the appropriate customer sector.[60]

PPL Electric's energy efficiency program staff provide overall strategic direction and program management. The ICSP provides turnkey services to administer and manage the program that includes marketing, call center services such as customer intake and scheduling, processing applications and rebates, tracking program data, and providing customer and transaction information to PPL Electric.

Additionally, PPL Electric and the ICSP partner with Best Buy and Sears (in PY6) to offer optional recycling services with the purchase of a new energy-efficient unit. Through this service—known as the "Buy New and Recycle" component—customers can opt to have their old unit picked up for recycling when the new unit is delivered by the retailer, making appliance recycling convenient for customers.

The program's primary objectives are to: [61]

- Encourage customers to dispose of their existing, inefficient appliances when they purchase new ones or eliminate a second unit that may not be needed.

60 Allocation to the low-income sector will be determined as part of the annual impact evaluation of low-income participation in general residential programs.

61 Program objectives are stipulated on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.41.

- Reduce the use of secondary, inefficient appliances.
- Ensure that appliances are disposed of in an environmentally responsible manner.
- Conduct on-site decommissioning to ensure that appliances are not resold in a secondary market.
- Promote other PPL Electric Utilities energy efficiency programs.
- Collect and recycle no fewer than 11,720 appliances in PY6, with a total energy reduction of 8,243 MWh/yr and demand reduction of 1.12 MW.

An executive summary of Phase II program metrics is presented in Table 5-2. Program metrics are shown by sector in Table 5-3.

Table 5-2: Phase II Appliance Recycling Program Executive Summary Table

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost ($/Annual kWh)	Cost of Conserved Energy[1] (TRC $/kWh)	Phase II Participants[2]
Appliance Recycling	16,568	16,489	15,692	0.68	3.30	$2,786	$0.18	$0.03	19,584
Total	**16,568**	**16,489**	**15,692**	**0.68**	**3.30**	**$2,786**	**$0.18**	**$0.03**	**19,584**

[1] Total TRC Costs divided by levelized lifetime kWh savings.
[2] Participants are defined as the number of unique CSP Job IDs. The number of units recycled in Phase II is 22,676.

Table 5-3: Phase II Appliance Recycling Program Executive Summary Table by Sector

Sector	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio[1]	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost ($/Annual kWh)	Phase II Participants[2]
Government, Nonprofit, and Educational	248	247	233	N/A	N/A	$41	$0.18	163
Large C&I	2	2	2	N/A	N/A	$0	$0.13	3
Residential	15,902	15,826	15,066	N/A	N/A	$2,676	$0.18	18,971
Small C&I	416	414	392	N/A	N/A	$69	$0.18	447
Total	**16,568**	**16,489**	**15,692** [3]	**0.68**	**3.30**	**$2,786**	**$0.18**	**19,584**

[1] NTG is not calculated by sector for ARP because residential customers account for 96% of participants and there is little reason to suspect that the disposal behavior of residential and nonresidential customers is any different, and stratifying surveys with such small populations would add considerable cost in trying to reach sufficient sample sizes. Additionally, with nonresidential surveys, it would likely be more difficult to reach the person who would have made the disposal decision absent the program.
[2] Participants are defined as the number of unique CSP Job IDs. The number of units recycled in Phase II is 22,676.
[3] Total does not add due to rounding

5.1 PROGRAM UPDATES

There were no significant permanent design changes in the Appliance Recycling Program in PY6.

In PY6, the program achieved 78% of its MWh/yr gross verified savings, 106% of its MW plan, and 78% of its annual planned participation.

5.1.1 Definition of Participant

Participant refers to the number of unique participants defined by unique conservation service provider (CSP) job number. Each customer who has an appliance picked up and recycled through the program is assigned a job number. A customer can recycle more than one unit at the same time. A customer who recycles more than one appliance, on multiple dates within the program year, will have two distinct job numbers.

5.2 IMPACT EVALUATION GROSS SAVINGS

5.2.1 Reported Gross Savings

Table 5-4 shows the cumulative reported results by sector for the Appliance Recycling Program for Phase II, through the end of PY6. As expected, the vast majority of participants were in the residential sector. The table also shows the smaller number of participants in small commercial and industrial; large commercial and industrial; and government, nonprofit, and educational.

Table 5-4: Phase II Appliance Recycling Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Residential	18,971	15,902	2.90	$681
Small Commercial and Industrial	447	416	0.08	$18
Large Commercial and Industrial	3	2	-	$0
Government, Nonprofit, and Educational	163	248	0.03	$11
Phase II Total	**19,584**	**16,568**	**3.00**[1]	**$710**

[1] Total does not add due to rounding.

5.2.2 EM&V Sampling Approach

The evaluation, measurement, and verification CSP (Cadmus) inspected a census of PY6 Appliance Recycling Program participant records to verify that all units reported as recycled were consistently recorded in both the EEMIS and the CSP databases.

Cadmus also selected a random sample of 140 participants for telephone survey verification. This sample size achieved 90% confidence and 10% precision for PY6, as shown in Table 5-5. Cadmus verified the records by asking respondents about the quantity and type of units collected and if the units were replaced. The survey also asked questions that apply to the net savings calculations.

Table 5-5: PY6 Appliance Recycling Impact Evaluation Sampling Strategy

Stratum	Population Size to Select Sample for each Activity	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Freezer Recycling	1,009	90/10	70	70	Surveys
Refrigerator Recycling	5,016	90/10	70	70	Surveys
Freezer Recycling	1,498	N/A	Census	Census	Database review
Refrigerator Recycling	7,062	N/A	Census	Census	Database review
Room Air Conditioner Recycling	631	N/A	Census	Census	Database review
Program Total [1]	**9,191**	**10%**	**140**	**140**	

[1] A census of records were reviewed for the database review. All refrigerator and freezer records available at the close of Q3 were also included in the population for drawing the survey sample. These records are not counted twice in the total. Therefore the program total is the sum of the census records.

5.2.3 *Ex Ante* Adjustment Methodology and Findings

Savings for recycled appliances are deemed on a per-unit basis in accordance with the 2014 Pennsylvania Technical Reference Manual (TRM).[62] Deemed savings for refrigerators and freezers in PY6 were in line with the TRM, so Cadmus made no *ex ante* adjustments.

Reported savings for room air conditioners were based on an assumed average of the locations specified in the 2014 Pennsylvania TRM rather than mapping savings to the exact locations. Cadmus made *ex ante* adjustments by mapping each ZIP code to the specified climate zone city specified in the 2014 Pennsylvania TRM. The climate zone determines the annual hours of operation ($EFLH_{RAC}$ in Table 5-6).

Cadmus produced final weighted savings of 166 kWh/yr per unit, as shown in Table 5-6. The table also lists the TRM savings assumptions for each city represented in the PY6 participant population, the number of room air conditioning units picked up in each climate zone, the percentage of units overall, and the overall weighted average savings value.

62 Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2014. Page 113-117. Available online: http://www.puc.pa.gov/pcdocs/1300345.docx

Table 5-6: PY6 Room Air Conditioner Retirement – Savings Assumptions and Participation Mapped to the Nearest City

City	Original Hours ($EFLH_{ES\text{-}RAC}$)[1]	Corrected Hours ($EFLH_{RAC}$) [1]	Energy Impact (kWh)	Demand Impact (kW)	City Counts	City Proportions
Allentown	487	151	166	0.638	212	34%
Erie	389	121	133	0.638	0	0%
Harrisburg	551	171	188	0.638	158	25%
Philadelphia	591	183	202	0.64	46	7%
Pittsburgh	432	134	148	0.641	-	0%
Scranton	417	129	143	0.643	134	21%
Williamsport	422	131	144	0.638	81	13%
TRM Adjusted Weighted Average			**166**	**0.639**		

[1] TRM-specified columns. See table 2-23. Page 66 of the 2014 TRM

5.2.4 Database Review

Cadmus inspected a census of PY6 participant records from the EEMIS database to verify that all units reported as recycled by the Appliance Recycling Program were consistently recorded in both the EEMIS and the ICSP databases. This reconciliation was conducted quarterly Q1 through Q3 and using the full year's data after the close of PY6.

In each quarter, Cadmus found that a small number of units in the ICSP's database were not matched in EEMIS but then verified that these records appeared in the subsequent quarter's EEMIS data extract with no overlap in EEMIS, that is, no units were counted in two subsequent quarters.

All units matched except for one that had a payment processing date and a CSP job number but no unit record in the ICSP database. The ICSP confirmed that this was an order placed through the retailer partnership but that it was cancelled and the unit was never collected so the record was excluded from the impact analysis. Table 5-7 shows the program's evaluation results for energy savings and Table 5-8 shows its evaluation results for demand savings.

Table 5-7: PY6 Appliance Recycling Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)[2]	Observed Coefficient of Variation (Cv), Error Ratio (ER), or Proportion in Sample Design	Relative Precision at 85% C.L.
Not Assigned	6,792	6,775	95%	6,437	0.24	3%
Program Total	**6,792**	**6,775**	**95%**	**6,437**	**0.24**	**3%**

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

Table 5-8: PY6 Appliance Recycling Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings [1] (MW)	Adjusted *Ex Ante* Demand Savings [2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings [2] (MW)	Observed Coefficient of Variation (Cv) or Proportion in Sample Design	Relative Precision at 85% C.L.
Not Assigned	1.225	1.327	96.97%	1.286	0.23	3%
Program Total	**1.225**	**1.327**	**96.97%**	**1.286**	**0.23**	**3%**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] Adjusted *Ex Ante* and Verified gross demand reductions include T&D losses.

5.2.5 Database Review

Ex post verified gross savings for the Appliance Recycling Program reflect discrepancies identified through the records reviews and survey verification activities. Cadmus adjusted the *ex post* savings based on differences between the participant survey responses and the EEMIS database regarding the number of refrigerators or freezers reported as replaced.

Cadmus survey verification revealed no discrepancies for the quantity or type of appliances in the tracking data. However, it did find slight differences between replacement rates in PY5 (that had been used to generate a weighted average per unit reported kWh value in the PY6 EEMIS database) and the rates reported by PY6 survey respondents. Survey results showed that 83% of customers (n=70) reported replacing a refrigerator in PY6, compared to 84% (n=69) in PY5.

The survey responses also revealed that 66% (n=70) of freezers were replaced in PY6, compared to 61% (n=71) of freezers in PY5.

The survey responses indicate that 91% (n=58) of the all refrigerators reported as replaced were replaced with ENERGY STAR® appliances and 83% (n=46) of freezers. Cadmus adjusted the savings using the appropriate 2014 TRM values to reflect this allocation of replaced units.

Table 5-9 presents the survey results and the energy adjustments. Though not included in the table, the same proportion of replacements were also applied to adjust demand savings.

Table 5-9: PY6 Appliance Recycling Program Summary of Survey Verification Results

Measure Category	Percentage of Refrigerator Sample in Category	Deemed Annual Savings Per Unit	Percentage of Freezer Sample in Category	Deemed Annual Savings Per Unit
Not Replaced	17%	1,073	34%	1,059
Replaced with ENERGY STAR	76%	669	54%	642
Replaced with Standard Efficiency	7%	553	11%	556
Weighted Average Annual kWh Per Unit	**100%**	**730**	**100%** [1]	**775**

[1] The sum of columns may not match totals due to rounding.

5.2.6 Surveys

5.2.6.1 Participant Surveys

For the PY6 survey, Cadmus randomly selected 140 participants, prorating the survey sample by appliance (refrigerators and freezers). To verify the measure, the surveyor asked each respondent how many appliances were recycled. To determine the gross and net savings, the surveyor asked each participant the likely use of the appliance if it had not been recycled through the Appliance Recycling Program.

5.2.6.2 Nonparticipant Surveys

Cadmus also conducted nonparticipant surveys by adding a small number of questions to the general population survey conducted for the upstream lighting component of the Residential Retail program and in the surveys for other residential programs. These questions asked if the household had disposed of an appliance outside of the program during PY6 and, if so, how it was disposed.

Program participants may answer survey questions in the way they perceive the interviewer considers "the right thing"—in this case, removing an old appliance from the grid independent of the program. Information from nonparticipants regarding how households actually disposed of working appliances outside of the program helps mitigate the impact of socially desirable response bias.

5.3 IMPACT EVALUATION NET SAVINGS

Cadmus conducted an analysis to determine net savings for the Appliance Recycling Program. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance plans are met using verified gross savings.

5.3.1 Net-to-Gross Ratio Methodology

Cadmus used the methodology described in the SWE's "Common Approach for Measuring Net Savings for Appliance Retirement Programs" to determine the net savings for the Appliance Recycling Program.[63] The SWE approach lists four major factors in the net savings analysis:

- Freeridership
- Secondary market impacts
- Induced replacement
- Spillover

Cadmus conducted a net savings analysis using findings from the PY6 customer telephone surveys. The survey asked participants how their appliance would have continued to operate in the absence of the program—either as a primary or secondary unit, in their home, or transferred to another home.

Based on the responses given, Cadmus classified respondents as either "keepers" or "removers." Participants classified as "removers" were further classified if their appliance would have been permanently removed from the grid, that is, destroyed at a local waste transfer station or recycling center

63 Research Into Action. *Common Approach for Measuring Net Savings for Appliance Retirement Programs.* March 2014.

or picked up by a retailer but deemed unviable on the secondary market.[64] Participants whose appliances would have been removed from the grid in the absence of the program were classified as free riders.

The next factor in the net savings analysis is the secondary market impact, which, as described in the Uniform Methods Protocol,[65] accounts for the fact that some of the would-be recipients of the units recycled through the Appliance Recycling Program will seek out another unit once the appliance recycled through the program is unavailable.

Secondary market impacts apply only to units that would have been transferred to another user in the absence of the program.

Induced replacement, the final factor in the analysis of net savings, accounts for the program's influence on some participants to purchase a replacement appliance that they otherwise would not have purchased absent the program. During the survey, Cadmus asked participants who replaced their appliances if they would have done so regardless of the program. Those who answered "no" were asked a follow-up question to confirm that they would not have purchased the replacement unit without the program. Those who confirmed their "no" answer were considered an induced replacement.

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

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

5.3.2 Net-to-Gross Ratio Sampling

Cadmus selected a random sample of 140 participants (70 refrigerators and 70 freezers) for telephone survey verification. This sample size exceeded 90% confidence and 10% precision for PY6 (Table 5-10).

Cadmus did not achieve the desired number of completed nonparticipant surveys. This is due to the design being limited to adding a small number of questions to the general population survey conducted for the upstream lighting component of the Residential Retail program and in the surveys for other residential programs. This was done primarily because a stand-alone nonparticipant survey effort would be cost prohibitive due to the low probability of reaching a household that had recently disposed of a program-eligible appliance and not received an incentive through PPL Electric's program.

The relatively low number of identified Appliance Recycling Program nonparticipants is not unexpected. Assuming that an equal number of refrigerators stop being used each year (either due to customer decision or failure) and an expected useful life (EUL) of 20 years means approximately 1 in 20 households

---

64 The SWE's net-to-gross method for appliance recycling assumes that units in operable condition and under 10 years old are likely to be viable for resale.

65 National Renewable Energy Laboratory. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. Chapter 7: Refrigerator Recycling Evaluation Protocols. March 2013. Available at: http://www1.eere.energy.gov/wip/pdfs/53827-7.pdf

(5%) discard a refrigerator annually. However, identifying nonparticipants is further complicated since customers were only surveyed if they had discarded an operable (therefore program-eligible) appliance.

Overall 146 customers were identified who disposed of an appliance. However, only 49 disposed of a working appliance and had not received an incentive.

Table 5-10: PY6 Appliance Recycling Sampling Strategy for NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percentage of Sample Frame Contacted [1]
Freezers	Measure	1,009	0.5	90/10	70	1,217	70	96%
Refrigerators	Measure	5,016	0.5	90/10	70		70	
Residential	Nonparticipants (General Population)	2,140,376	N/A	N/A	As many as possible	21,790	146 [2]	17%
	Nonparticipants (Program Surveys)	1,759	N/A	N/A		1,465		79%
	Nonparticipants (Cross Program Survey)	11,152	N/A	N/A		965		95%
Program Total		**2,159,312**	**0.5**	**90/10**	**140**	**25,437**	**286**	**75%**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete surveys.
[2] Overall, 146 customers (48 from general population survey, 50 from program surveys, and 48 from the cross-program survey) were identified as having disposed of an appliance. However, only 49 had disposed of a working appliance and had not received an incentive.

5.3.3 Net-to-Gross Ratio Findings

For the Appliance Recycling Program, Cadmus did not estimate a net-to-gross ratio but instead estimated the net per-unit savings and program-level net savings. This is because replacements were accounted for in the gross savings. The replacement status of the appliance determines the appropriate gross savings value to be applied; therefore, Cadmus calculated the net savings not from the gross savings but rather from the unit energy consumption (UEC) multiplied by part use (represented as UEC*part use). This avoids double-counting the penalty to the program for replacements. However, it also means there is no direct relationship between gross and net savings.

According to the participant survey responses, in PY6 25% of refrigerators recycled through the program and 33% of freezers would have been transferred to another household absent the program. Because of budget limitations and the difficulties in finding data to support the potential actions of a would-be recipient and to identify those who would seek out another unit once the program unit is unavailable, there is no clear mitigation strategy for secondary market impacts.[66] In addition, the secondary market impacts affect the net-to-gross ratio considerably less than freeridership.

Spillover decreased considerably from 8% of gross savings in PY5 to 1.7% (1.7% for refrigerators and 1.9% for freezers) of program savings in PY6. The decrease is largely due to one solar panel measure that was reported in the spillover responses in PY5. In PY6 the spillover measures were more in line with typical responses such as – central air conditioning, water heaters, and windows.

Table 5-11 shows the estimated per-unit impact on savings for each of the factors described above and the resulting per-unit net savings.

Table 5-11: PY6 Appliance Recycling Program Net Savings Factors

Stratum	UEC*Part Use	Freeridership and Secondary Market Impacts	Induced Replacement	Spillover	Net Per-unit kWh/yr
Freezers	1,073	447	19	18	756
Refrigerators	1,059	302	27	20	619

Although the EM&V ESP could not calculate a true net-to-gross ratio, the ratio of net per-unit savings to the UEC*part use indicates how effectively the program is achieving savings. In PY6, this ratio was 0.56 for refrigerators and 0.70 for freezers. Table 5-12 shows the total program net by strata.

Table 5-12: PY6 Appliance Recycling Program Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Population Size	Net Per-Unit kWh/yr	NTG Ratio	Verified Net Energy (MWh/yr)	Observed Coefficient of Variation or Proportion	Relative Precision
Refrigerator	7,061	619	0.58	4,371	0.13	16%
Freezer	1,498	756	0.71	1,131	0.08	10%
Room Air Conditioners	631	166	1.00	105	N/A[1]	N/A
Program Total	**9,190**		**0.60**	**5,607**		
[1] NTG for room air conditioners is assumed to be 100% since it is a convenience service so there is no precision.						

Market effects for appliance recycling programs are difficult to assess. There is not a clear mechanism to transform the market nor a succinct way to assess the market transformation. Presumably the program decreases, to some degree, the number of inefficient secondary appliances operating on the grid. But this does not constitute a lasting transformation. It is quite likely that, if the program were discontinued, the used or secondary appliance market would have an increase in the supply of older, inefficient appliances. Therefore, no market effects were quantified for this program.

Table 5-13 shows the historical net-to-gross ratio through Phase I and PY6. It is important to reiterate that the PY6 net-to-gross ratio is not a true ratio of net-to-gross savings, as were reported in the Phase I program years, but rather net savings to UEC*part use multiplied by the population of each appliance

66 Secondary market impacts involves hypothetical, counterfactual recipients of units that would have been transferred if not recycled. There is no way to identify these people to find out what motivates their decision to find an alternate unit or not. Nor is there a clear way to target households that are more likely to keep their appliance absent the program rather than transfer it

type. Because gross and net savings both account for replacement, and do so differently, there is no direct relationship between verified net and gross savings.

Table 5-13: Historical Program Net-to-Gross Ratio

Program Year	Net-to-Gross Ratio
PY6	60%
PY5	74%
PY4	68%
PY3	63%
PY2	61%

Direct comparison between PY6 and Phase I is limited because of changes in methodology prescribed in the annual TRMs. Beginning in PY5 the net-to-gross ratio included both induced replacement and secondary market impacts. However, the proxy net-to-gross ratio for PY6 is within the range of recent evaluation results from other programs using similar methodology as well as the range of values observed in other program years even after accounting for the additional impacts.

Based on the net-to-gross findings, Cadmus concludes there are no issues with program design of the Appliance Recycling Program that lead to freeridership and need to be addressed. The net-to-gross ratio is within the range of values found in other similar programs and has been increasing over time.

5.4 PROCESS EVALUATION

5.4.1 Research Objectives

The evaluation of the Appliance Recycling Program involves these research objectives:

- Assess customer awareness of the program and its role in the customer's decision to recycle an appliance
- Evaluate customer satisfaction with the program
- Identify improvements to the program recommended by customers
- Determine the program's role in cross-program promotion and participation in other energy-efficiency programs from PPL Electric[67]

5.4.2 Evaluation Activities

In PY6, Cadmus conducted the following process evaluation activities for the Appliance Recycling Program:

- Program staff and implementer interviews (n=2)
- Participant surveys (n=140)
- Cross-program survey (n=86)[68]

---

67 Although one of the program's objectives is to promote other PPL Electric energy-efficiency programs, the Appliance Recycling Program did not implement any cross-program marketing in PY6. Therefore, Cadmus did not investigate this research objective.

68 The cross program survey included participants of the Residential Retail, Residential Home Comfort, and Appliance Recycling programs. Cadmus completed 300 cross program surveys but are only discussing the results from the Appliance Recycling program in this report.

- Nonparticipant surveys (n=146)
- Interviews with retail partners
- Database and record quality control review

Cadmus conducted the staff interviews and the participant and nonparticipant surveys as stipulated in the PY6 evaluation plan (Table 5-14). However, we did not successfully complete the interviews with the program's retail partners. We made multiple call attempts to no avail.

5.4.3 Methodology

This section presents the process evaluation activities and methodology. Addendum A in this chapter provides additional information including sampling details and survey attrition tables.

5.4.3.1 Program Staff and Implementer Interviews

Cadmus conducted interviews with program management staff at PPL Electric and the ICSP in April and May 2015. The interviews followed up on the recommendations made in the PY5 report and discussed program design changes, key performance indicators, and implementation successes and challenges.

5.4.3.2 Participant Surveys

Cadmus administered a telephone survey with residential customers who participated in PPL Electric's Appliance Recycling Program. This program-specific survey was administered for verification purposes, calculating the net-to-gross ratio, and assessing program implementation. Within the area of program implementation, the survey asked customers how they learned about the program, about their awareness and level of energy efficiency, and satisfaction with the program and PPL Electric.

Cadmus used a stratified random sampling method for the program-specific survey. The sample frame contained 50% of participants who recycled a freezer and 50% of participants who recycled a refrigerator. Because freezers account for fewer units in the participant population, anyone who recycled both a freezer and a refrigerator was included in the freezer sample frame. Cadmus cross-checked the freezer and refrigerator sample frames to make sure that no one was included in both. Because room air conditioners are picked up as an additional service, we did not generate a separate sample for them.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

Table 5-14: PY6 Appliance Recycling Program Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted[1]	Evaluation Activities
PPL Electric Program and ICSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, program staff interviews, census
Residential	Participants in (Q1, Q2, and Q3	6,025	0.5	90/10	140	1,217	140	96%	Process, impact, NTG, participant survey, stratified random sampling
Cross-Program (Appliance Recycling, Residential Home Comfort, and Residential Retail)	Appliance Recycling Participants [2]	5,789	0.5	90/10	As many as possible	965	86	95%	Process, estimate low income participation, residential program participants, probability sample, simple random sample
Residential [3]	Nonparticipants (General Population)	2,140,376	N/A	N/A	As many as possible	21,790	146 [4]	17%	Impact, NTG, nonparticipant survey, combination of sampling approaches[3]
	Nonparticipants (Program Surveys)	1,604	N/A	N/A	As many as possible	1,323		76%	
	Nonparticipants (Cross-Program Survey)	11,152	N/A	N/A	As many as possible	3,083		96%	
Retail Partners	Staff	2	N/A	N/A	1-2	2	0	100%	Process, interviews, census
Program Total	**N/A**	**2,164,950**	**N/A**	**N/A**	**N/A**	**28,382**	**374**	**N/A**	**N/A**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews. [2] Cross-program survey included participants of the Residential Retail, Residential Home Comfort, and Appliance Recycling programs. Cadmus completed 300 cross-program surveys but the results in this table and report reflect only those records and surveys completed for the Appliance Recycling program.

[3] Nonparticipant respondents were reached through the cross-program survey, general population upstream lighting survey, and program surveys for Residential Home Comfort and Residential Retail. The cross-program survey contained participants and nonparticipants of the Appliance Recycling Program; however respondents who participated in the program were not included in the analysis.

[4] Overall, 146 customers (48 from general population survey, 50 from program surveys, and 48 from the cross-program survey) were identified as having disposed of an appliance. However, only 49 had disposed of a working appliance and had not received an incentive.

5.4.3.3 Cross-Program Participant Survey

Cadmus conducted a cross-program survey in PY6 that targeted customers participating in one of these general residential rebate programs—Appliance Recycling, Residential Home Comfort (equipment, weatherization, and audit), and Residential Retail (heat pump water heaters only). A total of 86 surveys were completed with participants of the Appliance Recycling program.

The primary purpose of this cross-program survey was to obtain a preliminary estimate of low-income participation in programs that are not specifically targeting this sector (i.e., programs that do not require income verification). We excluded only those customers who participated in surveys within the last year or who requested not to be contacted. From this sample frame, we selected a random sample (probability sampling), but we did not stratify the sample by program.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by applying random sampling and using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

Although the primary purpose of the survey was to estimate low income participation, we used the opportunity to gather additional data such as program satisfaction, energy efficiency behaviors, and challenges, the findings for which are aggregated with the Appliance Recycling program participant survey results and summarized in this report. We also included questions to identify ARP nonparticipants in the Residential Home Comfort and Residential Retail Programs. Additional details about this are in the next section.

These surveys were completed during March and April 2015.

5.4.3.4 Nonparticipant Surveys

Program participants may exaggerate the frequency with which they would have done what they perceive the interviewer considers “the right thing”—in this case, removing their old appliance from the grid independently of the program—and information from nonparticipants helps mitigate the impact of socially desirable response bias. The nonparticipant surveys, therefore, aimed to provide insights into what happens to older, operable appliances in the program’s absence and also helps inform the net-to-gross analysis.

Cadmus did not conduct a general population survey specifically to identify ARP nonparticipants, i.e., households recycling appliances outside of the program. Rather, survey questions for appliance recycling nonparticipants were included in non-ARP program participant surveys and in the general population survey. We used these surveys as a vehicle to identify ARP nonparticipants because it was less costly and could potentially identify larger numbers of nonparticipants than a general population survey alone. We recognize that an additional source of bias, introduced by the survey methodology could affect results if the number (or proportion) of non-ARP participants in the other program populations differed substantially from the general population. The proportion of nonparticipants in the program participant group (20%; n=479) is similar to the general population group (16%; n=301); therefore, we assumed that any bias introduced by the survey methodology will have minimal impact.

We administered the nonparticipant Appliance Recycling Program questions as part of other surveys: the cross-program survey, general population survey for residential upstream lighting, program participant surveys conducted for the Residential Retail Equipment and Residential Home Comfort programs.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We addressed these potential sources of bias by using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they were implemented consistently. Cadmus attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks when possible.

These surveys were conducted between April and July of 2015 through these activities:

- We used a random sampling method to select the survey sample for the cross-program and residential upstream lighting surveys.
- For the Residential Retail Equipment survey, we used a stratified random sample, where strata were defined according to the rebate type (heat pump water heater or refrigerator).
- Because the primary purpose of the Residential Home Comfort program survey was to verify whether customers switched from gas to electricity to receive a rebate, we attempted to survey the census of customers who indicated on their rebate form they had natural gas.

Table 5-14 above summarizes the sampling strategy for the nonparticipant surveys.

5.4.3.5 Interviews with Retail Partners

Cadmus aimed to conduct at least one interview with the program's retail partners (Best Buy and Sears) to inform the process and effectiveness of the "Buy New and Recycle" component. However, we did not successfully reach retail partner staff after multiple attempts.

5.4.4 Achievements Against Plan

The Appliance Recycling Program did not meet its PY6 planned MWh/yr savings and participation, but it did meet plans for demand savings (Table 5-15). At the end of PY6, the program had achieved:

- 62% of its 25,224 MWh/yr three-year planned savings
- 87% of its 3.50 MW three-year planned demand reduction
- 61% of its three-year planned participation of 36,920 units

The program recycled a total of 9,190 units, which was comprised of 77% refrigerators, 16% freezers, and 7% room air conditioners.

Table 5-15: Appliance Recycling Program Savings

	PY5 Verified	PY6			Phase II: PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	9,255	8,243	6,437	78%	25,224	15,692	62%
MW	1.86	1.12	1.19	106%	3.50	3.05	87%
Participation[2]	13,486	11,720	9,190	78%	36,920	22,676	61%

[1] Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table D7, p.46.
[2] Participation is defined in the EE&C Plan as the number of appliance units recycled.

Two possible reasons the program did not meet its planned energy savings for PY6 are:

- **Fewer units recycled.** PY6 saw a 32% decrease from PY5 in the number of appliance units recycled, which impacted the energy savings.
- **Scaled-back marketing.** PPL Electric and the ICSP scaled back on program marketing for most of PY6 after learning that in previous years participation slowed down near the end of summer and peaked in the spring. However, the marketing scale-back may have resulted in fewer customer touches, which means fewer customers could discover and participate in the program.

5.4.5 Program Delivery

Despite not meeting its plans, the program ran very smoothly in PY6 and is working very well. The ICSP's quick responsiveness to address customer issues and efficient tracking of program performance yielded a smooth delivery. In its survey, Cadmus found that very few customers reported complaints. The ICSP uses an EEMIS-compatible reporting portal, which makes data and performance tracking easy for the ICSP and PPL Electric's program management staff.

5.4.5.1 Logic Model

A program logic model identifies the relationships between activities and expected results. During PY5, Cadmus developed the logic model for the Appliance Recycling Program (Addendum C). In PY6, we reviewed the logic model and found that the program was not promoting other energy efficiency programs because these other programs did not need the additional savings. Instead, the reverse occurred—the Appliance Recycling Program was cross-promoted in the home energy reports delivered through the Residential and Low-Income Energy-Efficiency Behavior & Education program.

5.4.5.2 Key Performance Indicators

PPL Electric and the ICSP do not formally track key performance indicators with firm goals. However, the ICSP internally tracks its performance for on-time pick-ups, rebate processing times, answering customer calls, and the retail partner component, although contractual stipulations do not require it to report these metrics to PPL Electric. Table 5-16 shows the program metrics that the ICSP tracks internally.

Table 5-16: Appliance Recycling Program's ICSP Metrics

Metric	Goal/What Is Tracked	PY6 Result
On-time pick-ups	Arrive within a four-hour window	Achieves plan 98% of the time[1]
Rebate processing time	Under 30 days after pick-up	Achieves plan 98% of the time; 78% of checks were processed within two weeks[2]
Answering customer calls	How long it takes to answer a customer's call (no explicit goal)	Within 30 seconds on average[1]
Participation from retail partners	Proportion of the overall program that the "Buy New and Recycle" component contributes to (no explicit goal)	17% of appliance units[2]
[1] Results are based on what the ICSP reported. [2] Cadmus reviewed the program data to obtain the PY6 results.		

5.4.5.3 Program Updates

PPL Electric's program management staff and the ICSP reported no change in the program design, delivery, or eligibility of the Appliance Recycling Program in PY6.

In PY5, Cadmus made four recommendations for the program and followed up with PPL Electric to determine if any of the recommendations were implemented. PPL Electric implemented the recommendation to selectively deploy advertising and use a variety of marketing channels to promote the program. PPL Electric also implemented the recommendation to take advantage of room air conditioners' high demand savings by marketing these as eligible equipment for the program. PPL Electric did not implement the recommendations on ways to increase customer awareness of energy efficiency and of other programs through leave-behind materials and the distribution of an energy-savings kit. Instead, PPL Electric will consider these two recommendations if it needs more savings from other programs.

5.4.6 Participant Profile

In PY6, 8,073 customers participated in the program.[69] Based on the demographic responses in the participant surveys, the majority of participants (n=226):

- Live in a single-family home (88%)
- Own their home (96%)
- Have a household size of two members (42%)
- Have a high school diploma or equivalent (36%)
- Were in the 45-64 age group (48%)

Moreover, these four demographic survey findings hint at a likely empty-nester customer segment:

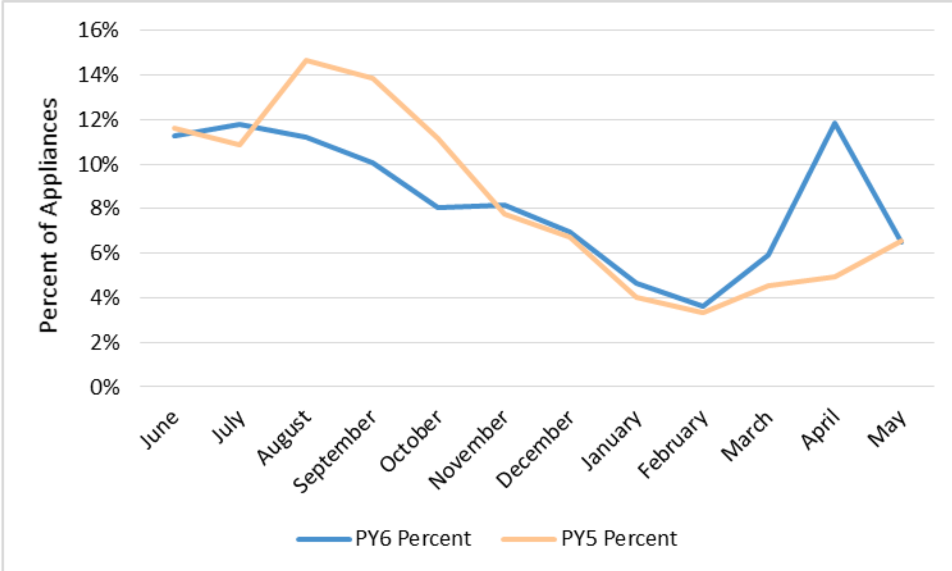
- 42% living in a two-person household → likely to be a couple
- 48% were in the 45-64 age group → likely to have a child who is old enough to be in college
- 88% in a single-family home → likely to have had more than two people living in the home at some point
- 96% own their home → likely to have the economic resources to send a child to college

5.4.7 Marketing and Outreach

PPL Electric and the ICSP scaled back the program's marketing throughout most of PY6 because they noticed the trend in previous years was that the program had the least participation in winter and peaked from spring to summer (Figure 5-1). In the last quarter of PY6 (March through May), program marketing picked up and focused on themes of convenience and spring cleaning. The campaign involved TV advertisements, bill inserts, social media, and a Connect article. Marketing and outreach activities during the rest of the year were limited to in-store displays (at partner stores), paid media advertising (newspaper and radio), and educating retail sales staff (at partner stores).

69 This number represents the number of unique customers.

Figure 5-1: PY6 Vs. PY5 Program Participation Trends



The Appliance Recycling Program is also promoted in the home energy reports sent every other month to customers participating in the Residential and Low-Income Energy-Efficiency Behavior & Education programs.

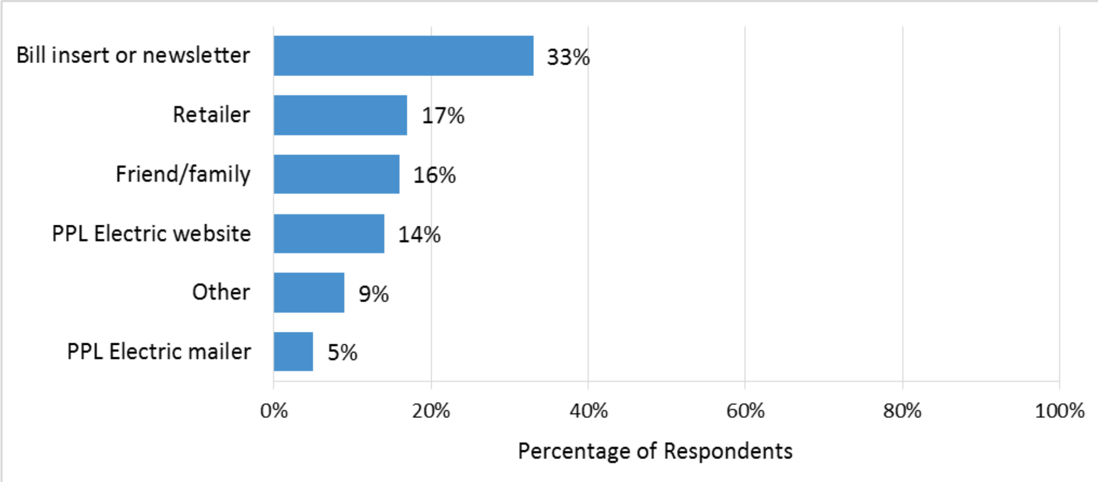
5.4.7.1 How Customers Learn About the Program

Bill inserts and newsletters continue to be the most common ways customers learn about the program. A third (33%) of the survey respondents (n=140) reported learning about the program from bill inserts or newsletters, a decrease from PY5 (39%, n=140). Respondents also mentioned retailers (17%) and friends/family (16%); the response rate for retailers increased from PY5 (12%) but the response rate for friends/family did not change.

The response rate mentioning PPL Electric's website also increased slightly from 12% of respondents mentioning it in PY5 to 14% in PY6. No participant respondents mentioned learning about the program through the home energy reports.[70] Figure 5-2 shows the top six ways customers learn about the program.

70 The survey did not actively target participants who also receive the home energy reports. Therefore, the lack of respondents learning about the Appliance Recycling Program through the home energy reports may be underreported.

Figure 5-2: Top Six Ways Customers Learn About the Program



Source: Question C1, "How did you learn about the Appliance Recycling Program? [Multiple responses allowed] (n=140).

5.4.8 Program Awareness

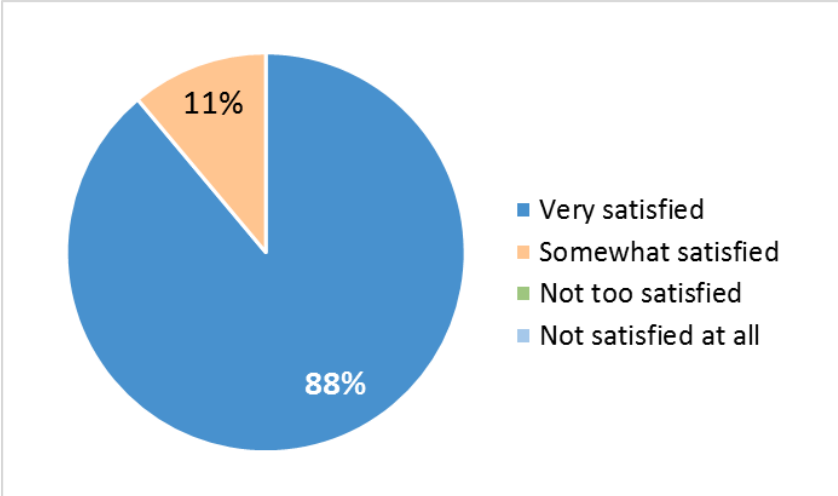
Because the Residential Energy-Efficiency Behavior & Education home energy reports promoted the Appliance Recycling Program, Cadmus chose to assess the awareness level of the program using survey data from the Residential Energy-Efficiency Behavior & Education Program's customer surveys. Approximately 33% of survey respondents receiving the home energy reports (treatment group, n=282) said they heard about the Appliance Recycling Program compared to 28% of respondents who did not receive the report (control group, n=142). The home energy reports generated some customer awareness for the program, though not a statistically significant amount.

5.4.9 Satisfaction

5.4.9.1 Program Satisfaction

Program satisfaction remains very high and did not change from PY5. Nearly all participant survey respondents (99%, n=226) reported that they were satisfied with the program overall. Specifically, 88% of participant respondents said they were *very satisfied* and 11% said they were *somewhat satisfied*. Figure 5-3 shows program satisfaction.

Figure 5-3: Program Satisfaction



Source: Question H4, "Thinking about your overall experience with the Appliance Recycling Program, how would you rate your satisfaction? Would you say you are...." (n=226).

When asked what PPL Electric could do to improve the program experience, respondents frequently suggested improvements related to pick-up (6 of 18 respondents):

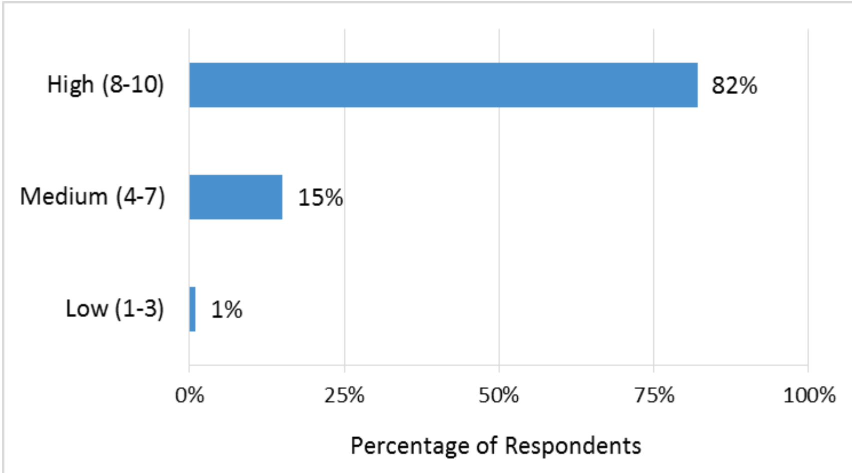
- *"Have more pick-up options."*
- *"Contractor needs to come at scheduled pick-up time."*
- *"Contractor that's customer-oriented."*
- *"Be faster. It took two weeks for them to come and get it."*
- *"[It took] a few months to book appointment. Faster availability would be nicer."*
- *"Pick up all refrigerators (small ones). More flexible pick-up times. Work on appointment windows."*

5.4.9.2 Satisfaction with PPL Electric

Satisfaction with PPL Electric among participants remained the same as in PY5. In PY6, participant respondents (n=222), on average, gave a rating of 8.6 out of 10 for overall satisfaction with PPL Electric as an electric service provider. In PY5, participant respondents gave an average rating of 8.5 (n=139). When looking at the top-tier ratings (8, 9, and 10), 82% of participant respondents gave top-tier ratings in both PY5 and PY6. Figure 5-4 shows the utility satisfaction ratings by tier for PY6.

For the majority of respondents (59%, n=226), participating in the program did not change their opinion of PPL Electric. Nonetheless, 64% of respondents said they have recommended the program to others.

Figure 5-4: Satisfaction with PPL Electric



Source: Question I1, "Using a 10-point scale where 1 means unacceptable and 10 means outstanding, using any number from 1 to 10, how do you rate PPL Electric overall as a provider of electric service to your home?" (n=222)

5.4.10 Energy-Efficiency Knowledge

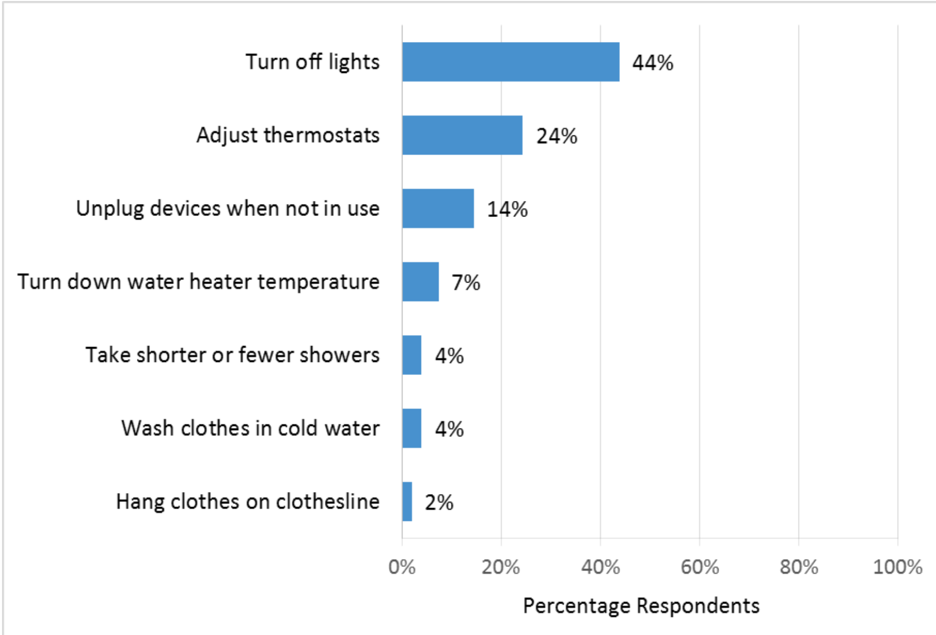
Before participating in the program, the majority of participant respondents (61%, n=226) reported they were *somewhat knowledgeable* about ways to save energy. A third of respondents (34%) considered themselves *very knowledgeable*. After participating in the Appliance Recycling Program, the majority of respondents (58%) reported becoming *more knowledgeable* about the ways to save energy.

Most respondents said they looked for energy efficiency information on websites other than PPL Electric's (62%, n=226), followed by news/media (20%), and finally PPL Electric resources (17%). Only 6% of respondents said they did not look for any energy efficiency information.

5.4.11 Energy-Saving Steps and Purchasing Patterns

An overwhelming majority of participant respondents reported taking steps to save energy at home on a regular basis (96%, n=140). The specific energy-saving steps were few in number. As shown in Figure 5-5, of the respondents who reported taking steps to save energy (n=135), most reported turning off lights (44%) and adjusting the thermostat (24%). Less common steps included taking short showers (4%), washing clothes in cold water (4%), and hanging clothes on the clothesline (2%).

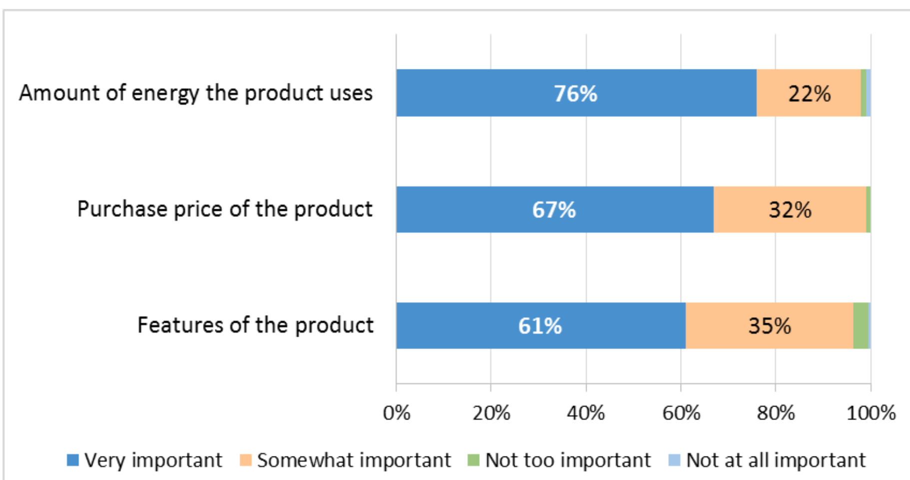
Figure 5-5: Energy-Saving Steps Taken



Source: Question J3, "What steps do you take?" [Multiple responses allowed] (n=135)

When shopping for products, a higher proportion of participant respondents (n=220) reported that the amount of energy the product uses was *very important* (76%) compared to the purchase price of the product (67%) and the features of the product (61%). Figure 5-6 shows the customers' purchasing patterns when shopping for products that use energy in the home.

Figure 5-6: Purchasing Patterns



Source: Question J6, "When shopping for products or appliances that use energy in your home, how would you rate the importance of each of the following…?" (n=220)

5.4.12 Attitudes Toward and Barriers to Energy Efficiency

The survey asked participant respondents (n=226) to agree or disagree with a number of statements.

- 82% disagreed with the statement *"I am not sure what I can do to save energy at home."*
- 62% disagreed with the statement *"information about energy efficiency is confusing or overwhelming."*
- 55% disagreed with the statement *"making an investment in energy efficiency is risky, because I'm not sure how much money or energy I will save."*

Generally, these findings indicate that the participants are well-informed (which coincides with other survey data already discussed), and that knowledge barriers are not significant. However, almost half of respondents (45%) agreed that investments in energy efficiency could be risky due to the unknown financial savings, indicating the need for more information about specific financial outcomes.

- 61% agreed with the statement "*my appliances and heating and air conditioning systems work fine, so why replace them."*
- 46% agreed with the statement "*the added up-front cost of energy-efficient equipment is a challenge for me*."

These data indicate that rather than knowledge and awareness, old, yet functioning equipment and cost are more prevalent barriers to making energy efficiency upgrades.

5.4.13 Retail Partners

Since Phase I, the program has partnered with retailers Best Buy and Sears on the "Buy New and Recycle" component. In PY6, the partnership recycled 1,606 units, or 17% of the overall program units. The ICSP manages the retail partner component and visits the partner stores each quarter. Sales associates at the store register the old appliances that are to be removed and collects customer information.

Beginning in PY7, Best Buy will no longer be a partner in the "Buy New and Recycle" component due to low program performance and lack of interest by the retailer in promoting the "Buy New and Recycle" component.

5.5 CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The Appliance Recycling Program continues to operate well; however, the program did not achieve its planned savings and participation due to a decrease in marketing which lead to a decline in the number of appliances recycled. The program reduced its overall marketing efforts in favor of a conservative yet strategic approach involving seasonal, targeted marketing. The scaled-back approach may have yielded fewer customer touches and ultimately fewer customers participating in the program, explaining the 32% drop in the number of appliance units recycled in PY6. The key performance indicators and few customer complaints reported from the participant surveys show that the program performed well in on-time pick-ups, reasonable rebate processing times, and quick responses to customer calls.

Recommendation

Increase program marketing and focus on summer and early fall months in addition to spring, if PPL Electric would like to levelize monthly participation to reduce the seasonal swing. Program participation in PY6 and PY5 began to pick up in spring and tapered by the end of August. PY6 participation peaked in the spring months as a result of the spring marketing campaign. However, PY6 participation in summer and fall saw a noticeable decrease compared to PY5 (Figure 5-1). Rather than focus most of the program marketing efforts in spring, consider a summer or fall marketing campaign. PPL Electric realized the need to increase program marketing and began to increase program marketing in the summer and fall months of PY7.

Recommendation
Consider a leave-behind flyer or post card that includes information on all PPL Electric program offerings, including Act 129 programs, to ensure participants are aware of all program resources available.

Conclusion
The program did not achieve significant customer awareness with the Residential Behavior & Education program' home energy reports' cross-program promotion. Approximately 33% of survey respondents receiving the home energy reports said they heard about the Appliance Recycling Program compared to 28% of the respondents who did receive the home energy reports, a difference not statistically significant.

Conclusion
Demographic data from the participant surveys suggest that a sizeable proportion of participants may be parents with children who have recently gone off to college (often referred to as empty-nesters). Larger households often need a second refrigerator or freezer to accommodate the greater amount of food, but once these households shrink, the second refrigerators/freezers are no longer needed.

Recommendation
Consider investigating customer segments to identify who is participating in the program and which segments have yet to be tapped. Identifying segments and characterizing them can yield information such as marketing and outreach entry points, effective paid media advertisements, and influencers.

5.5.1 Status of Recommendations for Program

Table 5-17 contains the status of each PY6 process recommendation made to PPL Electric Utilities. Based on the findings, we suggest PPL Electric consider the following recommendations in PY7.

Table 5-17: Appliance Recycling Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Appliance Recycling Program	
Increase program marketing and focus on the low season months such as summer and fall if PPL Electric would like to levelize monthly participation to reduce the seasonal swing, in addition to spring, .	Under consideration.
Consider a leave-behind flyer or post card that includes information on all PPL Electric program offerings, including Act 129 programs, to ensure participants are aware of all program resources available.	Will be implemented in Phase III.
Consider investigating customer segments to identify which segments have yet to participate; identifying segments and characterizing them can yield marketing and outreach ideas.	Will be implemented in Phase III.

5.6 FINANCIAL REPORTING

A breakdown of the Appliance Recycling Program finances is presented in Table 5-18.

Table 5-18: Summary of Appliance Recycling Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$0	$0
2	EDC Incentives to Participants	$281	$689
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$0	$0
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$829	$2,013
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$829	$2,013
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$1,109	$2,702
13	Total NPV Lifetime Energy Benefits	$3,588	$8,244
14	Total NPV Lifetime Capacity Benefits	$321	$669
15	Total NPV O&M Saving Benefits	($0)	($0)
16	Total NPV TRC Benefits[4]	$3,909	$8,913
17	TRC Benefit-Cost Ratio[5]	3.52	3.30

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

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report.

ADDENDUM A. PARTICIPANT SURVEY ATTRITION AND FINAL DISPOSITION

Dialing Instructions

PPL Electric provided dialing instructions for conducting surveys. Customers cannot be contacted within a year of the last time they completed a survey (with PPL Electric or Cadmus). Any customer who has requested to be removed from the sample frame for any survey cannot be contacted again. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Prior to the start of survey data collection, Cadmus coordinated with PPL Electric's survey subcontractor to screen the sample and remove records of any customers who were called in the past year (whether for a Cadmus survey or a PPL Electric survey) or who requested not to be contacted again. Duplicate records in the program were removed along with records with incomplete information.

For the cross-program survey, Cadmus selected a simple random sample of all remaining records and sent them to the survey subcontractor. Table 5-19 lists the number of records submitted and the final outcome of each record for the cross-program survey.

For the program survey, initial sample preparation also excluded program participants of the cross-program survey. Cadmus selected all remaining records and sent them to the survey subcontractor.

Table 5-19: Cross-Program Sample Attrition

Cross-Program: Appliance Recycling Participants	
Description	Count
Total population (number of participants Q1-Q2)	**5,789**
Random sample selection	**2,231**
Removed incomplete or bad phone number, inactive customer, completed survey in past year, on "do not call" list, selected for a different survey, duplicate contact	1,266
Sent to Survey Subcontractor	**965**
Records Not Attempted [1]	**46**
Records Attempted	**918**
Nonworking number	21
Business/wrong number	20
Refusal	306
Language barrier	0
Ineligible; PPL or market research employment	5
Ineligible; did not participate in program	2
No answer/answering machine/phone busy	319
Nonspecific or specific callback scheduled	139
Partially completed survey	20
Completed survey [2]	**86**

[1] These records were not needed because the overall survey target for the cross-program survey was reached before they were attempted.
[2] The survey target for the cross-program survey was 300 and was not stratified by program (Appliance Recycling, Residential Home Comfort, and Residential Retail).

Table 5-20 lists the total number of records submitted and the final outcome of each record for the program-specific survey (n=140).

Table 5-20: Survey Sample Attrition Table

Appliance Recycling Program	
Description of Call Outcomes	**Number of Records**
Population (number of rebates Q1, Q2, and Q3)	**6,025**
Removed because incomplete or bad phone number	1
Removed because inactive customer	353
Removed because completed survey in past	29
Removed because on do not call list	3
Removed because selected for other survey	834
Removed because duplicate	18
Removed because nonresidential	23
Survey Sample Frame (sent to survey subcontractor)	**1,217**
Not attempted [1]	**49**
Records Attempted	**1,168**
Non-working number	46
Wrong number, business	27
Ineligible; quota full	4
Language barrier	1
PPL Electric or market research employee	15
Did not participate in program or recycle	9
Refusal	383
No answer/answering machine/phone busy	338
Non-specific or specific callback scheduled	186
Partial complete	19
Completed survey	**140**

[1] These records were not needed because the interview target was reached before they were attempted.

ADDENDUM B. NONPARTICIPANT SURVEY ATTRITION AND FINAL DISPOSITION

Cadmus did not administer a program-specific nonparticipant survey. Instead, we administered the nonparticipant survey as part of the cross-program survey, general population survey for residential upstream lighting, and program participant surveys conducted for the Residential Retail Equipment and Residential Home Comfort programs. The number of completed surveys from each activity included in this analysis are in Table 5-21.

Table 5-21: Nonparticipant Surveys

Survey	Number of Completed Surveys
Cross-Program	48
Residential Retail Equipment	47
General Population Upstream Lighting	48
Residential Home Comfort	3
Total	**146**

Dialing Instructions

The same instructions apply to customers who did not participate in the Appliance Recycling Program. Customers cannot be contacted within a year of the last time they completed a survey (with PPL Electric or Cadmus). Any customer who has requested to be removed from the sample frame for any survey cannot be contacted again. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Prior to the start of survey data collection, Cadmus coordinated with PPL Electric's survey subcontractor to screen the sample and remove records of any customers who were called in the past year (whether for a Cadmus survey or a PPL Electric survey) or who requested not to be contacted again. Duplicate records were removed along with records with incomplete information. Table 5-22 through Table 5-25 list the total number of records submitted and the final outcome of each record for each of these programs.

Table 5-22: Cross-Program Survey Sample Attrition

Cross-Program Survey Sample Attrition Description	Count
Total population (number of participants Q1-Q2)	**11,152**
Random sample selection	**4,716**
Removed incomplete or bad phone number	2
Removed inactive customer	442
Removed completed survey in past year	277
Removed because on do not call list	2
Removed because selected for other survey	874
Removed because duplicate	36
Sent to Survey Subcontractor	**3,083**
Records Not Attempted [1]	**133**
Records Attempted	**2,948**
Nonworking number	94

Cross-Program Survey Sample Attrition Description	Count
Business/wrong number	60
Refusal	887
Language barrier	3
Ineligible; PPL or market research employment	34
Ineligible; did not participate in program	38
No answer/answering machine/phone busy	990
Nonspecific or specific callback scheduled	464
Partially completed survey	78
Completed survey [2]	**300**

[1] These records were not needed because the survey target was reached before they were attempted.
[2] Only 48 of these were used in the ARP nonparticipant analysis.

Table 5-23: Residential Retail Sample Attrition Table

Residential Retail Equipment Survey Sample Attrition Description	Count
Total population (number of rebate participants Q1-Q4)	**1,405**
Removed inactive customer	39
Removed contacted in past year	61
Removed do not call	2
Removed in concurrent sample	103
Removed duplicate	4
Removed incorrect sector	6
Sent to Survey Subcontractor	**1,190**
Records Not Attempted [1]	**312**
Records Attempted	**878**
Nonworking number	31
Business/wrong number	15
Refusal	222
Language barrier	1
Ineligible; PPL or market research employment	17
Ineligible; didn't participate in program	1
No answer/answering machine/phone busy	244
Nonspecific or specific callback scheduled	175
Partially completed survey	22
Completed survey [2]	**150**

[1] These records were not needed because the survey target was reached before they were attempted.
[2] Only 47 of these were used in the ARP nonparticipant analysis.

Table 5-24: General Population Upstream Lighting Sample Attrition

General Population Upstream Lighting Sample Attrition Description	Count
Total population (number of customers)	**2,140,376**
Random Sample Selection	**40,000**
Removed because bad or incomplete phone	1,913
Removed because duplicate	756
Removed because inactive customer	15,227
Removed because contacted in past year	223
Removed because selected for a different study	91
Sent to Survey Subcontractor	**21,790**
Records Not Attempted [1]	**18,095**
Records Attempted	**3,695**
Nonworking number	456
Business/wrong number	148
Refusal	1,214
Language barrier	30
Ineligible; PPL or market research employment	41
Ineligible; not PPL customer	0
No answer/answering machine/phone busy	934
Nonspecific or specific callback scheduled	451
Partially completed survey	120
Completed survey [2]	**301**

[1] These records were not needed because the survey target was reached before they were attempted.
[2] Only 48 of these were used in the ARP nonparticipant analysis.

Table 5-25: Residential Home Comfort Sample Attrition Table

Residential Home Comfort Sample Attrition Description	Count
Total population (number of participants with natural gas Q1-Q4)	**199**
Random sample selection	**199**
Removed inactive customer	5
Removed contacted in past year	10
Removed do not call	1
Removed in concurrent sample	3
Removed electric heat	47
Sent to Survey Subcontractor	**133**
Records Not Attempted [1]	**0**
Records Attempted	**133**
Nonworking number	9
Business/wrong number	5
Refusal	20
Language barrier	0
Ineligible; PPL or market research employment	1
Ineligible; didn't participate in program	1
No answer/answering machine/phone busy	30
Nonspecific or specific callback scheduled	35
Partially completed survey	3
Completed survey [2]	**29**

[1] These records were not needed because the survey target was reached before they were attempted.
[2] Only 3 of these were used in the ARP nonparticipant analysis.

ADDENDUM C. LOGIC MODEL

A program's theory informs its development and implementation, as well as its evaluation. A program logic model identifies the relationships between activities and expected results. Because logic models are designed to make the underlying theory explicit, they are useful tools for implementers and evaluators.

The program theory for the Appliance Recycling Program 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 from 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 maintaining efficient appliance stock.

The following lists the logic model for the Appliance Recycling Program:

- **Activities the program undertakes** include marketing and outreach (including cross-program referrals), processing applications, verifying customer eligibility, picking up and recycling inefficient refrigerators and freezers, and processing incentive payments.
- **Outputs produced by program activities** include the amount of marketing materials produced; the number of applications processed; the number of appliances scheduled, picked-up, and subsequently recycled; and the total amount of incentives paid.
- **Short-term outcomes** that result from customers' participation include secondary and inefficient appliances being permanently retired from use, and customer awareness of other PPL Electric EE&C programs.
- **Intermediate outcomes** consist of increased participation in the program due to customer familiarity; a 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** include fewer old and inefficient appliances in existence and achieve planned energy and demand saving of approximately 26,000 MWh/yr.

6 LOW-INCOME WINTER RELIEF ASSISTANCE PROGRAM (WRAP)

The Act 129 Low-Income Winter Relief Assistance Program (Act 129 WRAP) supplements and operates in tandem with PPL Electric Utilities' Universal Services Program (USP) WRAP. Both programs are designed to reduce electric consumption and improve living comfort for low-income customers.

USP WRAP targets residential customers whose income is at or below 200% of the federal poverty level. Act 129 WRAP operates in largely the same manner but targets customers whose income is at or below 150% of the federal poverty level. Both programs seek to reach these three groups:

- New participants
- PPL Electric Utilities customers who have received WRAP assistance in the past and may be in need of further WRAP services
- Customers who may not have been eligible for low-income assistance in the past due to eligibility rules, such as the requirement to have at least one year of pre-participation kWh usage data

USP and Act 129 WRAP is available to customers in existing single-family houses and multifamily housing (three or more dwelling units) where 50% or more of the tenants are income-qualified.

PPL Electric Utilities designed Act 129 WRAP and USP WRAP to operate seamlessly so that customers are not aware from which program they are receiving services. It funds both programs through tariffed electric bill surcharges, but it tracks each program's funding sources, budgets, and expenditures separately. The same PPL Electric Utilities program manager manages both programs.

Income-eligible customers receive a free energy audit that evaluates their home for eligible energy-saving products. The audit refers to a preapproved list of appliances and large equipment along with other criteria to determine if any can be replaced cost-effectively.

PPL Electric Utilities works with community-based organizations to implement the program. These organizations either use in-house contractors or outsource the installation of energy-saving products and replacement of outdated and inefficient equipment with program-qualifying energy-efficient equipment.

WRAP also offers energy education to encourage customers to conserve energy. In the unlikely event a structure requires minor health and safety repairs before services can be provided, contractors make the repairs so that the agencies implementing the program do not have to deny services altogether.

WRAP provides low-income customers with three types of service, also known as "jobs"—baseload (customers without electric heat and without electric water heater), low-cost (customers without electric heat but with electric water heater), and full-cost (customers with electric heat and an electric water heater). PPL Electric Utilities provides all services and products to income-qualified customers at no cost.

Baseload products include:

- Energy education
- Installation of efficient lighting (such as LEDs)
- Refrigerator replacement
- Air conditioner replacement
- Dehumidifier replacement
- Changing or cleaning of heating and cooling filters
- Dryer venting (electric dryer)
- Power strips and smart plugs

Low-cost products include all baseload products as well as water heating products such as:

- Water heater replacement
- Water heater pipe wrap
- Faucet aerators
- Efficient showerheads

Full-cost products and services include all baseload and low-cost products and adds shell products such as:

- Insulation (e.g., attic, floor, wall)
- Infiltration (e.g., caulking, weather-stripping, blower door testing)
- HVAC repair and replacement
- Duct insulation and repair
- Window repair and replacement

In addition, PPL Electric Utilities offers a heat pump water heater (HPWH) at no cost to qualified low-income customers with electric water heating.

The objectives of the Low-Income WRAP are to: [71]

- Provide low-income customers with education and measures to help reduce their energy costs and increase their energy efficiency.
- Maintain partnerships with local community-based organizations (CBOs) and contractors to ensure customers receive maximum and timely customer assistance.
- Promote other PPL Electric Utilities energy efficiency programs.
- Install WRAP measures in approximately 10,000 low-income customer's homes through 2016 with a total approximate reduction in energy use of 10,400 MWh/yr.[72]

An executive summary of cumulative Phase II program metrics can be found in Table 6-1.

Table 6-1: Act 129 WRAP Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost [1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Low-Income WRAP	7,626	7,626	7,335	1	0.77	$9,871	$1.35	$0.14	6,839
Total	**7,626**	**7,626**	**7,335**	**1**	**0.77**	**$9,871**	**$1.35**	**$0.14**	**6,839**

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

71 Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.82.

72 Low-income is defined at 150% of FPIG or below.

6.1 PROGRAM UPDATES

PPL Electric Utilities added low-cost and full-cost jobs back in to the program in PY6, after exclusion in PY5. Beginning in PY6, PPL Electric Utilities no longer offered CFLs to WRAP participants but instead provided LEDs. In PY6 Q4, PPL Electric Utilities began offering HPWHs with condensate pumps.

Through February 2015, tracking data for both programs were stored in the WRAP V database system; these data are now stored in PPL Electric Utilities' new Low-Energy Assistance Program (LEAP) tracking system.[73] In PY6, PPL Electric Utilities uploaded data for Act 129 WRAP participants from the WRAP V and LEAP systems to the EEMIS, the Act 129 participant-tracking database.

6.1.1 Definition of Participant

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

6.2 IMPACT EVALUATION GROSS SAVINGS

Through Act 129 WRAP in PY6, PPL Electric Utilities completed 4,287 jobs and served 4,048 unique participant households. The program provided 3,557 baseload jobs, 211 full-cost jobs, and 223 low-cost jobs, and installing 296 HPWHs.[74] The program reported energy savings of 4,561 MWh per year and a demand reduction of 0.5 MW per year. Because program services are provided free of charge to participants, there are no incentives.

Table 6-2: Phase II Act 129 WRAP Reported Results by Customer Sector

Sector	Participants	Reported Gross Energy Savings (MWh/yr)	Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Low-Income	6,839	7,626	0.77	$0
Phase II Total	**6,839**	**7,626**	**0.77**	**$0**

Energy savings and demand reductions must be calculated using the Pennsylvania TRM or Guidance Memo in effect on the date the product was installed. In PY6, 13% of all baseload jobs and 38% of all HPWHs had installation dates that occurred in PY5. All low-cost and full-cost jobs, 87% of all baseload jobs, and 62% of all HPWHs had installation dates that occurred in PY6.

Table 6-3 lists the approaches used to evaluate savings for each program stratum. These approaches are discussed in detail in the following sections.

73 The costs for developing the LEAP tracking system were shared equally by Act 129 WRAP and USP WRAP.

74 In PY6, 3,991 unique participants received a Baseload, low-cost, or full-cost job. Of these, 239 also received a HPWH. Another 57 participants received only a HPWH, for a total of 4,048 unique participants.

Table 6-3: PY6 Act 129 WRAP Impact Evaluation Sampling Strategy

Stratum	Population (Job Type)	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Baseload	3,557	N/A	30	463	Records Review; Billing Analysis
Low-Cost	223	N/A	20	96	Records Review; Billing Analysis
Full-Cost	211	N/A	30	60	Records Review; Billing Analysis
Heat Pump Water Heater	296	N/A	60	218	Records Review
Program Total [1]	**4,287**	**85/15**	**140**	**837**	

[1] In PY6, 3,991 unique participants received a Baseload, low-cost, or full-cost job. Of these, 239 also received a HPWH. Another 57 participants received only a HPWH, for a total of 4,048 unique participants.

6.2.1 WRAP Jobs

For Act 129 WRAP, *ex ante* reported energy savings and demand reductions for WRAP jobs are deemed by job type rather than by the TRM algorithm for each product installed. In Phase II, Cadmus and PPL Electric Utilities use energy savings estimates by job type derived from a customer usage analysis of previous years' Act 129 WRAP participants, in compliance with the Evaluation Framework and the PA Mass Market Protocol.[75, 76] Table 6-4 shows the annual savings by job type.

Table 6-4: Annual Savings by Job Type

Job Type	Annual Savings by Job Type (kWh)
Baseload Service Package Installed in PY5	911
Baseload Service Package Installed in PY6	988
Low Cost Service Package [1]	1,057
Full Cost Service Package [1]	1,360
Heat Pump Water Heaters Installed in PY5	1,698
Heat Pump Water Heaters Installed in PY6	1,776

[1] All low cost and full cost jobs were installed in PY6.

6.2.1.1 Installation Dates in PY5

To estimate the *ex post* evaluated savings per job for jobs completed in PY5, Cadmus conducted a customer usage analysis of PY2 and PY3 participants (Phase I). This analysis resulted in 911 kWh per year in savings per baseload job, which is 91% of the reported value of 1,003 kWh per year. More detailed

75 GDS Associates, Inc., et al. *Evaluation Framework for Pennsylvania Act 129 Phase II Energy Efficiency and Conservation Programs*. June 1, 2014. pp. 50-52. Available online: http://www.puc.pa.gov/Electric/pdf/Act129/SWE_PhaseII-Evaluation_Framework060114.pdf

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

information about the billing analysis for PY5 estimates is available in Appendix I: Act 129 WRAP Billing Analysis of the PPL Electric Utilities' Final Annual Report for PY 5.[77]

Cadmus calculated demand reductions by multiplying the per-unit kWh per job by the coincidence factor. In July 2014, Cadmus updated the coincidence factor for WRAP jobs to comply with the Phase II Evaluation Framework's peak demand window definition of 2:00 p.m. to 6:00 p.m. on non-holiday weekdays during June, July, and August (replacing the previously defined "top 100 hours"). Additionally, Cadmus used a different load shape—Residential Single-Family Miscellaneous—to calculate the updated coincidence factor because it is more representative of the whole-house weatherization approach used in Act 129 WRAP. Table 6-5 shows the original and updated coincidence factors.

Table 6-5: Act 129 WRAP Phase II Coincidence Factors for WRAP Jobs

Effective Period	Source	Coincidence Factor
PY3 – PY4	EM&V CSP calculation using PPL Electric Utilities Low-income Heating load shape	0.00011381
Phase II	EM&V CSP calculation using PPL Electric Utilities Residential Single-Family Miscellaneous load shape	0.00011797

The reported gross demand savings employed the original coincidence factor of 0.00011381. Cadmus applied the updated coincidence factor of 0.00011797 to estimate the adjusted *ex ante* demand savings and verified gross demand savings. As shown in Table 6-6, application of the updated coincidence factor changed the per-unit demand savings for baseload jobs with installation dates in PY5 by thousandths of a kW.

Table 6-6: Act 129 WRAP Phase II Per Unit Demand Values per Job with Installation Date in PY5

Job Type	Reported Gross Demand Savings (kW Per Unit)	Adjusted *Ex Ante* Demand Savings (kW Per Unit)	Verified Gross Demand Savings (kW Per Unit)
Baseload	0.114	0.118	0.107

6.2.1.2 Installation Dates in PY6

To estimate the *ex post* evaluated savings per job for jobs provided in PY6, Cadmus conducted a customer usage analysis of PY3 and PY4 participants (Phase I). This analysis resulted in 988 kWh per year in savings per baseload job, 1,057 kWh per year in savings per low-cost job, and 1,360 kWh per year in savings per full-cost job. PPL Electric Utilities applied the PY6 savings per job prospectively, so the reported gross energy savings, the adjusted *ex ante* energy savings, and the verified gross energy savings per job were the same. More detailed information about the billing analysis for PY6 estimates is available in the Appendix I: Act 129 WRAP Billing Analysis**.**

Cadmus calculated demand savings by multiplying the per-unit energy savings by the updated coincidence factor of 0.00011797. The per-unit demand savings are provided in Table 6-7. Reported gross demand savings employed the former coincidence factor of 0.00011381.

77 PPL Electric Utilities. *Final Annual Report to the Pennsylvania Public Utility Commission For the Period June 2013 through May 2014 Program Year 5*. Prepared by Cadmus. November 15, 2014. Appendix G. p. 233-238. Available online: http://www.puc.pa.gov/pcdocs/1326181.pdf

Table 6-7: Act 129 WRAP Phase II Per Unit Demand Values Per Job With Installation Date in PY6

Job Type	Reported Gross Demand Savings (kW Per Unit)	Adjusted *Ex Ante* Demand Savings (kW Per Unit)	Verified Gross Demand Savings (kW Per Unit)
Baseload	0.112	0.117	0.117
Low-Cost[1]	0.125	0.125	0.125
Full-Cost	0.150	0.160	0.160
[1]The reported demand per unit for low-cost jobs was 0.0 until Q4, when the value was updated to 0.1247 kW.			

6.2.1.3 Records Review

Cadmus also conducted a records review of a sample of baseload, low-cost, and full-cost jobs. Because the type of job depended on the water heating and space conditioning equipment in the home, the purpose of the records review was to verify that the job type the customer received corresponded to the original equipment.

In Q4 of PY6, data were available from PPL Electric Utilities' new LEAP tracking system. LEAP incorporates electronic data entry so there were no longer any paper documents to review; therefore, the Q4 records review involved comparing LEAP and EEMIS electronic data. Cadmus noted no WRAP jobs that did not correspond to the homes' space conditioning and water heating equipment.

Baseload jobs with installation dates in 2013 had a 91% realization rate and baseload jobs with installation dates in 2014 had a 100% realization rate; the aggregate PY6 baseload jobs' realization rate is 98.75%. Low-cost and full-cost jobs had a 100% realization rate. The program's aggregate energy savings realization rate was 99.2%.

6.2.2 Heat Pump Water Heaters

6.2.2.1 Installation Dates in PY5

For HPWHs with installation dates in PY5, the 2013 Pennsylvania TRM provides deemed values of 1,698 kWh per year energy savings and 0.02 kW demand savings.[78] Cadmus requested supporting documentation for 49 HPWHs with installation dates in PY5 to verify that the units were installed and to attribute these deemed savings and demand reduction values to these units. Because the reported gross energy savings, adjusted *ex ante* energy savings, and verified gross energy savings per unit are all 1,698 kWh, HPWHs installed in PY5 have a 100% realization rate for energy.

The 2013 and 2014 Pennsylvania TRMs stipulate coincidence factors for HPWHs using a PJM study of 82 water heaters in PJM territory. The only difference is that the 2014 TRM narrowed the peak demand window definition.

Cadmus noted that the stipulated reported gross demand savings of 0.0156 kW per unit for HPWHs installed in PY5 was in error and was too low by a factor of 10.

$$1{,}698 \times 0.00009172 = 0.156$$

To calculate the adjusted *ex ante* demand savings and verified gross demand savings for HPWHs installed in PY5, Cadmus updated the per-unit savings from 0.0156 kW to 0.156 kW. The adjusted *ex ante* energy

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

savings and the verified gross energy savings per unit for HPWHs installed in PY5 were the same, so the adjusted *ex ante* demand savings and the verified gross demand savings per unit were also the same, providing a 100% realization rate for demand.

6.2.2.2 Installation Dates in PY6

For HPWHs with installation dates in PY6, the 2014 TRM provides a savings algorithm for calculation of energy savings and demand reductions from HPWHs.[79] Using this algorithm, Cadmus calculated adjusted *ex ante* energy savings for PY6 HPWH installations, assuming a 50-gallon tank and a 2.3 efficient energy factor, the minimum required by PPL Electric Utilities.

Cadmus calculated verified gross energy savings using the 2014 TRM algorithm and data requested as part of the records review. Cadmus requested these parameters from PPL Electric Utilities for the 185 HPWH installed in PY6:

- Existing water heater tank size (informs EFbase)
- Installed tank size of the new HPWH
- Actual energy factor of the installed HPWH (EF_{ee})

Complete information was available for 91% (n=169) of the 185 HPWHs installed in PY6. Cadmus requested and reviewed copies of the paper WRAP applications for a sample of HPWH installations in Q1 through Q3; ultimately, to facilitate the analysis, it requested and analyzed electronic extracts for all units with installation dates in PY6.

The savings algorithm uses the difference between the inverse of the existing and efficient energy factors. Larger existing tanks have a lower baseline energy factor; the inverse of this lower baseline energy factor is a higher baseline value. PPL Electric Utilities assumes an existing tank size of 50 gallons and an EF_{base} of 0.9040 to calculate the reported gross energy savings for HPWHs. Of the HPWHs installed in PY6, approximately one-third (54, n=169) had existing tank sizes that differed from 50 gallons, which resulted in a larger or smaller baseline for these installations, as shown in Table 6-8.

Table 6-8: Energy Factors of Existing Water Heaters

Existing Tank Size	Number of Installations	Percentage of Installations	Energy Factor	1 / EF_{base}
40 Gallons	50	30%	0.9172	1.09
50 -55 Gallons	115	68%	0.9040	1.11
80 Gallons	4	2%	0.8664	1.15
PY6 Total	**169**	**100%**		

The majority of installations (162, n=169) received HPWHs with a 50-gallon tank. Of the remaining seven installations, two received a HPWH with an 80-gallon tank, one received a HPWH with a 52-gallon tank, and one received a HPWH with a 40-gallon tank. For three of the HPWHs, no information was provided about the tank size. Note that tank size is not a parameter in the savings algorithm so its absence did not impact savings calculations.

[79] Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2014. Page 41. Available online: http://www.puc.pa.gov/pcdocs/1265230.docx

Of the newly installed HPWhs, actual energy factors ranged from 2.3 to 2.4. Of these, 93% (157, n=169) had a higher energy factor than the required minimum energy factor of 2.3, as shown in Table 6-9.

Table 6-9: Energy Factors of Efficient Heat Pump Water Heaters

Energy Factor	Number of Installations	Percent of Installations	1 / EF_{base}
2.3	12	7%	0.435
2.35	40	24%	0.426
2.4	117	69%	0.417
PY6 Total	**169**	**100%**	

Savings calculated with the observed existing tank sizes and actual installed energy factors were approximately 2% higher than the adjusted *ex ante* energy savings per HPWH.

The 2014 TRM stipulates a 0.00008294 coincidence factor for HPWHs installed in PY6. The reported gross demand savings, adjusted *ex ante* demand savings, and verified gross demand savings per-unit estimates all employed this value in their calculations, so the verified demand savings for coincidence factor of HPWHs installed in PY6 differed from the reported values only for units where the existing tank size or efficient energy factor differed from the default assumptions.

The final realization rate for HPWHs combines the PY5 installations (for which the realization rate is 100%) and the PY6 installations (for which the realization rate is 102%) for a final overall realization rate of 101.5%.

In PY6, Act 129 WRAP reported energy savings of 4,561 MWh, adjusted *ex ante* energy savings of 4,561 MWh, verified gross energy savings of 4,525 MWh, and a realization rate of 99.2%. Table 6-10 lists reported, adjusted, and verified energy savings, realization rates, and relative precision by stratum for WRAP in PY6.

Table 6-10: PY6 Act 129 WRAP Summary of Evaluation Results for Energy

Stratum	Reported Gross Impact (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr) [1]	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr) [2]	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion [3]	Relative Precision at 85% Confidence [3]
Baseload	3,521	3,521	99%	3,478	0.06	8.30%
Full-Cost	287	287	100%	287	0.05	6.76%
Heat Pump Water Heater and Energy Education	517	517	102%	525	0.01	0.05%
Low-Cost	236	236	100%	236	0.08	11.71%
Program Total	**4,561**	**4,561**	**99%**	**4,525**		**6.42%**

[1] Values in this table refer to savings at the point of consumption. (Savings targets for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[3] Sample Cv and relative precision based on billing analysis regression for Baseload, Full-Cost, and Low-Cost strata; based on ratio estimation for Heat Pump Water Heater and Energy Education stratum.

In PY6, Act 129 WRAP reported demand savings of 0.472 MW, adjusted *ex ante* demand savings of 0.523 MW, verified gross demand savings of 0.518 MW and a realization rate of 99.1%. Table 6-11 provides the summaries of demand savings, realization rates and relative precision by stratum for PY6.

Table 6-11: PY6 Act 129 WRAP Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings [1] (MW)	Adjusted *Ex Ante* Demand Savings [2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings [2] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion [3]	Relative Precision at 85% Confidence [3]
Baseload	0.400	0.45135	99%	0.44566	0.06	8.30%
Full-Cost	0.032	0.03657	100%	0.03657	0.05	6.76%
Heat Pump Water Heater and Energy Education	0.032	0.04828	101%	0.04898	0.01	0.04%
Low-Cost	0.008	0.03020	100%	0.03020	0.08	11.71%
Program Total	**0.472**	**0.566**	**99%**	**0.561**		**6.63%**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex* Ante and Verified gross demand reductions include T&D losses.
[3] Sample Cv and relative precision based on billing analysis regression for Baseload, Full-Cost, and Low-Cost strata; based on ratio estimation for Heat Pump Water Heater and Energy Education stratum.

Cadmus does not conduct verification site visits for this program. All full-cost jobs and HPWH installations are slated for verification site visits conducted by PPL Electric Utilities and its trade allies. Although PPL Electric's goal is to conduct site visits at all full-cost jobs and HPWH installations, this goal is not reachable because participants may not keep an appointment for a site inspection. If PPL Electric's inspectors fail a WRAP job, the case goes to remediation, and the contractor corrects the job. No projects are final nor loaded into EEMIS until corrections are made. Therefore, it is unlikely the inspected jobs reported in EEMIS include any products that are not installed.

Table 6-12: PY6 Act 129 WRAP On-Site Inspection Summary

Stratum	On-site Inspection Goal – EE&C Plan[1]	On-Site Inspection Goal – PY6 EM&V Plan	On-Site Inspection Goal – PPL Electric Utilities	On-Site Inspections Completed	Number of Jobs Failed by PPL Inspectors	Type of Discrepancies	Resolution of Discrepancies[1]	Number of Jobs with Missed Opportunities Identified and Resolved
Baseload	0	0	0	0	N/A	N/A	N/A	
Low Cost	0	0	0	0	N/A	N/A	N/A	
Full-Cost	0	0	223	147	9	No drainpipe on WH pressure relief valve	Added pressure relief valve	6
						Customer claimed no smart strip/blower door test	Language barrier	
						Mold worse after air sealing	Not resolved	
						Smart Plug invoiced not provided	Installed smart plug	
						Door to kneewall did not close after insulation installed	Realigned kneewall hatch	
						W/s installed incorrectly on living room door - contractor corrected	Readjusted w/s	
						3 out of 8 LEDs installed	Installed LEDs	
						One CO detector installed but 2 invoiced	Installed CO detector	
						Thermostat and aerator not installed	Issued credit invoice	
Heat Pump Water Heater	0	0	296	174	9	HPWH installed not invoiced	Credit invoice (finaled account	6
						HPWH installed not invoiced	Installed HPWH	
						HPWH condensate pump billed – not invoiced	Installed condensate pump	
						HPWH condensate pump billed – not invoiced	Credit invoice (finaled account)	
						Dryer hood invoiced – not replaced	Replaced dryer hood	
						Condensate pump hose kinked into too small space	Condensate pump relocated	
						Condensate pump installed incorrectly – resulting in leak	Corrected kink in plastic tube	
						Wrong size breaker on HPWH	Customer no show for appt	
						HPWH hose prevented sump pump from turning on, basement leak	Re-routed condensate line	
Program Total	**0**	**0**	**519**					

[1] *PPL Electric Utilities Corporation Energy Efficiency and Conservation Plan Act 129 Phase II*. Docket No. M-2012-2334388. Compliance Filing dated April 7,2014.

6.3 IMPACT EVALUATION NET SAVINGS

Cadmus did not assess freeridership or spillover in Act 129 WRAP because freeridership and spillover do not occur in this low-income program. Products are installed at no cost to income-eligible customers; therefore, a net-to-gross ratio of 1.0 is assumed.

Table 6-13: PY6 Act 129 WRAP Sampling Strategy for NTG Research

Stratum	Stratum Boundaries	Population Size (number of unique households)	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted
WRAP	Program	4,048	N/A	N/A	N/A	N/A	N/A

Table 6-14: PY6 Act 129 WRAP Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
WRAP	N/A	N/A	100%	N/A	N/A

6.4 PROCESS EVALUATION

6.4.1 Research Objectives

Cadmus conducted the PY6 process evaluation to realize the following research objectives:

- Document the Act 129 features of the legacy USP WRAP through a program staff interview
- Assess customer satisfaction with program services with program services and contractors as well as verify participation for baseload participants through participant telephone surveys
- Ensure appropriate data are collected to inform the evaluation through a program database review

6.4.2 Evaluation Activities

For WRAP, Cadmus conducted the following research activities in PY6, which were consistent with the evaluation plan:

- Program staff and implementer interviews (n=1)
- Participant surveys (n=71)
- Database and quality assurance/quality control (QA/QC) review (n=200)
- Review WRAP Intake forms (n=92)

Table 6-15: PY6 WRAP Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size (Q1-Q2)	Assumed Proportion or C_V in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percentage of Sample Frame Contacted [1]	Evaluation Activities
PPL Electric Program and ICSP Staff	Staff	1	N/A	N/A	1	1	1	100%	Process, Impact, Program Staff Interview, Census
Baseload Participants	Customers receiving baseload jobs in Q1 and Q2	3,121	0.5	90/10	70	1,389	71	78%	Process, Impact, Telephone survey, Simple Random
Program Total		**3,122**			**71**	**1,390**	**72**		

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete surveys.

6.4.3 Methodology

6.4.3.1 Program Staff and Implementer Interviews

Cadmus conducted one program staff interview by telephone with the PPL Electric program manager.

6.4.3.2 Participant Surveys

Cadmus conducted a telephone survey with baseload job participants during April 2015. The purpose of the survey was to verify measure installation and assess satisfaction. (The survey is a new activity for Cadmus in PY6; in previous program years, PPL Electric conducted this survey.) The survey sample frame included all PY6 Q1 and Q2 WRAP participants who received a baseload job; from these, Cadmus selected a simple random sample.

PPL Electric and its trade allies plan to conduct verification site visits at all low-cost and full-cost jobs and all heat pump water installations. (However, in practical application, this is not reachable because of circumstances beyond PPL Electric's control; for example, participants may not keep an appointment for a site inspection.) During the site visit, the PPL Electric inspector leaves these customers with a mail-in survey asking them about their experience with the program and their satisfaction with PPL Electric as a service provider. Cadmus did not conduct any additional interviews with participants who received low-cost and full-cost jobs and heat pump water heaters.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by applying random sampling whenever possible and using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

Table 6-15 above presents the survey sampling strategy for PY6 WRAP baseload job participants. (The sampling methodology is described in more detail in Addendum A.)

6.4.3.3 Database and Records Quality Control Review

Cadmus reviewed the tracking database extracts for the sample of records selected of PY6 projects and WRAP program components for both the impact and process evaluations. Although the impact evaluation review focused on the completeness and accuracy of parameters such as energy savings, demand reduction, and algorithm input parameters, the process review assessed the completeness of fields necessary to conduct the participant telephone surveys, as well as to provide demographic information about program participants along with summary statistics about how customers heard about the program. The records review exceeded the sample design of meeting levels of 85% confidence and 15% precision by program.

For the Q1 through Q3 samples, Cadmus reviewed all of the supporting documentation (hard copy forms) for the sample requested. At the beginning of Q4, PPL Electric implemented its new LEAP tracking system. The LEAP system uses electronic data entry, therefore Cadmus requested an extract of all Q4 participant records from the LEAP system.

6.4.3.4 WRAP Intake Form Review

Cadmus selected a stratified random sample of 92 participants for the impact evaluation records review and requested all supporting documentation for these participants. One of the documents provided for each record is a copy of the WRAP Intake form. Cadmus reviewed these intake forms to provide information about program awareness and OnTrack participation.

Table 6-16: WRAP Process Evaluation Database Review

Stratum	Population Size (Number of Jobs)	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Used For Evaluation Activities (Impact, Process, NTG)
Database Review	4,287	N/A	140	837	Process, Impact, Database review, Census
Intake Form Review	4,287	N/A	92	92	Process, Impact, Records review, Stratified Random Sample
Program Total [1]	4,287			**292**	

[1] Households could receive more than one job; 4,048 unique households participated

6.4.4 Achievements Against Plan

Table 6-17 contains the program's energy savings and incentive plans and progress through PY6. Act 129 WRAP exceeded its energy savings and demand reduction plans for PY6 and will likely meet the Phase II goals by the end of PY7.

Table 6-17: WRAP Program Savings [1]

	PY5 Verified	PY6			Phase II: PY5-PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	2,810	3,901	4,525	117%	10,411	7,335	70%
MW	0.33	0.50	0.52	104%	1.33	0.85	64%
Participation	2,940	3,798	4,287	113%	10,220	7,227	71%

[1] Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) filed with the Pennsylvania PUC on June 5, 2015, Table J6, pp. 89.

There are several reasons why the program exceeded its planned megawatt hours for PY6. The primary reasons were:

- Program staff streamlined program processes and administrative work
- Program staff assumed targeted responsibilities
- Program had multi-pronged marketing initiatives
- Program staff and the PPL Electric EM&V group worked collaboratively to set and adjust plans during the program year

6.4.5 Program Delivery

PPL Electric has operated WRAP for five years under Act 129 and for over 30 years under the USP, yet any changes to improve program processes can still yield benefits. In PY6, the PPL Electric WRAP program team faced multiple challenges because, in addition to routine program management, the team devoted significant time to developing the new LEAP tracking system. The team responded to this challenge and implemented LEAP on time leading to streamlined program processes and administration.

During PY6, PPL Electric's WRAP team worked in concert with PPL Electric's Act 129 EM&V team to regularly review program achievements and adjust participation goals for each job type based on program performance. This collaborative process helped them to fine-tune participation targets so that WRAP could reach its MWh goals while still staying within the limits of the program budget.

The most significant change for the program in PY6 was the new LEAP tracking system, which PPL Electric implemented on March 6, 2015, then released to WRAP contractors on March 18. The WRAP program manager, who has managed Act 129 WRAP and USP for many years and has a wealth of practical and in-depth program experience, played an integral role in developing the system. The previous tracking system, WRAP V, which had been in place since 2001, could not be upgraded to improve reporting, analytics, quality assurance protocols, and more-detailed information about each transaction—as recommended by both Cadmus and the Act 129 Statewide Evaluator—nor did it have the capabilities needed to support paperless data collection methods.

The new LEAP system allows contractors to enter data directly rather than making a paper record for later entry. The LEAP system also has built-in data validation. For example, contractors can record only the measures listed for the job type identified in the audit because only these items will appear on the screen and be available to check off. Contractors who do not install specific, program-targeted, measures in homes where the measure qualified, such as heat pump water heaters, can bypass the measure in LEAP only by explaining why they considered the measure but elected to install a standard water heater or no water heater at all. The LEAP system also lets program management staff quickly and independently run program summaries. (In contrast, summaries from the WRAP V system often depended on the availability of staff outside the program management team and could not be run as quickly.)

The LEAP system combines information that contractors enter directly with information they upload. Currently, the system does not allow for e-signatures, so any paperwork requiring a customer's or landlord's signature must be scanned and uploaded into the system. E-signature functionality is planned for the second release of the LEAP system.

Response to the new system has been mixed. Contractors and community-based organizations like that the system is web-based, easy to learn and follow, and enables them to get "real time" data about a customer such as their kWh usage history or OnTrack status without having to contact PPL Electric. (OnTrack is PPL Electric's payment program for income-qualified customers.) Contractors can also keep track of their work and budget allocation through a contractor dashboard. Previously, contractors relied on reports from PPL Electric staff.

One of contractors' biggest complaints with LEAP is that they need to scan and upload documents. These documents include program forms, such as *Actions to Save, Refrigerator Testing, Appliance Order, and Health and Safety*, as well as signed WRAP applications. Most WRAP cases must upload three or more forms and the upload process can be time-consuming. (For the second release of LEAP, expected in January 2016, the WRAP team requested e-sign capability that should reduce the number of items that contractors need to upload.)

Other contractor complaints concern the inability to sum the expenditures for a case or view an invoice until the contractor has entered and submitted all invoices. Additionally, once a case is closed or uploaded to EEMIS, the contractor cannot add additional measures (for example, seasonal measures or missed opportunities).

In spite of these complaints, PPL Electric experienced little resistance to using LEAP. Some of the larger community-based organizations (organizations where the auditor previously wrote information on the Assessment Form in the field and an office worker later entered the data) feel that using LEAP is more time-consuming than using the previous system (WRAP V). However, auditors from smaller organizations enter the information directly into their tablet computers, such as iPads, and claim that using LEAP saves time. Although the implementation of LEAP was not without its challenges, overall, PPL Electric mangers feel that the process went much more smoothly than that of previous tracking systems.

PPL Electric made another change to Act 129 WRAP in late 2014 to match services USP WRAP already provided. Act 129 WRAP now offers an allowance of up to $200 for non-energy saving measures for health and safety or comfort measures. In PY5 there was no allowance for these measures.

6.4.5.1 *De Facto* Heating Pilot

In PY7, PPL Electric may launch a "de-facto" heating pilot through Act 129 WRAP. This pilot will be limited to WRAP-eligible customers living in homes where the installed heating equipment is nonfunctioning, irreparable, and oil-fired and where, in the absence of functioning heating equipment, the residents have resorted to heating their homes with electric space heaters. In the pilot, PPL Electric will install ductless mini-split heat pumps in up to 20 such homes to provide these customers a safer, more efficient heating source. Cadmus will prepare a separate EM&V plan for the pilot, if launched.

6.4.5.2 Logic Model

A program's theory informs its development and implementation as well as its evaluation. A program logic model identifies the relationships between activities and expected results. Because logic models are designed to make the underlying theory explicit, they are useful tools for implementers and evaluators. Full details are presented in Addendum B. Logic Model.

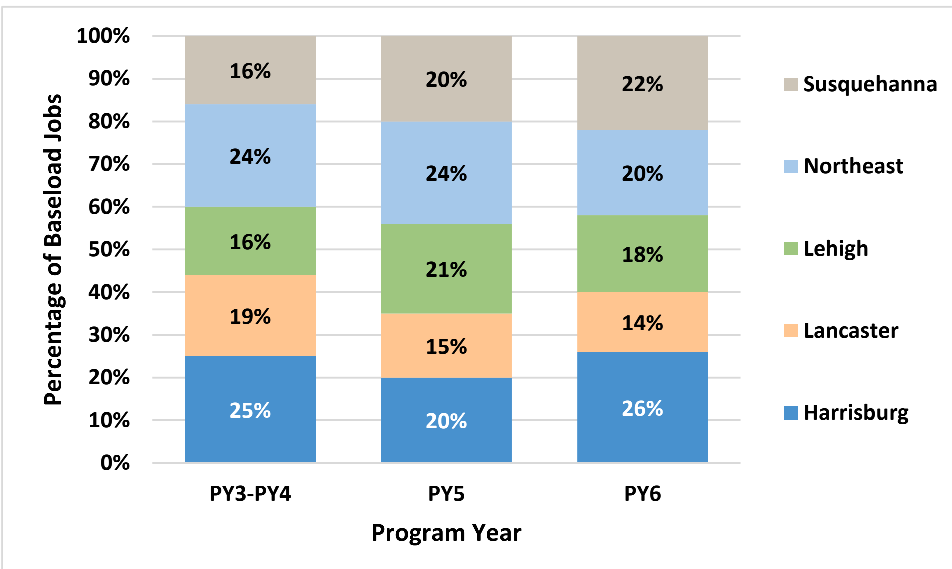
During PY5, Cadmus developed the logic model and process flow maps for Act 129 WRAP. We reviewed the logic model at the end of PY6 to determine if the program had changed from the description in the Phase II EE&C Plan and found that the model is still applicable.

6.4.5.3 Key Performance Indicators

The key performance indicators (KPIs) for Act 129 WRAP are energy savings and participation, which are tracked in EEMIS, the program-tracking database. PPL Electric also has internal savings and participation goals for each geographic region.[80] The WRAP program manager keeps track of performance by region, but there are no penalties involved if a region does not meet its goal.

The current KPIs reveal that the program did very well in achieving the participation and energy savings targets, surpassing its savings targets by the close of Q3 2015. In the first three quarters of PY6, the program conducted more baseload jobs (n=3,431) than in all of PY5 (n=2,773) and in the combined PY3 (n=1,703) and PY4 (n=1,303) programs, which total n=3,006. Participation by geographic region during PY6, PY5, and the combined PY3-PY4 was stable, differing by only 5% from year to year, as shown in Figure 6-1.

Figure 6-1: Baseload Participation by Region Over Time



Source: EEMIS data

During PY6, the WRAP program team's attention focused on meeting plans for participation, savings, and demand reduction, as well as developing and implementing the new LEAP tracking system. Consequently, PPL Electric has not identified other KPIs to measure program performance, although the program manager would like to add the functionality to track additional KPIs in the next release of the LEAP tracking system. Possible KPIs include program satisfaction, measures installed by contractor, and tracking invoiced measure costs.

Currently, the PPL Electric program manager checks the types of measures installed by each WRAP contractor. If she finds that a particular contractor is consistently not installing a specific measure, she follows up with that contractor to find out the reasons. Tracking invoiced measure costs would help PPL

80 The geographic regions are Susquehanna, Harrisburg, Northeast Pennsylvania, Lehigh, and Lancaster.

Electric understand and control overall program costs, especially important in Phase III because the stipulated acquisition cost requirements are low.

6.4.5.4 Program Updates and Outcomes

Low-cost and full-cost jobs. In PY6, PPL Electric responded to Cadmus' recommendations in the PY5 evaluation and added low-cost and full-cost jobs back into Act 129 WRAP. This allowed PPL Electric to serve customers needing water heaters or water heating measures through low cost jobs under Act 129 WRAP, rather than transferring them to USP WRAP.

Allowance for comfort or health and safety measures. In late 2014, PPL Electric added a $200 allowance for comfort or health and safety measures to the program to match services under Act 129 WRAP to USP WRAP so there would be no penalty to the participant served under Act 129.

Heat pump water heaters. In PY6 allowed installations of heat pump water heaters in homes that had a condensate pump. The PPL Electric program manager estimated that 40% of heat pump water heaters installed had condensate pumps.

Program costs. In the PY5 process evaluation benchmarking research, Cadmus recommended looking more closely at program costs. In PY6, PPL Electric reviewed its acquisition costs per kWh to understand: the acquisition costs by measure and contractor; how they vary; and the sources of that variation. Cadmus summarizes the analysis later in this report in the section Savings and Cost Analysis.

LEDs. Beginning in PY6, PPL Electric Utilities no longer offered CFLs to WRAP participants but instead provided LEDs.

LEAP tracking system.[81] Through February 2015, tracking data for both programs were stored in the WRAP V database system; these data are now stored in PPL Electric Utilities' new Low-Energy Assistance Program (LEAP) tracking system.[82] In PY6, PPL Electric Utilities uploaded data for Act 129 WRAP participants from the WRAP V and LEAP systems to the Energy Efficiency Management Information System (EEMIS), the Act 129 participant-tracking database.

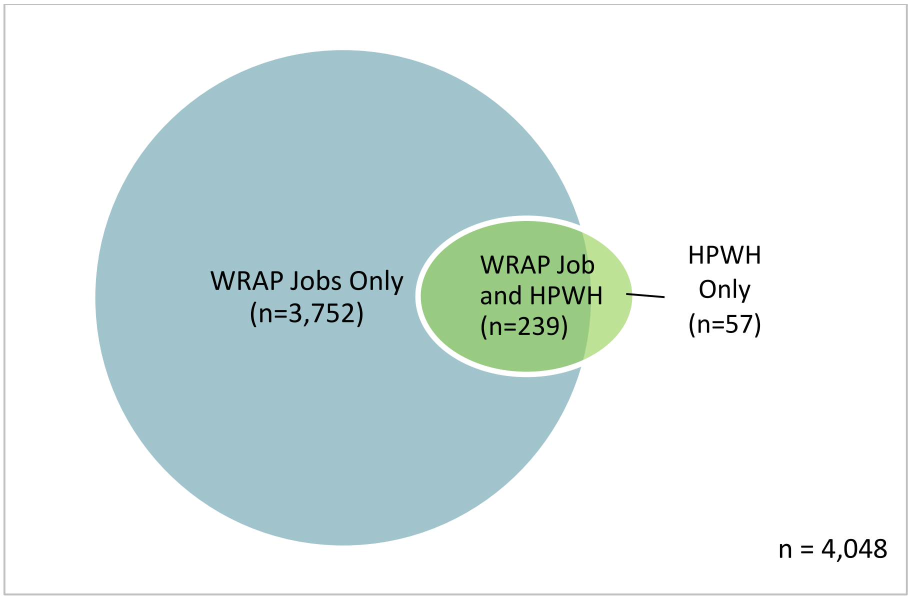
6.4.6 Participant Profile

During PY6, there were 4,048 unique participants in Act 129 WRAP. Of these, 3,557 received a baseload job, 223 received a low-cost job, 211 received a full-cost job, and 296 received a heat pump water heater. Figure 6-2 shows the number of participants who received a WRAP job, a heat pump water heater, or both.

81 The costs for developing the LEAP tracking system were shared equally by Act 129 WRAP and USP WRAP.

82 Ibid.

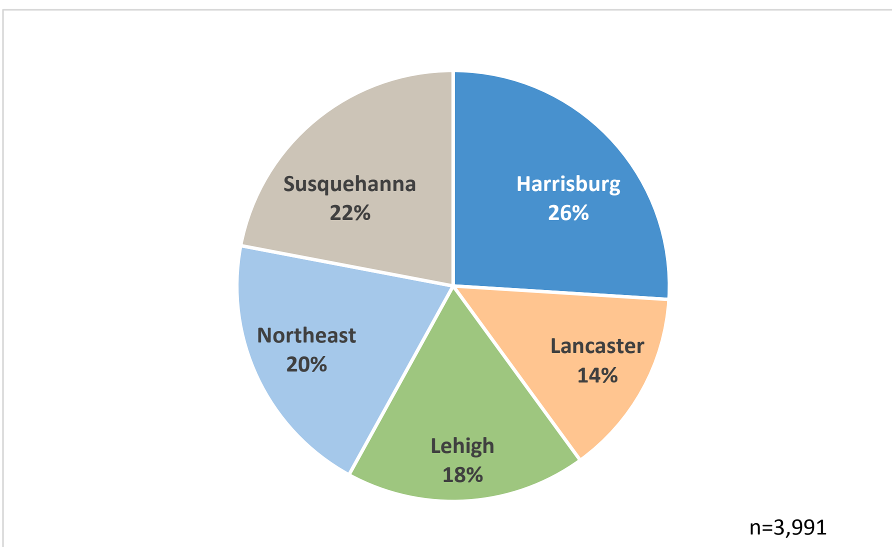
Figure 6-2: PY6 Act 129 WRAP Distribution of Measures Provided



The majority of participants who received a heat pump water heater also received a WRAP job (89%, or n=239). Of these, 206 received a baseload job, four received a low-cost job, and 29 received a full-cost job.

Figure 6-3 shows the percentage of participants from each region. Nearly half of the program participants live in the Harrisburg and Susquehanna regions.

Figure 6-3: Percent of WRAP Job Participants from Each Region

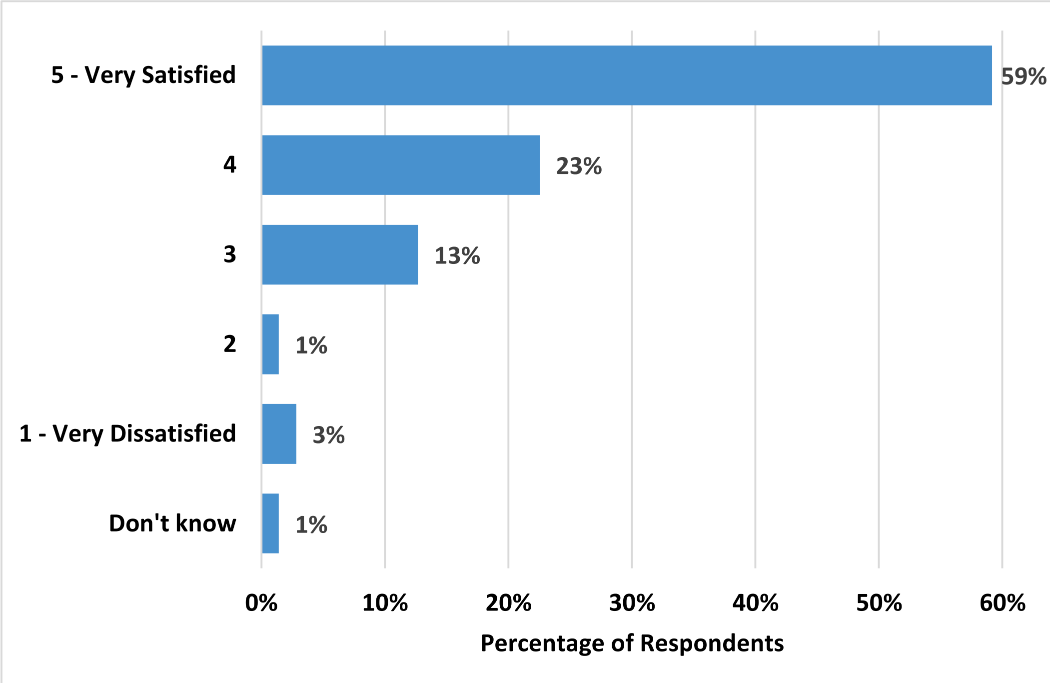


6.4.7 Participant Satisfaction

6.4.7.1 Program Satisfaction

Cadmus assessed participants' satisfaction with Act 129 WRAP using responses to the telephone survey of baseload job recipients (n=71). Because the majority (approximately 90%) of participants received a baseload job, their responses represent most of the participants' experiences. Figure 6-4 shows the responses to the question *"How satisfied are you with the WRAP program?"* The survey uses a scale of 5 to 1, with 5 being *very satisfied* and 1 being *very dissatisfied.*

Figure 6-4: Baseload Participant Satisfaction with WRAP Program



Question E1. "How satisfied are you with the WRAP program?" (n=71)

Fifty-nine percent of survey respondents said they were *very satisfied* with the WRAP program, and an additional 23% reported they were *satisfied*. Only 3% of survey respondents reported they were *very dissatisfied*, and 1% reported they were *somewhat dissatisfied*.

Respondents rating their satisfaction as other than *very satisfied* gave different reasons for their level of satisfaction with the program, and, how to increase that satisfaction.

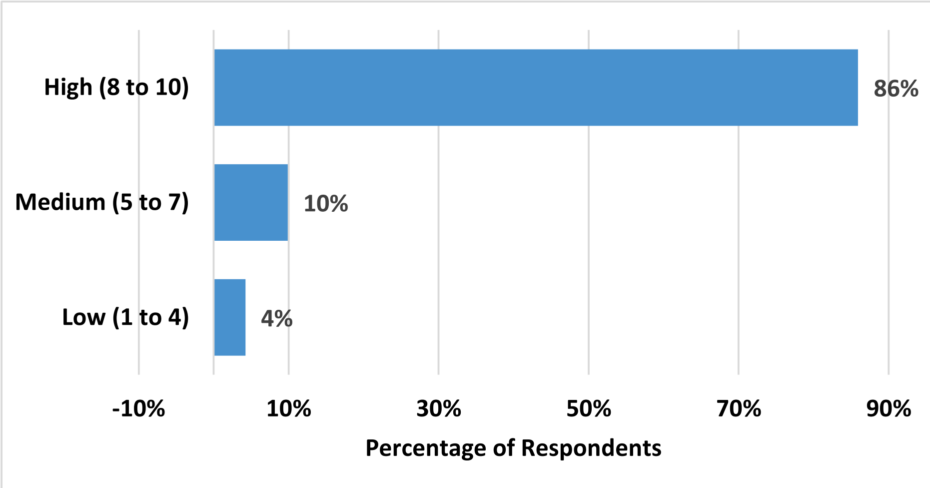
- **Serve me under another program.** Two respondents had gas heat and said it would have been better for them to receive service under the UGI program. Another respondent would have preferred a referral to the "national program."
- **Give me more.** Some respondents would have been more satisfied with the program if they could have received additional items, such as new windows (two respondents) or basement insulation (one respondent), while others would have been more satisfied if they had received the appliances scheduled for delivery (two respondents).
- **Call me back.** Three respondents asked to be called with information about appliances or repairs, but said they had not received a call.
- **Improve the quality.** Two respondents noted that the bulbs they received through the program had already burned out and they had to purchase new bulbs. Another respondent said *"the quality of the appliances could be improved."*

One respondent recommended that PPL Electric should *"make the arrival of more parts of the programs more punctual."* One respondent did not give the program the highest rating of 5, stating, *"[I] have learned that nothing is perfect, hence the 4."*

6.4.7.2 Satisfaction with PPL Electric

Cadmus asked survey respondents (n=71) about their satisfaction with PPL Electric as a service provider (using a rating scale from 1 to 10). Eighty-six percent gave a rating of 8 or greater, as shown in Figure 6-5.

Figure 6-5: Baseload Participant Satisfaction with PPL Electric as a Service Provider



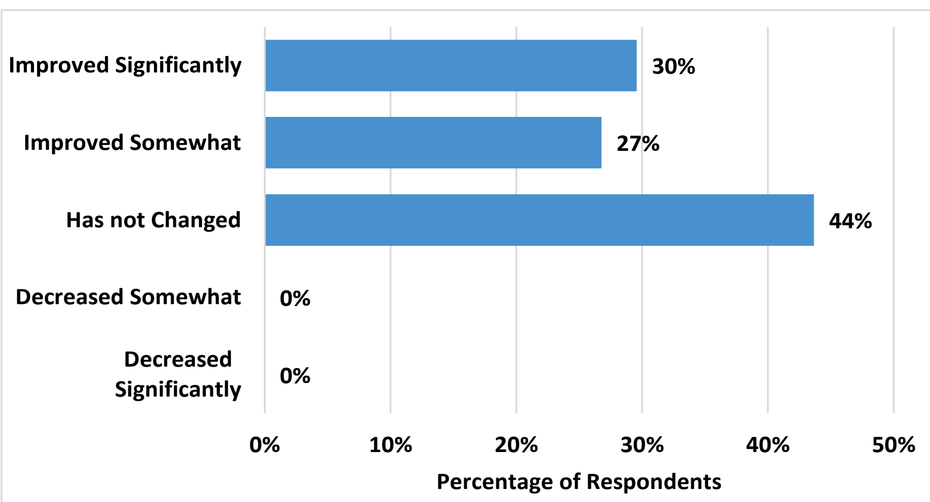
Question F1. "How do you rate PPL Electric overall as a provider of electric service to your home? (n=71)

Nearly half of the respondents (48%) rated PPL Electric outstanding (10) as a service provider and an additional 38% rated their satisfaction as an 8 or 9. Only 3% gave a rating of less than 5, and only 1% (one respondent) rated PPL Electric unacceptable as a service provider.

Sixty-one percent of survey respondents have recommended WRAP to friends, relatives, or colleagues since participating in WRAP.

As shown in Figure 6-6, over half (56%) of survey respondents reported their opinion of PPL Electric as a service provider has *improved* since participating in WRAP. The remaining 44% of respondents said their opinion of PPL Electric as a service provider has *not changed* since receiving WRAP services. No respondents reported their opinion of PPL Electric decreased.

Figure 6-6: Change in Opinion of PPL Electric



Question F2. "After participating in the WRAP program, has you opinion of PPL Electric..." (n=71)

6.4.8 Marketing and Outreach

PPL Electric uses multiple strategies to identify potential candidates for WRAP services. Customers who seek help with their electric bill by accessing the PPL Electric website see a link to WRAP, along with links to other options such as OnTrack, the Low-Income Home Energy Assistance Program (LIHEAP), and Operation HELP. All customers applying for the Payment Assistance Program or the OnTrack program are referred to WRAP, and applicants for OnTrack must apply for WRAP services.

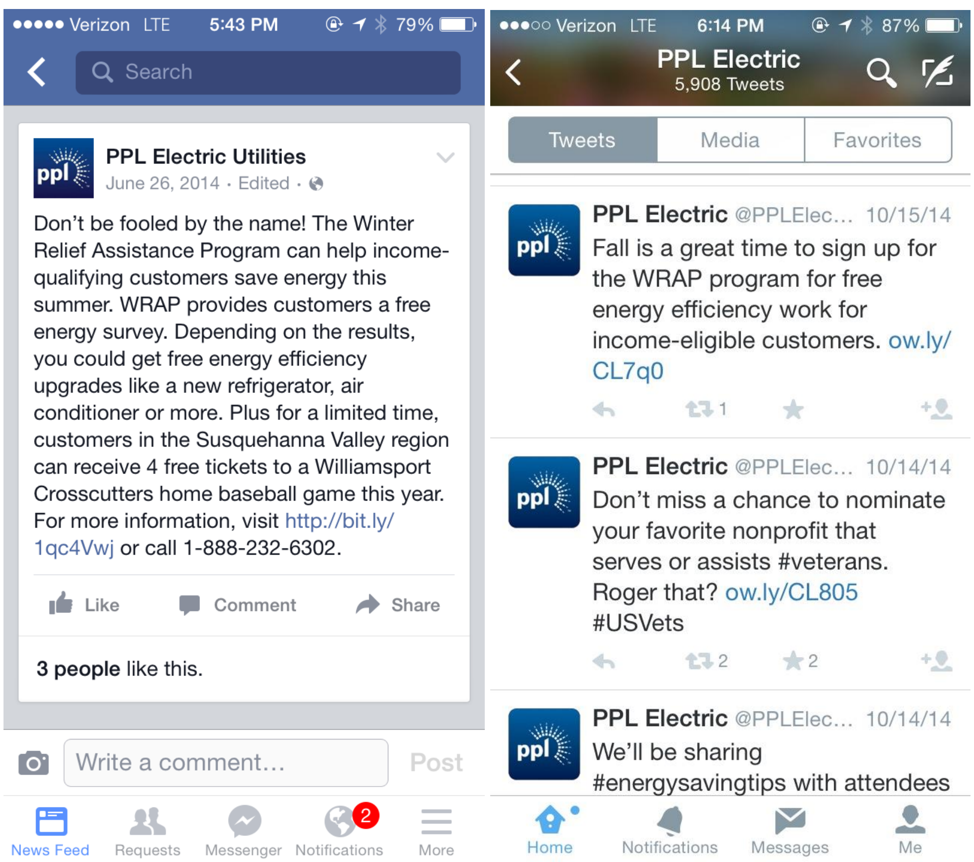
6.4.8.1 PPL Marketing

In PY6, PPL Electric conducted a flexible, multi-pronged marketing approach for WRAP using these and other activities:

- Direct-mail postcards
- Newspaper advertisements
- Advertisements on buses
- E-mail blasts
- Social media advertisements

Figure 6-7 provides examples of posts to PPL Electric's Facebook site (on the left) and from the company's Twitter account (on the right).

Figure 6-7: Examples of WRAP Social Media Advertisements



The WRAP program manager reported that, overall, the direct-mail postcards were highly successful in recruiting participants. E-mail blasts, advertising on buses, and social media posts were less successful marketing efforts.

PPL Electric tailored marketing activities to address the unique needs of each region's population. For example, the WRAP program manager reported that newspaper advertisements were a more successful strategy in the Northeast region, a remote area where the population is older and tends to read newspapers to connect with the community. In the Harrisburg region, the Community Action Program (CAP) contractors conducted marketing for WRAP, which proved to be very successful, exceeding the region's participation goal by 40%.

As an additional outreach strategy, PPL Electric conducted one "neighborhood blitz" in late summer of PY6. Coordinating services with UGI Utilities, (the local natural gas utility), PPL Electric provided baseload and full cost jobs to approximately 20 multifamily and single-family residences in the neighborhood. The landlord of the multifamily residences was very supportive and helped market the program to the tenants.

However, the neighborhood blitz was very labor-intensive and required a great deal of effort considering the number of participants who actually participated. The WRAP program manager reported that it took three to four weeks to identify a suitable neighborhood. One neighborhood considered early on had a serious mold problem, so program staff needed to regroup and continue their search. Once program staff identified a suitable neighborhood, they went door-to-door to recruit participants. Recruiting presented its own challenges, as during this same time, unfortunately, alternative energy suppliers were also going door-to-door to sell their energy services. Residents mistook PPL Electric program staff for alternative energy supply salespeople, and PPL Electric staff experienced a great deal of rejection.

The WRAP program manager noted it took a great deal of initiative and creativity to identify participants in PY6 and that these efforts paid off—the program exceeded its overall participation plans by 13%. The program also exceeded its participation plans for baseload jobs as well as for heat pump water heater installations.

6.4.8.2 Program Awareness

Information about how participants heard about the program is provided on the WRAP intake form and recorded in the WRAP V and LEAP tracking systems. Cadmus reviewed the intake forms for 92 WRAP jobs during Q1 through Q3 of PY6. Table 6-18 shows information about how participants (n=92) heard about the program.

Table 6-18: How Participants Heard About WRAP

How Participant Heard About WRAP	Number of Customers	Percentage of Customers
Bill insert	21	23%
Did not answer	15	16%
Utilities representative	13	14%
OnTrack	11	12%
Friends/Neighbors	5	5%
Radio/TV/Newspaper	3	3%
Other	24	26%
Source: WRAP Intake Forms; n=92		

Nearly half (49%) of program participants whose intake form Cadmus reviewed learned of WRAP through information provided directly from PPL Electric; approximately one-quarter heard about WRAP from PPL

Electric's bill inserts. Fourteen percent said their information source was a utility representative, and 12% said the OnTrack program. One-quarter of participants learned of the program through other sources, including the Internet, a landlord, or a family member.

Because all OnTrack participants must apply for WRAP services, Cadmus also reviewed the OnTrack participation status recorded on the 92 WRAP intake forms. Table 6-19 lists these data. Sixty percent of the WRAP participants were also participating in the OnTrack program.

Table 6-19: OnTrack Participation of WRAP Participants

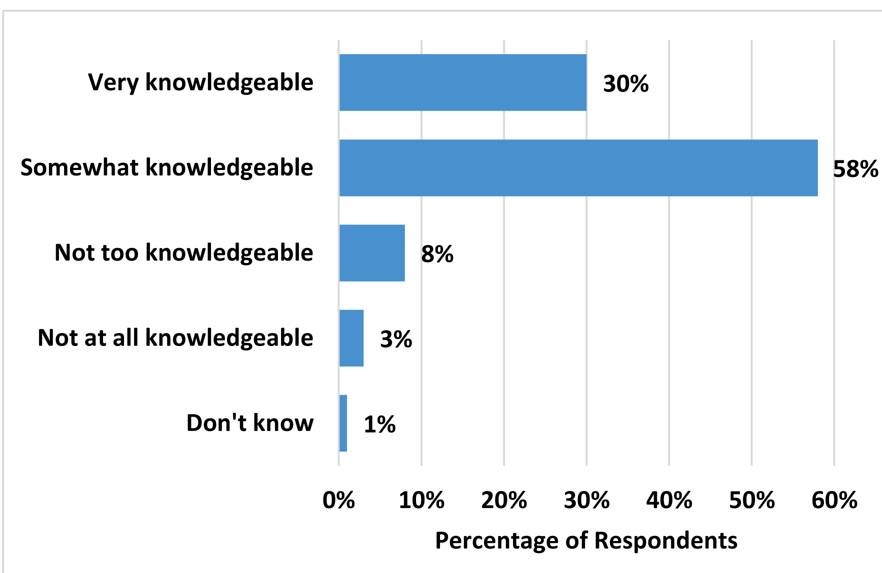
Customer on OnTrack	Number of Customers	Percentage of Customers
Yes	55	60%
No	29	32%
Did not answer	7	8%
Pending	1	1%
Source: WRAP Intake Forms; n=92		

6.4.9 Energy Efficiency Knowledge, Challenges, and Actions

6.4.9.1 Knowledge About Ways to Save Energy

Survey respondents (n=71) answered questions about their knowledge of ways to save energy in their home. As shown in Figure 6-8, the majority (88%) of survey participants said they were knowledgeable about ways to save energy in their home prior to participating in WRAP. Thirty percent indicated they were *very knowledgeable* and 58% felt they were *somewhat knowledgeable*. Eleven percent reported they were *not very knowledgeable*, 8% as *not too knowledgeable*, and only 3% (two respondents) stated they were *not at all knowledgeable*. The majority (83%) of survey respondents stated they have become more knowledgeable about ways to save energy since participating in WRAP.

Figure 6-8: Energy Efficiency Knowledge Prior to WRAP Participation



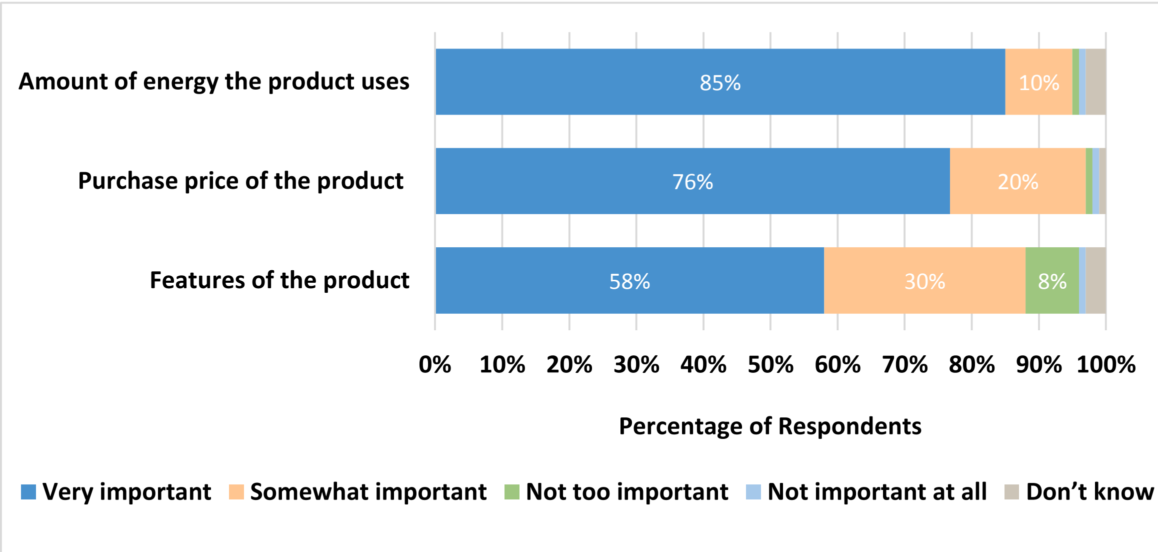
Question D1. "Before you participated in the WRAP program, how knowledgeable were you about ways to save energy in your home?" (n=71)

6.4.9.2 Challenges

Cadmus asked survey respondents (n=71) to think about different features they might consider when shopping for products or appliances that use energy in the home. Respondents then rated the importance of each of these features on their decision to purchase or not purchase the product, shown in Figure 6-9.

WRAP participants indicated the strongest concern for the amount of energy used by the product or appliance. Ninety-five percent of survey respondents rated energy use as an important consideration, and 85% rated energy use as a *very important* consideration, as shown in Figure 6-9. Only 2% indicated that the energy use of a product or appliance is not important to their purchase decision.

Figure 6-9: Decision Factors about Product Purchases



Question D5. "When shopping for products or appliances that use energy in your home, how would you rate the importance of each of the following…?" (n=71)

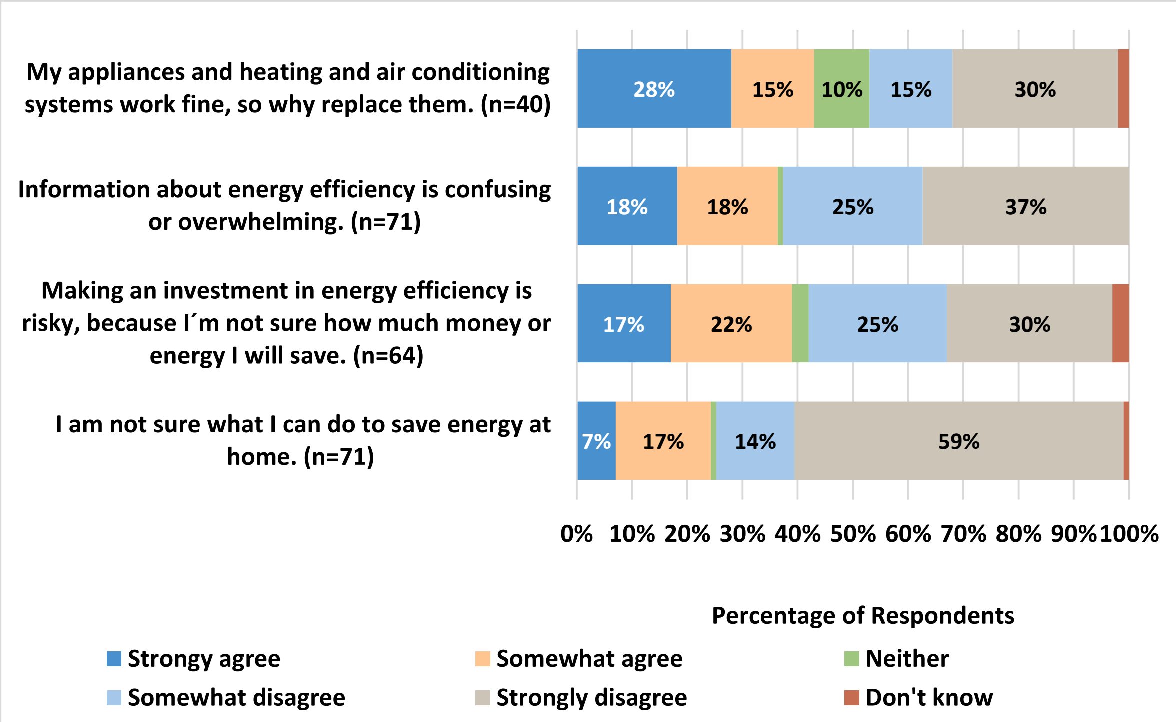
Because WRAP participants have incomes at or below 150% of the federal poverty level, it is not surprising that nearly all respondents (96%) reported that price is an important consideration when deciding whether to purchase a particular product. Over three-quarters of respondents (76%) rated product price as a *very important* consideration when purchasing an energy-using product, while another 20% rated price as *somewhat important*. Only 2% of WRAP participants indicated that price is not an important consideration.

We also asked respondents about the importance of product features on their purchase decisions. The responses listed in Figure 6-9indicate that the majority (88%) of respondents believe product features are an important consideration, but fewer (58%) indicated they are *very important* to their purchase decision.

Compared to price and energy use, more (9%) respondents said product features were not an important consideration when purchasing a product or appliance.

Next we presented four scenarios that people might face when purchasing new appliances or considering energy-efficient improvements to their home. We asked respondents to rate their level of agreement or disagreement with each statement (Figure 6-10).

Figure 6-10: Challenges to Making Energy-Efficient Improvements



Question D8. “Do you face these scenarios when purchasing new appliances or considering energy-efficient improvements to your home?"

These are findings about the four scenarios:

- *“My appliances and heating and air conditioning systems work fine, so why replace them.”* Slightly over half (56%) of the survey respondents said they own their home. When asked to rate their agreement or disagreement with this statement, these homeowners indicated they did not feel strongly one way or the other about replacing working appliances. A nearly equal percentage agreed (45%) as disagreed (43%) with the statement, while 10% took no position. An additional 2% stated they did not know whether they agreed or disagreed.
- *“Making an investment in energy efficiency is risky, because I am not sure how much money or energy I will save.”* As shown in Figure 6-10, a little more than half (55%) said they do not consider investments in energy efficiency to be risky, but nearly 40% agreed that such investments are risky. Three percent took no position on the statement, and 3% said they did not know.
- *“Information about energy efficiency is confusing or overwhelming.”* WRAP participants were confident in their ability to understand information about energy efficiency. The majority (62%) do not believe “I*nformation about energy efficiency is confusing or overwhelming.”* A little over one-third (38%) either *somewhat* or *strongly agreed* with the statement.
- *“I am not sure what I can do to save energy at home.”* WRAP participants were even more certain about their ability to save energy at home. As shown in Figure 6-10, nearly three-quarters (73%) of respondents indicated they were sure they knew what to do save energy in their home, and approximately 60% were very sure.

6.4.9.3 Steps to Saving Energy

During the telephone survey, WRAP participants answered questions about the energy-saving ideas that the energy educator provided during the visit. Eighty percent (57 respondents) were able to recall examples. Table 6-20 shows the energy-saving ideas recalled, along with the percentage of participants for each.

Table 6-20: Energy-saving Ideas Provided to WRAP Participants

Energy Savings Ideas	Percentage of Respondents
Information on using appliances	40%
Use efficient lighting	32%
Turn off lights	28%
Information about weatherization or infiltration	18%
Unplug devices when not in use	12%
Adjust thermostats	9%
Take fewer or shorter showers	7%
Turn down water heater temperature	4%
Hang clothes on clothesline	2%
Other	14%
Source: Question C4. "Can you list some of the ideas that were provided to you during the visit?" (n=57)	

Information on using appliances, the first category in Table 6-20, included keeping the refrigerator or freezer full, operating appliances at optimal times, running appliances with larger loads, washing in cold water, and putting a *"tennis ball in the dryer."* The *Other* category included installing kit measures, using "*blinds during the day,*" and "*testing the water heater*."

Later in the call, we asked participants if they regularly took steps to save energy at home and, if so, what steps they take. Nearly all WRAP participants (97%) said they take such steps. Table 6-21 shows the steps participants say they take, along with the percentage of participants providing the response.

Table 6-21: Energy Savings Steps Taken by WRAP Participants

Energy Saving Steps	Percentage Providing Response
Turn off lights	88%
Wash clothes in cold water	65%
Unplug devices when not in use	42%
Adjust thermostats	41%
Take fewer or shorter showers	38%
Turn down water heater temperature	28%
Other	12%
Hang clothes on clothesline	7%
Source: Question D4. "What steps do you take?" (n=69)	

The most popular energy-saving step was turning off the lights, followed by washing clothes in cold water, unplugging devices when not in use, adjusting the thermostat, and taking fewer or shorter showers. Steps mentioned in the *Other* category were turning off the water, turning off the TV, reducing oven and dryer use, washing larger loads, cooking more than one meal at a time, keeping more food in the freezer, using efficient or LED bulbs, putting blankets over the windows, and opening the blinds.

These steps track closely with the ideas participants remembered from the energy educator's visit, which indicates that energy education is effective. Participants are listening and implementing the ideas provided by the educator.

6.4.10 Savings and Cost Analysis

Cadmus investigated program costs in PY6 to examine the range of acquisition costs for the program, as well as factors driving program costs. PPL Electric implements Act 129 WRAP and USP WRAP using the same PPL program staff, the same program design, the same group of contractors, and offers the same mix of measures in both programs. Cadmus had already received extracts of the job cost data for USP WRAP contractors from the WRAP V tracking system to produce USP WRAP's 2013 annual report. Because the programs are very similar and the data were already available, Cadmus and PPL Electric opted to analyze the USP WRAP data to learn about program acquisition costs that would be germane to both WRAP programs.

The acquisition cost in dollars per annual kWh is defined as the per-unit costs divided by the per-unit savings. Units can be as high-level or as detailed as desired; the units used in this analysis were costs and savings per contractor within each job type. Cadmus calculated the average cost per job for each contractor within each job type using the WRAP V tracking system job costs, and modeled the average savings per contractor using regression analyses of customer use data. Acquisition costs for baseload jobs ranged from $0.49 to $1.68; for low-cost jobs, $0.38 to $4.98, and for full-cost jobs from $1.06 to $3.08.

It is important to determine if the differences in acquisition costs are statistically significant. These modeled estimates have uncertainty around them, expressed as confidence bands, or precision. In general, modeled estimates provide better (smaller) precision when the number of observations in the model are greater. However, in the 2013 USP WRAP data, the number of jobs per individual contractor were relatively small, ranging from 1 to 297. Precision around the modeled mean annual savings ranged from 23% to 160% for baseload jobs, from 24% to 228% for low-cost jobs, and from 16% to 48% for full-cost jobs. If these precision estimates are applied to the acquisition costs to display the range around these values, many of the contractors' cost ranges overlap, indicating the differences between the contractors' mean acquisition costs are not statistically significant.

If we next consider the cost per job per contractor, mean job costs per contractor ranged from $419 to $2,495 for baseload jobs, from $759 to $2,511 for low-cost jobs, and from $1,618 to $5,984 for full-cost jobs. Furthermore, within each mean cost per job, there was great variability. For example, the mean baseload job cost of $419 was based on 16 individual jobs where the costs ranged from $114 to $1,311. The mean baseload job cost of $2,495 was based on 25 individual jobs ranging from $890 to $10,718.

There are several sources of this variability in job costs. The job cost includes not only the costs of the measures and the labor associated with installing them but also the audit, the inspection, and time spent providing energy education to the home residents. Costs for the latter three tasks showed considerable variability:

- Audit costs ranged from $0 to $766, inspection costs ranged from $0 to $337, and energy education costs ranged from $0 to $219.
- 20% of the baseload jobs reported $0 in inspection costs, but only 2% and 3% reported $0 for audit and energy education costs, respectively.

For net costs (job cost minus costs associated with audit, inspection, and energy education), one obvious source of variability is the type of measures installed. In baseload jobs with lower net costs, the measures installed are typically limited to CFL bulbs. For example:

- In a job conducted for $63, the only measures the customer received were six spiral CFL bulbs.
- In a job conducted for $114 job, the customer received two candle-based CFL bulbs.
- In two jobs conducted for $124 and $133, the customer received 11 and 12 candle-based CFL bulbs, respectively.

Baseload jobs with higher costs often provided measures such as appliances and repairs, and job costs fluctuated depending on the measures installed at the home. For example:

- In a baseload job with a job cost of $10,718, the customer received several appliances—including a new refrigerator, 18 windows, 25 CFL-mini bulbs, several air-sealing and insulation measures, and a blower door test.
- One contractor had an average cost per job of $2,699 and conducted six jobs. Two cost under $1,000; the other four jobs cost over $2,200 and included infiltration measures, repairs, and appliances.

Another source of job cost variability is the contractor's labor costs. From an interview with the WRAP program manager, Cadmus learned that labor costs differ regionally as well as by contractor. Table 6-22 provides the mean cost per job by region and job type.

Table 6-22: Mean Cost per Job by Region and Job Type

Region	Mean Cost Per Job		
	Baseload	Low-Cost	Full-Cost
Harrisburg	$1,320	$2,087	$4,716
Lancaster	$1,035	$2,036	$3,465
Lehigh	$823	$1,200	$3,217
Northeast	$1,002	$1,812	$3,052
Susquehanna	$1,016	$1,436	$3,184
Company-wide	**$1,037**	**$1,626**	**$3,446**

Table 6-23 provides an example of cost variation of several contractors in different cities. The costs are associated with 20 baseload jobs where the only measures installed were two CFL bulbs. Net costs are the job costs minus the audit, inspection, and education costs.

Table 6-23: Costs for Homes Receiving Only Two CFL Bulbs

Contractor	City	Region	Bulb Type	Cost				
				Total Job	Audit	Inspection	Education	Net
A	Wilkes-Barre	Northeast	Spiral	$127	$41	$3	$65	$18
	New Hazelton	Northeast	Spiral	$350	$129	$5	$65	$151
B	Columbia	Lancaster	Mini	$465	$321	$0	$99	$45
C	Tamaqua	Northeast	Mini	$219	$164	$3	$40	$12
	Mahanoy City	Northeast	Candle	$257	$203	$3	$40	$11
D	Orefield	Lehigh	Candle	$114	$60	$3	$30	$21
	Honesdale	Susquehanna	Candle	$140	$86	$0	$30	$24
	Honesdale	Susquehanna	Candle	$140	$86	$0	$30	$24
	Honesdale	Susquehanna	Candle	$140	$86	$0	$30	$24
	Honesdale	Susquehanna	Candle	$140	$86	$0	$30	$24
	Honesdale	Susquehanna	Spiral	$140	$86	$0	$30	$24
E	Leola	Lancaster	Spiral	$347	$228	$0	$99	$20
	Akron	Lancaster	Spiral	$347	$228	$0	$99	$20
	Lancaster	Lancaster	Spiral	$352	$233	$3	$99	$17
	Lancaster	Lancaster	Mini	$412	$294	$3	$99	$16
F	Cumbola	Northeast	Mini	$198	$106	$3	$80	$9
	Shenandoah	Northeast	Mini	$198	$114	$0	$80	$4
	Mahanoy City	Northeast	Mini	$211	$118	$0	$80	$13
	Pottsville	Northeast	Mini	$211	$133	$3	$80	-$5
	Ashland	Northeast	Mini	$234	$141	$0	$80	$13

If we remove the audit, inspection, and energy education costs, Table 6-23 shows that the net cost of installing two spiral CFL bulbs ranges from $18 to $151. The cost of installing two CFL-mini bulbs ranges from $4 to $45. The costs of installing two candle-based CFL bulbs ranges from $11 to $24. Because the cost of the bulbs alone probably does not differ greatly, the majority of the difference is from differences in labor costs.

Still another source of job cost variability is the percentage of customers who own or rent their home. In general, contractors who conducted a higher percentage of baseload jobs for homeowners had higher acquisition costs. These homes received more expensive measures such as appliances, infiltration measures, and repairs. Contractors serving a higher percentage of homes occupied by renters tended to install measures such as CFLs.

6.5 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, we suggest PPL Electric Utilities consider the following recommendations in PY7.

Overall, PPL Electric's Act 129 program offers a comprehensive and customized weatherization service to its low-income customers, improving the comfort and safety of these homes while helping to reduce customer energy bills. Customers are satisfied with the program and they are acting on energy-saving strategies recommended by the program's energy educators.

Conclusion

Targeted responsibilities, multi-pronged marketing, and the WRAP program team's exceptional initiative, creativity, and teamwork, along with regular collaboration with PPL Electric's EM&V group, has paid off this year in high participation and savings for Act 129 WRAP in PY6. This program has exceeded all participation, energy savings, and demand reduction goals for the program year. However, as the program continues to reach this demographic, the number of unserved, income-eligible customers diminishes over time. PPL Electric estimates it has approximately 221,000 customers in its service territory who are at or below 150% of the federal poverty income guidelines. To date, PPL Electric has served approximately 20,500 income-qualified customers through Act 129 WRAP. Additionally, over the past nine years, PPL Electric has served approximately 25,000 more customers through USP WRAP. As these programs continue to run in tandem, it will take increased initiative, creativity, and teamwork to identify and reach the remaining income-eligible population and maintain current participation levels.

Conclusion

The new LEAP tracking system provides improved data collection and program tracking. Upgrades of additional features will provide more information to program management for tracking KPIs such as participant satisfaction.

Recommendation

Identify KPIs for the program (in addition to participation and savings) and include database functionality to collect and report on these KPIs in the second release of the LEAP tracking system. Possible KPIs include program satisfaction, measures installed by contractor, and tracking invoiced measure costs. Additionally, these could include, for example, setting a goal for job processing time—from initial request to job scheduling, and from scheduling to completion; setting a goal for an average cost per job by job type and acceptable variances; a goal to limit the number of issues and callbacks identified through on-site inspection.

To assess program satisfaction on an on-going basis, consider administering an online survey or leave-behind postcard survey to all participants (as opposed to conducting a phone survey with a sample of the baseload job participants as in PY6).

Conclusion

Program acquisition costs are high and show great variability from many interconnected factors. Although some differences between acquisition costs are not statistically significant, others are. The principal drivers of these differences are types of measures installed by the contractor and labor costs. We calculated the acquisition costs using USP WRAP participant data, but because Act 129 WRAP is operated using the same program design and program staff as the USP WRAP, many contractors provide services under both programs. Therefore, the programs to have similar variability in acquisition costs.

Recommendation

Cadmus offered the following recommendations to control or reduce program delivery costs to PPL Electric during PY6, and PPL Electric utilities has already started to explore options to control project costs in PY7 and Phase III.

- **Labor Costs**. To stabilize acquisition costs or keep them below a specific threshold, PPL Electric could consider setting a standard labor cost across the program, either per hour, per job, or per measure. Although this would help reduce variability in acquisition costs, there may be non-energy effects to consider.
- **Measures Offered.** If cost-effectiveness needs to be improved for this program, PPL Electric may want to review the measures and measure costs to prioritize measures offered in Act 129 and those offered in USP LIURP.

- **Measure Cost.** PPL Electric could stabilize acquisition costs by standardizing the allowable invoice cost per measure. For example, PPL Electric could reimburse all CFL spiral bulbs or all 18-cubic-foot refrigerators at the same price, regardless of the purchase price for the contractor. (There are other considerations. This may, however, penalize contractors who cannot buy in bulk or provide higher reimbursements to contractors who can.) For additional measure-cost control, PPL Electric could negotiate prices with manufacturers or contractors.

6.5.1 Status of Recommendations for Program

Table 6-24 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 6-24: Low-Income WRAP Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Custom Incentive Program	
Identify additional KPIs, such as participant satisfaction, and upgrade LEAP to collect and report them. To assess program satisfaction on an on-going basis, consider administering an online survey or leave-behind postcard survey to all participants.	Will be implemented in Phase III.
Consider steps to control or reduce program delivery costs, such as setting a standard labor cost across the program and reviewing the measures and measure costs to prioritize measures offered in Act 129 and those offered in USP LIURP.	Will be implemented in Phase III. The Phase III EE&C Plan projects an approximately 50% decrease in the program acquisition cost for Act 129 WRAP.

6.6 FINANCIAL REPORTING

A breakdown of the Low-Income WRAP finances is presented in Table 6-25.

Table 6-25: Summary of Low-Income WRAP Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$0	$0
2	EDC Incentives to Participants	$0	$0
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$0	$0
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$6,481	$9,383
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$6,481	$9,383
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$6,481	$9,383
13	Total NPV Lifetime Energy Benefits	$4,472	$6,820
14	Total NPV Lifetime Capacity Benefits	$270	$393
15	Total NPV O&M Saving Benefits	($0)	($0)
16	Total NPV TRC Benefits[4]	$4,743	$7,212
17	TRC Benefit-Cost Ratio[5]	0.73	0.77

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

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

[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report

ADDENDUM A. PARTICIPANT SURVEY METHODOLOGY

Dialing Instructions

PPL Electric provided dialing instructions for conducting surveys. Customers cannot be contacted for a survey until a year has passed since they last completed a survey or if they opted out of a survey. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Cadmus coordinated with PPL Electric's survey contractor to screen the sample and remove the records of any customers called in the past year (whether for a Cadmus survey or a PPL Electric survey) and any who requested not to be contacted again. Cadmus also removed records with incomplete information. This cleaning and survey sample preparation process reduced the available sample.

Cadmus selected a simple random sample of all remaining records and sent them to the survey subcontractor. Table 6-26 lists total number of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table 6-26: Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Population (number of Q1-Q2 baseload jobs)	**3,121**
Random Sample Selection	**2,800**
Removed incomplete or bad phone number	25
Removed inactive customer	269
Removed completed survey in past year	26
Removed because on do not call list	3
Removed because selected for other survey	1,080
Removed because duplicate	8
Survey Sample Frame (sent to survey subcontractor)	**1,389**
Not attempted [1]	**1,089**
Records Attempted	**300**
Non-working number	35
Wrong number, business	12
Call privacy	0
Language barrier	4
PPL Electric or market research employee	0
Do not know if product was installed	0
Refusal	28
No answer/answering machine/phone busy	65
Non-specific or specific callback scheduled	69
Partial complete	8
Completed survey	**71**

[1] These records were not needed because the survey target was reached before they were attempted.

ADDENDUM B. LOGIC MODEL

A program's theory informs its development and implementation as well as its evaluation. A program logic model identifies the relationships between activities and expected results. Because logic models are designed to make the underlying theory explicit, they are useful tools for implementers and evaluators.

The program theory for Act 129 WRAP can be summarized as follows:

> By providing low-income customers with energy education, and energy-efficiency measures, as well as some HPWHs and home repairs, the program helps these customers to reduce their electricity consumption. As a result, the program helps customers with energy efficiency upgrades and participants have increased knowledge of energy efficiency improves. Disposing of refrigerator and room air-conditioning 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 elements of the logic model are:

- **Activities the program undertakes** begin with marketing and referrals from other low-income programs (Act 129 and Universal Services), entail qualifying participants' eligibility and conducting energy audits and measure-eligibility assessments, and end with the installation of energy-efficient measures, energy education, and referrals to other organizations for participant households.
- **Outputs produced by program activities** include the immediate results of the program activities, such as participant enrollment, income qualification of participants, audits completed, repairs completed, and energy saving measures installed, and number of clients served.
- **Short-term outcomes** resulting from customers' participation in the program include increased program awareness, establishment of participant eligibility, establishment of eligibility for individual measures for each household, improvement of safety and health in participant homes, more-efficient equipment in participant homes, increased participant knowledge of energy efficiency and conservation, and participant access to other needed services.
- **Intermediate outcomes** include installation of selected measures that are cost-effective, reducing energy use of participant households through efficient equipment and conservation from residents.
- **Long-term outcomes** for this program include cost-effective energy savings resulting from energy-efficient equipment upgrades and conservation behaviors in the participating low-income population. Customer energy usage improves.

7 STUDENT AND PARENT ENERGY-EFFICIENCY EDUCATION PROGRAM

Student and Parent Energy-Efficiency Education Program completed its second year as a program in Act 129 Phase II of the PPL Electric Utilities Corporation Energy Efficiency and Conservation Plan. PPL Electric previously offered this successful program (referred to as the Think!Energy Program) to schools and students outside of Act 129. PPL Electric Utilities provides school-based energy-efficiency education through classroom presentations for students in various grade levels, training for teachers, and community workshops for parents in low-income neighborhoods. Participants in all program components receive educational materials and a take-home energy-efficiency kit of low-cost items they can install at home. Take-home energy-efficiency kits are tailored to each grade level participating in the program and contain items such as LED lamps, low-flow showerheads, faucet aerators, smart power strips, and electroluminescent nightlights.

The program's classroom workshop curricula are correlated to Pennsylvania academic standards for the appropriate grade levels and endorsed by the Pennsylvania Department of Education. The program implementer conducts teacher workshops in the summer, and designed them to address the sustainability standard of Pennsylvania academic standards supported by the Pennsylvania Department of Education. Teachers participating in the teacher workshops receive approximately seven hours of credit applicable to Act 48 requirements.

PPL Electric provides school-based energy-efficiency education through the following components:

- **Classroom Presentations.** Interactive classroom presentations for students and teachers in three student cohorts:
  - Bright Kids (primary grades, 2nd – 3rd)
  - Take Action (intermediate grades, 4th – 8th)
  - Innovation (secondary grades, 9th – 12th)
- **Teacher Workshop.** Professional development workshops for teachers focused on energy efficiency and sustainability topics.
- **Parent Workshop.** Community In Action workshops for parents in schools with a known low-income population; the workshops are a fundraising opportunity for schools and parent teacher organizations.[83,84]

Program participants receive educational materials and an energy-savings kit of low-cost products they can install at home. Table 7-1 lists the items in each energy-efficiency kit delivered to the five program cohorts contributing energy savings to the program. Teachers participating in the professional development training workshops received a smart strip but PPL Electric Utilities did not report energy

83 The term "parent" also refers to a student's guardian.

84 Low-income customers are generally customers who are at or below 150% of the federal poverty income guideline. However, PPL Electric and the ICSP, the conservation service provider, do not know the income of participating households. To determine low-income participation in the Student and Parent Energy-Efficiency Education Program, Cadmus analyzed the Pennsylvania Department of Education's data documenting schools in PPL Electric's service territory that offer free lunches to children from households with income below 120% of the federal poverty level, which is more conservative than 150% of the FPL. For more details, see Appendix C.

savings for these items. Therefore, the teachers attending the professional development training workshops are not referenced in any of the tables referencing the impact evaluation.

Although the energy-efficiency kits and training included behaviorally based activities that could reduce energy use, PPL Electric Utilities did not report or claim such savings for this program. Therefore, the evaluation, measurement, and verification CSP (Cadmus) did not evaluate savings from behaviorally based activities.

The Community in Action (CIA) workshops provided through the school Parent Teacher Organizations (PTO) target low-income neighborhoods. These provide a fundraising opportunity for the school or PTO to earn an incentive for recruiting parents to attend an energy-efficiency workshop at their school.

National Energy Foundation (NEF), the program ICSP, undertook a broad spectrum of responsibilities, including marketing to and recruiting potential schools, teachers, and PTOs; creating curriculum correlated to Pennsylvania academic standards; securing support of the program components by the Pennsylvania Department of Education; conducting the various energy-efficiency presentations; and assembling and shipping the take-home energy-efficiency kits.

PPL Electric Utilities collaborated with the ICSP on the program's strategic direction while maintaining overarching Act 129 administrative, program support, and evaluation and data management systems.

Table 7-1: Student and Parent Energy-Efficiency Education Program Kit Products

Program Component	Cohort	Kit Products							
		11-Watt LED Bulbs (x3)	11-Watt LED Bulbs (x2)	Electroluminescent Night Light	Showerhead	Bathroom Aerator	Kitchen Aerator	TrickleStar Smart Power Strip	Furnace Whistle
Classroom Presentations	Bright Kids	●		●					
	Take Action	●		●	●		●		●
	Innovation	●			●	●		●	
Classroom Presentations	Classroom Teachers							●	
Teacher Workshop	Workshop Teachers							● [1]	
Parent Workshop	Workshop Parents		●	●					

[1] PPL Electric Utilities did not report energy savings for the teachers attending the professional development training workshops.

The objectives of the Student and Parent Energy-Efficiency Education Program are to[85]:

- Expand and promote energy-efficiency literacy through education outreach programs.

[85] Program objectives are stipulated on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 5, 2015, p. 74.

- Provide energy-efficiency education to students offered through school assemblies and classroom curriculum and presentations to parent groups.
- Ensure energy-efficiency education correlates to Pennsylvania education academic standards.
- Build awareness of energy efficiency in targeted lower-income neighborhoods.
- Provide students, parents, and teachers with a take-home kit of energy-efficiency measures they can install at home.
- Provide teachers with energy-efficiency information, lesson plans, activities, training, materials, and support for classroom use.
- Obtain participation by approximately 70,000 students, parents, and teachers through 2016, with a total energy reduction of approximately 16,000 MWh/yr.[86]

An executive summary of cumulative Phase II program metrics can be found in Table 7-2.

Table 7-2: Phase II Student and Parent Energy-Efficiency Education Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Student and Parent Energy-Efficiency Education	11,055	14,339	10,523	1.0	2.68	$3,128	$0.30	$0.04	42,647

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

7.1 PROGRAM UPDATES

In PY6, PPL Electric Utilities and the ICSP made three changes to the program:

- Kit offerings changed whereby LEDs replaced CFLs offered in PY5and the TrickleStar smart power strip replaced the CyberPower smart power strip offered in PY5
- Teacher workshop curriculum changed to allow teachers who participated in the past to participate again
- Contests launched to get students and classrooms involved in extra-curricular activities pertaining to energy efficiency

7.1.1 Definition of Participant

For reporting purposes, PPL Electric defines the number of participants in the Student and Parent Energy-Efficiency Education Program as the total number of kits handed out to each classroom. Each record in EEMIS, PPL Electric's program tracking database, represents one participating classroom or workshop and the quantity reported is the total number of kits distributed. Each classroom reports the number of kits distributed to students and the number of returned Home Energy Worksheets (HEWs). The following tables note the differences between distributed kits and returned worksheets. Each participating

86 Participation and savings numbers from PPL Electric EE&C plan approved by the Pennsylvania Public Utility Commission on 06/05/2015.

classroom teacher received a smart strip for their participation in the program and EEMIS records the total quantity of smart strips distributed by cohort.

7.2 IMPACT EVALUATION GROSS SAVINGS

7.2.1 Reported Gross Savings

Table 7-3 shows the Phase II cumulative reported results by sector.

Table 7-3: Phase II Student and Parent Program Reported Results by Customer Sector

Sector	Phase II Participants[1]	Phase II Reported Gross Energy Savings (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Residential	42,647	11,055	0.98	$0
Phase II Total	**42,647**	**11,055**	**0.98**	**$0**

[1] Student and Parent Energy-Efficiency Education Program participants correspond to the total number of kits entered into EEMIS. This count includes the smart strips distributed to the Participating Classroom Teachers.

7.2.2 EM&V Sampling Approach

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

Student Cohorts: For the three participating student cohorts, Bright Kids (primary school students), Take Action (intermediate school students), and Innovation (secondary school students), Cadmus conducted two activities. Cadmus:

- Conducted a database review to ensure the accuracy of EEMIS records compared to the ICSP's records.
- Analyzed all HEWs returned by students who received a kit. The HEWs provided inputs, such as in-service rates (ISR), for calculating energy savings. Although not all students elected to return the HEWs, all returned were included in the analysis. The HEWs provided data for both the process and impact evaluations.

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

Participating Classroom Teachers: All teachers who hosted a student presentation received a smart strip plug outlet for their participation in their classroom. The smart strip savings are included in the PY6 totals. Participating teachers were invited to complete an online survey. Data collected from participating teachers' surveys were used in the impact evaluation. Table 7-4 provides a summary of the program sampling for the impact evaluation.

Table 7-4: PY6 Student and Parent Program Impact Sampling Strategy

Stratum	Population Size (Kits)	Target Levels of Confidence and Precision	Target Sample Size	Achieved Sample Size (Surveys)	Evaluation Activity
Bright Kids (Primary)	4,595	N/A[1]	All Available	3,711	HEW Survey
Take Action (Intermediate)	10,887	N/A[1]	All Available	8,147	HEW Survey
Innovation (Secondary)	4,957	N/A[1]	All Available	2,920	HEW Survey
Bright Kids, Take Action, Innovation	20,439[2]	N/A	Census	Census[2]	Records Review
Parent Workshop	1,172	90/10	308[3]	53	Phone and Online Survey
Participating Classroom Teachers	703	N/A[1]	All Participants	145	Online Survey
Program Total	**22,314**	**N/A[1]**		**14,976**	

[1] Since this program's evaluation did not include sampling, Cv and target precision are not meaningful.
[2] Values are not included in the Program Total calculation.
[3] Sample size was calculated from the January PTO workshop total participation of 1,015. After spring workshops, the total PTO workshop participation increased by 157 kits.

7.2.2.1 Survey Sample Sizes

Student Cohort Participants

The HEWs collected data necessary for Cadmus to complete engineering calculations and compute energy savings. The ICSP included a HEW in each kit distributed to classroom participants for students to take home and complete. After completing the HEWs, the students transferred their responses from the HEWs onto a Scantron form (a form that can be scanned electronically once completed). All student cohorts filled out the Scantron forms in the classroom.

The Scantron forms were returned by the participating classroom teachers to the ICSP shortly after the classroom presentations in October 2014. The ICSP subsequently provided the data collected from the returned Scantron forms to Cadmus.

Parent Workshop Participants

Parent workshop participants filled out HEWs at the end of the workshop before taking the kit home and installing the items. The worksheets provided information about the actions participants intended to take, but not what they actually did. Cadmus, therefore, conducted an opt-in follow-up survey with parent workshop participants, completing 53 follow-up surveys in which all participants responded to one or more questions about use of items in the energy conservation kit.

Participating Classroom Teachers

All participating classroom teachers received an invitation to complete an online survey, and 145 completed the survey. Teachers indicated where they used the smart strip they received, whether at home or in the classroom. Cadmus used the survey results in the energy savings calculations.

Table 7-5 presents the delivery method, sample size, and functions of each of the surveys used in the impact evaluation.

Table 7-5: Student and Parent Program Survey Data Collection to Determine Energy Impacts

Survey	Survey Delivery Method	Frequency	Total Surveys	Sample Size	Data Used For	
					Impact Evaluation	Process Evaluation
Bright Kids Participant HEW	Included in Kit	Q3	3,725	3,711[1]	Yes	Yes
Take Action Participant HEW[1]	Included in Kit	Q3	8,197	8,147[1]	Yes	Yes
Innovation Participant HEW[1]	Included in Kit	Q3	2,931	2,920[1]	Yes	Yes
Parent Workshop Participant Survey	Online and phone after opt-in during the workshop	Q3	53	53[2]	Yes	Yes
Participating Teachers Survey[2]	Online	Q3	145	145[2]	Yes	Yes

[1] Completed HEWs used in the analysis.
[2] Surveys completed by Cadmus.

7.2.3 *Ex Ante* Adjustment Methodology and Findings

A savings adjustment was necessary to calculate realization rates for the Student and Parent Energy-Efficiency Education Program. Cadmus adjusted the reported savings from EEMIS to align with the assumptions specified in the TRM and the characteristics of the kit items, resulting in the adjusted *ex ante* savings.

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

Table 7-6 shows the results of the TRM-adjusted *ex ante* calculations by cohort for the varying sets of measures included in each kit.

Table 7-6: Reported and Adjusted *Ex Ante* Savings per Technology and per Unit

Kit Item *Cohort*	Reported *Ex Ante* Savings (kWh/yr)	Adjusted *Ex Ante* Savings (kWh/yr)	Factors Included in TRM *Ex Ante* Adjustments
Furnace Whistle *Take Action*	58.28	Updated savings for ZIP Codes mapping. Scranton (61 kWh), Philadelphia/ Williamsport/Harrisburg /Allentown (59 kWh)	PPL assumed EFLH hours for Harrisburg as a placeholder. 2014 TRM Table 2-8 was used to update EFLH by mapping school zip codes to the nearest city. 2014 TRM Tables 2-9 through 2-15 specify savings by city.
Low Flow Showerhead *Take Action*	51.26	<u>Flow rate 1GPM:</u> single-family (85), multifamily (72), statewide (84). <u>Flow rate 1.5GPM:</u> single-family (56), multifamily (48), statewide (24). <u>Flow rate 2GPM:</u> single-family (28), multifamily (24), statewide (28).	PPL assumes statewide housing type for 1.75 gpm (2014 TRM Table 2.9.4) and 52% fuel saturation per PPL RASS study. Adjusted *ex* ante uses statewide housing type, kit measure rating of 1.5gpm, baseline GPM from surveys and 52% fuel saturation per PPL RASS study.2014 TRM stipulates different fixed values based on housing type[1]
Kitchen Faucet Aerator *Take Action*	38.62	Single-family (220), multifamily (147), statewide (212)	PPL assumes statewide housing type and applies 52% fuel saturation per PPL RASS study.

Kit Item *Cohort*	Reported *Ex Ante* Savings (kWh/yr)	Adjusted *Ex Ante* Savings (kWh/yr)	Factors Included in TRM *Ex Ante* Adjustments
Bathroom Faucet Aerator *Innovation*	4.94	Single-family (25.6), multifamily (30), statewide (26.4)	Adjusted *ex ante* uses default savings from 2014 TRM table in section 2.8.3.
Low Flow Showerhead *Innovation*	56.22	Flow rate 1GPM: single-family (85), multifamily (72), statewide (84). Flow rate 1.5GPM: single-family (56), multifamily (48), statewide (24). Flow rate 2GPM: single-family (28), multifamily (24), statewide (28).	PPL assumes statewide housing type for 1.75 gpm (2014 TRM Table 2.10.4) and 52% fuel saturation per PPL RASS study. Adjusted *ex* ante uses statewide housing type, kit measure rating of 1.5gpm, baseline GPM from surveys and 52% fuel saturation per PPL RASS study.2014 TRM stipulates different fixed values based on housing type[1]
Smart Strip *Innovation*	54.43	7-plug power strip, residential entertainment center use (74.5) 7-plug power strip, residential unspecified use (58.7) 7-plug power strip, commercial use (124)	2014 TRM Section 2-12 provides deemed per unit savings for residential use. 2014 TRM Section 3.12.4 provides deemed per unit savings for commercial use.
LEDs (3 bulbs) *Bright Kids, Take Action, Innovation*	Bright Kids (77.46); Take Action (68.25); Parent Workshop (71.94)	89.5	2014 TRM specifies 97% ISR (Table 2-73); Adjusted *ex* ante uses baseline wattage of 43W for a 60W equivalent as stated in 2014 TRM Table 2-74.
LEDs (2 bulbs) *Parent Workshop*	51.64	59.6	2014 TRM specifies 97% ISR (Table 2-73).
Electroluminescent Nightlight *Bright Kids, Take Action, Parent Workshop*	Bright Kids (23.96); Take Action (23.96); Parent Workshop (24.87)	29.06	2014 TRM Section 2.4 stipulates 29.49 kWh. Adjusted *ex* ante uses actual kit measure wattage.
Smart Strip *Participating Teachers*	53.28	7-plug power strip, residential entertainment center use (74.5) 7-plug power strip, residential unspecified use (58.7) 7-plug power strip, commercial use (124)	2014 TRM Section 2-12 provides deemed per unit savings for residential use. 2014 TRM Section 3.12.4 provides deemed per unit savings for commercial use.
[1] The 2014 TRM table 2-20 provides different fixed variables for number of persons in the house and number of showers based on single-family and multifamily home types.			

7.2.4 *Ex Post* Adjustment Methodology and Findings

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

- The results of quantity adjustments resulting from database review activities are incorporated.
- The measure savings are modified to reflect the installation rates determined through the returned HEWs, and the parent workshop and participating classroom teacher survey responses.
- Survey results adjusted the savings for participating teachers' smart strips by identifying the proportion of smart strips used at home and in the classroom (with corresponding TRM-specified unit savings).

7.2.4.1 Database Review

Cadmus compared participant records from EEMIS with enrollment data stored in the ICSP's electronic database to ensure that all records were traceable between databases. Cadmus found that the number of Teacher IDs for returned HEWs did not match between the two datasets for the Bright Kids, Take Action, and Innovation cohorts; the ICSP's database contained more Teacher ID records than EEMIS. Through discussion with the ICSP and PPL Electric program staff, Cadmus determined that the ICSP removed duplicate teacher names before the data were uploaded to EEMIS and, therefore, the EEMIS data reflected the correct count of participating teachers at the Teacher ID level.

For 48 student cohort classroom records in EEMIS, the count of HEWs was slightly higher than the recorded quantity of distributed kits. For example, one Innovation Teacher ID had five more HEWs than the quantity of distributed kits recorded in EEMIS. Most records reported one more HEW than distributed classroom kits. The ICSP noted that teachers are encouraged to fill out the HEW as an example and, in some cases, teachers returned this HEW with the student kit surveys. During the ICSP's quality control (QC) process, these records are not always removed from the total HEW count for the classroom. Also, a teacher may provide HEWs to another teacher to turn in to the ICSP if their own students have returned their HEWs late.

These HEWs can be missed in the ICSP's QC process and are then associated with the incorrect classroom. Upon completion of a records review of the 48 student cohort classroom records, the ICSP flagged 75 HEWs as duplicates within the classroom data. These 75 HEW records were removed from Cadmus' analysis and represented 1% of all returned HEWs. The duplicate record counts remain in EEMIS and Table 7-7 shows the database accuracy between PPL Electric records and the ICSP's database.

Table 7-7: Database Review Results for PY6 Student and Parent Program

Cohort	HEWS in EEMIS	HEWs in ICSP Database	Database Accuracy
Bright Kids	3,725	3,711	99.6%
Take Action	8,197	8,147	99.3%
Innovation	2,931	2,920	99.6%
Parent Workshop	1,172	1,170	99.8%

7.2.4.2 Records Review

Cadmus obtained all HEWs for each participant group from the ICSP in mid-January and compared participant responses from the scanned HEWS to the database extracts. The initial comparison identified extract formatting discrepancies and instances of missing or incorrect data, which were discussed and resolved after receiving corrected ICSP database extracts. Cadmus then used the corrected ICSP database extract files in the final program analysis.

7.2.4.3 Surveys

Cadmus used phone and online survey results from participants in the parent Community in Action (CIA) workshop to calculate *ex post* per-unit savings for the items contained in the energy-efficiency kit—two LED bulbs and one electroluminescent nightlight. Cadmus determined the relative per-unit savings using respondent-level installation rates, determined through the participant surveys and TRM algorithms. For the kits distributed to the three grade-level cohorts, Cadmus used the data obtained from the HEWs to calculate installation rates and actions taken as a result of the program and to determine the measure-level, cohort-level, and program-level realization rates.

A summary of PY6 kits and survey responses by cohort can be found in Table 7-8.

Table 7-8: PY6 Summary of Kits and Survey Responses by Cohort

Cohort	Kits in EEMIS	Survey Responses in EEMIS	Survey Responses (Analysis)	Classroom (Teachers) in EEMIS	Number of Classrooms with Survey Responses
Bright Kids	4,595	3,725	3,711	206	181
Take Action	10,887	8,197	8,147	390	342
Innovation	4,957	2,931	2,920	107	64
Parent Workshop	1,172	N/A[1]	53	21	52[2]
Participating Teachers	703	N/A[3]	145	3[4]	145[5]
Program Total	**22,314**		**14,976**	**724**	**784**

[1] Installation rates and savings for Parent Workshop calculated from Cadmus survey.
[2] Phone and on-line surveys were attempted for all Parent Workshop participants who opted-in.
[3] No HEWs for Participating Teachers. Installation rates and savings calculated from Cadmus survey.
[4] All 703 participating teachers who received a Smart Strip are entered into EEMIS as three records.
[5] On-line surveys were sent to all participants for Participating Teachers, not sampled by classroom.

7.2.4.4 Methodology to Compute Savings Using Survey Data

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

Each student was eligible for the ex *ante* savings associated with measures for which each answered the installation question. The *ex ante* savings were assigned if the student answered the survey question, regardless of the response (that is, whether the measure was or was not installed). Cadmus based each student's survey-verified *ex post* savings on the survey responses indicating the respondent installed the measures. The student level *ex ante* and *ex post* savings were summed for each class (corresponding to a unique teacher ID) to estimate a realization rate, total *ex post* savings, and the standard error at the classroom level.

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

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

This approach to estimation is consistent with two-stage cluster sampling methods where the sampling weights and standard error calculation at each stage account for sampling uncertainty both at the class level and the cohort level. Finally, the cohort totals were combined to estimate the program total savings, standard error, and precision.

7.2.4.5 Summary of Survey Findings

Program participants returned 14,975 HEWs and surveys. Table 7-9 presents the PY6 ISR for each of the items in the energy-efficiency kit and for the participating classroom teacher smart strips. ISRs represent the percentage of participants who verified they installed the measure of the total number of participants who answered the measure-specific question; this is not a percentage of the total number of people surveyed. Table 7-9 shows the savings attributable to each of the measures. The installations rates for each of the measures in the kit are useful for program planning purposes.

Table 7-9: Student and Parent Program Measure Savings per Distributed Unit in PY5 and PY6

Measure Installed	Valid Survey Responses		ISR		Per-unit Savings (kWh/yr)	
	PY5	PY6	PY5	PY6	PY5	PY6
LED (3 bulbs) Bright Kids[1]	3,916	3,679	73% combined for 3 bulbs	77% combined for 3 bulbs[1]	105.5	71.0
LED (3 bulbs) Take Action[2]	8,725	8,020	60% combined for 3 bulbs	67% combined for 3 bulbs[2]	86.3	61.8
LED (3 bulbs) Innovation[3]	2,792	2,904	67% combined for 3 bulbs	65% combined for 3 bulbs[3]	96.2	61.8
LED (2 bulbs) Parent Workshop[4]	43	50	87% combined for 2 bulbs	78% combined for 2 bulbs[4]	83.8	48.0
Nightlight Bright Kids	3,934	3,690	88%	87%	26.8	26.4
Nightlight Take Action	8,475	8,082	80%	79%	24.3	23.7
Nightlight Parent Workshop	41	51	90%	80%	27.4	24.0
Showerhead Take Action	8,582	8,002	31%	30%	93.7	55.5
Showerhead Innovation	2,733	2,832	34%	32%	103.9	53.8
Kitchen Aerator Take Action	8,665	8,007	35%	34%	8.7	37.6
Bathroom Aerator Innovation	2,763	2,855	36%	31%	9.7	4.23
Furnace Whistle Take Action	8,475	7,640	47% (TRM Stipulated); 15% survey verified	47% (TRM Stipulated); 14% survey verified	59 (varies by geographic location)	59 (varies by geographic location); 8.26 survey verified
Smart Strip Innovation	2,800	2,911	80%	74%	147.1	55.3[5]
Smart Strip Participating Teachers[5]	312	145	94%	93%	140.0	130.1[6]

[1] Individual PY6 LED ISR for Bright Kids – LED1 85%, LED2 76%, LED3- 69%.
[2] Individual PY6 LED ISR for Take Action – LED1 76%, LED2 66%, LED3 58%.
[3] Individual PY6 LED ISR for Innovation – LED1 73%, LED2 64%, LED3 58%.
[4] Individual PY6 LED ISR for Parent Workshop – LED1 81%, LED2 76%.
[5] Per unit savings is ISR*average rate of 55.3 based on survey findings showing 45% used for entertainment center (residential savings rate of 74.5 kWh) and 37% used for unspecified use (residential savings rate of 58.7 kWh)
[6] Per unit savings is ISR*average rate of 130.1 based on survey findings showing 52% used at home (residential savings rate of 74.5 kWh for entertainment center use and 58.7 kWh for unspecified use) and 41% used in the classroom (commercial savings rate of 124 kWh).

7.2.5 Summary of Evaluation Results

Estimated savings for measure installations were determined using 2014 TRM algorithms for each item in the kit. Data inputs for ISRs (where EDC data gathering was allowed in the TRM) were derived from the HEWs and from the parent workshop survey. Manufacturer's data (for example, aerator and showerhead flow rates) were used in the algorithms to calculate verified savings for each measure. Cadmus used all questions in the HEWs applicable to EDC gathered variables in the TRM algorithms. For some measures, such as furnace whistles and LEDs, the HEW questions did not align with the EDC gathered data required in the TRM and Cadmus used the TRM defaults to calculate savings.

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

Program saving results are provided in Table 7-10 and Table 7-11.

Table 7-10: PY6 Student and Parent Program Summary of Evaluation Results for Energy [1]

Stratum	Reported Gross Energy Savings (MWh/Year)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings[2] (MWh/yr)	Observed Coefficient of Variation (Cv) or Error Ratio in Sample	Relative Precision at 85% Confidence Limit
Bright Kids	477	545	97.8%	532	0.0246	0.1%
Take Action	2,617	4,862	72.9%	3,544	0.2682	0.4%
Innovation	924	1,144	99.9%	1,143	0.1285	0.3%
Parent Workshop	90	104	92.9%	97	0.1088	2.2%
Participating Teachers	37	41	146.6%	60	0.1863	2.2%
Program Total	4,145	6,696	80.3%	5,376	0.1523	0.2%

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

Table 7-11: PY6 Student and Parent Program Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings[1] (MW)	Adjusted *Ex Ante* Demand Savings[2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings[2], [3] (MW)	Observed Coefficient of Variation (Cv) or Error Ratio in Sample	Demand Relative Precision at 85% Confidence Limit
Bright Kids	0.04	0.05	100.0%	0.05	0.000	0.0%
Take Action	0.45	0.79	34.9%	0.27	0.415	0.7%
Innovation	0.09	0.13	98.9%	0.13	0.098	0.3%
Parent Workshop	0.01	0.01	100.0%	0.01	0.000	0.0%
Participating Teachers	0.00	0.00	146.6%	0.01	0.623	7.4%
Program Total	0.60	0.98	47.8%	0.47	0.234	0.3%

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

7.3 Impact Evaluation Net Savings

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

Table 7-12: PY6 Student and Parent Program Sampling Strategy for NTG Research

Stratum	Stratum Boundaries	Population Size (number of energy-savings kits)	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
Student and Parent Program	Program	22,314	N/A	N/A	N/A	N/A	N/A

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame contacted to complete surveys.

Table 7-13: PY6 Student and Parent Program Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Student and Parent Program	N/A	N/A	100%	N/A	N/A

7.4 Process Evaluation

7.4.1 Research Objectives

The evaluation of the Student and Parent Energy-Efficiency Education Program involve these research objectives:

- Determine the installation rates for the kit products
- Collect demographic data of participating households
- Collect and analyze feedback from participants to gather insights into program design, delivery, and satisfaction
- Assess the effectiveness of the energy-efficiency curriculum among participating teachers and parents

7.4.2 Evaluation Activities

In PY6, which ended May 31, 2015, Cadmus conducted the following process evaluation activities for the Student and Parent Energy-Efficiency Education Program:

- Interview program staff and implementer (n=4)
- Conduct participant surveys
    - Classroom teacher survey (n=145)
    - Teacher workshop survey (n=61)
    - Parent workshop survey (n=53)

- Analyze ICSP-administered home energy worksheets (HEWs)
  - Bright Kids returned HEWs (n=3,711)
  - Take Action returned HEWs (n=8,147)
  - Innovation returned HEWs (n=2,920)
- Analyze ICSP-administered parent postcard surveys
  - Bright Kids (n=935)
  - Take Action (n=452)
  - Innovation (n=98)
- Analyze open-ended responses from ICSP-administered participant program evaluation surveys
  - Bright Kids (n=44)
  - Take Action (n=285)
  - Innovation (n=45)
  - Parent workshop (n=970)
- Conduct program literature review and benchmarking
- Conduct database and quality assurance/quality control review of records

These activities were consistent with the PY6 evaluation plan (Table 7-14).

7.4.3 Methodology

This section summarizes the process evaluation activities and methodology. Addendum A in this chapter provides additional information including sampling details and survey attrition tables.

7.4.3.1 Program Staff and Implementer Interviews

Cadmus conducted interviews with PPL Electric's program manager and the ICSP's program manager in December 2014 and March 2015. The December interviews followed up on the outcomes of recommendations made in the PY5 report and focused on any program design changes and implementation successes and challenges. The March interviews focused on key performance indicators and general discussion of PY6's program performance.

7.4.3.2 Participant Surveys

As a follow-up to the ICSP surveys, Cadmus administered three participant surveys over the phone and Internet—classroom teacher survey, teacher workshop survey, and parent workshop survey. The surveys asked about experience with the program, program delivery and participation, and areas for improvement. The ICSP's surveys included a question asking respondents for permission for Cadmus to contact them for its participant surveys. Cadmus contacted all participants who opted in to follow-up contact. Participating classroom teachers, workshop teachers, and workshop parents completed Cadmus' surveys during March 2015.

Cadmus did not conduct a survey with classroom parents in PY6. Instead, we analyzed the parent postcard surveys returned to the ICSP to obtain comments about the program.

Table 7-14: Student and Parent Energy-Efficiency Education Program Process Evaluation Sampling Strategy for PY6

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or Cv in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Contacted [1]	Evaluation Activities
PPL Electric Program and ICSP Staff	Staff	4	N/A	N/A	4	4	4	100%	Process, Impact, Program Staff Interview, Census
Home Energy Worksheets	Bright Kids, Take Action, Innovation	14,778	N/A	N/A	All Records	14,778	14,778	100%	Impact, Process
Classroom Teacher	Classroom Teachers	703	N/A	N/A	As many as possible	703	145	73%	Impact, Process, Online survey
Teacher Workshop	Teacher Workshop	190	N/A	N/A	As many as possible	190	61	91%	Process, Online survey
Post Cards	Bright Kids, Take Action, Innovation	1,485	N/A	N/A	All Records	1,485	1,485	100%	Process, Qualitative analysis
Parent Workshop	Parent Workshop	1,172	N/A	N/A	As many as possible	308[2]	53	80%	Impact, Process, Phone and Online survey
Program Evaluation Surveys	Classroom Teachers, Teacher Workshop, Parent Workshop	1,344	N/A	N/A	All Records	1,344	1,344	100%	Process, Qualitative analysis
Program Total[3]	**N/A**	**19,676**	**N/A**	**N/A**	**N/A**	**18,812**	**17,870**	**N/A**	**N/A**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame contacted to complete surveys.
[2] Sample size was calculated from the January parent workshop total participation of 1,015. After the workshops held in April, the total participation increased by 157 kits.
[3] Program participants gave responses across various data collection activities (home energy worksheets, post cards, and surveys). Therefore, the program total row may double count participants.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they were implemented consistently. Cadmus sent all participating classroom teachers, workshop teachers, and parent workshop participants with an e-mail address an initial e-mail invitation and two reminder e-mail invitations to encourage response. The response rate is reasonable (22%; 259 of 1,201), therefore we assumed that any possible bias will have minimal impact.

Table 7-14 above summarizes the survey sampling strategy for the Cadmus-administered participant surveys. Details about our methodology are in Addendum A.

7.4.3.3 Analysis of ICSP-Administered Surveys

Cadmus also analyzed the ICSP's survey data to determine installation rates, establish the demographic profile of participants, and gather qualitative program insights. We analyzed all HEWs from the student cohorts (n=14,**778**), all postcard surveys (n=1,485), and all open-ended responses from the program evaluation surveys received by the ICSP (n=1,344).

7.4.3.4 Database and Records Quality Control Review

Cadmus conducted multiple reviews of the EEMIS and ICSP's databases as well as reviews of the records found in the databases. We inspected for HEW data accuracy and consistency, and found that the count of the HEWs was slightly higher than the recorded quantity of the distributed kits (Table 7-15); this discrepancy was due to duplication. Through discussion with the ICSP and PPL Electric program staff, Cadmus determined that the ICSP removed duplicate teacher names before the data were uploaded to EEMIS and, therefore, the EEMIS data reflected the correct count of participating teachers at the Teacher ID level.

Table 7-15: Student and Parent Energy-Efficiency Education Program Process Evaluation Database Review

Stratum	Population Size	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Used For Evaluation Activities (Impact, Process, NTG)
Classroom - Bright Kids	3,725	N/A	Census	3,711	Database review, Census, Impact, Process
Classroom - Take Action	8,197	N/A	Census	8,147	Database review, Census, Impact, Process
Classroom - Innovation	2,931	N/A	Census	2,920	Database review, Census, Impact, Process
Teacher Workshop	190	N/A	Census	190	Database review, Census, Impact, Process
Parent Workshop	1,172	N/A	Census	1,170	Database review, Census, Impact, Process
Program Total	**16,215**	**N/A**	**Census**	**16,138**	**N/A**

7.4.4 Achievements Against Plan

In PY6, the Student and Parent Energy-Efficiency Education Program achieved 124% of its planned MWh/yr savings,[87] 43% of its planned MW savings, and 101% of its annual participation.

The program exceeded its PY6 planned MWh/yr savings and participation, but did not reach its planned demand savings (Table 7-16). At the end of PY6, the program had achieved:

- 67% of its 15,628 MWh/yr three-year planned savings
- 39% of its 2.02 MW three-year planned demand reduction
- 63% of its three-year planned participation of approximately 70,000 kits

Table 7-16: Student and Parent Energy-Efficiency Education Program Savings

Unit	PY5 Verified	PY6			PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned	Verified	Percentage of Planned
MWh/yr	5,147	4,318	5,376	124%	15,628	10,523	67%
MW	0.35	1.0	0.43	43%	2.02	0.78	39%
Participants [1]	21,036	N/A	21,611	N/A	70,000	42,647	61%

[1] Beginning in PY6 Q3, the methodology for counting participants for the Student & Parent Education program changed. The participant count is now based on the number of kits distributed, instead of the previously reported number of classrooms. This change was applied to data for all of Phase II.

There are several possible reasons why the program exceeded its planned savings and participation for PY6.

- **Program maturity.** PPL Electric and the ICSP attribute the strong performance to the growth in program popularity over the years. During the course of PY6, the ICSP distributed an additional 1,164 kits from the planned 21,150.
- **Targeted marketing and personalized outreach efforts.** The marketing and outreach efforts in PY6 prioritized the recruitment of new participants. The ICSP also concentrated its efforts on reaching out to schools with low-income populations by making one-on-one calls and sending personalized e-mails to these schools. These efforts galvanized program awareness and helped to increase participation.
- **Switch to LEDs.** Feedback from parents and teachers in PY5 indicated an interest and demand for LEDs, which were supplied in the PY6 kits. In PY6, LEDs yielded higher installation rates than did CFLs in PY5 in two out of the three student cohorts: Bright Kids (PY6 77%, PY5 73%) and Take Action (PY6 67%, PY5 60%).

7.4.5 Program Delivery

According to interviews with PPL Electric and the ICSP, the Student and Parent Energy-Efficiency Education Program ran very smoothly in PY6; they did not report any challenges or issues with the program. PPL Electric and the ICSP had a smooth program delivery in PY5, which provided a solid foundation for PY6.

87 Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) filed with the Pennsylvania PUC on June 5, 2015, Table H5, pp. 72.

7.4.5.1 Logic Model

A program logic model identifies the relationships between activities and expected results. During PY5, Cadmus developed the logic model for the program (Model). In PY6, we reviewed the logic model and found that the program follows the description in the Phase II EE&C Plan.

7.4.5.2 Key Performance Indicators

In addition to energy savings and participation, PPL Electric and the ICSP identified four key performance indicators (KPIs) that measure how the program is doing. The ICSP monitors these metrics to assess its own performance. Table 7-17 shows these KPIs with their PY6 results.

Table 7-17: Student and Parent Energy-Efficiency Education Program KPIs

Key Performance Indicator	Metric	Goal	PY6 Result
Program Enrollment	Number of schools enrolled for the program	Be fully enrolled by the start of summer	Reached full enrollment by summer and also increased enrollment to accommodate demand
New School Enrollment	Number of new schools enrolled for the program	30% of program enrollment to come from new schools	Met goal
Teacher Workshop Participation	Number of teacher workshop participants	150 teachers	Exceeded goal with 190 teachers
Classroom and Parent Workshop Participation	Number of HEWs returned	Meet or exceed PY5's HEW return rate of 79%	Did not match PY5 with 72% HEW return rate

The KPIs reveal that the program did very well in program enrollment, new school enrollment, and teacher workshop participation. However, the program did not match PY5's HEW return rate of 79% (72% in PY6).

7.4.5.3 Program Updates and Outcomes

For PY6, the program implemented these three changes:

- **Kit offerings changed.** The PY6 student kits included LEDs, which replaced the CFLs offered in PY5. The PY6 teacher workshop kits no longer contained LEDs. The kits exchanged the CyberPower smart power strip for the TrickleStar smart power strip. LEDs proved to be a positive change as their average installation rate (70%) was higher than CFLs in PY5 (66%). However, the change in the brand of the smart power strip did not result in the same or higher installation rate in PY 6 (74%) as PY5 (80%).
- **Teacher workshop curriculum changed to allow teachers who participated in the past to participate again.** The Pennsylvania Department of Education imposes a requirement where teachers cannot attend the professional workshop if they attended a workshop with the same curriculum in a prior year. This requirement made it difficult to get teachers to participate in PY5. For PY6, the workshop curriculum added to and modified the renewable energy-related topics to align with the science, technology, engineering, and mathematics (STEM) paradigm. These curriculum changes allowed teachers who had participated in prior years to attend in PY6, and the workshop exceeded its planned teacher participation.
- **Contests launched to get students and classrooms involved in extra-curricular activities pertaining to energy efficiency.** The program held a poster contest and a creative messaging contest. Interested students from the Bright Kids and Take Action cohorts submitted posters on energy efficiency for a chance to win money and a party for their classroom. Interested students from the Innovation cohort, in teams of up to four, presented creative messages on energy efficiency (using video, art, poetry, etc.) for a chance to win student gear. These contests achieved a high number of entries and were

well received by students and teachers. Because of this success, PPL Electric and the ICSP plan to offer contests again in PY7.

Cadmus made recommendations in PY5 and followed up with PPL Electric and the ICSP to determine if these recommendations were implemented in PY6. PPL Electric and the ICSP implemented the recommendation to have Innovation students fill out the HEW Scantron forms in the classroom (as do the other two student cohorts) instead of at home. In PY5, Innovation students' return rate was 58%, the lowest among the three student cohorts. In PY6, Innovation students generated a return rate of 59%, so no real change. In fact, the overall HEW return rate was slightly lower than PY5, so the program still needs improvement in this area. The ISCP is currently considering testing an online HEW collection method with the Innovation student cohort.

Program planning takes place early so most of the recommendations from the PY5 evaluation report did not reach PPL Electric and the ICSP in time to be implemented for PY6. For example, because PY6 kits had already been finalized, PPL Electric and the ICSP were unable to implement the recommendations to remove or replace certain kit products (the furnace whistle and aerators) and educational materials (safety guidelines and flyers). PPL Electric is still considering some of the recommendations for implementation in PY7.

7.4.6 Participant Profile

Participants in the Student and Parent Energy-Efficiency Education Program consisted of four groups representing the different components of the program:

- Classroom teachers
- Workshop teachers
- Classroom parents
- Workshop parents

7.4.6.1 Classroom Teachers

A total of 703 teachers from 191 schools participated in the classroom presentation component of the program. The largest classroom teacher participation came from Take Action (n=390, 103 schools), followed by Bright Kids (n=206, 56 schools), and Innovation (n=107, 32 schools).

7.4.6.2 Workshop Teachers

A total of 190 teachers participated in the professional development workshop component of the program. Forty percent of workshop teachers represented primary grades (kindergarten – 5th grade), 12% represented intermediate grades (6th – 8th grade), and 14% represented secondary grades (9th – 12th grade).

7.4.6.3 Classroom Parents

The parents of students who received the classroom-distributed kits returned 14,778 HEWs.[88] The largest classroom parent participation came from the Take Action cohort (n=8,147), followed by Bright Kids

88 The number of classroom parents is not tracked for this program component. Instead, the number of HEWs returned is used to gauge classroom parent participation. HEWs are also used to gauge parent participation in the Community In Action (parent) workshops.

(n=3,711) and Innovation (n=2,920). Based on the demographic responses indicated in the HEWs, the majority of classroom parents:

- Live in a single-family home (83%)
- Have a household size of four members (34%)
- Use electricity as their main source of heat (39%)
- Heat their water with electricity (52%)

7.4.6.4 Workshop Parents

During PY6, PPL Electric and the ICSP held 21 Community In Action parent workshops in 21 schools. The workshop attendees returned 1,170 HEWs, which indicated that the majority of workshop parents:

- Live in a single-family home (81%) that is 31 years or older (55%)
- Have a household size of four members (30%)
- Use electricity as their main source of heat (32%)
- Heat their water with electricity (51%)
- Have a room air conditioner (48%)

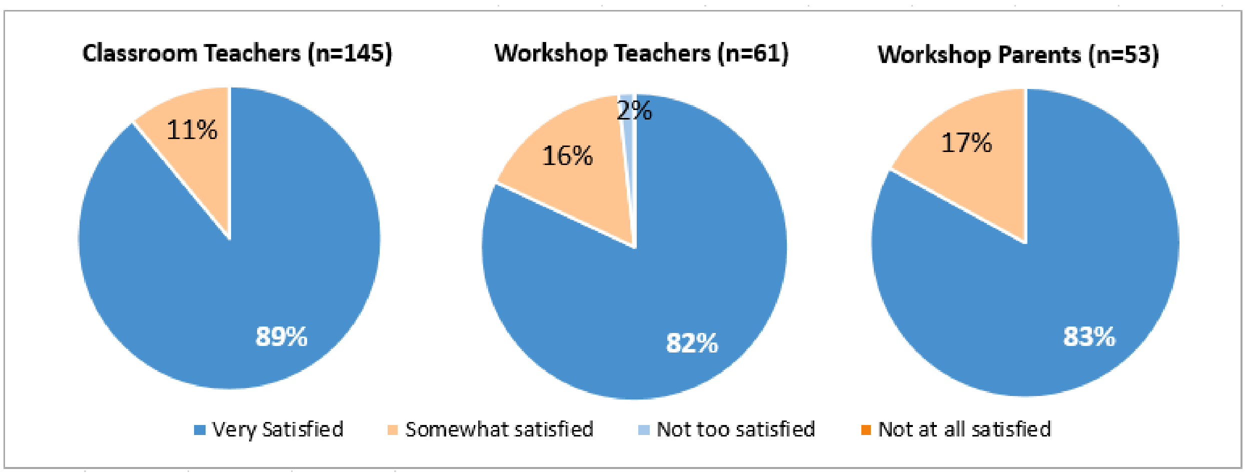
7.4.7 Satisfaction

Teacher and parent participants reported very high satisfaction with the program and with PPL Electric.

7.4.7.1 Program Satisfaction

As shown in Figure 7-1, teacher and parent participants reported very high satisfaction with the classroom and workshop components of the program. On average, 85% of teacher and parent participants combined reported being *very satisfied* with overall program.

Figure 7-1: Overall Program Satisfaction



Source: Teacher workshop survey; classroom teacher survey; parent workshop survey. Question, "How satisfied were you overall with the Think!Energy Professional Development Workshop/Think!Energy Program/Community In Action Forum? Would you say..."

Classroom component. The program's classroom component achieved higher teacher satisfaction ratings in PY6 than PY5. In PY6 (n=145), 89% of classroom teacher respondents said they were *very satisfied* with the program and 11% said they were *somewhat satisfied*. In PY5 (n=312), 81% of classroom teacher respondents said they *very satisfied* and 17% said they were *somewhat satisfied*. Moreover, 78% of classroom teacher respondents in PY6 reported recommending the program to colleagues, up from 72% reported in PY5.

Teacher workshop. In contrast, the program's professional development teacher workshop component received lower teacher satisfaction ratings in PY6 than PY5. In PY6 (n=61), 82% of teacher workshop respondents said they were *very satisfied* and 16% said they were *somewhat satisfied*. In PY5 (n=10), 90% of teacher workshop respondents *very satisfied* and 10% said they were *somewhat satisfied*. Moreover, 87% of teacher workshop respondents in PY6 reported recommending the workshop to colleagues, down from 100% reported in PY5. It is important to note there were far more respondents in PY6 (n=61) than in PY5 (n=10) so the differences in satisfaction may be due to sample size.

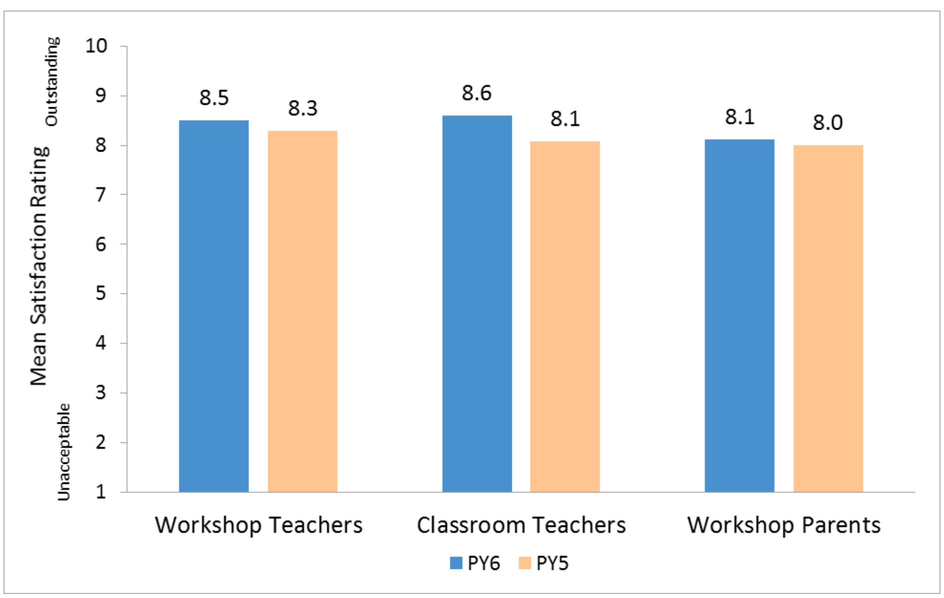
Parent workshop. The Community In Action parent workshop component achieved higher parent satisfaction ratings in PY6 than PY5. In PY6 (n=53), 83% of parent workshop respondents said they were *very satisfied* and 17% said they were *somewhat satisfied*. In PY5 (n=45), 80% of parent workshop respondents said they were *very satisfied* and 18% said they were *somewhat satisfied*. In PY6, 43% of parent workshop respondents reported recommending the workshop to friends/relatives/colleagues, down from 47% reported in PY5.

Based on the ICSP parent postcard surveys distributed with the kits, almost all parent respondents (99%) said they would like to see the program continue, with no change from PY5 (99%).

7.4.7.2 Satisfaction with PPL Electric

As shown in Figure 7-2, teacher and parent participants reported higher overall satisfaction with PPL Electric in PY6 than in PY5. Teacher respondents reported higher satisfaction with PPL Electric than parent respondents in both program years. For PY6, classroom teacher respondents (n=122), on average, gave the highest satisfaction rating of 8.6 out of 10. The teacher workshop respondents (n=53) gave a rating of 8.5 and parent workshop respondents (n=50) gave a rating of 8.1.

Figure 7-2: Overall Satisfaction with PPL Electric



Source: Teacher workshop survey PY6 (n=53) and PY5 (n=7); classroom teacher survey PY6 (n=122) and PY5 (n=253); parent workshop survey PY6 (n=50) and PY5 (n=42). Question, *"Using a 10-point scale where 1 means 'unacceptable' and 10 means 'outstanding', how do you rate PPL Electric overall as a provider of electric service for your home?"*

Although overall satisfaction with PPL Electric increased in PY6, the respondents' opinion of PPL Electric decreased. In PY6, 42% of classroom teacher respondents (n=145), 64% of teacher workshop respondents (n=61), and 51% of parent workshop respondents (n=53) reported that their opinion of PPL Electric had improved after participating in the program. In PY5, 58% of classroom teacher respondents (n=312), 80% of teacher workshop respondents (n=10), and 62% of parent workshop respondents (n=45) reported that their opinion of PPL Electric had improved.

From open-ended comments captured in the Cadmus and ICSP surveys, the vast majority of teacher and parent participants had a positive experience with the Student and Parent Energy-Efficiency Education Program and are grateful to PPL Electric for offering it. Many look forward to the program next year.

7.4.8 Marketing and Outreach

The ICSP used a targeted marketing and personalized outreach approach to recruit schools and educators into the program. The marketing placed a priority on recruiting new participant schools while the outreach efforts focused on making direct communication (via phone and e-mail) to educators at schools with a low-income population. The ICSP made sure to contact and invite all qualified schools in PPL Electric's service territory that had not participated in the past.

To market the teacher workshop, the ICSP sent e-mail blasts to educators, posted on social media (Facebook), and featured an article in PPL Electric's Connect newsletter. To market the Community In Action parent workshop, the ICSP directly phoned and e-mailed all Parent Teacher Organizations on the qualified schools' list, targeting the low-income schools first.

These marketing and outreach efforts paid off. The program distributed 22,314 kits in PY6, compared to 21,036 in PY5, and 190 teachers attended the workshops in PY6 compared to 153 teachers in PY5.

7.4.9 Participant Retention

A sizeable proportion of the teachers participating in the classroom and workshop components previously participated in the program. Among participating classroom teachers, 70% of surveyed respondents indicated that they had participated in the program in previous years. Bright Kids teachers showed the highest proportion of repeat participation (79%) followed by Innovation teachers (64%) and Take Action teachers (63%). Among workshop teachers, 36% of surveyed respondents indicated that they participated in the workshop in the past. These findings suggest that the program has strong participant retention.

7.4.10 Influence in the Classroom

The Student and Parent Energy-Efficiency Education Program influences teachers to adopt energy education into their classroom curriculum and provides a major boost in casting PPL Electric as a leading resource for energy education.

Prior to participating in the program, 30% of classroom teacher respondents said that they did not incorporate energy education into the classroom curriculum. After participating, 92% of classroom teacher respondents said that they will probably incorporate energy education into their future curriculum. Classroom teacher respondents who reported they will not incorporate energy education into their future curriculum said barriers were a lack of time in their curriculum and an irrelevance to high-priority subjects.

Prior to participating in the program, classroom teacher respondents said they frequently referred to online resources (63%), self-provided resources (50%), and PPL Electric (25%) to teach their students about energy. Twelve percent of respondents mentioned the ICSP as a resource. After participating in the program, respondents indicated that they frequently referred to PPL Electric (66%), online resources (49%), and self-provided resources (41%). Twenty-one percent of respondents mentioned the ICSP.

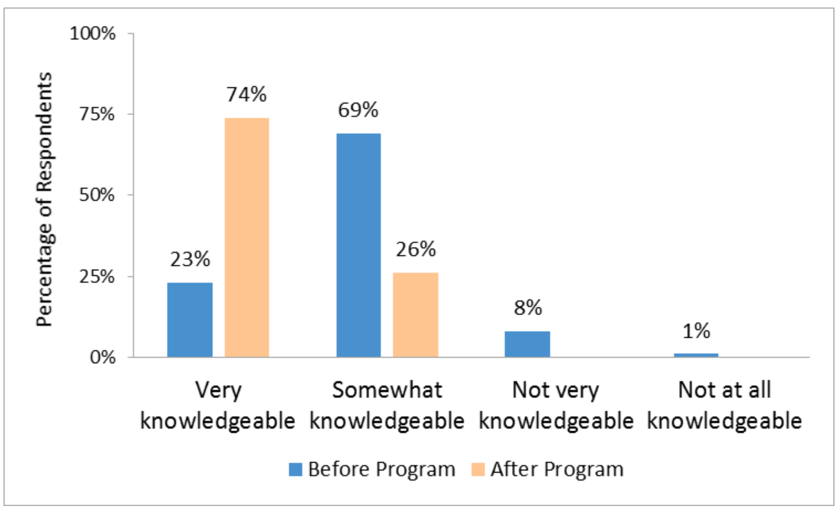
Among workshop teachers, 59% of respondents reported that they had incorporated the energy efficiency and sustainability concepts from the workshop into their classroom lesson plans. Over a third of teacher workshop respondents (39%) reported that they also participated in the classroom program component offered in the fall.

7.4.11 Impact on Energy-Efficiency Awareness

As intended, the program builds awareness of energy efficiency among participating teachers and parents. To determine the level of awareness before and the after the program, Cadmus compared responses between two survey questions (a before question and an after question) using a column proportions test.

Before participating in the program, the majority of classroom teacher respondents (69%) reported they were *somewhat knowledgeable* about ways to save energy (Figure 7-3). Only 23% of respondents considered themselves *very knowledgeable*. After participating in the program, the majority of classroom teacher respondents (74%) reported they were *very knowledgeable* about ways to save energy. The column proportions test showed a statistically significant difference for the *very knowledgeable* category whereby classroom teachers' knowledge was higher after the program (p≤0.01 or 99% confidence/1% precision level).

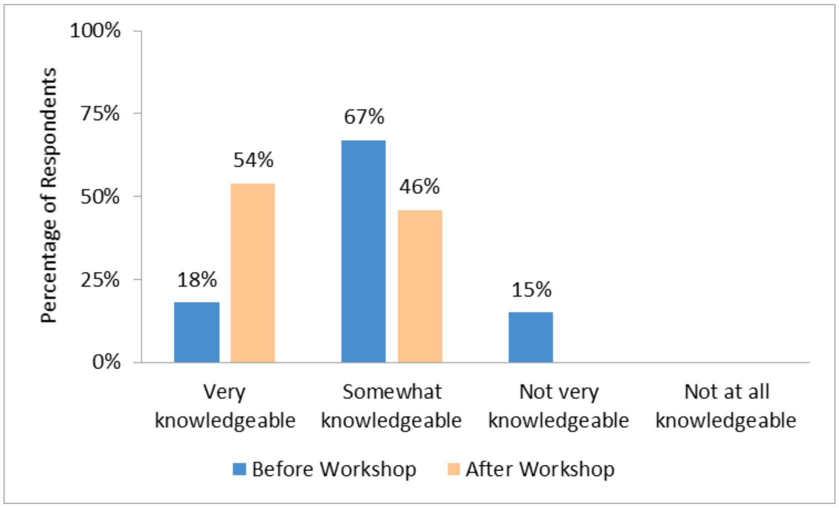
Figure 7-3: Classroom Teachers' Energy-Efficiency Knowledge Before and After the Program



Source: Classroom teacher survey. Question*, "Before/after you participated in the Think!Energy Program, how would you rate your knowledge on ways to save energy in your home? Would you say…"* (n=145).

Before attending the workshop, the majority of teacher workshop respondents (67%) reported they were *somewhat knowledgeable* about ways to save energy (Figure 7-4). Only 18% of respondents considered themselves *very knowledgeable*. After attending the workshop, the majority of teacher workshop respondents (54%) reported they were *very knowledgeable* about ways to save energy. The column proportions test showed a statistically significant difference for the very *knowledgeable category* whereby teachers' knowledge was higher after the workshop (p≤0.01 or 99% confidence/1% precision level).

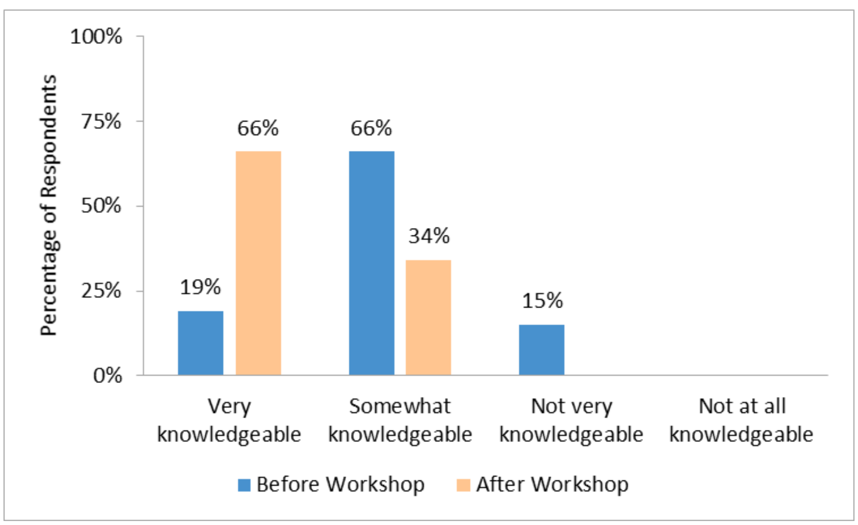
Figure 7-4: Teachers' Energy-Efficiency Knowledge Before and After the Workshop



Source: Teacher workshop survey. Question, "Before/after you attended the workshop, how would you rate your knowledge on ways to save energy in your home? Would you say…" (n=61).

Before attending the workshop, the majority of parent workshop respondents (66%) reported they were *somewhat knowledgeable* about ways to save energy in their home (Figure 7-5). Only 19% of respondents considered themselves *very knowledgeable*. After attending the workshop, the majority of parent workshop respondents (66%) reported they were *very knowledgeable* about ways to save energy in their home. The column proportions test showed a statistically significant difference for the *very knowledgeable* category whereby parents' knowledge was higher after the workshop ($p \leq 0.01$ or 99% confidence/1% precision level).

Figure 7-5: Parents' Energy-Efficiency Knowledge Before and After the Workshop



Source: Parent workshop survey. Question, "Before/after you attended the workshop, how would you rate your knowledge on ways to save energy in your home? Would you say…" (n=53).

7.4.12 Impact on Behavior Change

Since participating in the classroom and workshop components of the program, the majority of teachers and parents reported a behavior change toward energy efficiency:

- Teacher workshop respondents changed the way they use energy in the classroom (62%).
- Parent workshop respondents changed the way they use energy in the home (81%).
- Take Action (intermediate grades) parent respondents changed the way they use energy in the home (80%).
- Innovation (secondary grades) parent respondents changed the way they use energy in the home (76%).
- Classroom teacher respondents agree with the statement *"Students exposed to the Think!Energy curriculum are reporting changes in their families' energy related behaviors and decisions"* (66%).
- Parent workshop respondents talk to family members about saving energy in the home at least once a month (78%).

On the specific behaviors and actions that participants implemented to save energy in the home, parent respondents frequently mentioned turning off lights in unoccupied rooms, unplugging equipment not in use, and purchasing and installing LEDs.[89]

7.4.12.1 Spillover

After participating in the parent workshop, 59% of respondents said they had purchased energy-efficient products for the home. These products are:

- 57% reported purchasing energy-efficient lighting (CFLs or LEDs).
- 20% reported purchasing an energy-efficient appliance (a washer or dryer).
- 10% reported purchasing an energy-efficient refrigerator or freezer.
- 10% reported purchasing a smart power strip.

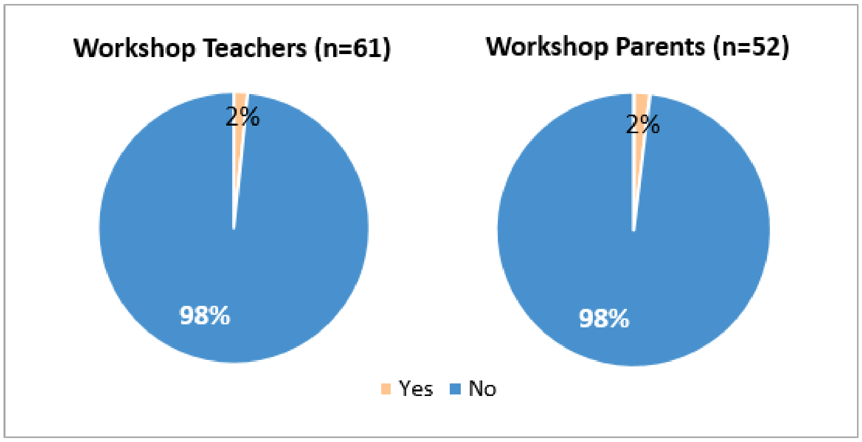
When asked how important the workshop was in their decision to purchase a particular product, 40% of respondents said their attendance at the Community In Action workshop was *very important* and 47% said *somewhat important*. The survey did not include follow-up questions to explore the reasons for specific responses.

7.4.12.2 Program Lift

The Student and Parent Energy-Efficiency Education Program continues to have little impact on steering participants into other energy-efficiency programs offered by PPL Electric. Figure 7-6 shows that only 2% of respondents, one each from the teacher workshop and parent workshop, reported participating in other PPL Electric's energy efficiency programs. The teacher workshop respondent had participated in the Residential Retail Program, and the parent workshop respondent had participated the Residential Home Comfort Program.

89 The ICSP's HEW did not ask the parents of Bright Kids the question about behavior change.

Figure 7-6: Participation in Other PPL Electric Programs



Source: Teacher workshop survey; parent workshop survey. Question, "Since participating in the workshop, have you participated in any other PPL Electric energy-efficiency programs?"

7.4.13 Energy-Savings Kits

In PY6, PPL Electric and the ICSP distributed energy-savings kits to participating classroom students (in the three cohorts), teacher workshop participants, and parent workshop participants.

7.4.13.1 Student Kits

Table 7-18 lists the three student cohorts and the products and supplementary items contained in their kits.

Table 7-18: Description of Student Kits

Student Cohort	Grade Level	Products							Supplementary Items				
		11-Watt LED Bulbs (x3)	Electroluminescent Night Light	Showerhead	Bathroom Aerator	Kitchen Aerator	TrickleStar Smart Power Strip	Furnace Whistle	Turn It Off Stickers	Shower Timer	Flow Test Bag	Mirror Decal	Plumber's Tape
Bright Kids	Primary (2nd – 3rd)	●	●						●				
Take Action	Intermediate (4th – 8th)	●	●	●		●		●	●	●	●		
Innovation	Secondary (9th – 12th)	●		●	●		●		●	●	●	●	●

Cadmus did not conduct a survey with classroom parents in PY6. Instead, we analyzed participants' comments about the kit items reported in the ICSP's parent postcard surveys. Overall, nearly all parent respondents (99%) across all three student cohorts found the products easy to install. Virtually all parent respondents (99%) also said that they continue to use the products provided in the kit.

According to the classroom teacher survey, 78% of respondents reported that their students and parents did not have questions nor have any problems installing the products provided in the kits. However, 4%

of teacher respondents said they did and added that their students and parents mostly had questions about:

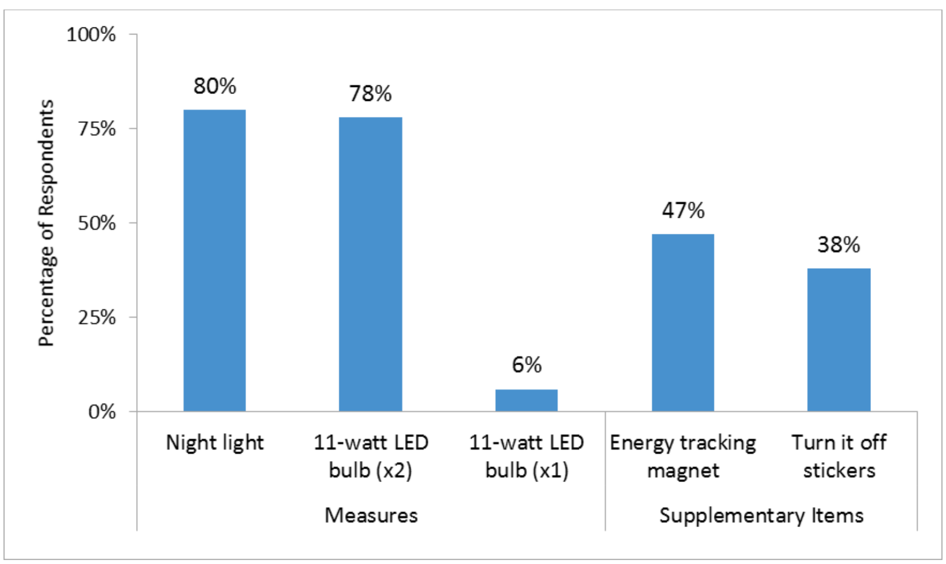
- Installation instructions
- Energy savings associated with the kit products
- How to conduct the experiments tied to the supplementary items

7.4.13.2 Workshop Kits

Teacher workshop participants received a TrickleStar smart power strip as an energy-saving product and a P3 Kill-a-Watt power meter as a supplementary item in their kit. According to the teacher workshop survey (n=61), 78% of respondents reported using the smart power strip. Of these, 64% reported using the smart power strip in the home and 21% reported using it in the classroom. Among these smart power strip users, 98% of teacher respondents continue to the use the smart power strip.

Parent workshop participants received two products (two 11-watt LED bulbs and an electroluminescent night light) and two supplementary items ("turn it off" stickers and a house-shaped energy-tracking magnet). As shown in Figure 7-7, most parent respondents installed the night light (80%) and both of the LED bulbs (78%). Of the respondents who installed the night light, 87% reported that they continue to use it. Of the respondents who installed the LED bulbs, 94% reported that they have not removed any of the LED bulbs. Half of the parent respondents (47%) reported using the energy-tracking magnet, and fewer parent respondents reported using the stickers (38%). Of the respondents who used the energy-tracking magnet, 27% found the magnet to be *very useful* in reminding them to save energy. Of the respondents who used the "turn it off" stickers, 62% found the stickers to be *very useful*.

Figure 7-7: Installation and Usage of Parent Workshop Kit Items



Source: Parent workshop survey. Questions, "Did you install both of the LED light bulbs from the kit?" (n=51); "Did you plug in the night light?" (n=51); "Did you use the turn it off stickers?" (n=42); "Did you use the energy tracking magnet?" (n=47).

7.4.14 Aspects Working Well and Areas of Improvement

Table 7-19 provides a high-level summary of the responses participating teachers and parents gave about aspects of the program that are working well and areas that can be improved. Responses came from open-ended survey questions from the Cadmus- and ICSP-administered surveys.

Table 7-19: Teacher and Parent Feedback on Program Components

Program Component	Aspect Working Well	Area For Improvement
Classroom – Bright Kids Primary (2nd – 3rd)	• Mini-grants • Posters, energy stick, and activity sheets from the Teacher Guide • Program's ability to engage students	• Provide more student interaction opportunities such as hands-on activities • Have more enthusiastic presenters • Reduce paperwork of HEWs
Classroom – Take Action Intermediate (4th – 8th)	• Posters, lesson on fossil fuels, and Energy for Electricity form the Teacher Guide • Program's ability to engage students • Materials and resources are useful	• Provide more student interaction opportunities such as follow-up visits • Improve the interactive tech components (web/digital) • Provide supplementary kit items that correlate with STEM • Have more enthusiastic presenters, especially ones with strong voices • Reduce paperwork of HEWs
Classroom – Innovation Secondary (9th – 12th)	• Electricity related activities from the Teacher Guide (Kill-A-Watt, Cost of Looking Your Best, and school lighting audit) • Program's ability to engage students • Materials and resources are useful	• Tailor information and materials more to suit high school students • Provide more student interaction opportunities such as hands-on activities • Offer more interactive tech components (web/digital) • More integration of kit items into the classroom curriculum, especially to conduct experiments • Improve the PowerPoint presentations and videos • Reduce paperwork of HEWs • Have students participate in an online survey
Teacher Workshop	• Workshop content useful for upper grade level students • Free goodies • Application of ideas to STEM	• Gear workshop content more toward lower grade level students [1] • Hand out a set of the same items for classroom use
Parent Workshop	• Information was useful, especially about smart power strips, LEDs, phantom loads, and the cookie demonstration • Great program overall	• Get the word out more; promote • Improve the presentation such as improving the sound on the video and reducing the noise in the workshop environment • Have more enthusiastic presenters

[1] Cadmus reviewed the teacher workshop binder for grade appropriateness of content, and agrees with teacher workshop respondents that the content is intended for upper grade levels.
Source: ICSP program evaluation surveys; classroom teacher survey; teacher workshop survey; parent workshop survey.

7.4.15 Benchmarking Against Other Programs

Cadmus compared kit items and installation rates from the PY6 Student and Parent Energy-Efficiency Education Program to PY5 and three utility programs from the Midwest.[90] Due to the lack of publicly available documentation of kit items and their installation rates, we were limited to evaluations from Midwest utilities.

7.4.15.1 Types of Products and Supplementary Items Offered

The comparisons focused on the kits distributed to classroom students. Table 7-20 shows the products and supplementary items offered in the student kits. The student kits contained at least one lighting product (CFLs or LEDs) and two water products (a kitchen faucet aerator and a low-flow showerhead).

Several differences emerged in the kit products:

- PPL Electric offered the greatest number of products (seven) in both program years.
- PPL Electric was the only utility to offer LEDs, a smart power strip, and a mirror decal.
- PPL Electric was the only utility to offer and count the furnace whistle as a product; Midwest Utility 2 counted the furnace whistle as a supplementary item.
- Supplementary items that the other utilities offered but PPL Electric did not use were scratch n' sniff stickers, a door sweep, a digital thermometer, and an informational chart.

Table 7-20: Comparison of Student Kit Items

Utility	Conservation Service Provider	Products								Supplementary Items								
		LEDs	CFLs	Kitchen Aerator	Bathroom Aerator	Showerhead	Night Light	Smart Power Strip	Furnace Whistle[1]	Shower Timer	Light Switch Stickers	Scratch N Sniff Stickers	Door Sweep	Digital Thermometer	Flow Rate Test Bag	Informational Chart	Teflon Tape	Mirror Decal
PPL Electric PY6	National Energy Foundation	●		●	●	●	●	●	●	●	●				●		●	●
PPL Electric PY5	National Energy Foundation		●	●	●	●	●	●	●	●	●							
Midwest Utility 1	National Energy Foundation		●	●	●	●	●			●	●	●				●		
Midwest Utility 2	National Energy Ed. Development		●	●	●	●			●				●					
Midwest Utility 3	Resource Action Programs		●	●		●								●	●	●	●	

[1] Midwest Utility 2 counted the furnace whistle as a supplementary item instead.

90 Cadmus conducted evaluations in 2012 and 2013 for these three school-based kit programs offered by utilities in the Midwest. These reports are not available to the public. The methodology for determining the installation rates for these Midwest utilities was similar to PPL Electric. Cadmus used paper surveys included in the kits and follow-up telephone surveys with participating households to determine the installation rates.

7.4.15.2 Installation Rates of Kit Products

Table 7-21 shows how PPL Electric's installation rates of the kit products compared to the three other Midwest utilities. Overall, lighting products achieved higher installation rates than water products. The following lists installation rate comparisons by product.

- **LEDs.** No comparisons could be made to LED installation rates because no other utility programs reviewed offered LEDs in their student kits. Nonetheless, PPL Electric's PY6 achieved, on average, a higher installation rate for LEDs (70%) than the ICSP-implemented programs that offered CFLs (PY5 and Midwest Utility 1). All three ICSP-implemented programs offered three bulbs, but the PY6 parent workshop kit (78%) and Midwest Utility 2 (78%), which had the highest installation rates on average, offered two bulbs.
- **Kitchen Aerator.** PPL Electric's PY6 installation rate (34%) was on par with PY5 and two other utilities (33% to 37%). This is a substantial difference from the highest performer, Midwest Utility 1 (51%), whose program was also implemented by the ICSP.
  - On closer review, the high installation rate from Midwest Utility 1 may be that the utility provides electric and gas services and partnered with another electric and gas utility in the same region to reach customers who were serviced by the two different utilities. Depending on the service territory, Midwest Utility 1 provided kits to electric fuel customers while its partner utility provided kits to gas fuel customers and vice versa, therefore increasing the program's participation reach and increasing the overall likelihood of installation.
- **Bathroom Aerator.** PPL Electric's PY6 had the lowest installation rate (31%) compared to other utility programs.
- **Showerhead.** PPL Electric's PY6 had the lowest installation rate (31%) compared to other utility programs.
- **Night Light.** Although the night light achieved the highest installation rate out of the PY6 products, PPL Electric's PY6 had the lowest installation rate (83%) among the ICSP-implemented programs.
- **Smart Power Strip.** Only PPL Electric offered this product. Therefore, we made no installation rate comparisons with other utilities. PY6's installation rate (74%) was lower than PY5 (80%).
- **Furnace Whistle.** PPL Electric's PY6 installation rate (14%) did not differ from PY5 (15%), but was considerably lower than Midwest Utility 2 (34%).

Table 7-21: Comparison of Student Kit Installation Rates

Utility	Conservation Service Provider	Products							
		LEDs [1]	CFLs [2]	Kitchen Aerator	Bathroom Aerator	Showerhead	Night Light [3]	Smart Power Strip	Furnace Whistle
PPL Electric PY6	National Energy Foundation	70%	--	34%	31%	31%	83%	74%	14%
PPL Electric PY5	National Energy Foundation	--	66%	35%	36%	32%	89%	80%	15%
Midwest Utility 1	National Energy Foundation	--	65%	51%	39%	44%	93%	--	--
Midwest Utility 2	National Energy Ed. Development	--	78%	33%	40%	48%	34%	--	34%
Midwest Utility 3	Resource Action Programs	--	52%	37%	--	36%	--	--	--

[1] PPL Electric PY6 offered three LED bulbs in their kits.

[2] PPL Electric PY5, Midwest Utility 1, and Midwest Utility 3 offered three CFL bulbs in their kits while Midwest Utility 2 offered two CFL bulbs. The averaged installation rate of CFLs is reported here.

[3] PPL Electric and Midwest Utility 1 offered an electroluminescent night light. Midwest Utility 2 offered an LED night light.

7.5 Conclusions and Recommendations

Based on the findings, Cadmus drew conclusions and suggests that PPL Electric consider these recommendations in PY7.

Conclusion
The Student and Parent Energy-Efficiency Education Program achieved the savings planned for PY6. Program satisfaction and satisfaction with PPL increased from PY5 for the most part. Still, teacher and parent participation and feedback indicated that the program could improve its installation rates, the workshop curriculum, and the HEW data collection process.

Conclusion
The ISCP's targeted marketing and personalized outreach efforts that focused on recruiting new participants, making one-on-one calls, and sending personalized e-mails to schools with a low-income population galvanized program awareness and helped to increase participation across all cohorts and workshops. In PY6, more kits were distributed (22,314 kits) than in PY5 (21,036 kits).

Conclusion
A sizeable proportion of the participating teachers in the classroom (70%) and workshop (36%) components had previously participated, suggesting strong participant retention and presenting a case for more new recruitment marketing.

Recommendation
Focus on recruiting new schools and educators for participation in the classroom component to maintain strong kit distribution. The ICSP is on the right track with its marketing approach of targeted marketing and personalized outreach efforts employed in PY6 that focus on new participants, schools with a low-income population, and personalized communication.

Conclusion

Installation rates stayed relatively consistent from PY5 to PY6. Participants continued to use the “plugged-in” products (LED bulbs, smart power strips, and night lights) more than the furnace whistle or the water products. Items offered in the kits remained unchanged from PY5.

Recommendation

Consider increasing the grade-appropriate classroom instructions and discussion about the furnace whistle, showerhead, and faucet aerator items.

Recommendation

Explore new program implementation ideas such as rotating kits, product trade-ins, and donating unused products as ways to help boost installation rates. When kit products continue to remain the same, saturation of the products will make it more unlikely that they will get installed. In the PY5 evaluation, participants commonly cited that they did not install a particular product because they had already installed one. Although PPL Electric and the ICSP carefully track kit distribution to avoid any repeat kit distributions to the same population of participants, rotating the kits or products every other year may offer an easier way to track kit distributions. Offering a way for participants to trade for different products with other participants, or donating them to others, can ensure that products are used. Changing up the program implementation rather than the kit offerings provides an alternative solution to maintaining or improving the installation rates and overall program savings.

Conclusion

The teacher workshop curriculum changes allowed teachers who participated in prior years to attend in PY6, resulting in the workshop exceeding its planned participation. PPL Electric and the ICSP exceeded their KPI plan of 150 teacher workshop participants by reaching 190 participants. The Pennsylvania Department of Education imposes a requirement where teachers cannot attend the professional workshop if they attended a workshop with the same curriculum in a prior year. The workshop curriculum in PY6 changed by adding topics related to renewable energy and aligning them with the STEM paradigm.

Conclusion

From the program evaluation surveys, Innovation classroom teachers and workshop parents commonly cited the electricity-related topics to be their favorites (lighting audit, kill-a-watt, phantom loads, smart power strips).

Recommendation

Consider revising the workshop curriculum to allow repeat participation. Include more topics that align with STEM or modify existing curriculum topics to align with STEM, such as electricity-related topics.

Conclusion

Based on a materials review of the teacher workshop binder, the PY6 workshop curriculum, with its focus on STEM, was found to be appropriate for upper grade levels; however, the majority (40%) of participating teachers represented primary grade levels. In the open-ended comments, several teachers requested that the workshop provide content appropriate for lower grade levels.

Recommendation

Offer grade-appropriate breakout sessions or grade-specific workshop dates. Breakout sessions can provide teachers of similar grade levels a chance to brainstorm ideas on ways to adjust the workshop curriculum for their specific grade-level needs. Grade-specific workshop dates offer an alternative to the breakout sessions by automatically grouping teachers of primary, intermediate, and secondary grades in their respective cohorts. Both the breakout sessions and grade-specific workshop dates can further provide teachers with networking and professional support opportunities long after the workshop ends.

Conclusion

The PY6 program did not meet its KPI plan for workshop and classroom participation as measured by the number of HEWs returned. PY6 achieved a HEW return rate of 72%. PY5 achieved a HEW return rate of 79%. From classroom teachers' qualitative open-ended responses, respondents suggested reducing the paperwork involved with the HEWs (transferring the HEWs onto Scantron forms). Classroom teachers from the Innovation student cohort also suggested more interactive tech components (web/digital) and getting students to complete an online survey.

Recommendation

Test the idea of using an online HEW completion process proposed by the ICSP with the Innovation student cohort.

Recommendation

Consider a streamlined online HEW data collection input process where students input the data online instead of filling out a Scantron form. The paper HEW would be completed at home, but the data would be entered online through an identical-looking form. Teachers can then review the collected data and submit everything online, reducing the amount of paperwork for both students and teachers.

Conclusion

The parent workshop's impact on participation in other PPL Electric energy-efficiency programs was minimal. Only one respondent out of 52 surveyed respondents reported having participated in another program after the workshop. PY6 program lift did not improve from PY5.

Recommendation

Consider cross-program marketing through the kits to achieve better program lift. With over 22,000 kits being distributed and participants curiously exploring the contents of the kits, the Student and Parent Energy-Efficiency Education Program provides tremendous reach in educating customers about all of PPL Electric's energy-efficiency programs.

Conclusion

In general, utilities found that water products had lower installation rates than lighting products. Our benchmarking study found that Midwest Utility 1, which had the highest installation rates, may have increased their installation rates by partnering with another utility in the same region to reach customers who were serviced by two different utilities.

7.5.1 Status of Recommendations for Program

Table 5-17 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 7-22: Student and Parent Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Student and Parent Energy-Efficiency Education Program	
Continue to recruit new schools and educators.	Will be implemented in Phase III.
Consider increasing the grade-appropriate classroom instructions and discussion about the furnace whistle, showerhead, and faucet aerator items.	Will be implemented in Phase III.
Explore new program implementation ideas such as rotating kits, product trade-ins, and donating unused products.	Being considered for Phase III.
Consider revising the workshop curriculum by including more topics that align with STEM or modify existing curriculum topics to align with STEM.	Being considered for Phase III.
Offer grade-appropriate breakout sessions or grade-specific workshop dates.	Being considered for Phase III.
Test the idea of using an online HEW completion process proposed by the ICSP with the Innovation student cohort.	Being considered for Phase III.
Consider a streamlined online HEW data collection process where after students enter the data online, teachers can review and submit data online, thus reducing the paperwork.	Being considered for Phase III.
Consider cross-program marketing through the kits.	Being considered for Phase III.

7.6 FINANCIAL REPORTING

A breakdown of the Student and Parent Energy-Efficiency Education Program finances is presented in Table 7-23.

Table 7-23: Summary of Student and Parent Energy-Efficiency Education Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$0	$0
2	EDC Incentives to Participants	$0	$0
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$0	$0
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$1,967	$2,980
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$1,967	$2,980
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$1,967	$2,980
13	Total NPV Lifetime Energy Benefits	$4,256	$7,039
14	Total NPV Lifetime Capacity Benefits	$189	$268
15	Total NPV O&M Saving Benefits	$427	$692
16	Total NPV TRC Benefits[4]	$4,872	$7,999
17	TRC Benefit-Cost Ratio[5]	2.68	2.68

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

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

ADDENDUM A. SURVEY METHODOLOGY

Sample Cleaning and Attrition

Prior to the start of survey data collection, Cadmus coordinated with PPL Electric's survey subcontractor to screen the sample and remove customer records that were called in the past year (whether for a Cadmus survey or a PPL Electric survey) or that requested not to be contacted again. Duplicate records across all groups in the program were removed along with records with incomplete information.

In some cases, this cleaning process reduced the available sample. Cadmus selected all remaining records and sent them to the survey subcontractor. Table 7-24 lists total number of records submitted and the final outcome of each record.

Table 7-24: Survey Sample Attrition

Description	Teacher		Parent
	Workshop	Participant	Workshop
Number of Kits	**190** [1]	**703** [2]	**1,015** [3]
Total Population (Number of Participants who Returned the HEWs)	190	703	1013
Opt-in Population	190	703	308
Removed because no e-mail address and no phone number	15	89	54
Removed because no e-mail and incomplete phone number	0	0	2
Removed because incomplete or unreadable e-mail and no phone number	0	0	1
Removed because duplicate e-mail address	2	3	0
Removed because duplicate phone	0	0	1
Removed because completed survey in past 12 months	1	98	3
Survey Sample Frame (Records Sent to Survey Subcontractor)	172	513	247
Records Attempted	**172**	**513**	**247**
Did not qualify to take survey	1	3	0
Nonworking number	0	0	5
Business/wrong number	0	0	4
Refusal	0	1	8
Language barrier	0	0	3
No answer/answering machine/phone busy	0	0	8
Nonspecific or specific callback scheduled	0	0	16
Partially completed survey	7	46	5
Remaining non-final records [4]	103	318	146
Completed survey	**61**	**145**	**53**

[1] Number of attendees (no claimed savings for teacher workshop kits).
[2] Number of participants for classroom teacher is the number of people who received a smart power strip.
[3] Parent workshop population includes anyone who received a kit.
[4] These records were included in the sample frame but participants did not respond.

ADDENDUM B. LOGIC MODEL

The following lists the logic model for the Student and Parent Energy-Efficiency Education Program:

- **Activities the program undertakes** include conducting in-classroom energy-efficiency education for primary, intermediate, and secondary grade level students, conducting outreach, providing training to teachers, providing workshops for low-income customers (parents), and providing free take-home kits with energy-efficiency products for all participants.
- **Outputs produced by program activities** include the number of free take-home energy-savings kits produced and disseminated to customers, the number of workshops conducted, the number of teachers trained, and the number of low-income consumers (parents) educated.
- **Short-term outcomes (usually one to two years)** include training and workshops that educate students and low-income customers about energy efficiency to help customers reduce their energy consumption and energy costs. Energy savings from installed kit products are another short-term outcome. Participation in other PPL Electric programs, and the associated energy savings accruing from participation, is a possible short-term outcome.
- **Intermediate outcomes (two to three years**) include a more knowledgeable student, teacher, and low-income customer base. As this occurs, customers will continue to make informed and effective decisions about their energy use. This will result in additional energy savings, higher customer satisfaction, and environmental benefits.
- **Long-term outcomes (four years and longer)** include energy savings that persist from installed kit products and a more energy-literate customer base.

ADDENDUM C. BENCHMARKING

After presenting the PY5 evaluation findings, PPL Electric expressed interest in knowing how the Student and Parent Energy-Efficiency Education Program's installation rates compared to student kit programs offered by other utilities nationwide. By researching other utility programs' installation rates and their program delivery, PPL Electric aims to discover solutions and ideas on ways to increase installation rates.

Due to the lack of publicly available documentation of kit items and their installation rates, Cadmus was limited to evaluations from three Midwest utilities. Cadmus had conducted impact and process evaluations in 2012 and 2013 for school-based kit programs offered by these utilities. These reports are not available to the public.

8 RESIDENTIAL HOME COMFORT PROGRAM

The Residential Home Comfort Program offers energy-saving products and rebates for new construction and retrofitted existing homes. The program offers a wide range of energy-efficient products, rebates, education, and services that allow customers to customize solutions to increase their home's energy efficiency. The program has five program components:

- **New homes** encourages construction of energy-efficient new homes through two paths:
  - **Prescriptive path** offers a $2,000 rebate to builders for installing a specific package of efficient products.
  - **HERS approach** offers builders a rebate of $0.30 per kWh saved (up to $2,000) for homes built with any combination of a specific package of products.
- **Manufactured homes** offers a $1,200 rebate to buyers of an ENERGY STAR® manufactured home and an additional rebate of up to $300 for the installation of efficient heating.
- **Audit** provides customer rebates for professional comprehensive home energy audits or a less comprehensive audit for $50. It also offers thermal imagery guns and technical training to Building Performance Institute (BPI)-certified contractors who conduct program audits to improve audit diagnostics.
- **Weatherization**, based on recommendations from an audit, provides rebates for ceiling and wall insulation.
- **Energy-efficient equipment** provides rebates for installation of high-efficiency air source heat pumps (ASHPs), ductless heat pumps (DHPs), and in-ground pool pumps.

The objectives of the Residential Home Comfort Program are to:[91]

- Encourage customers to view energy-efficiency in a holistic manner.
- Introduce and educate customers on new energy saving technology.
- Promote construction of energy-efficient new homes.
- Educate construction industry professionals about the benefits of energy-efficient new homes.
- Provide customers with audits, surveys, and energy-saving solutions.
- Provide immediate energy savings to customers by providing free direct install products.
- Improve audit diagnostics by adding thermal imagery guns and providing technical training to participating BPI contractors on their use.
- Obtain participation by approximately 14,500 customers and trade allies through 2016, with a total reduction of approximately 15,300 MWh/yr.

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

[91] Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.57.

Table 8-1: Phase II Residential Home Comfort Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio [1]	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Residential Home Comfort	6,255	6,207	6,493	0.60	0.66	$3,449	$0.53	$0.18	6,823
Total	**6,255**	**6,207**	**6,493**	**0.60**	**0.66**	**$3,449**	**$0.53**	**$0.18**	**6,823**

[1] PY5 results for equipment are assumed for PY6; no new surveys were conducted. Too few participants of new program component responded to surveys; no meaningful conclusions can be drawn.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

8.1 PROGRAM UPDATES

In PY6, PPL Electric Utilities added these rebates to the Residential Home Comfort Program:

- **HERS Approach Rebate to the New Construction Component.** This flexible new construction option provided a rebate of $0.30 per kWh saved with a cap of $2,000 for homes built with any of these products— air source or geothermal heat pumps, natural gas furnaces, central air conditioners, heat pump water heaters (HPWHs), attic and wall insulation, ENERGY STAR refrigerators and dishwashers.
- **Manufactured Homes Rebate.** This provided an incentive of $1,200 to customers who purchased an ENERGY STAR manufactured home with an ASHP installed in a property using active service from PPL Electric Utilities. An additional rebate of $200 was available to PY6 participants who installed a SEER 14 ASHP; a rebate of $300 was available to those also installing an ASHP with an efficiency rating greater than or equal to SEER 15.
- **Bonus Rebate**. PPL Electric Utilities added a bonus rebate of $375 for audit participants who followed through and installed recommended insulation products within 180 days of the comprehensive audit.
- **Residential Thermal Storage Rebate.** This was a $200 rebate for customers who were on PPL Electric Utilities' Residential Thermal Storage (RTS) rate and who upgraded their heating system to an ASHP or DHP of SEER 15 or greater.
- **Thermal Imagery.** PPL Electric Utilities offered assistance to its audit contractors with purchasing thermal imagery guns along with technical training to audit contractors to improve audit diagnostics. Audit contractors were eligible to take advantage of the training regardless of whether they received assistance with purchasing a thermal imagery gun through the program.
- **LEDs.** In PY6, PPL Electric Utilities stopped offering CFL bulbs to audit participants and instead offered LED bulbs.
- **Air Source Heat Pumps.** Amended federal conservation standards applying to minimum SEER, EER, and HSPF for residential air conditioners and heat pumps manufactured on or after January 1, 2015, took effect on January, 1, 2015.[92]

92 Code of Federal Regulations, 10 CFR 430.32(c)(3) and 10 CFR 430.32(c)(5). Full text available here: http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR.

8.1.1 Definition of Participant

In the Residential Home Comfort Program, a participant is defined as a participant (a database record) with a unique CSP Job ID (Conservation Service Provider Job Identifier). There may be (and often are) multiple products installed by a single participant, such as the low-cost efficiency products installed at the time of the audit. All products with the same CSP Job ID are associated with and counted as one participant.

8.2 IMPACT EVALUATION GROSS SAVINGS

Table 8-2 shows the cumulative reported gross energy savings and incentives paid in Phase II. Participants include counts for all Residential Home Comfort Program components—audit, weatherization, efficient equipment, new construction, and manufactured homes. In PY6, the program provided rebates to 4,269[93] participants, reported gross energy savings of 3,888 MWh per year, and a gross demand reduction of 1.5 MW.

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

Sector	Phase II Participants	Phase II Reported Gross Energy Savings (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Residential	6,816	6,249	2.44	$1,565
Small Commercial and Industrial	5	5	-	$0
Government, Nonprofit, and Educational	2	-	-	$0
Phase II Total	**6,823**	**6,255**	**2.44**	**$1,565**

Energy savings and demand reductions must be calculated using the Pennsylvania TRM or Guidance Memo in effect on the date the product was installed. In PY6, 15% of all rebates had installation dates that occurred in PY5, and 85% had installation dates that occurred in PY6.

8.2.1 Sampling

For verification activity sampling, records were assigned to one of eight strata. The strata definitions are defined in Table 8-3.

Table 8-3: PY6 Residential Home Comfort Program Strata Definitions

Sector	Stratum	Products Included
Residential	Audits	Energy education, CFLs, LEDs, faucet aerators, showerheads, water heater pipe insulation, smart power strips, water heater temperature setbacks, furnace whistles
	Weatherization	Ceiling and wall insulation in existing homes
	Air-Source Heat Pumps	SEER 15, SEER 16
	Ductless Heat Pumps	SEER 15 or greater
	Fuel-Switching	From electric systems to gas-fired furnaces or propane-fired furnaces
	Pool Pumps	Variable-speed pumps
	New Homes	ASHP 16, HPWH EF 2.3, Energy STAR appliances, ceiling and wall insulation
	Manufactured Homes	Energy STAR manufactured homes, ASHP SEER 15 or greater

93 In PY6, 4,269 unique households participated. There were 4,330 unique jobs (identified by the CSPJobNo) that received an item(s) in one of the stratum., therefore, some participants could install items from more than one stratum. Further, some participants installed more than one item in a stratum, e.g., installed more than one DHP outdoor and indoor unit.

The sampling strategy for these strata is shown in Table 8-4. The EM&V sample plan was designed to meet levels of 85% confidence and 15% precision by program. Table 8-4 summarizes the approaches used to evaluate savings for each program stratum. These approaches are discussed in detail in the following sections.

Table 8-4: PY6 Residential Home Comfort Program Impact Evaluation Sampling Strategy[1]

Stratum	PY6 Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Audits	1,066	85/15 at program level 90/10 at sector level	40	40	Records review
Weatherization	218		40	109	Records review
Air-Source Heat Pumps	1,753		40	40	Records review
Ductless Heat Pumps	1,177		40	39	Records review
Pool Pumps	55		Census	55	Records review
Fuel-Switching (Electric to Gas)	24		Census	16	Records review
New Homes	31		Census	31	Records review
Manufactured Homes	6		Census	6	Records review
Program Total	**4,330**			**336**	

[1] 4,330 participants (unique CSPJobNo) (representing 4,269 households) received these products and services; some could appear in more than one stratum.

8.2.2 Verification Activities

Cadmus reviewed all records for the sample of PY6 projects and the supporting documentation. The records review involved verifying information in EEMIS using program intake forms and home energy reports.

Table 8-5 lists the sample sizes for each stratum by quarter. The records review exceeded the sample design targeting levels of 85% confidence and 15% precision by program.

Table 8-5: PY6 Residential Home Comfort Program Sampling by Quarter[1]

Stratum	Q1	Q2	Q3	Q4	Total	Participation in PY6
Audits	10	10	10	10	40	1,066
Weatherization	38	61	10	0	109	218
Air-Source Heat Pumps	10	10	10	10	40	1,753
Ductless Heat Pumps	10	10	10	9	39	1,177
Pool Pumps	34	4	3	14	55	55
Fuel-Switching (Electric to Gas)	3	3	7	3	16	24
New Homes	0	0	27	4	31	31
Manufactured Homes	0	0	4	2	6	6
Total Sample Points	**105**	**98**	**81**	**52**	**336**	**4,330**

[1] 4,330 participants (unique CSPJobNo) received these products and services and represent 4,269 households. Some could appear in more than one stratum, and some could receive more than one item, e.g., more than one DHP outdoor and indoor unit. There were 1,177 households installing a DHP outdoor unit. A household can install more than one outdoor unit; 1,441 outdoor DHP were rebated.

For the quarterly records reviews, Cadmus drew 10 sample points each from the audit stratum, the ASHP stratum, and the DHP stratum. Cadmus reviewed all pool pump, weatherization, and fuel-switching records since EEMIS does not provide all of the parameters necessary to calculate *ex ante* adjusted and *ex post* verified.

Additionally, Cadmus requested and reviewed all records for the new construction HERS approach stratum, all three records for the new construction prescriptive path stratum, and all six records for the manufactured homes stratum because the new construction components did not report participation and savings until the second half of PY6 and therefore merited closer scrutiny.

Cadmus conducted phone surveys with the six manufactured homes participants and the 133 participants who installed heat pumps and noted that natural gas service was available at their home.

Cadmus also fielded a cross-cutting survey of 177 participants in the audit and efficient equipment components. These surveys were not designed to verify product installation but rather to verify participation in the program and whether the participant met the definition of a low-income customer. The surveys also collected information about fuel-switching and customer satisfaction with the program. The phone survey samples were drawn independently of the records review sample.

8.2.3 Adjusted *Ex Ante* Savings

Reported gross energy savings and demand savings records with installation dates in PY5 are deemed or calculated per the 2013 Pennsylvania TRM.[94] Reported gross energy savings and demand savings for products with installation dates in PY6 are deemed or calculated using the algorithms in the 2014 Pennsylvania TRM.[95] Cadmus calculated adjusted *ex ante* energy savings and demand savings using the input parameters reported in EEMIS for each record. Where input parameters were not provided in EEMIS, such as for weatherization products, Cadmus used default values provided in the TRM to calculate *ex ante* adjusted savings and demand reductions.

8.2.4 *Ex Post* Evaluated Gross Savings

Cadmus calculated verified energy savings and demand reductions for each product in the sample using parameter values sourced from the supporting documentation provided by the ICSP in response to Cadmus' quarterly data requests. From the verified savings, Cadmus calculated weighted realization rates by stratum and for each stratum applied the appropriate realization rate to all records in the stratum to calculate the *ex post* evaluated savings to date in PY6. These are provided in Table 8-7 and Table 8-8.

8.2.4.1 Air Source Heat Pumps

All verified input parameters matched those reported in EEMIS, with five exceptions. For these five records, Cadmus found discrepancies between the capacity and efficiency values reported in EEMIS and the values found on the Air Conditioning, Heating, and Refrigeration Institute (AHRI) certificate or on the rebate forms. To calculate *ex post* savings for these records, Cadmus used the verified parameter values found on the AHRI certificates or rebate forms. Cadmus calculated *ex post* evaluated savings for all heat

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

95 Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2014. Available online: http://www.puc.pa.gov/pcdocs/1265230.docx

pumps in aggregate, but for ASHPs in PY6, the unweighted realization rate for energy savings was 101% and for demand reductions was 102%.

8.2.4.2 Ductless Heat Pumps

In PY6, Cadmus found six rebates with inaccuracies in parameter values such as the SEER, capacity, or heating seasonal performance factor (HSPF) of either the existing or installed equipment. Cadmus calculated verified savings using values observed on the application forms and supporting documentation. Cadmus calculated *ex post* evaluated savings for all heat pumps in aggregate, but for DHPs in PY6 realization rate for energy savings was 102% and for demand reductions was 101%.

8.2.4.3 Audit

For the audit component records review, Cadmus selected a random sample stratified on audit type. Cadmus calculated the *ex post* energy savings and demand reduction values for all audits in aggregate using the realization rate for the entire audit component, not just rates for each individual audit.

Cadmus found no discrepancies in quantities in the PY6 records reviews. Beginning in PY6, auditors recorded data about direct-install products electronically, using tablet or notebook computers, instead of on paper. Cadmus verified these quantities using data from each participant's Home Energy Report and made adjustments to in-service rates as part of the records review. Because this program contributes a small percentage of savings to PPL Electric's portfolio, Cadmus did not conduct participant surveys for audit participants in PY6 but instead reviewed historical installation rates and compared them with the in-service rate assumptions in the 2013 and 2014 TRMs, as shown in Table 8-6. Where applicable, Cadmus assumed the ISR determined via PY5 surveys.

Table 8-6: PY6 Residential Home Comfort Program In-Service Rate Adjustments

TRM	Measure Category	PY6 Population	Reviewed in PY6 Verification Sample	In-Service Rate	
				Default	Verified
2013	Aerators	156	7	100%	Assume PY5 97%
	CFLs	878	34	84%	96%
	LED Nightlights	134	0	84%	97%
	Pipe Insulation	112	0	None	None
	Smart Strips	139	6	None	None
	Showerheads	50	0	None	Assume PY5 88%
2014	Aerators	123	0	None	Assume PY5 97%
	Furnace Whistles	6	0	47%	47%
	LEDs	4,405	163	97%	97%
	LED Nightlights	744	32	97%	97%
	Pipe Insulation	1,890	48	None	None
	Smart Strips	521	18	None	None
	Showerheads	85	3	None	Assume PY5 88%
	Water Heater Setback	44	0	None	None

For LED bulbs, Cadmus did not apply the historical verified in-service rate of 96% for CFL bulbs developed from responses to the PY5 participant survey. There is no current information to support the assumption that the in-service rate for LED bulbs is the same as that for CFL bulbs.

For the audit component, the realization rate for energy savings was 101% and for demand reduction was 100%.

8.2.4.4 Weatherization

In the PY6 review, Cadmus found some records where the additional square footage of weatherization was not included in the quantity recorded in EEMIS. Cadmus calculated *ex post* savings with the revised quantities.

Cadmus also found weatherization records where the code reported in EEMIS did not match the heating or cooling equipment recorded on the rebate form. Energy savings and demand reduction algorithms vary, depending on the heating and cooling equipment present in the home, and each weatherization product has multiple possible codes to identify the home's heating and cooling equipment. Cadmus calculated *ex ante* adjusted energy savings and verified energy savings using the product code (EEMIS measure code) and algorithm corresponding to the heating or cooling equipment found on the rebate form.

Finally, Cadmus found records with incorrectly assigned baseline R-values. For insulation products, both the 2013 and 2014 TRM savings algorithms employ parameters for the baseline and efficient R-values of insulation. Both TRMs stipulate a minimum value for the baseline R-value—the 2014 TRM stipulates the baseline of R5 for an uninsulated space, whether ceiling (roof) or wall, and the 2013 TRM stipulates a minimum baseline of R3 for wall insulation and a minimum baseline of R5 for ceiling (roof) insulation. Cadmus noted that for weatherization records where the rebate form recorded a baseline R-value of zero, the savings calculation used to produce the reported savings should have adjusted the baseline to R5 or R3. Cadmus used the TRM-stipulated minimum baseline values in calculations of *ex ante* adjusted energy savings and verified energy savings.

The PY6 weatherization component's realization rate for energy savings is 101% and for demand reduction is 108%.

8.2.4.5 Pool Pumps

Cadmus reviewed the specification sheets for all 14 pool pumps installed in Q4 and determined that all were variable-speed pumps. In the savings algorithm, Cadmus used the actual hours of operation per day recorded on the rebate form. The PY6 pool pump realization rate for energy savings is 403% and the realization rate for demand reductions is 115%.

8.2.4.6 New Construction

Cadmus reviewed the supporting documentation for all three prescriptive path new construction rebate applications and all 28 HERS approach rebate applications. For the prescriptive path applications, Cadmus calculated savings per the 2014 TRM algorithms for these products—insulation, HPWH, refrigerators, and dishwashers. The realization rate for the prescriptive path rebates was 100% for both energy savings and demand reduction.

For the HERS approach applications, Cadmus reviewed the REM/Rate files and fuel reports provided with the rebate applications and remodeled savings using REM/Rate and the program's user-defined reference home (UDRH) specifications. Fourteen homes, which were submitted early in the program year, either used the incorrect UDRH specification or reported the total savings including appliances as the temperature-sensitive savings. Because separate savings are reported in EEMIS for the appliances, this meant that savings were double-counted. Cadmus calculated the *ex ante* adjusted savings using the temperature-sensitive savings found on the fuel reports and calculated the *ex post* savings using the values produced by Cadmus remodeling.

All four rebates submitted in Q4 used the IECC 2009 specification rather than the UDRH specification. Cadmus recalculated savings using the correct baseline. For the appliances (HPWH, refrigerators, and dishwashers), Cadmus calculated savings using the algorithms in the 2014 TRM. These adjustments resulted in a realization rate for energy savings of 102% for the HERS approach rebates. Because the program did not report demand reductions for the new construction component, the realization rate for demand reductions is not meaningful.

8.2.4.7 Manufactured Homes

Cadmus reviewed the supporting information for all six rebates submitted for manufactured homes in PY6. Cadmus modeled savings for the six applications using REM/Rate and information in the supporting documentation. All six homes were manufactured by the same company, which produces only ENERGY STAR manufactured homes and, to simplify its construction process, builds all homes to meet the requirements of Climate Zone 1, the most extreme climate zone in the northeastern United States.[96] Consequently, modeled savings for all homes were higher than the reported values and the realization rate for manufactured homes was 111% for energy savings and 206% for demand reductions.

8.2.4.8 Fuel-Switching

Cadmus requested and reviewed the supporting documentation for all 24 fuel-switching rebates reported in PY6. Sixteen records provided the complete information necessary to calculate savings using the algorithms of the 2014 TRM protocol.[97] For the PY6 records, the majority of the installed units were fossil-fuel furnaces (19, n=24), the average capacity of the new fossil-fuel equipment was 78,100 Btu/hr, and the average savings per unit was 8,888 kWh. The PY6 fuel-switching pilot had a 193% realization rate for energy savings. The fuel-switching pilot produces only heating savings; therefore, it does not produce a demand reduction.

Some of the PY6 rebate applications included the AHRI certificate for the new heating equipment, which had information about the capacity and equipment type and is a useful source of information when the application form is incomplete.

These four values are absolutely necessary to collect on the rebate form or supporting documentation:

- Equipment type of the replaced equipment – equivalent full load hours (EFLH) depend on this value
- Capacity of the replaced equipment
- Equipment type of the new equipment, specifically, whether the unit is a furnace or a boiler. For boilers, the annual pump energy consumption is negligible (< 50 kWh per year) and is not included in the energy impact calculations in the TRM algorithms.[98]
- Capacity of the new equipment

---

96 PPL Electric Utility's service territory is in Climate Zone 2.

97 The 2014 Pennsylvania TRM, Chapter 2.19 Fuel Switching: Electric to Gas/Propane/Oil Heat, applies three critical parameters—equipment type of the new equipment (furnace or boiler) and the capacities in Btu/hr of both the new and replaced heating equipment. All other algorithm parameters have default values, as the TRM shows in Table 2.38 Default values for algorithms terms, Electric Heat to Gas Heat; however, the capacity values are listed as "variable" with a source of "EDC Data Gathering."

98 Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2014. p. 101. Available online: http://www.puc.pa.gov/pcdocs/1265230.docx.

8.2.5 Summary of Evaluation Results

Cadmus calculated energy savings per product using the algorithms in both the 2013 and 2014 TRMs and electric distribution company (EDC) data gathering. Cadmus calculated the realization rate using findings from the projects chosen for telephone verification and from the results of the records reviews. The realization rate was then applied to the population and calculated as the ratio of *ex post* verified gross savings to *ex ante* adjusted savings.

Cadmus' final estimate of program-wide savings for each component of the program employed a single realization rate, which was calculated by first aggregating savings by customer (for TRM-adjusted *ex ante* and for *ex post*) and then calculating a single realization rate that applies to the program-wide TRM-adjusted *ex ante* total. Because this approach employs a single realization rate, rather than a collection of interdependent realization rates, standard variance calculations yield valid program-wide precision estimates.

Table 8-7 provides the verified gross energy savings, the realization rates, and the precision around the estimates by stratum and for the program in aggregate. The Residential Home Comfort Program achieved verified gross energy savings of 4,083 MWh per year, plus or minus 1.48%, and a realization rate of 106% over adjusted *ex ante* energy savings with precision of 1.48% at the 85% confidence level.

Table 8-7: PY6 Residential Home Comfort Program Summary of Evaluation Results for Energy

Stratum	Reported Gross Impact (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr) [1]	Observed Coefficient of Variation (Cv) Error Ratio (ER), or Proportion in Sample Design	Relative Precision at 85% C.L.
Audit Measures	344	359	101%	364	0.04	0.68%
Efficient Equipment - HVAC	2,793	2,834	101%	2,875	0.10	1.39%
Efficient Equipment – Pool Pumps	69	30	403%	119	0.48	N/A (census)
Fuel Switching	114	114	193%	219	0.60	11.28%
RNC – HERS Option	217	186	102%	189	0.16	N/A (census)
RNC – Manufactured Homes	13	18	111%	19	0.16	N/A (census)
RNC – Prescriptive Option	12	12	100%	12	0.00	N/A (census)
Weatherization	326	283	101%	285	0.18	1.74%
Program Total	**3,888**	**3,835**	**106%**	**4,083**	**N/A**	**1.30%**

[1] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.

Table 8-8 provides the verified gross demand savings, the realization rates, and the precision around the estimates by stratum and for the program in aggregate. The Residential Home Comfort Program had verified gross demand savings of 1.7 MW per year, plus or minus 1%, and a realization rate of 102% over adjusted *ex ante* demand savings.

Table 8-8: PY6 Residential Home Comfort Program Summary of Evaluation Results for Demand

Program	Reported Gross Demand Savings [1] (MW)	Adjusted Ex-Ante Demand Savings [2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings (MW) [2]	Observed Coefficient of Variation (Cv) Error Ratio (ER), or Proportion in Sample Design	Relative Precision at 85% C.L.
Efficient Equipment - HVAC	1.450	1.61439	101%	1.63100	0.02	0.37%
Audit Measures	0.031	0.03463	100%	0.03475	0.08	1.14%
Efficient Equipment - Pool Pumps	0.014	0.01894	115%	0.02180	0.36	N/A (census)
Fuel Switching	-	-	-	-	-	-
RNC - HERS Option	0.004	0.00838	288%	0.02411	1.20	N/A (census)
RNC - Manufactured Homes	-	0.00082	207%	0.00170	0.83	N/A (census)
RNC - Prescriptive Option	0.002	0.00349	100%	0.00349	0.00	N/A (census)
Weatherization	0.028	0.02827	108%	0.03060	0.22	2.11%
Program Total	**1.529**	**1.709**	**102%**	**1.747**	N/A	1.20%

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] Adjusted *ex ante* and verified gross demand reductions include T&D losses.

The ICSP conducts verification site visits for the Residential Home Comfort program, with a goal to visit about 5% of the jobs. These are QA/QC site visits. Cadmus does not use the ICSP's site visit data for verification of savings. Table 8-9 lists high level information about the ICSP's site visits.

Table 8-9: PY6 Residential Home Comfort Summary of Site Visits Conducted by ICSP

Measure	Inspection Firm	Number of Inspections Conducted	Number of Sites with Discrepancies from Reports	Resolution of Discrepancies
Pool Pumps	ICSP	9	0	No discrepancies found.
ASHP	ICSP	485	0	No discrepancies found.
DHP	ICSP	272	1	Unit did not match submitted; contacted contractor to remedy with customer.
CAC	ICSP	36	0	No discrepancies found.
Weatherization	ICSP	50	0	No discrepancies found.
Survey	ICSP	39	1	Customer claims did not receive energy report; contacted Surveyor to send report.
Audit	ICSP	20	2	Rebate issued to contractor; put customer in contact with contractor to resolve. Blower Door test number large variance; determined reason for variance, no issue.
New Home	ICSP	20	0	No discrepancies found.
Manufactured Home	ICSP	1	0	No discrepancies found.
Fossil Fuel	ICSP	2	2	Heat Pump replaced with Heat Pump and gas auxiliary; sent letter to contractor for future reference.

8.3 IMPACT EVALUATION NET SAVINGS

In accordance with the PY6 EM&V Plan, the freeridership values for weatherization and efficient equipment participants, as well as audit participants, use the PY5 telephone survey results. These program components had no significant changes, rebates are the same in PY6 as they were in PY5, and changes in the participant population are not expected. This program contributes a lesser amount to the total portfolio and with no changes to the program in existing program components, PPL and Cadmus focused resources on the new program components.

To understand the standard practice in the market for new construction and manufactured homes, Cadmus interviewed trade allies and those receiving rebates for the new program components: manufactured homes rebates and new residential construction. Cadmus conducted surveys with the two groups receiving rebates to assess freeridership, that is, manufactured homes buyers and new home builders.

- **Home builders** (n=5) receive the rebate and could be free riders if they planned to install all the rebated equipment, or build homes that exceed the minimum building efficiency codes in the absence of the program.
- **Manufactured home buyers** (n=6) receive a rebate and could be free riders if they planned to purchase a home with the same efficient equipment and characteristics as the rebated homes.

Table 8-10 reports the sampling strategy only for the two new survey groups receiving rebates who were contacted this year. In addition to these two groups, Cadmus interviewed trade allies including manufactured homes manufacturers, manufactured homes retailers, and nonparticipating builders. The process evaluation discusses the results of participant and trade ally interviews in more detail. It also discusses observations about standard practice in the market.

Table 8-11 reports results from PY5 (depending on the stratum). There were very few participants in the new program components in PY6 and even fewer survey and interview respondents. Cadmus made multiple attempts to contact all participants and completed two interviews with participating builders and two with participating manufactured home buyers. Therefore, there were too few respondents to draw meaningful conclusions about freeridership and spillover within the program's two new program components. (Survey attrition tables can be found in the Residential Home Comfort Process Evaluation Addendum A and Addendum B.) Cadmus applied the PY5 net-to-gross ratios to the appropriate PY6 program records to arrive at a weighted by verified energy savings net-to-gross ratio of 60% for PY6.

Table 8-10: PY6 Residential Home Comfort Program Sampling Strategy NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
New Construction	Builders participating in PPL Electric Utilities' program	5	--	--	As many as possible	2	100%
Manufactured Homes	Manufactured home buyers	6	--	--	As many as possible	2	100%
Program Total	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completes.

Table 8-11: PY6 Residential Home Comfort Program Summary of Evaluation Results for NTG Research

Target Group or Stratum	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Audit	0.18	0.10	0.92	PY5 results	
Efficient Equipment	0.54	0.05	0.51	PY5 results	
Weatherization	0.35	0.08	0.73	PY5 results	
New Construction	N/A				
Manufactured Homes	N/A				
Program Total	Uses PY5 program level net-to-gross ratio applied to PY6 records : .60				

8.4 PROCESS EVALUATION

8.4.1 Research Objectives

The ICSP is responsible for all program development and operation aspects. The primary process issues that Cadmus identified for this program are efficiency, delivery infrastructure, and customer response. Other topics that this evaluation sought to inform were:

- Program delivery
- Satisfaction with program procedures and installed products
- Barriers to participation and products installation
- Recommendations for program improvements and other process issues

8.4.2 Evaluation Activities

For the Residential Home Comfort Program, the PY6 process evaluation activities included:

- Program staff and implementer interviews (n=2)
- Participant surveys (n=179)
  - Cross-program surveys (n=148)[99]
  - Fuel switching survey (n=29)
  - Manufactured homes buyers (n=2)
- Builder and vendor interviews
  - Participant builders (n=2)
  - Nonparticipant builders (n=2)
  - Manufactured homes retailers (n=4)
  - Manufactured homes manufacturers (n=4)
- Program database review

The research activities were consistent with the evaluation plan except for the interviews with builders, retailers, and manufacturers. Cadmus planned to interview six new homes builders in PY6. However, the program launched later than expected and no participant data were available until the beginning of the fourth quarter (Q4). This unfortunately corresponded with the beginning of the busy homebuilding season. Additionally, the cold weather of the previous winter lasted into spring, delaying the start of and shortening the homebuilding season. Consequently, it was difficult to reach any builders and obtain their agreement to an interview. At the close of PY6, there were five participant builders and, from information obtained from the ICSP, 12 nonparticipating builders. Cadmus completed interviews with two participant builders and two nonparticipant builders.

Cadmus also experienced difficulty connecting with manufactured homes retailers. Many were busy with customers and not interested in talking. The small incentive for participating initially hindered recruitment because the retailers immediately assumed the call was part of a scam. We revised the interview script to delay mentioning the incentive until the end of the interview, which helped achieve four completed interviews with retailers.

Although the survey target was for all buyers of the manufactured homes, we completed only two surveys because of the low number of participants (n=6).

8.4.3 Methodology

8.4.3.1 Program Staff and Implementer Interviews

For the Residential Home Comfort Program, Cadmus conducted telephone interviews with two program managers—one at PPL Electric Utilities and the other at CLEAResult, the ICSP. The purpose of these interviews was ensure Cadmus thoroughly understood all of the program offerings and the delivery and marketing strategies and obtained stakeholder perspectives on program successes and challenges, particularly with the newly launched components in PY6 (new construction and manufactured homes).

99 The cross-program survey included participants of the Residential Retail, Residential Home Comfort, and Appliance Recycling programs. Cadmus completed 300 cross-program surveys but is discussing only the results from the Residential Home Comfort Program respondents in this report.

8.4.3.2 Cross-Program Participant Survey

Cadmus conducted a cross-program survey in PY6 that targeted customers participating in any one of these general residential rebate programs—Appliance Recycling, Residential Home Comfort (equipment, weatherization, and audit), and Residential Retail (heat pump water heaters only). Cadmus completed a total of 148 surveys with participants of the Residential Home Comfort Program, 69 of whom participated in the audit and weatherization offering.

The primary purpose of the cross-program survey was to obtain a preliminary estimate of low-income participation in programs that are not specifically targeting this sector (i.e., programs that do not require income verification). We selected a random sample (probability sampling) but did not stratify the sample by program. We excluded those customers who participated in surveys within the last year, who requested not to be contacted, were duplicates, had incomplete information, in sample selected for other program surveys, or were inactive accounts. Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by applying random sampling whenever possible and using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

Although the primary purpose of the survey was to estimate low-income participation, we used the opportunity to gather additional data such as program satisfaction, energy efficiency behaviors, and any challenges to using energy wisely. These findings are aggregated with the fuel-switching participant survey results and summarized in this report.

These surveys were completed during March and April 2015.

8.4.3.3 Fuel Switching Participant Survey

Cadmus conducted a telephone survey with 29 Residential Home Comfort Program participants who received rebates for replacing existing fossil fuel-fired space conditioning equipment with efficient air source or ductless heat pumps. The sample frame included customers who indicated natural gas distribution service was available at their home (reported on their rebate forms) and switched from a non-electric appliance to an electric appliance. We then excluded any customers who had participated in the cross-program survey or other surveys within the last year, who requested not to be contacted, inactive customers, or who indicated on their rebate forms they had electric heat. From this final sample frame, we conducted a survey with all customers. Although the survey objective was to verify if the Residential Home Comfort Program participants switched from fossil fuel-fired equipment to electric equipment, we also gathered additional data about program satisfaction, energy efficiency behaviors, and any challenges to using energy wisely. The survey was not used to estimate net savings. Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

These surveys were completed in July 2015.

8.4.3.4 Manufactured Homes Buyers

Cadmus attempted telephone interviews with all six participants who received a rebate for purchasing an ENERGY STAR manufactured home and completed two interviews. As with the other participant surveys, questions explored satisfaction with the program, satisfaction with PPL Electric Utilities as an electric service provider, knowledge of energy efficiency, and challenges to using energy wisely. Cadmus fielded the phone participant surveys during July 2015. Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they were implemented consistently. Cadmus attempted to reach all participants by contacting them multiple times over several days at different times of the day and scheduled callbacks when possible.

8.4.3.5 Manufactured Homes Manufacturer and Retailer Interviews

In the Residential Home Comfort Program's manufactured homes component, key market actors are companies building manufactured homes for the Pennsylvania market and retailers of manufactured homes selling in the PPL Electric Utilities service territory. The objectives of the interviews were to assess awareness of the incentive offered by PPL Electric Utilities, gather information about standard manufacturing and sales practices in Pennsylvania, understand the influence of the program on efficient product installation in ENERGY STAR manufactured homes, and assess satisfaction with PPL Electric Utilities and the program.

The ICSP gave Cadmus a list of nine home manufacturers and 26 retailers. In August 2015, Cadmus conducted four interviews with manufacturers and four with retailers at random (although a census was contacted).

8.4.3.6 Builder Interviews

In the Residential Home Comfort Program's new homes component, builders submitting prescriptive path or HERS approach rebates for new homes through the program are program participants. The objectives of these interviews were to assess awareness of the incentives and gather information about standard building practices, the influence of the program on efficient product installation in the new homes, and assess builder satisfaction with PPL Electric Utilities and the program. Cadmus interviewed participating and nonparticipating builders chosen from a list provided by the ICSP—five participating builders and 12 nonparticipant builders.

In August 2015, Cadmus contacted a census of the builders provided by the ICSP and completed four interviews—two with participating builders and two with nonparticipant builders.

8.4.3.7 Database Review

Cadmus reviewed the tracking database extracts for the Residential Home Comfort Program for the process evaluations. Program tracking data are stored in five separate extracts because products and components have different parameter collection requirements. The following extracts from PPL Electric Utilities' EEMIS database provided these data:

- Audit and weatherization
- HVAC (air source heat pump and electric-to-fossil fuel switching)
- Ductless heat pumps
- New homes whole house (prescriptive rebate and manufactured homes)

- New homes HERS approach
- Pool pumps

The database review assessed the completeness of fields necessary to conduct the cross-program and fuel-switching telephone surveys and the new construction builder interviews. Cadmus determined that a key field for the fuel-switching telephone surveys and analysis—"Is natural gas available"—was sparsely populated in the Q1 extract and partially populated in the Q2 extract for air source heat pump and ductless heat pump. The data were available on the rebate forms but had not been uploaded into EEMIS. Cadmus requested this information from the ICSP.

The database review also examined the data in the "How did you hear about the program?" field, which varied by data extract. The extracts for air source heat pump and ductless heat pump contained the most information for this field, but extracts for audit and weatherization and pool pump contained very little information. More than half of the values were blank or reported as "N/A." Table 8-12 summarizes the survey sampling strategy for the Residential Home Comfort Program for PY6. See Addendum A. Participant Survey Methodology for more details.

Table 8-12: Residential Home Comfort Process Evaluation Sampling Strategy for PY6

Stratum/Survey	Stratum Boundaries	Population Size	Assumed Proportion or Cv in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]	Used For Evaluation Activities (Impact, Process, NTG)
PPL Electric Utilities Program and ICSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, program staff interviews, census
Cross-program Survey	PY6 (Q1-Q2) Audit / Weatherization Component participants, Efficient Equipment Component participants [2]	2,937 [2]	0.5	90/10	300 [3]	1,675 [4]	148	81%	Process, estimate low-income participation, residential program participants, probability sample, simple random sample
Fuel Switching Participant Survey	PY6 ASHP or DHP rebate participants with natural gas distribution service available	199	N/A	N/A	As many as possible	133 [5]	29	100%	Process, impact, verify number of fuel switchers, participants, census
Manufactured Homes Buyers	PY6 participants who received a rebate for purchase of an ENERGY STAR manufactured home	6	N/A	N/A	6	6	2	100%	Process, participants, census
Manufactured Homes Retailers	Retailers selling manufactured homes in PPL Electric Utilities' service territory	26	N/A	N/A	8	26	4	100%	Process, retailers, census
Manufactured Homes Manufacturers	Manufacturers manufacturing homes sold in PPL Electric Utilities' service territory	9	N/A	N/A	4	9	4	100%	Process, manufacturers, census

Stratum/Survey	Stratum Boundaries	Population Size	Assumed Proportion or Cv in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]	Used For Evaluation Activities (Impact, Process, NTG)
Participating Builder	Builder building homes in PPL Electric Utilities' service territory and who submitted a rebate application in PY6	5	N/A	N/A	3	5	2	100%	Process, participating builders, census
Nonparticipating Builder	Builder building homes in PPL Electric Utilities' service territory and did not submit a rebate application in PY6	12	N/A	N/A	3	12	2	100%	Process, non-participating builders, census
Program Total		**3,196**			**26 or more**	**1,868**	**193**		

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews.
[2] Cross-program survey included participants of the Residential Retail, Residential Home Comfort, and Appliance Recycling programs. Cadmus completed 300 cross-program surveys but the results in this table and report reflect only those records and surveys completed with participants of the Residential Home Comfort Program.
[3] We completed surveys within all three programs until we reached the overall goal of 300.
[4] We selected a random sample of 1,675 records and removed 263 because they were duplicates, were included in other sample frames, were inactive customers, were incomplete records, completed a survey in the past year, or requested not to be contacted.
[5] We removed 66 records from the population because they were inactive customers, completed a survey in the past year, indicated they did not want to be contacted, were included in a different survey call list, or indicated they had electric heat.

8.4.4 Achievements Against Plan

Table 8-13 contains the program's energy savings and incentive plans and the progress on these plans through the end of PY6.

Table 8-13: Residential Home Comfort Program Savings

	PY5 Verified	PY6			Phase II: PY5-PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	2,410	3,748	4,083	109%	15,268	6,493	43%
MW	1.0	0.62	1.75	282%	2.34	2.75	117%
Participation	2,554	4,792	4,269 [2]	89%	14,500	6,823	47%

[1] Planned savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table F6, p.65.
[2] 4,269 unique households installed 4,330 measures (each identified with a unique CSPJobNo). Some projects included more than one product or audit/product.

The primary reason the program exceeded its planned MWh/yr and MW savings for PY6 was because the verified savings using rebate-specific parameter values (where the Pennsylvania Technical Reference Manual [TRM] allows electric distribution company [EDC] data gathering) yielded higher savings than the deemed values used to report savings. Additionally, corrections for data entry errors produced higher savings values than reported savings. Finally, all six manufactured homes rebated through the program were built to meet the energy requirements of a more severe climate zone than eastern Pennsylvania; therefore, the verified savings for these homes were higher than anticipated.

In other words, although the program components are functioning well, the high achievement had much to do with high realization rates and less to do with program delivery. The realization rates are discussed in more detail in the impact report.

8.4.5 Program Delivery

Residential Home Comfort is an established program that grew out of the Phase I Residential Home Assessment and Weatherization and Efficient Equipment programs. It provides residential customers with a selection of energy-saving items to increase the comfort of their home.

PPL Electric Utilities continued to implement Cadmus' recommendation from the PY3 process evaluation and made eligibility for weatherization rebates contingent upon receipt of an energy audit. For PY6, the conversion rate (percentage of audit customers who followed through and installed recommended products) was approximately 30%.

An average of 265 customers per quarter received a program audit in PY6 (the range was 249 to 272 audits). Although the program manager is satisfied with this participation level, she would like the number of audits to increase. However, she reports it is difficult to interest customers because of the cost of the audit (typically $350 to $650). The upfront cost can be approximately $400 to $500 and cannot be financed. The rebate returns up to $250 of the cost (depending on the heating and cooling equipment), but customers must wait to receive it.

Possibly the greatest participation barriers are the economic climate in PPL Electric Utilities' service territory and the cost of the equipment that is eligible for a rebate. Interview respondents said the area has not fully recovered from the recession and many of the products offered in the Residential Home Comfort Program are quite expensive. PPL Electric Utilities has tested various approaches to pique interest. For example, in the audit and weatherization component, it has recruited participants to blog about their experiences.

Interview respondents said that messaging about protecting the environment and saving energy no longer resonates with customers. Customers are now more concerned about their comfort; consequently, marketing has shifted its focus to stress customer comfort.

Ductless mini-split heat pumps were popular with customers and contributed 33% to the program's total savings from heat pumps. Table 8-14 shows the rebate structure and number of rebates by program tier. Nearly 60% of the rebates were for very high-efficiency units with a seasonal energy efficiency rating (SEER) of 19 or greater. (A total of 1,441 outdoor units were installed in 1,177 households. One household could have more than one outdoor unit. Each outdoor unit could be associated with more than one indoor unit.)

Table 8-14: PY6 Residential Home Comfort Program – Ductless Heat Pump Rebate Structure

Minimum Equipment Efficiency in Each SEER Range	Rebate Per Ton	Number of Rebates	Percentage of Rebates
SEER 15 HSPF 8.6	$100.00	87	6%
SEER 17 HSPF 9.5	$150.00	514	36%
SEER 19 HSPF 10.5 or greater	$200.00	840	58%

The minimum requirement to receive a rebate was SEER 15. Cadmus' analysis showed that PPL Electric processed a very small number of rebates in PY6 for this tier (6% of all ductless heat pump rebates for SEER 15 and SEER 15.5). If PPL Electric Utilities were to increase the minimum equipment efficiency requirement by one SEER in each tier, nearly 50% of PY6 rebates would still be in the most efficient tier, as shown in Table 8-15. Only 25 (1.7%) of the ductless heat pump systems in PY6 had an efficiency rating of less than 16 SEER and would not have been eligible for a program rebate. Table 8-15 illustrates how the rebates could be distributed in the proposed tiers and the percentage in each tier, based on all 1,441 PY6 rebates (percentages are rounded).

Table 8-15: PY6 Residential Home Comfort Program – Hypothetical Revision to Rebate Structure

Minimum Equipment Efficiency	Rebate Per Ton	Number in Category	Percentage of Rebates[1]
Lower than SEER 16	No rebate	25	2%
SEER 16	$100.00	201	14%
SEER 18	$150.00	515	36%
SEER 20	$200.00	700	49%
[1]Percentage exceeds 100% because of rounding.			

PPL Electric could consider a "challenge" tier structure, shown in Table 8-16. If the minimum equipment efficiency requirement values were set even higher, SEER 18, SEER 20, and SEER 22, then 24% of the PY6 rebates would be in the most efficient tier, as shown in Table 8-16, and only 226 (16%) of the PY6 ductless heat pump systems would not have qualified for a rebate (percentages are rounded).

Table 8-16: PY6 Residential Home Comfort Program – Hypothetical Challenge Tier Structure

Minimum Equipment Efficiency	Rebate Per Ton	Number in Category	Percentage of Rebates
Lower than SEER 18	No rebate	226	16%
SEER 18	$100.00	515	36%
SEER 20	$150.00	349	24%
SEER 22	$200.00	351	24%

8.4.5.1 Logic Model

A program logic model identifies the relationships between activities and expected outcomes. During PY5, Cadmus developed the logic model for the Residential Home Comfort Program and reviewed it in PY6 (see Addendum C. Logic Model). We found that the program continues to operate as described by the logic model.

8.4.5.2 Key Performance Indicators

Besides savings and participation targets, PPL Electric Utilities and the ICSP identified two key performance indicators that it tracks together to measure how the program is performing. Table 8-17 shows these key performance indicators with the PY6 results. The key performance indicators reveal that the program did very well in the areas of program satisfaction and customer complaints.

Table 8-17: Residential Home Comfort Program KPIs

Key Performance Indicator	Metric	Goal	PY6 Result
Customer Satisfaction	Satisfaction rating determined from participant telephone or online surveys conducted by Cadmus	80% of customers satisfied with the program	Met goal. 69% rated satisfaction as *very satisfied* and 22% rated satisfaction as *somewhat satisfied*, determined from combined responses to cross-program and fuel-switching surveys
Customer Complaints	Number of complaints	0 complaints	Met goal

The ICSP also tracks several other metrics that are not reported as a goal. These include the number of applications rejected each month, the number of approved auditors, and the number of contractors building to Residential Home Comfort Program standards; signing up at least one new builder to the program per month; and adding five new HVAC contractors to the program per month. The ICSP also tracks traffic on the program webpage and conducts its own short satisfaction surveys.

8.4.5.3 Program Updates and Outcomes

LEDs. In PY6, PPL Electric Utilities stopped offering CFL bulbs to audit participants and instead offered LED bulbs, which were very popular. LEDs have similar savings as CFLs but a higher cost per bulb. The program has a $150 cap on the total cost of direct install products provided during the audit; the cost per LED is higher, so in PY6 the number of direct install products per home was lower. Consequently, the average savings per home was also lower.

Air source heat pumps. Amended federal conservation standards applying to minimum SEER, EER, and HSPF for residential air conditioners and heat pumps manufactured on or after January 1, 2015, took effect on January 1, 2015.[100] Customers can still install units meeting the previous federal standards as long as distributors have them in stock. Table 8-18 presents the previous and current federal conservation standards for minimum SEER and heating seasonal performance factor (HSPF) for residential air conditioners and heat pumps.[101]

Table 8-18: Amended Conservation Standards for Residential Central Air Conditioners and Heat Pumps

Product Class	SEER		HSPF	
	Previous	Current	Previous	Current
Split system air conditioners	13.0	14.0	N/A	N/A
Split system heat pumps	13.0	14.0	7.7	8.2

With the amended baseline, in March 2015, the program increased the rebate for air source heat pumps with an efficiency rating of SEER 16 or greater from $200 to $1,200 late in the 4th quarter as a strong inducement to customers to install higher-efficiency equipment. This approach was based on input from stakeholders and trade allies and it was very successful. Prior to increasing the rebate, the percentage for higher efficiency (SEER 26 or greater) air source heat pumps was consistently around 62% of all rebated units per quarter. After increasing the rebate (at the beginning of Q4), the percentage of rebated higher-efficiency air source heat pumps increased 23%. Table 8-19 shows the number and percentage of SEER 15 and SEER 16 and higher air source heat pumps rebated in PY6 by quarter.

Table 8-19: Residential Home Comfort Program Air Source Heat Pumps Rebated by Quarter

Minimum Efficiency Rating	Quarter 1	Quarter 2	Quarter 3	Quarter 4	PY6
Number of Air Source Heat Pumps					
SEER 15	191	130	134	86	541
SEER 16 and higher	308	210	224	470	1,212
Percentage of Air Source Heat Pumps of Total Rebated Units					
SEER 15	38%	38%	37%	15%	31%
SEER 16 and higher	62%	62%	63%	85%	69%

HVAC dealers liked the increased incentive and reported that sales of higher-efficiency air source heat pumps were "through the roof." The incentive for SEER 15 ASHP expired June 1, 2015.

Thermal imagery gun training. In PY6, PPL Electric Utilities offered two levels of thermal imagery gun training, basic and advanced, for audit contractors to improve audit diagnostics. Many auditors already owned and were using thermal imagery guns and took advantage of the advanced training. The program manager and ICSP noted the training was well received by the auditors, who reported it was valuable. Some auditors earned continuing education units by attending the training. The budget for thermal imagery training allowed for one training session per contractor. PPL Electric Utilities also supported

---

100 Code of Federal Regulations, 10 CFR 430.32(c)(3) and 10 CFR 430.32(c)(5). Full text available here: http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR.

101 The 2015 TRM Table 2-10 references SEER 13 baseline for central AC replace on burnout, and SEER 14 for ASHP.

vendor-sponsored training by distributing information to program auditors. The ICSP attended these vendor-sponsored training sessions and provided information about PPL Electric Utilities' programs.

Prescriptive rebate for builders. At the beginning of Phase II, the Residential Home Comfort Program offered a prescriptive rebate for builders of new homes. The EE&C plan anticipated 400 new homes through this program. There were no participants in the new construction component in PY5 and nine built in PY6; feedback from builders indicated that the $2,000 incentive did not cover the incremental cost of installing the required program products. The product installation requirements proved to be a participation barrier; builders believed they were too strict. Builders wanted more flexibility to qualify a home for the program rebate. They also said they typically do not offer appliance packages in their new homes, yet two of the required products in the prescriptive option—ENERGY STAR refrigerators and dishwashers—are appliances. The ICSP is interested in revising the prescriptive path rebate so that builders can choose from a larger number of energy-efficient products, though with the directive to select and install a specific number from the list.

HERS Approach. To address builders' concerns, PPL Electric Utilities provided the HERS approach as an alternative participation path in PY6. Homes can qualify for the PPL Electric Utilities Utility rebate based on energy savings estimated using rating software. Savings for weather-sensitive products such as HVAC equipment or insulation are taken from the rating software's fuel summary report. Savings for appliances are estimated using Pennsylvania TRM algorithms. This enables builders more flexibility in the home's products. The ICSP reported that the Multiple Listing Service (MLS) is beginning to include HERS ratings in new home listings and builders are learning that HERS ratings can be a valuable marketing tool.

The program posted savings for new homes for the first time in Q3 of PY6. Of all PY6 rebates for new homes, only three builders used the prescriptive path. The remaining 28 homes used the HERS approach.

ENERGY STAR Manufactured Homes. In PY6, the Residential Home Comfort Program added a $1,200 rebate for the purchase of ENERGY STAR manufactured homes heated by an air source heat pump. Participants were eligible for additional rebates of $200 for installing a SEER 14 ASHP or $300 for installing a SEER 15 or greater air source heat pump.

The manufactured homes rebate launched in mid-PY6, and there were six participants by the close of the program year. All participants purchased their home from the same manufacturer, and none opted to install the more efficient heat pumps. The four manufacturers Cadmus interviewed said that a very low percentage of these homes use electric heat. Two said 10% of the homes use electric heat, one said 2% are electrically heated, and one did not know. One manufacturer said developments or leased communities are either all gas or all electric, and there were very few all-electric manufactured homes.

Bonus Rebate. PPL Electric Utilities added a bonus rebate of $500 for audit participants who followed through and installed recommended insulation products within 180 days of the comprehensive audit.

Residential Thermal Storage Rebate. This was a $200 rebate for customers who were on PPL Electric Utilities' Residential Thermal Storage (RTS) rate and who upgraded their heating system to an ASHP of SEER 15 or greater.

8.4.6 Participant Profile

There were 4,330 individual participation events recorded in the Residential Home Comfort Program in PY6:

- 1,066 participated in the audit portion of the program[102]
- 218 received weatherization (ceiling insulation, wall insulation, and/or duct sealing)
- 2,930 received energy-efficient heat pump rebates
- 55 received efficient pool pump rebates
- 6 received rebates for purchasing an ENERGY STAR manufactured home
- 31 builders received a rebate for building a PPL E-Power new home
- 24 customers received a rebate for switching from an electric heat source to an efficient fossil-fuel fired furnace

The majority of survey respondents were homeowners (95%, 141 of 148). Ninety-three percent (164 of 177) of survey respondents said they lived in a single-family detached home and 78% (138 of 177) said they either had a college degree or had attended technical or business school.

Both participants in the manufactured homes program survey were over 65 years of age and said the highest level of education they had achieved was a high school diploma.

8.4.7 Participant Satisfaction

8.4.7.1 Program Satisfaction

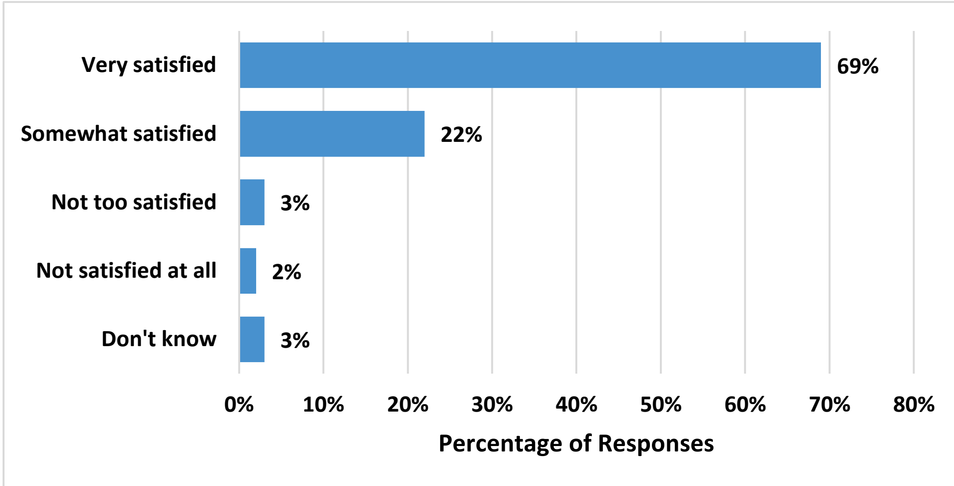
Participants expressed satisfaction with the Residential Home Comfort Program (Figure 8-1). Ninety-one percent (n=162 of 177) of respondents in the cross-program and fuel-switching surveys rated their satisfaction with the program as either *somewhat satisfied* (22%, 39 of 177) or *very satisfied* (69%, 123 of 177). Only 10 of the 177 respondents indicated they were less than satisfied with the program, and only four of those 10 said they were *not satisfied at all*.

Respondents who did not rate their satisfaction as *very satisfied* were asked how PPL Electric Utilities could improve the program. Eighteen of the 49 respondents did not know how the utility could improve the program. The three top ways mentioned were:

- Lower rates (7 out of 49)
- Improve rebate process (6 out of 49)
- Make the audit more comprehensive (3 out of 49)

[102] Of the 1,066 who participated, 991 received audit or survey, 12 received products without audit, 63 received bonus rebate.

Figure 8-1: Overall Program Satisfaction



Source: Question D1. "Our first questions are about the Residential Home Comfort Program you participated in. Thinking about your overall experience with the program, how would you rate your satisfaction?" (n=177)

8.4.7.2 Manufactured Home Satisfaction

Overall, participants in this program are satisfied with this program. The first customers to receive a rebate through the manufactured home program are pictured here.[103]

Cadmus spoke with two participants of the manufactured homes component.[104] Both respondents answered questions about how satisfied they were with the information presented by the salesperson, the length of time it took to receive the rebate, and the amount of the rebate. They were *very* or *somewhat satisfied* with each of these items.

The two participants answered a question about ways PPL Electric Utilities could improve the program. One said the application process was confusing because he or she did not know what information to provide to PPL Electric Utilities when submitting the application. The other said he or she was unaware of the program before purchasing the house but happy to receive the rebate once made aware.

8.4.7.2.1 Satisfaction with PPL Electric Utilities

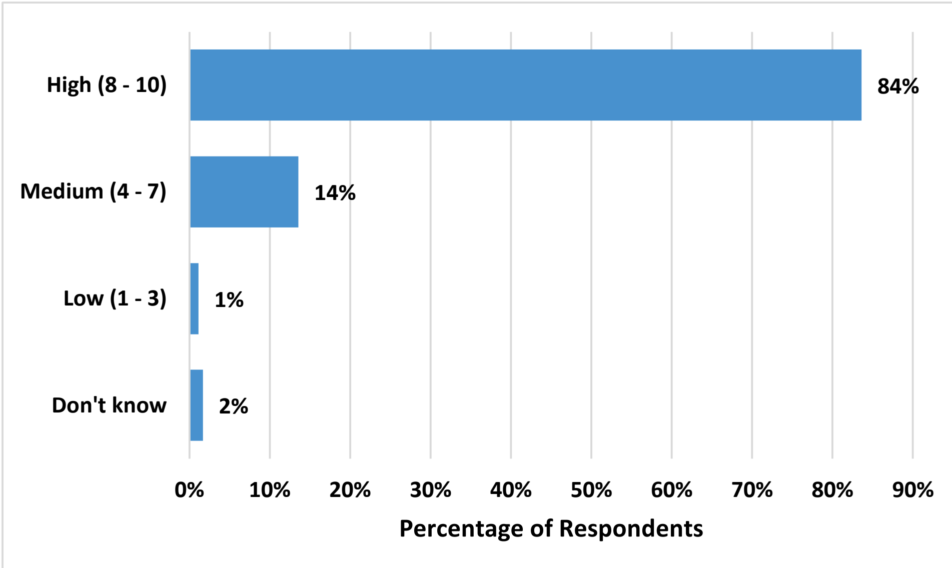
Participants in the Residential Home Comfort Program were also satisfied with PPL Electric Utilities as an electric service provider, as shown in Figure 8-2. Eighty-four percent of respondents (148 of 177) rated their satisfaction with PPL Electric Utilities from 8 to 10. An additional 14% (24 of 177) rated their satisfaction from 4 to 7. Forty-seven percent of respondents (83 of 177) said they had recommended the

103 Published January 9, 2015, on PPL Electric Utilities' blog, "The Wire." Available at: http://thewire.pplelectric.com/2015/01/09/manufactured-home-program/#.VfBKhk3bLcs

104 The survey respondents are not the couple in the photograph.

program to a friend, relative, or colleague since participating in the program; 50% said they had not. Since participating in the Residential Home Comfort Program, 48% (84 of 177) said their opinion of PPL Electric Utilities had improved *somewhat* or *significantly.*

Figure 8-2: Satisfaction with PPL as a Provider of Electricity



Source: Question M1. "Using a 10-point scale where 1 means unacceptable and 10 means outstanding, using any number from 1 to 10, how do you rate PPL Electric Utilities overall as a provider of electric service to your home?" (n=177)

8.4.8 Marketing and Outreach

8.4.8.1 Manufactured Homes Component Awareness

Cadmus asked buyers (n=2), builders (n=4), and retailers (n=4) about their awareness of PPL Electric Utilities' rebate program for manufactured homes. One participant (buyer) learned about the program from the salesperson and one from the owner of the manufactured home park after purchasing the home. Neither participant learned of additional ways to save energy in their homes from the salesperson.

Neither of the buyers were looking for an ENERGY STAR home before hearing about the program. One said he or she would have purchased the same home without the rebate because it was the desired home and layout. The second respondent would have purchased a home that was not ENERGY STAR-certified if he or she had not purchased this home. This respondent bought this home because the development offered only this type of home.

Manufactured home builders (n=4) were more aware of PPL Electric Utilities' rebates to customers who purchase an ENERGY STAR-qualified home than were retailers (n=4). Two of four manufactured homes builders said they were aware of the program. All four retailers said they were not familiar with the program.

All four manufactured homes retailers said that homeowners were not aware of the PPL Electric Utilities rebate program either. Two of the retailers said homeowner awareness about ENERGY STAR homes has changed because people are more concerned with energy efficiency, but two said awareness about ENERGY STAR homes has not changed. The retailers suggested mailers and bill inserts as the best way to reach customers about the program. They also said that they do not promote other PPL Electric Utilities energy efficiency rebate programs when they market their homes.

8.4.8.2 PPL and ICSP Marketing

The ICSP is responsible for all program marketing. It produces the marketing materials, which are reviewed by PPL Electric Utilities' marketing and communications staff. The preferred marketing channel to customers is bill stuffers in PPL Electric utility bills because the cost is low for the high volume.

Cadmus did not have information about where other program participants (in the audit and weatherization and energy-efficient equipment components) learned about the PPL Electric Utilities rebates because of the incomplete data in EEMIS for this field.

8.4.9 ENERGY STAR Partnership

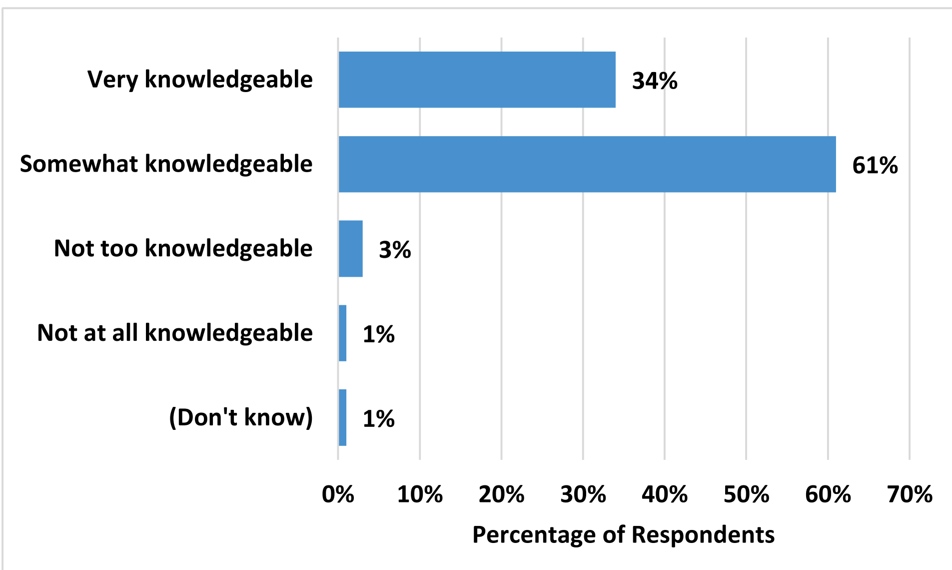
Cadmus interviewed four builders of manufactured homes. All were ENERGY STAR partners. Three said they had been a partner for over seven years and one had been a partner for "a long time." Two said being an ENERGY STAR partner offered marketing benefits, and one said it is easier to resell the home. One person said there are no benefits because the homes are more expensive to build.

8.4.10 Energy Efficiency Knowledge, Challenges, and Actions

8.4.10.1 Knowledge About Ways to Save Energy

When asked how knowledgeable program participants were about saving energy in their home before participating in the program, the majority of respondents said they were *very* (34%, 50 of 148) or *somewhat knowledgeable* (61%, 90 of 148) about how to save energy in their home (Figure 8-3).

Figure 8-3: Participant Knowledge Level



Source: Question E1. "Before you received a rebate from PPL Electric, how would you rate your knowledge on ways to save energy in your home? Would you say you were ... (READ LIST)" (n=148)

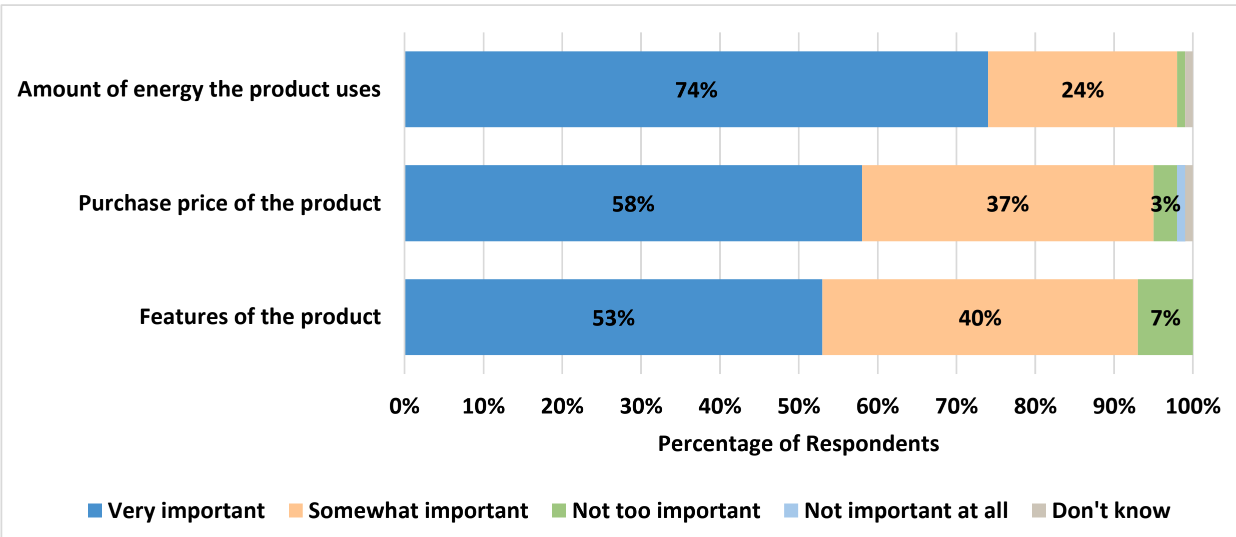
When asked if they were more knowledgeable about ways to save energy after participating in the program, 68% (n=101) said they were more knowledgeable and 28% (n=42) said their knowledge was the same as before.

8.4.10.2 Challenges – Participants Purchasing Equipment

Cadmus asked survey respondents (n=148) to think about factors they consider when shopping for products or appliances that use energy in the home. Respondents then rated the importance of each of these features on their decision to purchase or not purchase the product.

Residential Home Comfort Program participants indicated the strongest concern was for the amount of energy used by the product or appliance. Ninety-eight percent of survey respondents rated energy use as an important consideration, and 74% rated energy use as a *very important* consideration, as shown in Figure 8-4. Only 1% indicated that the energy use of a product or appliance is not important to their purchase decision.

Figure 8-4: Decision Factors about Product Purchases



Source: Question E5. "When shopping for products or appliances that use energy in your home, how would you rate the importance of each of the following?" (n=148)

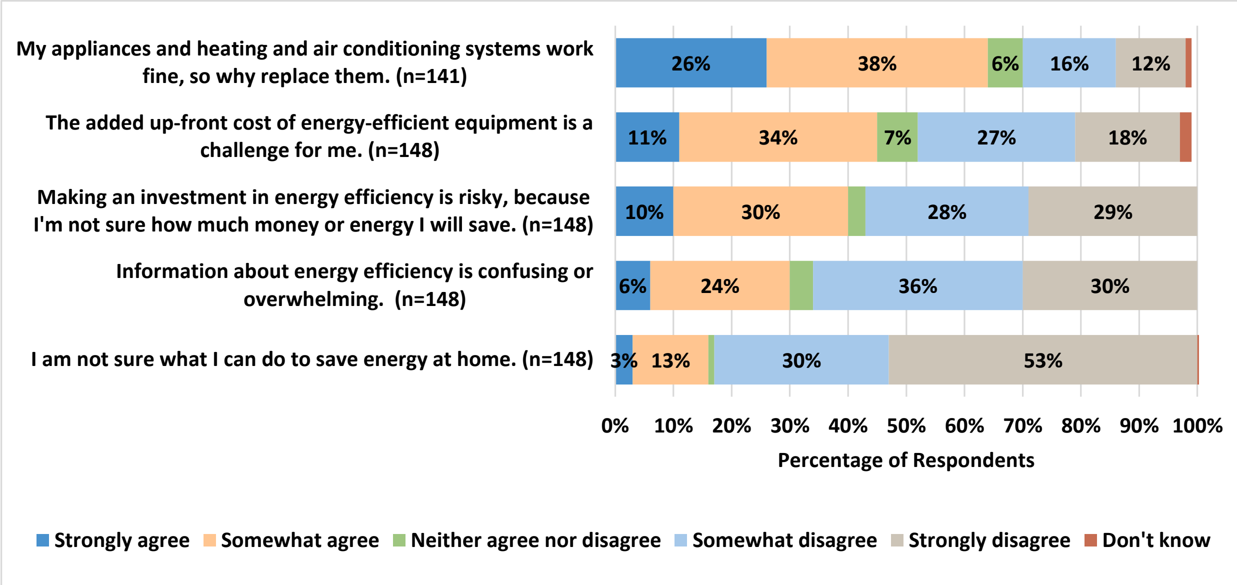
Because PPL Electric Utilities' service territory has still not experienced full economic recovery, it is not surprising that nearly all respondents (95%) reported that price is an important consideration when deciding to purchase a particular product. Over half of respondents (58%) rated product price as a *very important* consideration when purchasing an energy-using product, while another 37% rated price as *somewhat important*. Only 3% of respondents indicated that price was not an important consideration.

We also asked respondents about the importance of product features on their purchase decisions. The responses listed in Figure 8-4 indicate that the majority (93%) believe product features are an important consideration, and over half (53%) indicated they are *very important* to their purchase decision.

Compared to price and energy use, more respondents (7%) said product features were *not an important* consideration when purchasing a product or appliance.

We also presented four scenarios that people might face when purchasing new appliances or considering energy-efficient improvements to their home. We asked respondents in the cross-program survey (n=148) to rate their level of agreement or disagreement with each statement shown in Figure 8-5.

Figure 8-5: Challenges to Making Energy-Efficient Improvements



Source: Question E8. "I'm going to read a list of scenarios that people might face when purchasing new appliances or considering energy-efficient improvements to their home. Would you say you strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, or strongly disagree?"

The largest barrier to improving energy efficiency for Residential Home Comfort Program participants appeared to be the presence of old, yet functioning, equipment. Sixty-four percent of respondents (n=141) agreed with the statement, *"My appliances and heating and air conditioning systems work fine, so why replace them?"* with 26% agreeing *strongly*. Other barriers were less present. Most people disagreed with information and knowledge barrier statements, indicating participants have a good understanding of opportunities to save energy.

8.4.10.3 Challenges – Manufactured Homes Component

Two of the four manufactured homes dealers said there were challenges to selling ENERGY STAR homes and two said there were not. One respondent said that demand is low and homes are already energy efficient. This respondent also said that ENERGY STAR homes cost more than other homes. The other respondent said the biggest challenge is financing.

One of these respondents suggested that customers need more education to overcome the challenges while another said that sending details about the rebate would help dealers answer customer questions. One person suggested PPL Electric Utilities create a website to discuss these rebate opportunities (unaware that PPL Electric Utilities already has a website listing the details of the program). One of the four respondents had no suggestions to overcome challenges.

8.4.10.4 Challenges – New Homes Component

As previously discussed, Cadmus spoke with two participating builders and two nonparticipating builders. The two participants said there are challenges to selling new homes, such as the efficiency upgrades required by PPL Electric Utilities' new construction program. Other challenges are the perception that customers are risk averse, the low payback for efficient strategies such as increased home envelope insulation, and hesitation to promote the program because of the rebate structure and concern about maintaining customers' trust. On the last point, one builder said he does not mention the rebate because he does not want customers to think he is encouraging them so that *he* can get a rebate. One of the nonparticipating builders said there were no challenges and the other nonparticipating builder said that code restrictions could be challenging.

Both participants and one nonparticipant builder said the best way to overcome these challenges is to educate customers about energy efficiency. The other nonparticipant builder said PPL Electric Utilities should offer more rebates for solar technologies.

8.4.11 Market Effects

"Market effects" are changes in the market or behavior of participants attributable to an energy efficiency incentive program.[105] An assessment of a program's effect on the market can provide evidence that a market barrier has been partially or fully mitigated. The Residential Home Comfort Program has several components, each designed to increase energy efficiency in different aspects of the residential market. These aspects of the residential market are at different stages of market maturity.

8.4.11.1 Audit and Weatherization

Typically, homeowners do not seek out home energy audits without the intervention of an energy efficiency program—in this case, PPL Electric Utilities' offerings. A simple market change theory is that the offer by the program will change the behavior of market actors and the utility's residential customers. That is, an increasing number of contractors will offer home energy audits, and residential customers will agree to one. PPL Electric Utilities has designed the Residential Home Comfort Program to encourage customers to act on the auditor's recommendations to install energy-efficient equipment. Customers who convert audit recommendations to actions is evidence of changes in the market toward increased energy efficiency of the residential sector.

Audit and weatherization programs are commonplace; utilities have offered these services for a number of years. Any change in the market for PPL Electric Utilities' audit and weatherization offering is informed by the perceptions of the contractors offering services, barriers reported by customers and contractors, any mitigation to participation barriers, and the number of audits and conversion of recommendations to installed measures. Additionally, an increase in the number of bonus rebates indicates customers' interest and implementation of multiple weatherization products.

Table 8-20 shows an increase of in-home surveys and audits, customers installing weatherization products, and bonus rebates from PY5 to PY6, an indication that the program is influencing the retrofit residential market for these services and products.

Table 8-20: Phase II Audit and Weatherization Completed Projects

Projects	PY5	PY6
Total number of Home Surveys and Home Audits conducted	555	1,066
Number of home walk-through surveys conducted	373	744
Number of comprehensive home audits conducted	182	247
Number installing recommended weatherization (insulation)	88	218
Program conversion rate percentage	40%	30%
Number of bonus rebates	3	63

105 Eto, Joseph, Ralph Prahl, and Jeff Schlegel. 1996. *A Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs.* Prepared for the California Demand-Side Management Committee.

Chief among the barriers to completing an audit and installing recommended equipment are the cost for both the audit and the equipment and the time to complete the work. The PY7 analyses will further investigate these barriers and conversion rates.

8.4.11.2 New Home Construction

PPL Electric Utilities offers rebates to builders who meet program requirements for energy-efficient new homes through either the HERS approach or prescriptive path. The program objectives are to encourage builders to construct homes that meet or exceed specified HERS ratings and to install energy-efficient equipment in new homes. Evidence of market change—for both builders and consumers—will be a greater knowledge of energy efficiency and conservation and increased numbers of qualified energy-efficient homes built and sold.

The baseline for new construction is standard practice, that is, homes meet the minimum energy code. This program pushes builders to construct homes that exceed the minimum code; the program baseline is determined by the standard of practice among participating builders. Although there were no participants in the new construction component in PY5, nine homes were eligible for a rebate in PY6. As stated earlier, a market barrier that hampers builders' sales is the low level of buyer awareness of the benefits of increased energy efficiency.

The program appears to be influencing the new construction market, and PPL Electric Utilities is responding to builders by offering the two ways to receive rebates. The PY7 analyses will monitor market progress on activities in this program.

8.4.11.3 Manufactured Homes

PPL Electric Utilities offers rebates to purchasers of energy-efficient manufactured homes. The program's objective is to promote ENERGY STAR-rated manufactured homes to PPL Electric Utilities customers and encourage installation of high-efficiency HVAC equipment. Evidence of market change will be increasing numbers of customers aware of and purchasing ENERGY STAR homes. Manufactured home retailers are instrumental to sale and are, therefore, important market actors. In PY7, Cadmus will assess PPL Electric Utilities' influence on changes in this market within its service territory by tracking the number of homes sold and discussing awareness of the program, awareness of energy efficiency, and any purchase barriers and mitigating factors with buyers and retailers.

The manufactured homes component is new to PPL Electric Utilities' portfolio, so no home sales represent the baseline. In PY6, PPL Electric Utilities received rebate applications for two homes that met eligibility requirements. We expect this number to increase as the program influences more buyers and retailers. As discussed above, increases in awareness and demand for rebate-eligible ENERGY STAR manufactured homes are needed to mitigate purchase barriers.

It is unlikely that PPL Electric Utilities will influence the manufacture of ENERGY STAR homes; yet it is important to understand how manufacturers approach home building standards related to energy efficiency. Some build homes to minimum U.S. Department of Housing and Urban Development (HUD) standards, others to the ENERGY STAR standard. In Cadmus' interviews, two of the four manufacturers reported building only ENERGY STAR homes, even though all are ENERGY STAR partners. Manufacturers can achieve an energy efficiency performance that earns the ENERGY STAR rating by either:

- Offering preapproved packages of ENERGY STAR features based on climate zone provided in the U.S. Department of Energy's guide to climate regions.[106]
- Using computer analysis (using energy-modeling software) to create designs that meet the ENERGY STAR requirements.

Two manufacturers reported they use the computer analysis path, one uses the preapproved packages path, and the fourth did not know which path his company used. This suggests the market is highly influenced by the ENERGY STAR requirements and internal policy to meet those standards.

8.5 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, we suggest PPL Electric Utilities consider the following recommendations in PY7.

Conclusion
Overall, PPL Electric's Residential Home Comfort Program is meeting its program goals for energy savings and demand reductions.

Conclusion – Audits
The cost of an audit is a barrier to participation for some customers. It is difficult to interest customers in the audits because of the upfront cost, which cannot be financed through PPL Electric. Customers already have the option of receiving the less comprehensive Home Energy Survey for $50 rather than the more comprehensive and costly Home Energy Audit, but this may still not be enough to interest customers in the audit.

Recommendation
PPL Electric Utilities should continue to offer and market the bonus rebates, which are designed to reduce participation barriers by covering more of the cost of the audit.

Conclusion – HVAC
Ductless heat pumps are popular with customers. The majority of participants opt for DHP systems with a SEER 18 or higher. The $200/ton rebate for high-efficiency systems with an efficiency rating of at least SEER 19 is working to push installations of these systems.

Recommendation
Consider dropping the rebate for SEER 15 ductless heat pump systems and raising the minimum efficiencies for each rebate tier by at least one SEER. Very few customers opted for SEER 15 and SEER 15.5 ductless heat pump systems, and over half of the installed systems were SEER 20 or higher. To really push the market for high-efficiency equipment, consider starting the minimum efficiency eligibility at SEER 18 and reserve the highest rebate for customers installing systems with a minimum efficiency rating of SEER 22.

Conclusion
Raising the rebate for air source heat pumps during the Limited Time Offer was very successful in increasing installation of systems with an efficiency rating of SEER 16 or higher. Previously, these higher-

---

[106] U.S. Department of Energy. *Guide to Determining Climate Regions by County.* Prepared by Pacific Northwest National Laboratory & Oak Ridge National Laboratory. August 2010. Available at: http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_climateguide_7_1.pdf

efficiency units were consistently around 62% of all rebated units per quarter. After raising the rebate, the percentage of these units rebated increased to 85% in PY6 Q4.

Recommendation
Closely monitor participation in the air source heat pump rebate component to avoid oversubscription. If oversubscription approaches, either close the air source heat pump rebate or raise the minimum SEER requirement to SEER 17 or 18 to push installation of equipment that is significantly above the baseline of SEER 14.

Conclusion
Rebates are designed to encourage customers to purchase equipment that is more energy efficient than they would have otherwise purchased. Considering that air-source heat pump technology becomes more complex above SEER 15 - 16, units can vary considerably in price. Above SEER 16, units typically have two speed or variable speed fans in the air handler and two-stage compression in the compressor unit, which leads to higher differentials in price between SEER ratings. The $1200 Limited Time Offer rebate (which ended Oct. 16, 2015) reflected the increased cost of these units. The $200 rebate for ASHP (offered in PY7, commencing Oct. 17, 2015) might not influence consumers to purchase SEER 16 and successively higher efficiency units.

Recommendation
If the number of rebates for SEER 16 and above falls lower than desired in PY7, PPL Electric Utilities may want to consider re-offering the $1200 ASHP rebates for SEER 16 and above in Phase III. This rebate for higher efficiency ASHP reflects the increased SEER and the more complex system with two speed or variable speed functionality, and the higher incremental costs than lower SEER (from SEER 14 to SEER 15 for example).

Conclusion – Manufactured Homes
The manufactured home component is struggling to generate interest. This component targets a very small percentage of the overall market for new manufactured homes. The majority of manufactured homes sold by Pennsylvania retailers have gas heat rather than heat pumps. Customers are opting for homes with gas heat, which is one factor that drives low participation.

Manufactured homes retailers need more exposure to and information about the manufactured homes rebate offered through the Residential Home Comfort Program.

Recommendation
Consider extending marketing to manufactured homes retailers through personal contact and/or personal e-mail messages that direct retailers to the PPL Electric Utilities website for additional program information. In the communications, describe the benefits of the program and rebate so they can discuss it with their customers. Personal communications and marketing materials may increase purchase of electrically heated manufactured homes.

Additionally, or alternatively, consider further study to assess the potential market for electrically heated manufactured homes. Since very few all-electric manufactured homes are being built, this program component may not be as successful as originally anticipated. Revisions to the requirements or participation goals of the manufactured homes component may be needed.

Recommendation
Interest in the new construction component is still low, given the number of new homes participating in the program. The current climate among builder groups appears to prefer that specific efficient construction practices are not mandated. Builders may need more rebate options and continuing education to support the new construction component because they are currently focused on keeping

their own costs low. Marketing should stress the advantages (i.e., the business case) of building homes that are more energy efficient than current building codes.

Recommendation

Continue to market to new home builders by emphasizing their selling power. Builders can demonstrate to home buyers the benefits of efficiency in lower monthly energy bills and greater comfort.

- Consider expanding the list of products rebated through the prescriptive path, but with the directive that builders must choose a specific number.
- Alternatively, offer the same prescriptive product rebate, but with a reduced rebate if appliances (refrigerator and dishwasher) are not installed.
- When marketing the HERS approach option, refer to the MLS entries, which may list the home's HERS rating, and that customers are paying attention to efficiency.

8.5.1 Status of Recommendations for Program

Table 8-21 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 8-21: Residential Home Comfort Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status Report for Process Evaluations (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC
Residential Home Comfort	
Continue to offer and market bonus rebates to reduce financial participation barriers to participating in audits.	Under consideration for Phase III.
Consider dropping the rebate for SEER 15 ductless heat pump systems and raising the minimum efficiencies for each rebate tier by at least one SEER; consider starting the minimum efficiency eligibility at SEER 18 and reserve the highest rebate for customers installing systems with a minimum efficiency rating of SEER 22.	Under consideration for Phase III.
Consider eliminating the SEER 15 rebate raising the minimum SEER requirement for the air source heat pump rebate to SEER 16 or above to push installation of equipment that is significantly above the baseline of SEER 14., and increase savings.	Under consideration for Phase III.
The $1200 limited time offer for SEER 16 ASHP rebates was very successful in moving the market. Consider re-offering the $1200 ASHP rebates for SEER 16 and above in Phase III if savings are needed and the budget can accommodate this (over $1/annual kWh saved acquisition cost).	Under consideration for Phase III but the budget likely cannot accommodate this level of rebate (program acquisition cost is more than $1/annual kWh saved).
Consider extending marketing to manufactured homes retailers through personal contact and/or personal e-mail messages; messaging could describe the benefits of the program and rebate.	Under consideration for Phase III.
Consider further study to assess the potential market for electrically heated manufactured homes.	Under consideration for Phase III.
Continue to market to new home builders by emphasizing their selling power.	Under consideration for Phase III.
Consider expanding the list of products rebated through the prescriptive path or offer the same prescriptive product rebate, but with a reduced rebate if appliances are not installed.	Under consideration for Phase III.
When marketing the HERS approach option, refer to the MLS entries.	Under consideration for Phase III.

8.6 FINANCIAL REPORTING

A breakdown of the Custom Incentive Program finances is presented in Table 8-22.

Table 8-22: Summary of Custom Incentive Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$4,983	$7,538
2	EDC Incentives to Participants	$1,148	$1,478
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$3,835	$6,060
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$1,113	$1,800
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$1,113	$1,800
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$246	$227
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$6,342	$9,566
13	Total NPV Lifetime Energy Benefits	$3,414	$5,116
14	Total NPV Lifetime Capacity Benefits	$784	$1,119
15	Total NPV O&M Saving Benefits	$47	$60
16	Total NPV TRC Benefits[4]	$4,245	$6,295
17	TRC Benefit-Cost Ratio[5]	0.67	0.66

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

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report

ADDENDUM A. PARTICIPANT SURVEY METHODOLOGY

Dialing Instructions

PPL Electric Utilities provided dialing instructions for conducting surveys. Customers cannot be contacted within a year of the last time they completed a survey (with PPL Electric Utilities or Cadmus). Any customer who has requested to be removed from the sample frame for any survey cannot be contacted again. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Cadmus used three surveys to gather results about participants. The sample methodology was slightly different among all three groups. In all cases, Cadmus coordinated with PPL Electric Utilities' contractor to screen the sample and remove customer records called in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and those who requested not to be contacted again. Cadmus removed records with incomplete information, duplicate contact information, inactive customers, and customers selected for a different survey,

For the cross-program survey, Cadmus selected a simple random sample.

For the fuel switching program survey, we included customers in the sample frame who indicated they had natural gas on their rebate forms and switched from a non-electric appliance to an electric appliance. We removed those who had electric heat. We then included all remaining records in the sample frame.

All participants who received a rebate for purchasing a new home were included in the sample frame.

In some cases, this cleaning and survey sample preparation process reduced the available sample. Table 8-23 through Table 8-25 lists total number of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table 8-23: Cross-Program Survey Sample Attrition Table

Cross-Program Survey: Residential Home Comfort Participants	
Description	**Count**
Total population (number of participants Q1-Q2)	**2,937**
Random sample selection	**1,675**
Removed incomplete or bad phone number, inactive customer, completed survey in past year, on "do not call" list, selected for a different survey, duplicate contact	**263**
Sent to Survey Subcontractor	**1,412**
Records Not Attempted [1]	**52**
Records Attempted	**1,360**
Nonworking number	45
Business/wrong number	31
Refusal	377
Language barrier	2
Ineligible; PPL or market research employment	20
Ineligible; did not participate in program	25
No answer/answering machine/phone busy	448
Nonspecific or specific callback scheduled	224
Partially completed survey	40
Completed Survey [2]	**148**

[1] These records were not needed because the overall survey target for the cross-program survey was reached before they were attempted.

[2] The survey target for the cross-program survey was 300 and was not stratified by program (Appliance Recycling, Residential Home Comfort, and Residential Retail). Survey calls continued until the overall target of 300 was met; completing as many surveys within each program as possible.

Table 8-24: Fuel Switching Sample Attrition Table

Fuel Switching Participants	
Description	**Count**
Total population (number of participants with natural gas)	**199**
Random sample selection	**199**
Removed inactive customer	5
Removed contacted in past year	10
Removed do not call	1
Removed in concurrent sample	3
Removed electric heat	47
Sent to Survey Subcontractor	**133**
Records Not Attempted	**0**
Records Attempted	**133**
Nonworking number	9
Business/wrong number	5
Refusal	20
Ineligible; PPL or market research employment	1
Ineligible; didn't participate in program	1
No answer/answering machine/phone busy	30
Nonspecific or specific callback scheduled	35
Partially completed survey	3
Completed Survey	**29**

Table 8-25: New Homes Participants Sample Attrition

New Homes Participants	
Description	**Count**
Total population (program participants)	**6**
Sent to Survey Subcontractor	**6**
Records Not Attempted	**0**
Records Attempted	**6**
Refusal	2
No answer/answering machine/phone busy	2
Completed Survey	**2**

ADDENDUM B. TRADE ALLY METHODOLOGY

Table 8-26 through Table 8-29 list the total number of records used for interview calls and the outcome (final disposition) of each record.

Table 8-26: Manufactured Homes Manufacturers Sample Attrition Table

Description of Call Outcomes	Number of Records
Survey Sample Frame	**9**
Not attempted	**0**
Records Attempted	**9**
No answer/answering machine/phone busy	5
Completed survey	4

Table 8-27: Manufactured Homes Retailers Sample Attrition Table

Description of Call Outcomes	Number of Records
Survey Sample Frame	**26**
Not attempted	**0**
Records Attempted	**26**
Non-working number	1
Refusal	3
No answer/answering machine/phone busy	16
Partial complete	2
Completed survey	**4**

Table 8-28: New Homes Participating Builders Attrition Table

Description of Call Outcomes	Number of Records
Survey Sample Frame	**5**
Not attempted	**0**
Records Attempted	**5**
No answer/answering machine/phone busy	3
Completed survey	**2**

Table 8-29: New Homes Nonparticipating Builders Attrition Table

Description of Call Outcomes	Number of Records
Survey Sample Frame	**12**
Not attempted	**0**
Records Attempted	**12**
Refusal	1
No answer/answering machine/phone busy	9
Completed survey	**2**

ADDENDUM C. LOGIC MODEL

The program theory for the Residential Home Comfort Program can be summarized as follows:

> PPL Electric Utilities offers customers incentives and two levels of energy audits. Participating customers will have their homes audited and will install low-cost energy saving products. Customers will be educated about the long-term energy cost-saving benefits of higher-efficiency equipment. PPL Electric Utilities expects energy savings and demand reduction from the installation of both the low-cost products and the larger energy-efficiency products.
>
> Offering builders incentives for installing a package of efficient products, constructing homes to meet or exceed a stipulated HERS rating, or promoting Energy STAR-rated manufactured homes with high-efficiency HVAC equipment will encourage them to include the energy-efficient equipment in new homes. Builders will be educated about the benefits of incorporating energy-efficiency into their general building practices. Offering incentives for training will improve audit diagnostics and will achieve best practices.

The elements of the logic model are listed below.

- **Activities the program undertakes** consist of marketing, developing educational materials, conducting audits, installation of low-cost products during initial audits, installation of major products, and rebates to customers and builders.
- **Outputs produced by program activities** are the marketing activities, the number of program participants, the number of builders, the number and type of products installed, and the total amount of incentive compensation that has been paid.
- **Short-term outcomes** are increased program awareness, establishment of participant eligibility, establishment of builder eligibility, establishment of eligibility for individual products, establishment of targeted HERS rating, installation of program-eligible energy-saving items in participant homes, increased participant and builder knowledge of energy efficiency and conservation.
- **Intermediate outcomes** are installation of cost-effective products, and reduced energy use by participant households through efficient equipment and conservation from residents.
- **Long-term outcomes** are the desired final program impacts, including cost-effective energy savings resulting from energy-efficient upgrades and changes in building practices.

9 E-POWER WISE PROGRAM

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

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

The objectives of the E-Power Wise Program are to: [107]

- Provide quality energy conservation and efficiency education to low-income customers.
- Provide information about low-cost/no-cost energy efficiency strategies that low-income customers can use in their homes.
- Provide low-income customers with energy-efficient products in free take-home and direct mail energy-savings kits.
- Obtain participation by 11,400 customers through 2016 and achieve energy savings of approximately 5,600 MWh/yr.

An executive summary of cumulative Phase II program metrics can be found in Table 9-1.

Table 9-1: Phase II E-Power Wise Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
E-Power Wise	3,488	4,236	3,241	1.0	3.39	$636	$0.20	$0.03	6,317
Total	**3,488[3]**	**4,236[3]**	**3,241[3]**	**1.0**	**3.39**	**$636**	**$0.20**	**$0.03**	**6,317[4]**

[1] Total EDC Costs divided by first year kWh savings.
[2] Total TRC Costs divided by levelized lifetime kWh savings.
[3] The E-Power Wise kit's education measure has a one-year measure life. 355.65 MWh and 0.0915 MW reported in PY5 calculations has expired.
[4] As of PY7 Q1, the E-Power Wise program distributed 1,991 energy-savings kits bringing the total Phase II distribution to 8,308 kits. This is 73% of the planned participation for Phase II.

107 Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.91.

9.1 PROGRAM UPDATES

PPL Electric Utilities removed two 13W CFLs and the bathroom aerator and added two 10.5W LEDs to the PY6 energy-savings kit.

9.1.1 Definition of Participant

Participants in PY6 are defined as any low-income customer who received an energy-savings kit either through the community-based organization or the direct mail delivery channel of PPL Electric's E-Power Wise Program, between June 1, 2014, and May 31, 2015.

9.2 IMPACT EVALUATION GROSS SAVINGS

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

Table 9-2: Phase II E-Power Wise Reported Results by Customer Sector

Sector	Phase II Participants	Phase II Reported Gross Energy Savings (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Low-Income	6,317	3,488	0.37	$0
Phase II Total	**6,317**	**3,488[1]**	**0.37[1]**	**$0**

[1] The E-Power Wise kit's education measure has a one-year measure life. 355.65 MWh and 0.0915 MW reported in PY5 calculations has expired.

9.2.1 EM&V Sampling Approach

Cadmus conducted a database review of the census of EEMIS records each quarter. Another review included all written surveys returned by participants; these surveys were used in the energy-savings analysis. Phone surveys were not conducted in PY6.

9.2.1.1 Database Review Sample Sizes

Cadmus conducted a database review of the census of EEMIS records, as presented in Table 9-3.

Table 9-3: PY6 E-Power Wise Impact Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
All	3,602	N/A[1]	All Records	3,600[2]	Database Review
Program Total	**3,602**	**N/A[1]**	**All Records**	**3,600[2]**	

[1] Since this program's evaluation of the database did not include sampling, confidence and precision are not meaningful.
[2] During verification activities, Cadmus identified and removed two accounts that received multiple kits or could not be traced between databases.

9.2.1.2 Paper Survey Sample Sizes

The ICSP included a paper survey in each kit distributed. The surveys were returned by participants to the ICSP throughout the year. All surveys returned to the ICSP were provided to Cadmus. This survey gathered the data necessary for Cadmus to complete engineering calculations to compute energy savings in PY6.

Of the 2,325 participants who entered the program through the agency-based delivery channel, 390 returned surveys. Of 1,275 participants who entered through the direct mail delivery channel, 215 returned surveys. All surveys returned by PY6 participants were included in the evaluation and energy savings analyses. Table 9-4 presents the delivery method, sample size, and functions of each of the surveys used in this evaluation.

Table 9-4: Survey Data Collection for E-Power Wise Program

Survey	Survey Delivery Method	Frequency	Population	Sample Size	Impact Evaluation	
					Product Installation Energy Savings	Behavior Change Energy Savings
Agency-Based Participant Kit	Included in kit	All quarters	2,325	390 (All)	Yes	Yes
Direct Mail Participant Kit	Included in kit	All quarters	1,275	215 (All)	Yes	Yes
Total			**3,600**	**605**		

9.2.2 *Ex Ante* Adjustment Methodology and Findings

A savings adjustment was necessary to calculate the E-Power Wise Program realization rate. Cadmus adjusted the reported savings (presented in Table 9-5) from EEMIS to align with assumptions specified in the TRM and the characteristics of the items themselves, resulting in adjusted *ex ante* savings for several of the kit products. Adjustments are made to the population prior to any evaluation analyses. The adjustment accounts for differences between planning assumptions, the TRM assumptions, and the equipment that was actually distributed to participants. The results of this adjustment to the population are the *ex ante* savings used in the equation to determine the program's realization rate.

Table 9-5 shows the reported savings and the results of the TRM-adjusted *ex ante* calculations for the products included in each kit.

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

Product[1]	Reported *Ex Ante* Savings (kWh/yr)	TRM Adjusted *Ex Ante* Savings (kWh/yr)	Factors
Furnace Whistle	59	Updated savings for ZIP code mapping. Scranton (61 kWh), Philadelphia/Williamsport/ Harrisburg/Allentown (59 kWh)	PPL Electric assumes EFLH hours for Harrisburg as a placeholder. 2014 TRM Table 2-8 was used to update EFLH by mapping participant ZIP codes to the nearest city.
Smart Strip	66.6	66.6	No adjustments made to reported *ex ante* savings. PPL Electric assumes an average of default values for 7-plug unspecified use and entertainment center from 2014 TRM Section 2.12.4
LED 10.5W	30.3	30.3	No adjustments made to reported *ex ante* savings. Program bulbs are rated to replace a 60W equivalent light bulb. Per the 2014 TRM Table 2-74, the base watts assumption for the bulbs is 43W and is included in the calculations.
LED2 10.5W	30.3	30.3	
Faucet Aerator - Kitchen	94	Multifamily participants (65 kWh), single-family participants (97 kWh)	PPL Electric uses 52% fuel saturation per PPL RASS study. 2014 TRM Table 2.8.3 stipulates different fixed values based on housing types. [2]

Product[1]	Reported *Ex Ante* Savings (kWh/yr)	TRM Adjusted *Ex Ante* Savings (kWh/yr)	Factors
Low-Flow Showerhead	104	Multifamily participants (89 kWh), single-family participants (104 kWh)	PPL Electric uses 52% fuel saturation per PPL Electric RASS study. 2014 TRM Table 2.9.4 stipulates different fixed values based on housing types.[2]
Energy Education (Initial)	160	160	No adjustments made to reported *ex ante* savings. Behavior-based CMP approved by the SWE in Phase I.[3]
LED Nightlight	27.6	27.6	No adjustments made to reported *ex ante* savings.

[1] Savings from all products are attributed to the low-income sector.
[2] The 2014 TRM provides different fixed variables for number of persons in the house and number of showers based on single-family and multifamily home types. Enrollment data regarding home type was available for both agency and direct mail participants. Cadmus used enrollment data to determine home type and associated energy savings.
[3] Savings from energy education and related behavior activities are derived from survey data using the Custom Measure Protocol for E-Power Wise Behavior Savings Calculations. Cadmus updated the CMP in PY6 to conform with updates to the 2014 TRM water heaters, clothes washers, and programmable thermostats algorithms. This update affects the survey-verified savings for survey respondents.

9.2.3 *Ex Post* Adjustment Methodology and Findings

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

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

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

9.2.3.1 Database Review

Cadmus conducted a database review of all PY6 participant records in EEMIS. Participants' PPL Electric Utilities account numbers, E-Power Wise Program kit numbers, and other data stored in EEMIS were reviewed across all previous program years and quarters to ensure that the program counted only one kit per household. Additionally, participant records from EEMIS were compared with enrollment data stored in the ICSP's electronic database to ensure that records were traceable between the ICSP and EEMIS databases.

EEMIS listed a total of 3,602 participants prior to the database review. Through the database review, Cadmus identified and removed accounts that received multiple kits or could not be traced between databases. As a result, the total number of program kits was reduced to 3,600, representing 99.9% accuracy.

Table 9-6 summarizes the database review and the number of kits verified in the PY6 analysis. Cadmus accounted for the four duplicate accounts and total savings estimate by assigning them zero verified savings.

Table 9-6: PY6 E-Power Wise Program Database Review Results

Sector	Product	Kits in EEMIS	Database Accuracy	PY6 Eligible Kits
Low-Income	Kit (including all products)	3,602	99.9%	3,600

9.2.3.2 Participant Surveys

Each kit distributed through the program included a PPL Electric-approved participant survey. These surveys collected the necessary data to calculate installation rates and to determine participant actions taken as a result of the program. The analysis included 390 mail-in surveys returned by the participants who received the kit from the community-based organization and 215 surveys returned by direct mail participants. Altogether, 605 mail-in surveys were included in the program evaluation. In PY6, the overall survey return rate was 17%, which is a 3% increase from PY5.

Participant Surveys Methodology. Cadmus used participant returned paper surveys to calculate *ex post* per-unit savings for each item contained in the E-Power Wise Program energy efficiency kit as well as for savings attributed to behavior change. In PY5, Cadmus updated the survey verification methodology to calculate energy savings and continued to use this updated methodology in PY6. The methodology relied on individual survey respondent-level information available from returned surveys and the program enrollment cards. Cadmus assigned specific survey *ex ante* and survey-verified *ex post* savings values to each respondent for each product based on the following variables:

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

TRM adjusted *ex ante* savings were assigned as product-level survey *ex ante* savings for all product-specific questions. *Ex ante* savings calculations for energy education (behavior-based savings) are described in detail in section 9.4.3. Additionally, refer to Appendix H: E-Power Wise Behavior Savings Calculations for more information on updates to the energy education savings calculations.

The PY6 methodology calculates the variation among program participants by applying specific values to each survey respondent's answers to product-specific questions and home characteristics. The resulting realization rate reflects this variation and the precision captures any uncertainty associated with the participant level variation and sampling. Refer to Appendix G: Methodology for Determining Savings from Energy-Savings Kits for more information on the respondent-level methodology.

9.2.3.3 Summary of Survey Findings

Program participants returned 605 surveys that were included in the energy-savings kits. Table 9-7 presents the PY6 installation rates (ISR) for each of the energy saving kit items. ISRs are presented as a percentage of participants who answered the question and not a percentage of the total number of people surveyed. The installations rates for kit products are useful for program planning purposes.

Table 9-7: PY6 Installation Rates for Kit Products Distributed Through E-Power Wise Program

Product Installed	Kit Delivery Method			
	PY6 Agency		PY6 Direct Mail	
	Sample Count (n)	ISR	Sample Count (n)	ISR
Kitchen Aerator	386	30%[1]	212	51%[1]
Low-Flow Showerhead	382	31%[1]	214	50%[1]
10.5W LED[2]	389	96%	215	98%
10.5W LED[2][3]	389	91%	215	91%
LED Nightlight	389	87%	215	92%
Furnace Whistle[2]	367	17%[4]	210	20%[4]
Smart Strip[2]	388	77%	215	83%

[1] Represents the percentage of electric water heat fuel type homes where the product was installed, out of the total number of respondents to the specific question.
[2] The TRM does not allow EDC data gathering for this product but the information collected via participant surveys is useful for program planning.
[3] This line item represents the second LED bulb in the kit.
[4] Represents the percentage of electric heating/cooling fuel type homes where the product was installed, out of the total number of respondents to the specific question.

As shown in Table 9-8, the installation rates in PY6 stayed relatively consistent with rates in PY5. The installation rate for the smart power strip increased the most from PY5 to PY6. Customers are installing the LED bulbs at a higher rate than the CFLs in PY5. The water products continue to have low installation rates, especially through the agency-delivery channel. The furnace whistle has the lowest installation rate of all products in the kit and is especially low through the direct mail delivery channel.

Table 9-8: E-Power Wise Kit Product PY5 and PY6 Installation Rates

Products	Agency		Direct Mail	
	PY5	PY6	PY5	PY6
10.5W LED (x2)	-	96%	-	98%
CFL (x2)	92%	-	96%	-
LED Nightlight	88%	87%	94%	92%
Showerhead	65%	64%	72%	72%
Kitchen Aerator	72%	63%	74%	75%
Furnace Whistle	43%	45%	58%	42%
Smart Strip	61%	77%	58%	83%

Cadmus determined relative per-unit savings for each of the items included in the kits using two methods:

- Assigned TRM-specified savings for products with fixed ISRs and;
- Assigned savings based on respondent-level installation rates determined through the participant surveys for products with EDC data gathered ISRs in the TRM.

Both methods used product-specific TRM algorithms for determining per-unit savings. Table 9-9 shows the survey verified savings attributable to all of the products included in the kit except for the furnace whistle verified savings, which can be found in Table 9-10.

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

Product Installed	PY6 Per-Unit Savings (kWh/yr)
Kitchen Aerator	Single-family (220); Multifamily (147); Unspecified (212)
Low-Flow Showerhead	Single-family (239); Multifamily (203); Unspecified (239)
10.5W LED	30.3
10.5W LED[1]	30.3
LED Nightlight	28.5
Smart Strip	Entertainment Center (74.5); Unspecified (58.7)
[1] EEMIS contains separate placeholder values for each kit 10.5W LED bulb.	

Table 9-10: E-Power Wise Program Survey Verified Furnace Whistle Savings per Distributed Unit

TRM Specified Installation Location	Both Heating and Cooling Savings (kWh/yr)	Heating Only Savings (kWh/yr)	Cooling Only Savings (kWh/yr)
Allentown	59.72	42.41	17.31
Erie	61.79	47.96	13.83
Harrisburg	58.8	39.21	19.59
Philadelphia	58.69	37.68	21.01
Pittsburgh	58.34	42.98	15.36
Scranton	60.89	46.07	14.82
Williamsport	59.47	44.47	15

9.2.4 Summary of Evaluation Results

Program energy savings results are provided in Table 9-11 and Table 9-12.

Table 9-11: PY6 E-Power Wise Summary of Evaluation Results for Energy[1]

Stratum	Reported Gross Impact (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr) [2]	Observed Coefficient of Variation (Cv), Error Ratio (ER), or Proportion in Sample Design	Relative Precision at 85% C.L.
Agency	1,319	1,805	68%	1,224	0.62	5.54%
Direct Mail	730	1,002	85%	848	0.73	4.82%
Program Total	**2,060[3]**	**2,807[3]**	**74%**	**2,071[3]**	**N/A[4]**	**3.63%**

[1] Values in this table refer to savings at the point of consumption. (Savings for MWh refer to values at the point of consumption.) Due to line losses, savings at the point of generation are systematically larger.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[3] The E-Power Wise kit's education measure has a one-year measure life. PY6 verified savings do not deduct PY5 expired savings. 424.9 MWh and 0.071 MW verified savings in PY6 will expire in PY7.
[4] Observed Coefficient of Variation (Cv) is not applicable at the program level.

Table 9-12: PY6 E-Power Wise Summary of Evaluation Results for Demand

Stratum	Reported Gross Demand Savings [1] (MW)	Adjusted Ex-Ante Demand Savings [2] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings [2] (MW)	Observed Coefficient of Variation (Cv), Error Ratio (ER), or Proportion in Sample Design	Relative Precision at 85% C.L.
Agency	0.185	0.25249	88%	0.22206	0.75	6.71%
Direct Mail	0.102	0.13975	116%	0.16246	0.85	5.62%
Program Total	**0.286**	**0.392**	**98%**	**0.385**	**N/A[3]**	**4.31%**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] Adjusted *Ex Ante* and Verified gross demand reductions include T&D losses.
[3] Observed Coefficient of Variation (Cv) is not applicable at the program level.

9.3 IMPACT EVALUATION NET SAVINGS

This program targets the low-income community, and there is no freeridership among the population receiving the kits. No spillover is assumed. The E-Power Wise Program is assigned a net-to-gross ratio of 1.0.

Table 9-13: PY6 E-Power Wise Sampling Strategy for NTG Research

Stratum	Stratum Boundaries	Population Size (number of energy-savings kits)	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
E-Power Wise	Program	3,600	N/A	N/A	N/A	N/A	N/A

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means of all the sample frame how many were called to get the completes.

Table 9-14: PY6 E-Power Wise Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
E-Power Wise	N/A	N/A	100%	N/A	N/A

9.4 PROCESS EVALUATION

9.4.1 Research Objectives

Cadmus conducted the PY6 process evaluation to address the following research objectives:

- Identify areas of program success;
- Identify areas that may benefit from program improvements; and
- Assess agency satisfaction with program.

9.4.2 Evaluation Activities

For the E-Power Wise Program, the PY6 process evaluation activities were:

- Interviews with program staff and implementer (n=2)

- Interviews with agencies (n=5)
- Review of database and quality assurance/quality control (QA/QC) records
- Analysis of process-related questions from customer surveys returned from the energy-savings kits (n=605)

The process evaluation activities were consistent with the evaluation plan.

9.4.3 Methodology

9.4.3.1 Program Staff and Implementer Interviews

Cadmus interviewed the E-Power Wise Program managers from PPL Electric and the ICSP to review program design changes, areas of the program that are working well, and any areas where the program has experienced challenges.

9.4.3.2 Agency Interviews

The community-based organizations, or agencies, distribute the energy-savings kits to income-qualified clients. Cadmus interviewed staff members from selected agencies to learn about their experiences, opinions, and overall satisfaction with the program. The ICSP provided the complete list of 17 participating agencies. Each agency was provided an inventory of energy-savings kits to distribute. We stratified the agencies according to the percentage of kits each agency distributed from their inventory. Distribution activity levels were defined as high (85% to 100% of the inventory was distributed), medium (70% to 84%), and low (30% to 69%). A sample of agencies was randomly selected from each stratum.

Cadmus conducted five interviews with participating agencies. Table 9-15 lists the agency sampling strategy for the E-Power Wise Program for PY6. (A detailed methodology is included in Addendum A. Agency Interview Methodology.)

Table 9-15: PY6 E-Power Wise Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries [1]	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percentage of Sample Frame Contacted [2]	Evaluation Activity
PPL Electric Program and ICSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, Impact, Program Staff Interview, Census
Agency Interview									
High Activity Agencies	85%–100%	5	N/A	N/A	2	5	2	60%	Process
Medium Activity Agencies	70%–84%	7	N/A	N/A	2	7	2	30%	Process
Low Activity Agencies	30%–69%	5	N/A	N/A	1	5	1	60%	Process
Total		**19**			**7**	**19**	**7**	**47%**	**Process**

[1] Percentage of kit inventory distributed.

[2] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews.

9.4.3.3 Surveys Included in Kits

In each energy-savings kit, the ICSP included a survey that asked basic questions about installing the products. Customers who returned the surveys were automatically entered into a monthly raffle for a $100 gift card. Cadmus used these data to verify program savings for the impact evaluation analysis. Also included in the surveys were a few questions about the participant experience with the program and program materials, and these data were included in the process evaluation analysis.

The ICSP collected the surveys and sent all survey data to Cadmus on a quarterly basis. In total, the ICSP sent 605 surveys which represents 17% of the total participation. We reviewed the data for consistency and clarity. Results are based on a convenience sample – all returned surveys were included in the analysis. We recognize that associated biases could affect the results if, for example, respondents act and answer in a way different than non-respondents. The response rate is reasonable (17%; 605 of 3,600) and higher than for many surveys, therefore we assumed that any possible bias would have minimal impact.

9.4.4 Achievements Against Plan

Table 8-13Table 9-16 shows the program's PY6 planned energy savings and incentives.

Table 9-16: E-Power Wise Program Savings

	PY5 Verified	PY6 Only			Phase II: PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	1,525	1,797	2,071	115%	5,611	3,241[2]	58%
MW	0.26[3]	0.23	0.39	170%	0.73	0.65	89%
Participation	2,715	3,600	3,600[4]	100%	11,400	6,317[5]	55%

[1] Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table K7, pp. 88.
[2] The E-Power Wise kit's education measure has a one-year measure life. 355.65 MWh and 0.0915 MW reported in PY5 calculations has expired.
[3] Includes line loss of 8.33%.
[4] EEMIS reports 3,602 kits. During verification activities, Cadmus identified and removed two accounts that received multiple kits or could not be traced between databases.
[5] As of PY7 Q1, the E-Power Wise program distributed 1,991 energy-savings kits bringing the total Phase II distribution to 8,308 kits. This is 73% of the planned participation for Phase II.

There are several possible reasons why the program exceeded both its planned MWh and MW savings for PY6. These include:

- The installation rate for the LED bulbs was high (98% for the first bulb and 91% for the second bulb)
- Two duplicate accounts that had previously received savings for the program lifetime during Phase I; the accounts were assigned zero savings, which had a small effect on overall program savings

9.4.5 Program Delivery

Overall, Cadmus found that the ICSP delivers and manages the program very well. The PPL Electric and ICSP program managers speak each week and work together to ensure that kit distribution remains steady throughout the program year. Agency staff members reported they were very satisfied with the communications from the ICSP program manager.

In PY6, the ICSP reconfigured the agency management structure to be more flexible to the needs of individual agencies. The ICSP gave each participating agency a goal for kit distribution, customized to its available resources, then worked closely with agency staff to coordinate kit inventory, collect enrollment cards,[108] and address any challenges in distribution. In turn, this coordination streamlined the ICSP's records consolidation process. In PY6, Cadmus identified only two duplicate records in the EEMIS database and both indicated the customer participated in a prior quarter. In addition to working closely with agency staff on kit distribution plans, the ICSP and PPL coordinate to offer webinars and breakfasts for the participating agencies to show appreciation for the agencies' work.

The process used to send kits through the direct mail delivery channel remained relatively consistent from PY5 to PY6. The PPL Electric customer service center lists potential kit recipients from customers who call in regarding bill assistance or other low-income program participation, such as Winter Relief Assistance Program (WRAP). The E-Power Wise Program manager sends the list to the ICSP, which checks for any account numbers that have received an energy-savings kit in the past. The ICSP sends eligible customers a promotional card indicating they can receive a kit. Customers opt in by sending in the enrollment card; the ICSP then sends the kit. In PY6, the ICSP staggered the distribution of the promotional cards to maintain a consistent outreach schedule.

9.4.5.1 Logic Model

A program's theory informs its development and implementation as well as its evaluation. A program logic model identifies the relationships between activities and expected results. Because logic models are designed to make the underlying theory explicit, they are useful tools for implementers and evaluators. The logic model details are provided in Addendum B. Logic Model.

During PY5, Cadmus developed a logic model and process flow maps for the E-Power Wise Program. We reviewed the logic model at the end of PY6 to determine if the program had changed from the description in the Phase II EE&C Plan and found that the model is still applicable.

9.4.5.2 Key Performance Indicators

In addition to program savings and overall number of kits distributed, PPL Electric and the ICSP identified two key performance indicators (KPIs) they use to measure how the program is performing. The KPIs are the number of agencies distributing kits for the program and the tailored plans for kit distribution for each agency. Table 9-17 shows these two KPIs along with the PY6 results.

Table 9-17: E-Power Wise Program KPIs

Key Performance Indicator	Metric	Goal	PY6 Result
Agency participation	Number of agencies distributing kits for the program	Increase number of agencies participating in program to reach all of PPL territory	Increased by two agencies and plan to increase by two in PY7
Kit distribution planning	Number of kits distributed by agencies	Individual plans for kit distribution by agency to consistently distribute kits within agency capacity	High program satisfaction from agencies, smooth inventory tracking and record consolidation

Cadmus' review found that the program did very well in enlisting additional agencies to participate and modifying each agency's kit distribution plans to facilitate smooth program tracking. In the program logic

[108] Enrollment cards are collected by agency staff for each participant who receives an E-Power Wise kit. The cards include details regarding the participant's demographics and utility account number.

model, energy education delivered to participants is identified as a program objective. Energy education is not tracked as a specific KPI, however, because it is intrinsically tied to kit distribution.

9.4.6 Program Updates and Outcomes

The E-Power Wise Program increased the plan for kit distribution from 2,700 kits to 3,600 kits in PY6. To meet this, PPL Electric and the ICSP added two new agencies in PY6 and enrolled two more agencies to start in PY7, bringing the total to 20 participating agencies. The ICSP selected the new agencies by focusing on the geographic areas in PPL Electric's service territory with low program representation and with agencies that have the capacity to deliver the program within their existing community services

In PY6, PPL Electric removed the bathroom aerator from the kit and replaced the kit's CFL bulbs with two LED bulbs. Both the ICSP and the agency staff agreed that changing lighting options increased participant excitement about the kits. One agency believed the kits have changed so much from previous years that new kits should be offered to past participants. Upon review of past kit configurations, Cadmus confirmed that the products have stayed relatively consistent since PY2; therefore, the agency perception may not align with fact.

When Cadmus asked which products should be removed or added to the kit, agencies said they would like to remove the furnace whistle and add another LED. Agencies reported that clients ask the most questions about the furnace whistle because clients do not understand how to install or use it. Also, the furnace whistle may not function in all electric-heat households; many homes use baseboard heating.

In PY5, Cadmus recommended that PPL Electric investigate the possibility of offering two types of kits, one with water-saving products (for homes with electrically heated water) and another without (for homes with water heated by fossil fuels). We suggested removing certain items that had low installation rates, e.g., furnace whistles. Although PPL Electric and the ICSP continue to discuss the feasibility of these options, the ICSP said agencies are less than willing to handle the logistics of tracking and distributing two kits.

In PY5, Cadmus recommended that the E-Power Wise Program update the train-the-trainer materials to focus more on the benefits of installing the kit products. This recommendation assumed that if participants understood the products' benefits they would be more likely to install them in their home. In PY6, the ICSP changed the train-the-trainer format to focus on tips to explain to clients the benefits of installing kit products. The ICSP also added installation diagrams to the Quick Start Guide.[109] In PY7, the ICSP plans to add an instructional DVD to the kit to supplement the Quick Start Guide and provide additional resources as participants install items in their homes.

During the interview, the ICSP program manager said that, overall, *"Installation rate success is based on the involvement of the families and how much they buy into the message of the program."*

Included in every energy-savings kit is a survey that asks questions about the installation of each kit product and other topics. The ICSP encouraged agencies to follow up with participants who frequent the agency and ask about the kit installation survey. The PY6 survey return rate in the agency delivery channel increased to 17% over 14% in PY5. Table 9-18 shows PY5 and PY6 survey return rates.

[109] The Quick Start Guide is the installation instruction manual included in the energy-savings kit.

Table 9-18: E-Power Wise Survey Return Rate by Year and Distribution Channel

	PY5			PY6		
	Agency	Direct Mail	Program Total	Agency	Direct Mail	Program Total
Total Participants	1,600	1,115	2,715	2,325	1,275	3,600[1]
Returned Surveys	199	188	387	390	215	605
Survey Return Rate	**12%**	**17%**	**14%**	**17%**	**17%**	**17%**

[1] During verification activities, Cadmus identified and removed two accounts that received multiple kits or could not be traced between databases.

9.4.7 Participant Profile

There were 3,600 participants in the E-Power Wise Program in PY6. Of these, 2,325 received an energy-savings kit through an agency and 1,275 received an energy-savings kit via direct mail. About half of the participants (52%) live in single-family housing. Sixty percent have electric water heating in their homes. We used these and other participant characteristics in the savings verification analysis of the kit products.

9.4.8 Agency Program Delivery

Interviewed agencies indicated they were motived to participate because the E-Power Wise Program's energy-savings kits and energy education align with and/or expand upon the agency's services. Each agency distributed the kits in ways that complemented its existing community program offerings; the most common was through one-on-one meetings between agency staff and clients. For example, one agency we interviewed distributed the kits during in-home visits through WRAP. Only one agency we interviewed said it conducted workshops specifically about the energy-savings kits at its location. Most agencies had challenges with getting clients to participate in workshops and, therefore, focused on one-on-one meetings. Most agencies said they met or exceeded their kit distribution plans.

All interviewed agencies said they distributed the energy-savings kits to any client who met the income-eligibility guidelines; agencies did not target any specific demographics. They also screened potential kit recipients to ensure they had not received a kit in the past. Two agencies interviewed said that senior citizens were the group most interested in the energy-savings kits; another agency said young families were more interested. These variations in demographic groups depend on the population served by the individual agency.

A common concern expressed by agency staff was program saturation. Some agencies said they frequently encountered clients who had already received an energy-savings kit. One agency said that in PY6, almost a quarter of their clients received an energy-savings kit through a school program and they were uncertain if this disqualified the clients from receiving a kit through the E-Power Wise Program. Agencies were concerned that such repeat participants will become more common, especially in counties where kit distribution is high; this may decrease the opportunity to distribute kits in future years.

The current program delivery structure does not provide energy-savings kits to tenants in master metered apartments. One agency, which worked closely with low-income senior citizens in housing complexes where the electric bill is included in the rent, said this housing situation was not a good fit as the program does not work with building owners or landlords who pay the utilities. This agency expressed interest in working with the housing authority to distribute the energy-savings kits and energy education to the residents, but it did not know if starting a partnership was possible within the existing program structure or how to communicate this program delivery strategy to PPL Electric.

9.4.9 Satisfaction

9.4.9.1 Agency Satisfaction

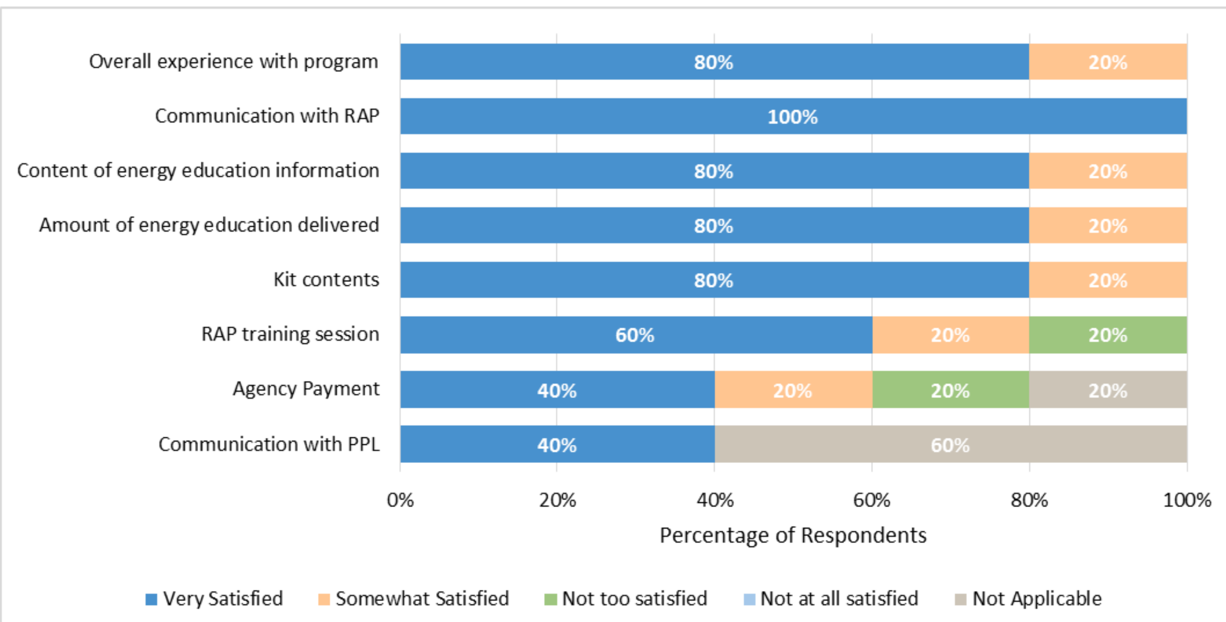
Overall, four of the five interviewed agencies are *very satisfied* with the E-Power Wise Program, while one said it was *somewhat satisfied*. Figure 9-1 shows the satisfaction levels for various components of the program. Agencies reported high levels of satisfaction with these program components:

- The content of the energy education information
- The amount of energy education delivered to clients
- The contents in the kit
- Communication with the ICSP

Some agencies reported lower levels of satisfaction with the energy-savings kit incentive and said the incentive amount could be higher. One agency said it was *not too satisfied* with the training session provided by the ICSP as it *"[does] not require the level of information provided by RAP through the training"* and that *"Veterans of the program should get a different level of training."* [110]

Most agencies interviewed (3 out of 5) indicated that they do not speak directly with PPL Electric staff regarding the program and therefore had no comment on their level of satisfaction with utility staff.

Figure 9-1: Agency Satisfaction with E-Power Wise Program Components



Source: Agency interview guide QE1, "I am going to ask you about your satisfaction with several features of the E-Power Wise program. Please tell me whether you are very satisfied, somewhat satisfied, not too satisfied, or not at all satisfied with the following statements." (n=5)

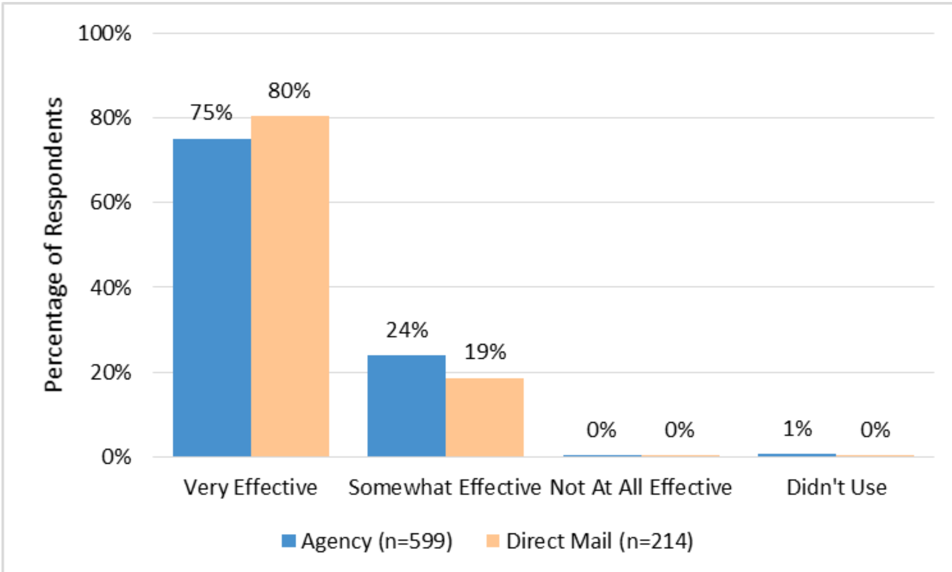
9.4.9.2 Effectiveness of Quick Start Guide

In the kit installation survey, participants rated the effectiveness of the Quick Start Guide. Figure 9-2 shows that over three-quarters of participants (75% of agency participants and 80% of direct mail participants) found the Quick Start Guide was *very effective* in helping them become more energy efficient. The

110 Resource Action Program, Inc. (RAP), is the ICSP.

difference in responses between the agency and direct mail delivery channels is not statistically significant.

Figure 9-2: Effectiveness of the Quick Start Guide



Source: Survey Q25, "How effective was the PPL Electric Utilities E-Power Wise Quick Start Guide in helping you become more energy efficient?" (n=813)

9.4.10 Marketing and Outreach

9.4.10.1 Program Marketing

Consistent with previous years, the E-Power Wise Program continues to provide minimal promotional materials to agencies for program marketing. These materials are posters for agency waiting rooms and informational flyers. Agencies are encouraged to use the program website as a promotional and informational resource.

Three of the five agencies interviewed said they used additional outreach channels to promote the program. One agency promoted its family workshop sessions through internal agency channels in the school district and community center. Another agency promoted the program through a workshop at a local food pantry. The third agency combined outreach activities with other local agencies' outreach programs to raise awareness in the community. The three agencies indicated that these methods raised program awareness, but that it took extra effort and resources to conduct the additional outreach.

9.4.10.2 Program Awareness

Agencies reported that most clients learned about the energy-savings kits online via the E-Power Wise Program website and called agencies directly to schedule a meeting. Some clients requested a kit directly from the agency, which advised them they must complete the program's energy education component before receiving a kit. Word-of-mouth was a major channel; some clients requested an energy-savings kit because a friend received one through the program; some clients learned about the program through participation in PPL Electric's WRAP.

Agencies promoted these PPL Electric programs in conjunction with the E-Power Wise Program using flyers and verbal communication:

- WRAP
- OnTrack
- Operation HELP

9.4.11 Energy Education

9.4.11.1 Agency-Delivered Energy Education

During both one-on-one meetings with clients and in workshops, agency staff reviewed the Quick Start Guide and discussed installation instructions for the kit's products using examples from personal experience. Agency staff reviewed additional energy-savings tips in the Quick Start Guide, such as turning down the temperature on the water heater, washing clothes in cold water, and adjusting the thermostat to save energy in the summer and winter. These tips helped empower the client to use all of the knowledge gained through the program in their own homes.

Agencies reported that clients are most interested in these energy efficiency topics:

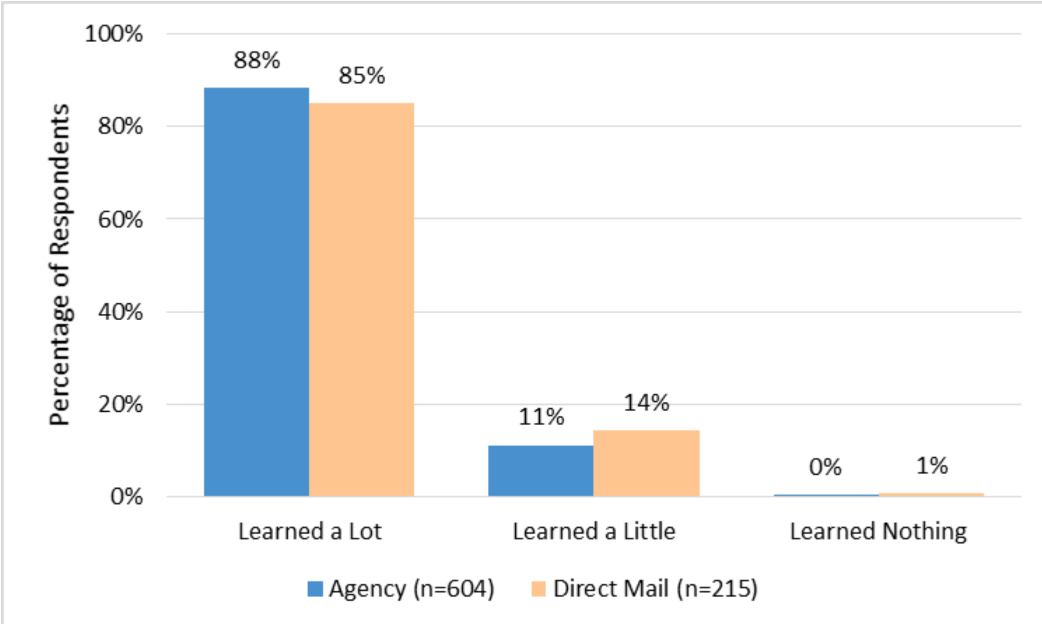
- Anything related exactly to their usage and monetary savings
- Plug load
- How to save on heating and cooling costs

According to the agencies, clients had the most questions about how to use and/or install these energy-efficient products:

- Furnace whistle
- High-efficiency showerhead
- Smart strip

As shown in Figure 9-3, the majority of participants (87% of 819 returned surveys) said they *learned a lot* of about saving energy through the program. The difference between the agency and direct mail delivery channels is not statistically significant.

Figure 9-3: Participant Knowledge Gained Through E-Power Wise Program



Source: Survey Q26, "Now that you have completed the PPL Electric Utilities E-Power Wise Quick Start Guide, how much have you learned about saving energy and money in your home?" (n=819)

9.5 CONCLUSIONS AND RECOMMENDATIONS

Overall, PPL Electric's E-Power Wise Program is managed very well. The individual agency's plans for kit delivery and the close program coordination implemented by the ICSP streamlined program tracking and helped ensure a steady flow of kits distributed over the year.

Based on findings of this evaluation, we suggest PPL Electric consider the following recommendations for PY7. These conclusions and recommendations are intended to help PPL Electric capture additional low-income savings through the E-Power Wise Program, as this program is a great entry point for low-income customers who may then move toward other energy efficiency services.

Conclusion

The ICSP and PPL Electric Utilities continue to provide a well-managed program and have worked together to create a manageable system for tracking program participants. This method was very successful in PY6 as only two duplicate accounts were found over the program year.

Conclusion

The installation rates for the water-saving devices continue to struggle, especially within the agency delivery channel. The installation rates for the showerhead and the kitchen faucet aerator in the agency delivery channel are consistent with the installation rates from the Student and Parent Energy Efficiency Education Program (Table 7-9), which are 34% for kitchen faucet aerators and 30% for showerheads, respectively. Considering the hands-on energy education provided to participants via the agency delivery channel, Cadmus anticipated the agency has an opportunity to explain the benefits of the water-saving products (aerators and showerheads) and how to install them. This could lead to higher installation rates. However, agencies reported clients often had questions about how to use and/or install the water measures. Agencies who receive feedback say participants often cited personal preference for not installing the showerheads. Subsequently, installation rates remain low.

Recommendation
To encourage installation of the water-saving devices, consider adding details to the agency training slides to highlight various benefits to installing the water products. This can include:

- Displaying installation demonstrations using sink and showerhead props and/or streaming installation videos during the energy education sessions with clients.
- Emphasizing the interactive effects between the hot water temperature reduction with the water product installation, and, the money (provide dollar amounts) a family can save when it installs the products and turn down the water tank temperature.
- Using real-life examples that are applicable to low-income families will help participants feel empowered to install the water-saving devices. For example, many families may rent their home and feel they cannot make changes to the faucet hardware. Reminding families that they should keep the old showerhead and aerators to reinstall when they move out may help overcome the initial installation barrier.

Recommendation
Continue to explore the feasibility of offering different energy-savings kits with varied products in Phase III as a way to increase installation rates of the water-saving devices. For example, PPL Electric Utilities could provide a general kit that includes LED bulbs and a power strip for all participants. An optional kit of water-saving devices could be distributed if the recipient heats water with electricity.

For the agency delivery channel, customers could be screened during the program intake process and provided targeted energy-saving products and education based on their hot water fuel source. Those with electric water heaters receive the aerators and showerheads if they show interest installing the products. Those with fossil fuels would not receive the aerators and showerheads.

Customers send an enrollment card or call a customer service line to receive a kit through the direct mail delivery channel. Those with electric water heaters receive the aerators and showerheads if they show interest installing the products. Those with fossil fuels would not receive the aerators and showerheads.

Conclusion
Agencies offer a variety of services to the community and may interact with low-income populations that the E-Power Wise Program does not currently serve, such as residents of master-metered multifamily buildings. Some agencies expressed interest in introducing the E-Power Wise Program to residents of these housing complexes, but were uncertain how the program can assist. Agency staff may not have a clear understanding of the PPL Electric program offerings available to these multifamily populations.

Recommendation
Consider conveying information about the Master Metered Low-Income Multifamily Housing (MMMF) Program to the agencies that distribute the energy-savings kits through the E-Power Wise Program. Increasing communication between MMMF and the E-Power Wise program will keep agencies informed.

The Master Metered Low-Income Multifamily Housing ICSP could communicate directly with the agencies in the E-Power Wise Program to let the agencies know which multifamily buildings have already participated. The E-Power Wise Program agencies may be able to identify other eligible housing complexes, which could ensure that MMMF approaches and recruits all known eligible housing complexes. Agencies could direct potentially eligible buildings and their owners to PPL Electric and the MMMF ICSP.

Conclusion

Some agencies expressed concerns about the saturation of energy-savings kits. These agencies often serve populations in counties where the E-Power Wise Program has been highly active and may therefore be experiencing higher saturation rates. These agencies would like to provide some assistance but are unable to provide energy-savings kits or program-specific energy education to clients seeking assistance on their energy bills if the client has already received these through earlier E-Power Wise participation.

Recommendation

In Phase III, explore the potential for distributing a kit containing LEDs to customers who have already received energy-savings kits in Phase I. In Phase II, LEDs replaced CFLs. However, households that previously received a kit with CFLs could now benefit from LEDs. Distributing LED-only kits to the Phase I and Phase II customers at the agencies would be less costly than mailing them directly. Customers would also benefit from direct energy education, which would increase the chances the LEDs will be installed and empower these previous customers to continue energy-saving behaviors. PPL Electric would still have the option to directly mail an LED-only kit to Phase I E-Power Wise participants.

Additionally, agencies or RAP could distribute LEDs with an installation survey similar to the current survey in the energy-savings kit and, once returned, these customers could be included in the monthly gift card raffle.

Based on the LED algorithm inputs in the 2015 Pennsylvania Technical Reference Manual, the program would achieve 30.3 kWh per bulb installed, assuming the LED bulb replaces a 60W-equivalent bulb.

Conclusion

Agencies reported that clients are most confused about the furnace whistle, and that many homes have baseboard heating and clients cannot use the furnace whistle. The combination of confusion about how to use the equipment and incompatible heating types has resulted in low installation rates for the furnace whistle.

Recommendation

Cadmus recommends three options for the furnace whistle product in Phase III:

- Consider removing the furnace whistle from the energy-savings kit.
- Keep the product in the energy-savings kit but increase the energy education about its installation, how to change out a furnace filter, and the benefits of replacing a dirty furnace filter.
- Remove the furnace whistle from the energy-savings kit and explore offering a rebate for furnace filters instead (TRM savings apply).

9.5.1 Status of Recommendations for Program

Table 9-19 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 9-19: E-Power Wise Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
E-Power Wise Program	
To encourage installation of the water-saving devices, consider adding additional details to the agency training slides to highlight the various benefits to installing the water products. Consider installation demonstrations using sink and showerhead props and real-life examples that are applicable to low-income families so they will feel empowered to install the water-saving devices. Also emphasize the interactive effects of reducing the hot water temperature and the money a family can save when it installs the products and turn down the temperature.	Under consideration for Phase III.
Continue to explore the feasibility of offering different energy-savings kits with varied products in Phase III as a way to increase installation rates of the water-saving devices. PPL Electric Utilities could provide a general kit that includes LED bulbs and a power strip for all participants as well as the option to include the water-saving devices based on the recipient's hot water fuel source.	Under consideration for Phase III.
Consider communicating information regarding the Master Metered Low-Income Multifamily Housing (MMMF) program to the E-Power Wise agencies.	Under consideration for Phase III.
Explore the potential for distributing LED bulbs to Phase I participants. Agencies or RAP could distribute LEDs with an installation survey similar to the current survey in the energy-savings kit and, once returned, these customers could be included in the monthly gift card raffle.	Under consideration for Phase III.
Consider alternatives for the furnace whistle: increase energy education around the furnace whistle; or remove the furnace whistle from the energy-savings kit; and/or consider a rebate for a new furnace filter.	Under consideration for Phase III.

9.6 FINANCIAL REPORTING

A breakdown of the E-Power Wise Program finances is presented in Table 9-20.

Table 9-20: Summary of E-Power Wise Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$0	$0
2	EDC Incentives to Participants	$0	$0
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$0	$0
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$376	$607
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$376	$607
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$376	$607
13	Total NPV Lifetime Energy Benefits	$1,217	$1,830
14	Total NPV Lifetime Capacity Benefits	$123	$155
15	Total NPV O&M Saving Benefits	$48	$74
16	Total NPV TRC Benefits[4]	$1,387	$2,059
17	TRC Benefit-Cost Ratio[5]	3.69	3.39

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

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report

ADDENDUM A. AGENCY INTERVIEW METHODOLOGY

Interview Methodology

Cadmus received the complete list of 17 participating agencies from the ICSP. Cadmus stratified the sample to include a random selection of agencies according to kit distribution activity level (defined as "high," "medium," and "low.") Cadmus identified these labels according to the ratio of how many kits an agency delivered compared to the number of kits they received from the ICSP. Cadmus then flagged agencies that were contacted in PY5 and prioritized agencies that had not been contacted in Phase II. Table 9-21 summarizes the detailed agency sampling strategy for the E-Power Wise for PY6.

Table 9-21: Detailed Agency Sampling Strategy

Agency	Kits Shipped	Kits Distributed (as of Q3)	Percentage of Inventory Distributed	Activity Level	Contacted in PY5 (Yes, No)
Agency 1	226	198	88%	High	No
Agency 2	280	245	88%	High	Yes
Agency 3	100	87	87%	High	Yes
Agency 4	250	216	86%	High	No
Agency 5	330	285	86%	High	Yes
Agency 6	150	123	82%	Medium	Yes
Agency 7	144	117	81%	Medium	No
Agency 8	90	72	80%	Medium	Yes
Agency 9	160	120	75%	Medium	No
Agency 10	100	75	75%	Medium	No
Agency 11	50	37	74%	Medium	No
Agency 12	70	51	73%	Medium	No
Agency 13	170	117	69%	Low	Yes
Agency 14	40	27	68%	Low	No
Agency 15	180	119	66%	Low	No
Agency 16	20	13	65%	Low	No
Agency 17	75	25	33%	Low	No

ADDENDUM B. LOGIC MODEL

A program's theory informs its development and implementation, as well as its evaluation. A program logic model identifies the relationships between activities and expected results. Because logic models are designed to make the underlying theory explicit, they are useful tools for implementers and evaluators.

The program theory for E-Power Wise 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 energy usage. Providing low-income customers with a sample of low-cost energy-efficiency products increases their familiarity with those products, promotes their acceptance of energy-efficient technologies, and encourages them to seek out similar technologies on their own. As a result, PPL Electric helps low-income consumers save on their utility bills, which reduces the energy burden on their households and lessens baseload demand.

The logic model's elements are:

- **Activities the program undertakes** include identifying potential participants, income-qualifying the participants, conducting education and outreach, providing training to trainers, providing workshops for low-income customers, providing free Energy Savings kits with energy-efficiency products.
- **Outputs produced by program activities** include the number of free Energy Savings kits produced and disseminated to customers, the number of workshops conducted, the number of trainers trained, and the number of low-income consumers educated.
- **Short-term outcomes** include training and Energy Savings workshops that educate low-income customers about energy efficiency to help customers reduce their energy consumption and energy costs. Installed kit products are another short term outcome.
- **Intermediate outcome** of the program is a more knowledgeable low-income customer base. As this occurs, customers will continue to make informed and effective decisions about their energy use. This will result in additional energy savings, higher customer satisfaction, and environmental benefits.
- **Long-term outcomes** include energy savings from installed kit products, and additional savings from behavioral changes.

10 MASTER METERED LOW-INCOME MULTIFAMILY PROGRAM

The Master Metered Low-Income Multifamily Housing (MMMF) Program targets energy efficiency improvements in master metered multifamily low-income housing buildings. Eligible multifamily buildings must have five or more residential units and be PPL Electric Utilities customers. Tenants must also be income-eligible (meeting the low-income definition of 150% of the federal poverty level). The program targets decision-makers, that is, property owners and managers of multifamily buildings, to install energy improvements in both tenant units and common areas. MMMF Program savings are reported in the government, nonprofit, and institutional and education (GNE) sector.

The program provides a free walk-through audit of master metered multifamily buildings followed with analysis and a report that shows the potential energy savings for installing recommended measures.

Energy efficiency improvements recommended in the audit report may include direct installation and prescriptive efficiency measures. Customers may also qualify for custom measure rebates offered by other PPL Electric Utilities programs to help offset the incremental costs between high-efficiency and baseline measures.

A turnkey ICSP, SmartWatt Energy, manages the program and handles initiation, planning, and completion of customers' energy projects.

The objectives of the Master-Metered Low-Income Multifamily Housing Program include:

- Provide energy-saving opportunities to customers within the multifamily master metered housing segment.
- Incentivize the adoption, within the multifamily housing segment, of high-efficiency and ENERGY STAR®-rated appliances, lighting equipment, and HVAC systems.
- Enhance the adoption of energy-saving measures among low-income populations within the PPL Electric service territory.
- Increase the market penetration of high-efficiency technologies.
- Promote other PPL Electric energy-efficiency programs.
- Target up to three all electric buildings for a comprehensive building approach.
- Achieve approximately 130,000 installed measures through 2016, with a total reduction of approximately 6,900 MWh/yr.

An executive summary of program metrics can be found in Table 10-1.

Table 10-1: Phase II Master Metered Multifamily Executive Summary Results

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost[1] ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/Lifetime kWh)	Phase II Participants
Master Metered Multifamily	3,364	3,300	3,586	0.81	1.44	$1,402	$0.39	$0.06	85
Total	**3,364**	**3,300**	**3,586**	**0.81**	**1.44**	**$1,402**	**$0.39**	**$0.06**	**85**[111]

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

10.1 PROGRAM UPDATES

The MMMF Program was established in PPL Electric Utilities' Phase II EE&C plan and began offering incentives in late 2013.[112] PPL Electric Utilities projected completion of a total of 88 audits in Phase II, or an estimated 29 properties per year.[113] In PY6, the MMMF Program successfully completed 49 projects in 41 multifamily properties across PPL Electric Utilities' service territory.

Program implementation has remained unchanged since inception. In PY6, LEDs replaced CFLs as the program-eligible efficient lighting product for screw base residential lighting applications. Thermostatic shower restriction valves, water heater tank wraps, and refrigerator recycling were added to the program in quarter 3 (Q3) of PY6. Smart strip plug outlets were removed from the list of program-eligible products. Additionally, nursing homes were targeted as part of the program staring in Q4 of PY6.

Following Cadmus' recommendations in PY5 to increase tenant participation at energy education workshops, the ICSP raised the amount of the gift card raffled and offered LED night lights. The ICSP is also leaving literature for tenants to review at their convenience.

10.1.1 Definition of Participant

Participants are master metered multifamily buildings located in PPL Electric Utilities' service territory and identified by unique service account numbers. The program requires multifamily property owners and/or managers to sign a participation agreement and, by working with the ICSP, complete at least one project at the property. Each individual project is assigned a unique CSP job number. Note that one participating

111 The number of Phase II participants consists of 49 projects in PY6 and 36 projects in PY5 based on unique CSP job numbers. The number of Phase II participants in the PY5 annual report was reported as 37 instead of 36. This is because the ICSP reported lighting and direct install measure retrofits completed in two different quarters for the same property, using the same CSP job number. Since these retrofits were reported in two different quarters, Cadmus counted them as distinct project participants. To avoid this confusion in PY6, the ICSP has used a distinct CSP job number for retrofit projects completed during different quarters, even if the retrofits were completed in the same property.

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

113 Based on PPL Electric. *PPL Electric Utilities Corporation Energy Efficiency and Conservation Plan Act 129 Phase II*. Pennsylvania Public Utilities Commission. Docket Number M-2012-2334388. April 7, 2014. P. 153

property can be assigned more than one CSP job number, for example, if the ICSP goes back to perform additional retrofits in the same property.

10.2 IMPACT EVALUATION GROSS SAVINGS

10.2.1 Reported Gross Savings

Table 10-2 shows the MMMF Program reported results for Phase II (PY5 and PY6) by sector.

Table 10-2: Phase II Master Metered Multifamily Reported Results by Customer Sector

Sector	Phase II Participants	Phase II Reported Gross Impact (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Government/Nonprofit/Educational	85	3,364	0.31	$460
Phase II Total	**85**	**3,364**	**0.31**	**$460**

10.2.2 EM&V Sampling Approach

In PY6, the evaluation, measurement, and verification (EM&V) CSP performed these evaluation activities:

- Energy Efficiency Management Information System (EEMIS) database review for the census of projects completed
- ICSP project records review for 12 Q1/Q2 projects, 11 Q3 projects, and one Q4 project measure
- Site visits to 23 projects completed in Q1 (six projects), Q2 (six projects), and Q3 (11 projects)

Cadmus completed site visits in two rounds, one after the end of Q2 and the other after the end of Q3. In the first round of site visits, Cadmus conducted site visits to all six projects completed in Q1 and to four projects completed in Q2 that were randomly selected.

In the second round, Cadmus conducted site visits to all 11 Q3 projects installed in properties that had participated in both common area lighting and direct install measures. Two projects completed in Q2 were added to the second round of site visits since they were installed in properties chosen as part of the Q3 site visit sample. Hence, two projects from Q2 and 11 projects from Q3 were included in the second round of site visits.

Cadmus reviewed the EEMIS database records of all projects visited. For the one Q4 project, Cadmus reviewed records for the common area lighting and common area direct install measures because the review indicated that the ICSP had incorrectly reported screw-in LEDs as common area direct install measures instead of common area lighting measures.

In total, Cadmus conducted site visits at about half of the completed projects (23 of 49) and verified 60% (950,254 kWh) of the 1,574,113 MWh savings reported for PY6. This approach ensured that Cadmus achieved results with 85% confidence at 15% precision at the program level, as stipulated in the EM&V plan.[114] Cadmus determined the program sample size once the total number of projects was estimated after the close of Q3. The sample size was larger than what was originally projected in the EM&V plan.

114 Cadmus. *PPL Electric Utilities EM&V Plans Act 129 Phase 2.* January 31, 2014. P. 264.

During site visits, Cadmus verified that the project documentation for the sampled projects was recorded correctly in EEMIS for these items:

- A census of lighting and direct install products installed in building common areas (e.g., hallways, stairwells, laundry rooms) and on the exterior of the building (on the building structure and in adjacent areas such as parking lots).
- All direct install products installed in a sample of tenant units. These included screw-in LEDs, T8 fixtures, low-flow bath and kitchen aerators, low-flow showerheads, water heater tank wrap, thermostatic shower restriction valves, and refrigerator recycling and replacement.

In each building with direct install products in tenant units, Cadmus randomly selected a sample of units to visit at the selected project, identifying the number required to achieve results with 90% confidence at 20% precision as stipulated in PPL Electric Utilities' EM&V Plan and the Evaluation Framework.[115] The sampling strategy for the MMMF Program is shown in Table 10-3.

Table 10-3: PY6 Master Metered Multifamily Impact Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
EEMIS Database	49	All available	49	All available	Database review
Projects[1]	49	85/15	23 site visits	24	Site visits (23) and one additional desk audit
Tenant Units within Sampled Projects[2]	1,133	90/20	262	262	Site visits
Program Total	**49 projects, 1,133 tenant units**		**As above, per sampling unit**	**As above, per sampling unit**	

[1] Identified by unique CSP job number.
[2] Identified by unique unit number within each CSP job number selected for site visits.

10.2.3 *Ex Ante* Adjustment Methodology and Findings

Cadmus adjusted the reported savings from EEMIS to align with assumptions specified in the 2014 Pennsylvania Technical Reference Manual (TRM), resulting in adjusted *ex ante* savings.

The 2014 Pennsylvania TRM *ex ante* adjustments modify the savings reported in EEMIS (when reported *ex ante* savings are placeholders) to reflect each measure's specifications. These adjustments are made to the population and account for differences among planning assumptions, the 2014 Pennsylvania TRM assumptions, and specifications of the equipment. The result of these adjustments to the population are the adjusted *ex ante* savings used in the equation to determine the program's realization rate.

The most significant *ex ante* adjustments were made to the reported energy and demand savings associated with medium screw base LEDs installed in tenant units. EEMIS-reported savings for this product were correctly calculated using the assumptions and algorithms in the 2014 Pennsylvania TRM—with one exception. Cadmus found that savings were calculated using a 60-watt incandescent bulb as the assumed baseline (replaced bulb) wattage for all 1,931 tenant units where screw-in LEDs were installed.

[115] Cadmus. *PPL Electric Utilities EM&V Plans Act 129 Phase 2.* January 31, 2014. P. 264.

The ICSP confirmed that it had assumed that all installations were 60-watt incandescent lamps, without documenting the as-found baseline in each installation. The 2014 Pennsylvania TRM indicates that in the absence of a documented baseline, an adjustment for EISA should be made to the baseline, resulting in an assumed baseline wattage of 43 watts.[116] Using the baseline of 43 watts resulted in lower TRM-adjusted *ex ante* energy savings and demand reductions than reported in EEMIS.

Cadmus provided *ex ante* adjusted energy and demand savings for the thermostatic shower restriction valve and water heater tank wrap. Zero savings were reported in EEMIS because the measure code had not yet been added to EEMIS for the MMMF Program at the time of installation. The thermostatic shower restriction valve measure code was added to EEMIS in Q4, and the water heater tank wrap measure code will be added to EEMIS in Q2 of PY7.

All 2014 Pennsylvania TRM *ex ante* adjustments to reported savings in PY6 are summarized in Table 10-4, on the next page.

10.2.3.1 Database Review

Cadmus conducted a review of the records for a census of PY6 MMMF Program participants to verify that EEMIS accurately captured all required project data and that the reported quantity and savings values were reasonable. Cadmus found no discrepancies outside of minor rounding issues to the savings values for bath and kitchen aerators. EEMIS-reported savings for low-flow bath and kitchen aerators (kWh only) are rounded to zero decimal places, while the default TRM energy savings are rounded to the tenth decimal place. [117] This issue had very little impact on total kWh values.

Cadmus noted one project in Q4, where the ICSP incorrectly reported savings for screw-in LEDs installed in common areas as common area direct install measures instead of common area lighting measures. Cadmus subsequently reviewed records for this project as described under 10.2.4.1.

10.2.4 *Ex Post* Adjustment Methodology and Findings

10.2.4.1 Records Review

For the 23 projects selected for site visits, Cadmus compared project documentation (the ICSP Measure Report and the Appendix C Calculator for common area lighting measures installed in the project) to the data reported in EEMIS. Cadmus noted that the Appendix C Calculator provided for four projects did not match the values reported in EEMIS for common area lighting measure savings. The discrepancy occurred as the ICSP corrected its use of actual hours of use and started using 2014 Pennsylvania TRM Whole Building Hours of Use late in 2014.

For one project in Q4 (identified as part of Cadmus' database review), Cadmus reviewed the ICSP Measure Report and the Appendix C Calculator for common area lighting measures installed to verify that the screw-in LED measure savings were not double-counted as both common area lighting and common area direct install savings.

Cadmus also reviewed the ICSP Measure Report to verify the baseline lamp wattage, lamp quantities, location of the installed lamps, and hours of use assumptions. These data were compared to the EEMIS data and used to estimate verified savings for common area lighting in this project.

---

[116] See page 154 of the 2014 Pennsylvania TRM: Table 2-74. Baseline Wattage by Lumen Output.

[117] See page 53 of the 2014 Pennsylvania TRM: Section 2.83: Default Savings.

Table 10-4: PY6 Summary of 2014 Pennsylvania TRM Ex Ante Adjustments to Reported Savings

Stratum	Measure	Factors	Reported Savings	Adjusted Savings
Appliance Recycling	Refrigerator recycling and replacement	Adjustment to use PPL Electric Utility unit energy consumption (UEC) value and 100% part-use factor in saving calculations	669 kWh per refrigerator 0.083 kW per refrigerator	676 kWh per refrigerator 0.084 kW per refrigerator
Common Area Lighting	Common area lighting	Replaced deemed savings for LED pole lighting with project specific savings from each Appendix C calculator	3,636 kWh (total savings for all LED pole lighting measures)	12,265.52 kWh (total savings for all LED pole lighting measures)
Direct Install - Apartments	Medium screw base LEDs	Adjustment to the baseline lamp wattage	46.59 kWh per LED 0.005 kW per LED	30.75 kWh per LED 0.003 kW per LED
	Bath aerators	Adjustment to round to tenth decimal place	30.0 kWh per aerator	30.1 kWh per aerator
	Kitchen aerators	Adjustment to round to tenth decimal place	147 kWh per aerator	146.9 kWh per aerator
	T8 linear florescent fixtures	Adjustment to match baseline fixture type with PPL Electric Utilities Appendix C fixture codes	Average savings per fixture (to account for different fixture lengths and lamp quantities): 34.42 kWh per fixture 0.001 kW per fixture	Average savings per fixture (to account for different fixture lengths and lamp quantities): 34.05 kWh per fixture 0.004 kW per fixture
	Thermostatic Shower restriction valves	Assigned default savings for reported measures	0 kWh per valve 0 kW per valve	98.98 kWh per valve 0.008 kW per valve
	Water heater blanket wrap	Assigned default savings for reported measures	0 kWh per wrap 0 kW per wrap	Average savings per wrap (to account for different water heater sizes): 211.08 kWh per wrap 0.023 kW per wrap
Direct Install – Common Area	Vending machine control	None	1,432.00 to 1,931.00 kWh per control depending on machine capacity	Same as reported

10.2.4.2 Site Visits

Cadmus completed site visits in two rounds, one after the end of Q2 and a second after the end of Q3, verifying a total of 23 completed projects computed during Q1 through Q3. Projects completed in Q4 were not materially different from those completed in Q1 through Q3; therefore, the sampled projects represent all PY6 completed projects.

During site visits, Cadmus verified key calculation inputs to determine *ex post* verified gross savings. While on site, Cadmus also collected model numbers and other information that informed but were not directly included in *ex post* verified gross savings calculations.

Table 10-5 lists the number of verification site visits planned and conducted by Cadmus and the number of site visits with discrepancies identified. Discrepancies ranged from small items, such as the count of products installed, to products that were incorrectly installed. In a few instances, the tenant had removed the product due to dissatisfaction with its performance. In other instances, the tenants who had originally received the product had taken it with them when they moved out.

The next sections discuss site visit findings for direct install measures, common area lighting measures, and appliance recycling.

Table 10-5: PY6 Master Metered Multifamily Summary of Site Visits

Program	Measure	Inspection Firm	Inspections Planned	Inspections Conducted	Sites with Discrepancies from Reports	Resolution of Discrepancies
Master Metered Multifamily	All	EM&V CSP (Warren Energy Engineering)	23 projects[1]	23	23	Savings adjusted based on site-specific data
[1] Site visits were performed at 21 individual properties. For two site visits, two jobs were verified (work completed and submitted in different quarters).						

Table 10-6 summarizes the site visit sample attrition.

Table 10-6: Master Metered Multifamily Site Visits Sample Attrition

Site Visit Sample	Count
Program Projects (Q1 -- Q3)	36
Projects Sampled for Site Visits (Q1 -- Q3)	23
Projects Sampled for Desk Audit	1
Unique Decision Makers Involved in Site Visit/Desk Audits (Q1 --Q3) [1]	10
[1] Unique decision makers represented anywhere from 1 to 9 projects sampled for site visit/desk audits.	

Direct Install Measures

Cadmus conducted site visits to verify that products rebated or funded by the MMMF Program were installed and operating as reported and that correct data were used to calculate *ex ante* savings. Discrepancies were documented and these site-specific data were used to calculate the verified gross savings. Reasons for adjustments to the reported *ex ante* savings included corrections to the variables listed in Table 10-7.

Table 10-7: Key Information Verified on Site for Direct Install Products

Stratum	Measure	Location	QTY	GPM	Equipment Capacity or Size	Lamps/ Fixtures	Lamp Type	Lamp Length	Watts/ Lamp (Bulb)	Ballast Type	Water Heater Wrap R-Value
Direct Install – Apartments	LEDs	✓	✓						✓		
	Bath aerators	✓	✓	✓							
	Kitchen aerators	✓	✓	✓							
	Shower heads	✓	✓	✓							
	Water Heater Tank Wrap	✓	✓		✓						✓
	T8s[1]	✓	✓			✓	✓	✓	✓	✓	
	Thermostatic Shower Restriction Valves	✓	✓	✓							
Direct Install – Common Area	Vending Machine Controls	✓	✓		✓						

[1] Key inputs also collected for replaced fixtures, to the extent possible.

The records review and site visits to verify measures installed in PY6 revealed differences between the 2014 Pennsylvania TRM default in-service rate (ISR) and the verified ISR for several projects. Table 10-8 provides the deemed 2014 Pennsylvania TRM in-service rate estimates, by measure, used in the reported energy savings calculation and the in-service rate verified while on the site. The most significant discrepancy for direct install measures was that fewer were verified than reported.

Table 10-8: Verified Direct Install Measure In-Service Rates[1]

Stratum	Measure	2014 Pennsylvania TRM ISR	Verified ISR
Direct Install - Apartments	Medium Screw Base LEDs (10W)	97%	95%
	Bath Aerators	100%[2]	99%
	Kitchen Aerators	100%[2]	92%
	Showerheads	100%[2]	86%
	T8 Linear Fluorescent Fixtures	95%	100%
	Thermostatic Shower Restriction Valves[3]	100%[2]	88%
	Water Heater Tank Wrap	100%[2]	24%
Direct Install - Common Area	Beverage Vending Machine Controls	100%[2]	75%

[1] 2014 Pennsylvania TRM ISR values are to be used absent EDC data gathering. If no ISR provided, 100% used in calculations. Values specified for ENERGY STAR lighting including medium screw base LEDs and T8 linear fluorescent lamps are provided on p.149 and p.151 of the 2014 Pennsylvania TRM.
[2] No deemed ISR estimate specified in 2014 Pennsylvania TRM for this measure.
[3] This measure was added as an Interim Measure Protocol in PY6 and is documented in the 2015 Pennsylvania TRM.

Of note is the verified 24% in-service rate for water heater tank wrap. Cadmus verified the installation of water heater tank wrap in 18 tenant units. It found that one tenant removed the tank wrap. In 12 units the tank wrap was not properly installed (and only covered half of the water heater). Therefore, these were not counted as installed wraps and Cadmus assigned no savings to these 13 units.

PPL Electric Utilities and the ICSP developed a plan to correct this situation and review 131 total water heater tank wraps installed as part of the program in PY6. As of September 2015, the ICSP has corrected 33 water heater tank wraps. The ICSP will be correcting 90 water heater tank wraps in October 2015 and is awaiting permission from the property manager to review eight additional wraps. After notification, Cadmus will verify a new random sample of all repaired water heater tank wrap installations. Any additional savings from the corrected tank wraps may be claimed in PY7.

Common Area Lighting Measures

Key information verified on site and used to estimate *ex post* verified gross savings for common area lighting measures includes:

- Building type
- Measure location—inside or outside building (e.g., second floor storage room, parking lot)
- Measure hours of use and coincidence factor
- Space cooling where measures were installed
- Pre- and post-installation fixture quantity
- Pre- and post-installation fixture lamps/fixture
- Pre- and post-installation fixture lamp type
- Pre- and post-installation fixture lamp length

- Pre- and post-installation fixture watts/lamp
- Pre- and post-installation fixture ballast type
- Pre- and post-installation fixture controls

The differences between the EEMIS-reported *ex ante* savings and the *ex post* verified gross savings for common area lighting measures result from these two adjustments:

- **Adjustment 1**: **Retrofit-specific adjustments** made to reflect differences in measure quantities, specifications, replaced equipment, controls, or other factors observed by Cadmus while on site.
- **Adjustment 2:** Differences between the ICSP and Cadmus' interpretation of the **2014 Pennsylvania TRM assumptions** used in energy savings calculations.

Retrofit-Specific Adjustments. Through site visits, Cadmus confirmed the vast majority of the key project information (listed above) was correct as reported. However, in a few cases, Cadmus found slightly different quantities and types of installed measures. Overall, these adjustments had a minor impact on overall verified savings for the projects reviewed.

Updates to conform to 2014 Pennsylvania TRM. Two adjustments were needed:

- Applying whole-building hours of use and coincidence factor estimates in the calculations rather than area-specific estimates calculated for each retrofit from information provided by the customer, posted schedules, etc.
- Including cooled spaces and the interactive factor for cooled spaces in savings calculations.[118]

Cadmus, following instruction from the SWE,[119] concluded that the approach taken to identify the hours of use used to calculate project savings was not in line with guidance in the 2014 Pennsylvania TRM and SWE Guidance Memo 27.[120]

The customer Appendix C files reviewed by Cadmus included area-specific hours of use estimates to calculate savings combined with coincidence factors based on values from the 2014 Pennsylvania TRM. Cadmus adjusted, as appropriate, the building hours of use and coincidence factors to the whole-building estimates listed in the 2014 Pennsylvania TRM for "Multi-Family (Common Areas) - High-rise & Low-rise," "Nursing Homes," or "Dusk-to-Dawn/Exterior Lighting." This adjustment was necessary for these reasons:

- All common area lighting projects are less than 20 kW.
- The customer application materials did not include the source for the hours of use estimates used (e.g., interviews with staff, use of posted schedules). The site contacts interviewed by Cadmus generally appeared uncertain when providing hours of use estimates.
- According to SWE Guidance Memo 27, both hours of use and coincidence estimates *must come from the same source* (i.e., data collected on site *or* the 2014 Pennsylvania TRM). Because it is difficult to

118 See Table 3-7: Interactive Factors and Other Lighting Variables on page 215 of the 2014 Pennsylvania TRM.

119 SWE provided comments in reports following three ride-along site visits with EM&V CSP staff during the second round of site visits.

120 GDS Associates, Inc. *Data Source Consistency in Non-Residential Lighting Savings Calculations.* GM-027. July 24, 2014.

calculate coincidence from self-report hours-of-use data without making several significant assumptions about when usage occurs during the day, week, and year, the value provided in the 2014 Pennsylvania TRM is a more defensible estimate.

- All retrofits rebated or funded through the program are located in areas clearly identified in the 2014 Pennsylvania TRM, specifically: "Multi-Family (Common Areas) - High-rise & Low-rise," "Nursing Home," or "Dusk-to-Dawn/Exterior Lighting."[121]

Making this adjustment in Q3 had an impact on project-level energy savings and demand reduction estimates, especially for projects that focused on lighting retrofits in specific, low-use areas such as refuse rooms or maintenance closets.

While on site, Cadmus found that the interior, ambient temperature of most buildings satisfied the 2014 Pennsylvania TRM's definition of "Cooled Spaces" (60°F – 79°F).[122] In many cases, temperature in these locations (e.g., halls, stairwells, and common areas) was maintained either by a central air system or by space-cooling technologies (e.g., window air conditioners, packaged terminal air conditioners) installed in adjacent or nearby areas with connected airflows.

Because the 2014 Pennsylvania TRM does not require that spaces be directly cooled to satisfy the temperature requirements for cooled spaces, Cadmus adjusted the interactive factors in numerous locations across the verified projects.

Several projects focused exclusively on retrofits located on the exterior of the building and therefore no adjustments were necessary.

Appliance Recycling

Cadmus verified the refrigerator recycling and replacement measure in eight tenant units. During the site visits, Cadmus asked the property manager (and tenant when present) about the age and type of refrigerator that was replaced. Cadmus also confirmed the quantity, make, model, and the ENERGY STAR labeling of the new refrigerators installed. In one tenant unit, there was an old refrigerator (non-ENERGY STAR) that was not recycled and the tenant confirmed declining refrigerator replacement. Using the actual verified quantities of refrigerators resulted in verified gross savings lower than the *ex ante* adjusted savings.

Table 10-9 summarizes the appliance recycling measure verified in-service rate used to estimate *ex post* verified gross savings for the appliance recycling measure.

121 See page 214 of the 2014 Pennsylvania TRM: Table 3-6: Lighting HOU and CF by Building Type or Function. The 2014 Pennsylvania TRM hours-of-use and coincidence factor estimates for Multi-Family (Common Areas) - High-rise & Low-rise building include lighting installed on the exterior of the multifamily building as long as the location is part of the physical structure. Lighting installed on adjacent buildings or areas (e.g., parking lots) are not included.

122 See page 215 of the 2014 Pennsylvania TRM: Table 3-7: Interactive Factors and Other Lighting Variables.

Table 10-9: Verified Appliance Recycling Measure In-Service Rates[1]

Stratum	Measure	2014 Pennsylvania TRM ISR	Verified ISR
Appliance Recycling	Refrigerator Recycling and Replacement	100%[2]	88%

[1] 2014 Pennsylvania TRM ISR values are to be used absent EDC data gathering. If no ISR provided, 100% used in calculations.
[2] No deemed ISR estimate specified in 2014 Pennsylvania TRM for this measure.

10.2.5 Summary of Evaluation Results

Adjustments to the key calculation inputs identified above resulted in the evaluation results summarized in Table 10-10 and Table 10-11.

The relative precision for the PYTD verified gross energy and demand savings in Direct Install – Apartments, is higher than the relative precision for the verified savings in other strata. This is due to the fact that Cadmus selected verification measures in this stratum according to a clustered sample design. In a clustered sample design the property is selected first and the apartment units within that property are selected next. The variance calculation accounts for the variation in savings between apartment units in a single property and between the properties participating in the program, and incorporates any correlation there might be between apartments within the same property. The variance (and hence the precision) will almost always be larger in a clustered random sample than for a simple random sample of the same size.

Table 10-10: PY6 Master Metered Multifamily Summary of Evaluation Results for Energy[1]

Stratum	PYTD Reported Gross Impact (MWh/yr)	PYTD Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	PYTD Verified Gross Energy Savings (MWh/yr) [1]	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Appliance Recycling	7	7	88%	6	-	0.00%
Common Area Lighting	765	773	114%	881	0.13	2.89%
Direct Install - Apartments	773	716	89%	636	0.45	13.88%
Direct Install – Common Area	30	30	86%	26	0.34	11.02%
Program Total	**1,574**	**1,526**	**101%**	**1,549**	**N/A [3]**	**5.81%**

[1] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.
[2] Cv is not applicable at the program level for this program.

Table 10-11: PY6 Master Metered Multifamily Summary of Evaluation Results for Demand

Program	PYTD Reported Gross Demand Savings [1] (MW)	PYTD Adjusted *Ex Ante* Demand Savings [2] (MW)	Demand Realization Rate (%)	PYTD Verified Gross Demand Savings [2] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Appliance Recycling	0.001	0.00089	87%	0.00078	-	0.00%
Common Area Lighting	0.083	0.08827	93%	0.08180	0.06	1.61%
Direct Install - Apartments	0.083	0.07837	89%	0.06981	0.44	13.60%
Direct Install - Common Area	0.002	0.00182	100%	0.00182	-	0.00%
Program Total	**0.169**	**0.169**	**91%**	**0.154**	**N/A [3]**	**6.09%**

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] *Ex ante* and verified gross demand reductions include T&D losses.
[3] Cv is not applicable at the program level for this program.

10.3 Impact Evaluation Net Savings

Cadmus conducted surveys with participant decision-makers to determine net savings for the MMMF Program. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

10.3.1 Net-to-Gross Ratio Methodology

For the MMMF Program, Cadmus determined freeridership and spillover estimates in accordance to the SWE net-to-gross guidelines, which uses self-report survey information from project decision-maker interviews.

10.3.2 Net-to-Gross Ratio Sampling

In PY6, a total of 17 decision-makers participated in the program and represented 49 projects. Cadmus conducted surveys at the beginning of Q4 and attempted to complete interviews with all 13 decision-makers who completed projects in Q1 through Q3 of PY6. These 13 decision-makers represented 36 projects completed through Q3 in the MMMF Program.

The sampling strategy used in the net-to-gross research is summarized in Table 10-12.

Table 10-12: PY6 Strategy for NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]
Landlord Participants (Decision-Makers)	Q1 - Q3	13	0.5	85/15	13	7	100%
Program Total	**Q1 - Q3**	**13**	**0.5**	**85/15**	**13**	**7**	**100%**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means percentage of the sample frame called to get complete the surveys.

Table 10-13 attrition table summarizes the number of projects in the population, associated number of decisions makers and completed calls.

Table 10-13: PY6 NTG Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Number of Projects	36
Total Population (unique decision makers) [1]	13
Not attempted	0
Records Attempted	13
No answer/answering machine/phone busy	6
Completed survey [2]	5

[1] The number of unique decision makers represents 30 properties with 36 projects.
[2] Two respondents did not answer the NTG questions, and are not included in the count of completed net-to-gross surveys.

10.3.3 Net-to-Gross Ratio Findings

The freeridership and spillover estimates for the MMMF Program, estimated in accordance with the SWE net-to-gross guidelines, are shown in Table 10-14.

Table 10-14: PY6 Master Metered Multifamily Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision at 85% C.L.
Common Area Lighting (Rebated)	0.25[1]	0.00	0.75	0.112	20%
Tenant and Common Area Direct Install Measures [2]	0.00	0.00	1.00	N/A	N/A
Program Total [3]	**0.14**	**0.00**	**0.86**	**N/A**	**N/A**

[1] Estimate is weighted by the survey sample-verified program kWh savings. This method ensures that respondents who achieved higher energy savings through the program measures are given a greater influence on the final freeridership estimate than those respondents who achieved lower energy savings. A single respondent who was estimated as a 37.5% free rider represents 57% of the survey sample-verified program kWh savings. This means the respondent represents 21 percentage points of the total 25% freeridership estimate.
[2] NTG ratio was assumed to be 1.00 because the direct install measures are free upgrades, offered at no cost to the participating customer.
[3] Freeridership, spillover, and NTG ratios at the program level are weighted by the stratum's *ex post* kWh program population savings.

The MMMF Program offers multifamily property decision-makers rebated measures, for which the participant must contribute funds, and direct install measures at no cost to the customer.

Direct install: Energy costs are included in the tenant rent in these master metered buildings, but tenants are generally responsible for maintaining their own unit. In the absence of the program, it is not likely that a property decision-maker would purchase the same free products offered by this program and install them in tenant units. Therefore, when calculating program freeridership, Cadmus assumed no freeridership for measures offered at no cost to property decision-makers.

Rebated measures: These are equipment improvements that include, for example, replacing older inefficient lighting in building common areas. In PY6, all rebated measures were common area lighting retrofits.

Cadmus determined freeridership for rebated measures using self-report data from interviews with participating property decision-makers, and attempted to complete interviews with all 13 decision-makers who completed projects in Q1 through Q3 of PY6. However, only five respondents completed the freeridership and spillover questions. Therefore, results are heavily influenced by responses from individual respondents. For example, a single respondent represents 21 percentage points of the total 25% freeridership estimate. Table 10-15 shows the freeridership response details and their influence on the score. Note that Cadmus is conducting additional research to explore the customers' decisions to participate in more detail. This may result in adjustments to freeridership, however, data were not available for the PY6 annual report.

Table 10-15: PY6 Master Metered Multifamily Freeridership Respondent Detail

Target Group or Stratum (if appropriate)	Respondent	Rebated Measures		Customer Contribution to Program Freeridership
		Freeridership Score	*Ex Post* kWh Savings	
Common Area Lighting (Rebated)	Respondent 1	0.00	14,226	0.000
	Respondent 2	0.375	57,885	0.215
	Respondent 3	0.25	12,836	0.032
	Respondent 4	0.00	15,740	0.000
	Respondent 5	0.00	279	0.000
	All Respondents	0.25[1]	100,967	N/A

[1] Weighted by the respondents' *ex post* kWh program savings.

The PY6 estimated freeridership for rebated measures (0.25 as shown in Table 10-14) is very close to the rebated measures freeridership estimated in PY5 (0.28). However, the estimated program level freeridership in PY6 (0.14 as shown in Table 10-14) is lower than the program level freeridership estimated in PY5 (0.23).

The difference in the overall program level freeridership estimates between PY6 and PY5 is driven by the distribution of program population savings between the rebated and direct install measures. In PY6, rebated measures accounted 56% of the total program population *ex post* savings, while direct install measures accounted for 44%. In PY5, rebated measures accounted for 83% of the total program population *ex post* savings, while direct install measures accounted for 17%. The effect of this shift in the distribution of savings between rebated and direct install measures is that the PY6 direct install freeridership estimate of 0% has over 2.5 times more weight on the overall program level freeridership estimate than it did in PY5.

10.4 PROCESS EVALUATION

10.4.1 Research Objectives

The purpose of this process evaluation is to assess the program's effectiveness in generating awareness, driving participation to achieve desired savings, and disseminating information. The evaluation examines whether the program operates efficiently and effectively and assesses whether the program increases awareness among PPL Electric Utilities master metered multifamily customers about energy efficiency and energy-efficient equipment and appliances.

10.4.2 Evaluation Activities

For the Master Metered Low-Income Multifamily Housing Program, Cadmus conducted these research activities in PY6, consistent with the Energy Efficiency and Conservation (EE&C) plan:

- Program staff and implementer interviews (n=2)
- Leave-behind tenant surveys (n=137 responses received from individual building tenants)
- Decision-maker participant surveys (n=7 surveys representing 24 projects in 19 properties)
- Database review (all Energy Efficiency Management Information System [EEMIS] database records, n=49 projects)
- Quality assurance/quality control (QA/QC) review of records (n= EEMIS records reviewed for a sample of 24 verified projects)

Table 10-16 summarizes the survey sampling strategy for the Master Metered Low-Income Multifamily Housing Program for PY6.

10.4.3 Methodology

10.4.3.1 Program Staff and Implementer Interviews

Cadmus conducted telephone interviews with the PPL Electric Utilities program manager and staff at the ICSP at the beginning of the fourth quarter (Q4). Cadmus conducted a follow-up interview with the PPL Electric Utilities program manager at the end of Q4. The interviews asked questions about the recommendations made in the PY5 report and discussed program design changes, key performance indicators, and implementation successes and challenges.

10.4.3.2 Leave-Behind Tenant Surveys

The purpose of the survey was to assess the tenant's experience with the program. During the verification site visits in Q1, Q2, and Q3 to a selected sample of tenant apartments of participating buildings, Cadmus left a short postcard survey. The postage-prepaid postcard was always accompanied by an explanatory letter from PPL Electric Utilities asking the tenant to complete and mail the postcard. If tenants were home during the site visit, Cadmus verbally requested their participation in the survey.

Beginning in Q4, the ICSP began leaving behind the postcard survey in all apartments it treated. In Q4, Cadmus left a postcard survey only for tenants in units selected into the site visit who had not already responded.

Cadmus and the ICSP distributed 919 postcard surveys. A total of 137 tenants completed postcards, a 14.9% response rate and representing 6.4% of the total participant population of 2,125. All returned postcard surveys were included in the analysis so results are based on a convenience sample. Cadmus recognizes response potential bias could affect the results, but the response rate is reasonable with no systematic bias so we assumed that any possible bias will have minimal impact on the results.

Cadmus received survey responses between June 2014 and June 2015.

Table 10-16: PY6 Master Metered Low-Income Multifamily Housing Program Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or C_V in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample[1]	Used For Evaluation Activities (Impact, Process, NTG)
PPL Electric Utilities Program and ICSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process, Impact, Program Staff Interview, Census
Participating Tenants	Q1-3[2]	1,462	N/A	N/A	As many as possible	256	137	100%	Process, Leave Behind Postcard Survey, Convenience Sample
	Q4[4]	663	N/A	N/A		663		100%	
Participating Decision-Makers	Q1-3[4]	36 projects (13 unique building contacts)	N/A	N/A	36 projects (13 unique building contacts)	36 projects (13 unique building contacts)	24 projects (7 unique contacts)	100%	Process, Impact, Telephone Survey, Census
Program Total[5]		**2,127 tenant units; 36 projects in Q1-Q3 (13 unique building contacts)**					**139 tenant units; 24 Q1-Q3 projects (7 unique contacts)**		

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews.
[2] In Q1 through Q3, Cadmus left a postcard survey in 256 tenant apartments following verification site visits. Therefore, the assumed proportion, confidence, and precision is based on the sampling strategy used for selecting verification site visits.
[3] In Q4, the ICSP left a postcard survey in all 663 treated apartments and no sampling was performed. Therefore, assumed proportion, confidence, and precision are not applicable.
[4] All participants within the stratum boundaries were contacted for the survey; therefore, assumed proportion, confidence, and precision are not applicable.
[5] 49 projects were completed during PY6, Q1-Q4.

10.4.3.3 Decision-Maker Surveys

Cadmus conducted surveys with property decision-makers to assess overall satisfaction and program processes and to inform the net-to-gross ratio. The survey targeted multifamily owners and operators with properties participating in the program. Cadmus contacted all 13 unique property decision-makers, representing 36 completed projects through Q3. Seven unique property decision-makers, representing 24 projects (one to 13 properties per decision maker), responded to the survey. This response was fewer than the EM&V plan's projected 19 decision-maker surveys; the plan assumed a one-to-one relationship between property decision-makers and projects.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they were implemented consistently. Cadmus attempted to reach all unique decision making customers multiple times over several days at different times of the day and scheduled callbacks when possible.

Table 10-16, above, summarizes the decision-maker participant sampling strategy for the Master Metered Low-Income Multifamily Housing Program for PY6, drawing the sample from Q1-Q3 participants. Details are in Addendum A. Decision-Maker Participant Survey Methodology.

Cadmus fielded the interviews during June and July 2015.

10.4.3.4 Database and Records Quality Control Review

Cadmus conducted a high-level review of the EEMIS database for a census of PY6 program projects (n=49 in Q1-Q4) to verify that all required data are accurately captured and that the reported quantity and savings values were reasonable. Cadmus found minor rounding errors with the savings values for bath and kitchen aerators. The database review also indicated that for one project in Q4, the ICSP had incorrectly reported screw-in LEDs as common area direct install measures instead of common area lighting measures. A subsequent desk audit verified common area direct install and common area rebated lighting for this project.

Cadmus also conducted a QA/QC review of the database records for all projects visited (n=23) as part of its verification activities.

Table 10-17 summarizes the sampling methodology for the database review activities conducted for the Master Metered Low-Income Multifamily Housing Program in PY6.

Table 10-17: Master Metered Low-Income Multifamily Housing Program Process Evaluation Database Review

Stratum	Population Size	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Used For Evaluation Activities (Impact, Process, NTG)
Database Review	49 projects	All available	All available	All available	Process, Impact, Database review, Census
Records Review	49 projects	85/15	23 projects selected from Q1-Q3	24 projects	Process, Impact , Records review for 23 site visits and one additional desk audit, Random Sample
Program Total	**49 projects**		**As above, per sampling unit**	**As above, per sampling unit**	

10.4.4 Achievements Against Plan

In PY6, the program had aggressive plans of 2,736 MWh/yr and 0.45 MW in energy and demand savings. For comparison, in PY5 the program's planned savings were 1,720 MWh/yr for energy and 0.29 MW for demand, 63% and 64%, respectively, of the PY6 plans.

Table 10-18 contains the PY6 planned energy savings and incentive and the *ex post* verified savings for the program through Q4. The program did not achieve its PY6 planned savings; the verified program savings were 57% of planned energy savings and 33% of planned demand savings. In PY5, for comparison, the program achieved 116% and 67% of planned energy and demand savings. Given that the Master Metered Low-Income Multifamily Housing Program is new to PPL Electric Utilities' Phase II portfolio, planned savings were lower in PY5 to account for program ramp-up.

The reasons for not achieving planned program savings in PY6 are discussed in Program Delivery.

The program may not achieve Phase II planned savings; the total verified savings through PY6 constitute 52% of energy and 28% of demand. However, PPL Electric indicated that there are enough projects in the PY7 pipeline to catch up to Phase II planned savings in PY7.

Table 10-18: Master Metered Low-Income Multifamily Housing Program Savings [1]

	PY5 Verified	PY6			Phase II: PY5-PY7		
		Planned	Verified	Percentage of Planned	Planned [1]	Verified	Percentage of Planned
MWh/yr	2,039	2,736	1,549	57%	6,885	3,586	52%
MW	0.17	0.45	0.15	33%	1.14	0.32	28%
Participants 2]	36	N/A	49	N/A	N/A	85	N/A

[1] Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 5, 2015, Table S6, pp. 156

[2] The number of Phase II participants consists of 49 projects in PY6 and 36 projects in PY5 based on unique CSP job numbers. The number of Phase II participants in the PY5 annual report was reported as 37 instead of 36. This is because the ICSP reported lighting and direct install measure retrofits completed in two different quarters for the same property, using the same CSP job number. Since these retrofits were reported in two different quarters, Cadmus counted them as distinct project participants. To avoid this confusion in PY6, the ICSP has used a distinct CSP job number for retrofit projects completed during different quarters, even if the retrofits were completed in the same property.

10.4.5 Program Delivery

Cadmus found that program delivery has been going well. Survey results indicated customers like the simple turnkey approach and individual projects are completed efficiently. However, the program has been unable to achieve planned savings and participation targets in PY6, and more broadly in Phase II.

10.4.5.1 Program Participation

Cadmus considered three possible reasons that the program has not reached planned savings and participation targets—unrealistic projections, participant enrollment, and marketing and outreach.

Planned Savings

Given the difference between program planned savings (2,736 MWh/yr) and reported savings (1,574 MWh/yr) and verified savings (1,549 MWh/yr) in PY6, Cadmus suspects that the planned savings for PY6 and Phase II may be too high. The remaining savings potentials among eligible program participants may be smaller than originally estimated, or more time and effort may have been needed to enlist program participants (enrollment is discussed in the next section).

Participation is limited because of the program's eligibility requirements:

- Qualifying buildings must have 50% or more of their units occupied by tenants who have an annual income at or below 150% of the federal poverty level; and
- Qualifying buildings must be classified as master metered, nonprofit, and low-income.

In planning this program, PPL Electric Utilities estimated participation levels through collaboration and consultation with the Pennsylvania Housing Finance Agency (PHFA), local housing authorities, and other utilities with active multifamily efficiency programs.[123] However, PPL Electric Utilities program staff said that the GNI (nonprofit) classification restricts it from contacting otherwise eligible master metered low-income multifamily properties. If the program is continued in Phase III, staff said program participation could be increased by extending program eligibility requirements beyond the GNI (nonprofit) sector to include other facilities with similar purposes to the list of eligible structures. Regardless, the Phase III savings targets for the program should be established based on an updated review and assessment of the remaining savings potential for program-eligible buildings.

PPL Electric Utilities and the ICSP are looking for ways to increase program participation given the current eligibility requirements. Until Q4 of PY6, the program focused exclusively on nonprofit low-income multifamily housing properties. In Q4, PPL Electric Utilities started to contact eligible nursing homes and look at common spaces of individually metered multifamily facilities that are nonprofit and low-income. It might also consider other building types with potentially eligible occupants in its territory, such as college and university housing, prisons, and substance abuse treatment centers.

Enrolling Potential Participants

PPL Electric Utilities program staff and the ICSP said their experience enlisting properties for participation has required years of preparation to find and access decision-makers, establish relationships, and convince decision-makers about the long-term benefits of participation. Concerns involve gaining access to decision-makers when there is more than one, often the case with buildings owned by nonprofit organizations, and extending sufficient lead time to make decisions regarding projects. Some potential participants who completed retrofits with energy service companies (ESCOs) prior to the enactment of Act 129 in 2008 are resistant. Since 2008, new technologies and new products with significantly higher savings at low or no cost have become viable; however, the ICSP finds it challenging to communicate these opportunities to the potential program participants. In fact, the ICSP has performed audits at facilities under performance contracts, or ESCOs, and has found ample new savings opportunities.

PPL Electric Utilities and the ICSP are increasing their direct marketing efforts. They have also found that offering free audits is the most effective way to increase interest in the program's energy-efficient products.

Marketing and Outreach Efforts

Cadmus considered if current marketing and outreach efforts have been adequate to reach potential participants and effective in turning opportunities into projects. PPL Electric Utilities and the ICSP staff said in their interviews that marketing and outreach efforts are going well and that messaging is effective. The ICSP has reached and enrolled the majority of larger nonprofit low-income multifamily buildings in PPL Electric Utilities' territory. Given the limited number of remaining potential program participants, the ICSP is targeting smaller properties. Per PPL Electric Utilities direction, the ICSP is marketing to customers

---

123 PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.163.

who have shown little interest in the past, but may have a change of thinking in the future. The ICSP is also making an effort to help customers understand that funding for Phase II is coming to an end – creating a sense of urgency to participate.

10.4.5.2 Logic Model

During PY5, Cadmus developed the logic model and process flow maps for Master Metered Low-Income Multifamily Housing Program. We reviewed the logic model at the end of PY6 to determine if the program had changed and found that the model is still applicable. The program theory and logic model are in Addendum B. Logic Model.

10.4.5.3 Key Performance Indicators

Along with performance and energy savings, the program logic model identifies short-term outcomes and performance indicators for increasing customer awareness of the program and energy-efficient equipment. PPL Electric Utilities and the ICSP internally monitor specific factors to assess how the program is performing. The metrics include customer complaints, safety violations, tenant energy education workshops offered at properties, and the tenants' and property decision-makers' satisfaction with the program. Table 10-19 shows these indicators with the PY6 results.

10.4.5.4 Program Updates

PPL Electric Utilities made a number of changes to the program in PY6. In Q4, the program added nursing homes to the list of eligible building types. It added new measures (water heater tank wraps, thermostatic shower restriction valves, and refrigerator recycling) and stopped offering smart strips. PPL Electric Utilities is continuously evaluating and, if cost-effective, will consider expanding the products available through the program.

Following Cadmus' recommendations in PY5 to increase tenant participation at energy education workshops, the ICSP raised the amount of the gift card raffled and offered LED night lights. The ICSP is also leaving literature for tenants to review when convenient.

10.4.6 Participant Profile

Cadmus interviewed seven property decision-makers, representing 24 projects completed at 19 properties during Q1, Q2, and Q3 of PY6. The building stock at these properties was constructed between 20 and 75 years ago. Figure 10-1 shows age distribution for the buildings whose owners or managers provided an estimate.

Table 10-19: Master Metered Low-Income Multifamily Housing Program KPIs

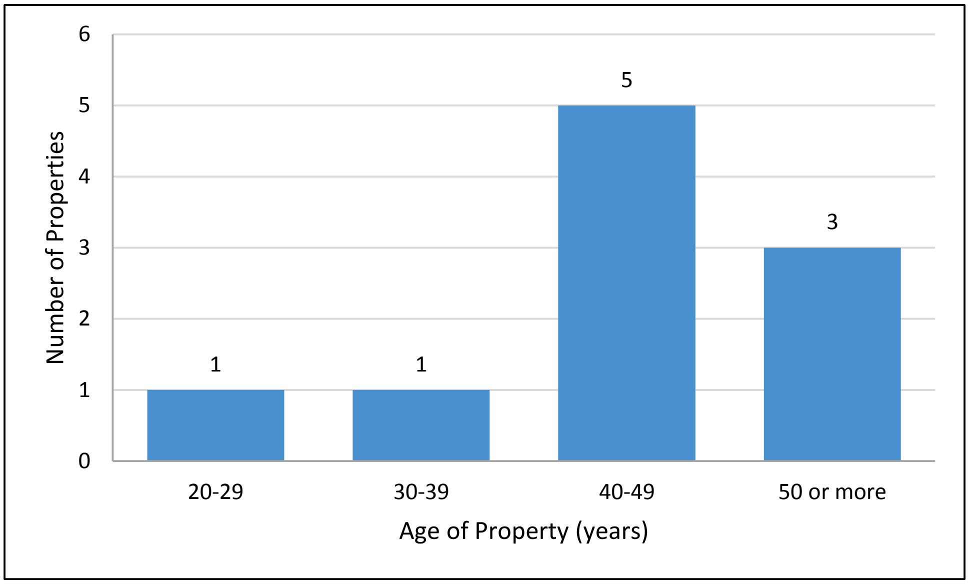
Key Performance Indicator	Metric	Company Tracking the Metric	Goal	PY6 Result
Energy Savings[1]	Verified kWh savings	PPL Electric, ICSP, Cadmus	2,736 MWh/yr	1,515 MWh/yr
Participation	Number of installed measures	PPL Electric, ICSP, Cadmus	43,000 installed measures	14,708 installed measures [2]
	Number of completed building walkthroughs	PPL Electric, ICSP, Cadmus	29 completed walkthrough audits	41 completed walkthrough audits
Internal Metrics Tracked by PPL Electric Utilities and ICSP				
Customer Complaints	Number of customer complaints for the program	PPL Electric	Low number of customer complaints	Only one customer complaint [3]
Safety Violations	Number of safety violations for the program	PPL Electric	Zero safety violations	No safety violations
Energy Education Workshop Building Participation	Number of buildings that allow tenant energy education workshops	ICSP	Conduct one tenant energy education workshop per property	Only a few properties did not allow tenant energy education workshops
Tenant Energy Education Workshop Satisfaction	Level of satisfaction among tenants who attend energy education workshops	Cadmus	High satisfaction level	Average satisfaction level was 4.5 out of 5 in the tenant postcard survey administered by Cadmus
Program Satisfaction	Level of program satisfaction among property decision-makers	Cadmus	High satisfaction level	No negative feedback about program in the property decision-maker survey administered by Cadmus

[1] Energy savings, participation, and project complete goals are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 5, 2015, Table S6, pp. 156.

[2] Measure count is based on the quantity reported in EEMIS.

[3] The customer complaint was not directly related to the energy audit or retrofit project.

Figure 10-1: Age of Buildings at Participating Sampled Properties



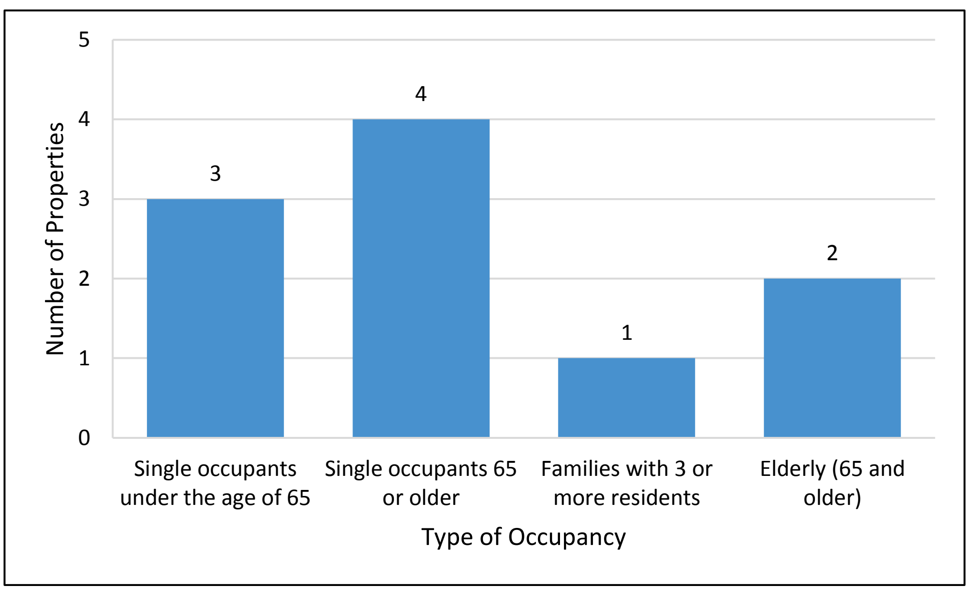
Source: Decision-Maker Survey Question L1. "When was / were the building(s) constructed?" (n=10 properties)

Property decision-makers reported using electricity for space heating and water heating at 14 of 19 properties. The remaining five properties used natural gas to heat both tenant apartments and water.

Electricity costs are included in the rent at all properties, which emphasizes the split incentive issue in these properties, where the cost benefits accruing from energy-efficient and water-efficient improvements will be realized by property owners and not directly by tenants.

The participating properties house a variety of household characteristics, as shown in Figure 10-2.

Figure 10-2: Tenant Characteristics



Source: Decision-Maker Survey Question L2, "Are the primary tenants…?" (n=10 properties)

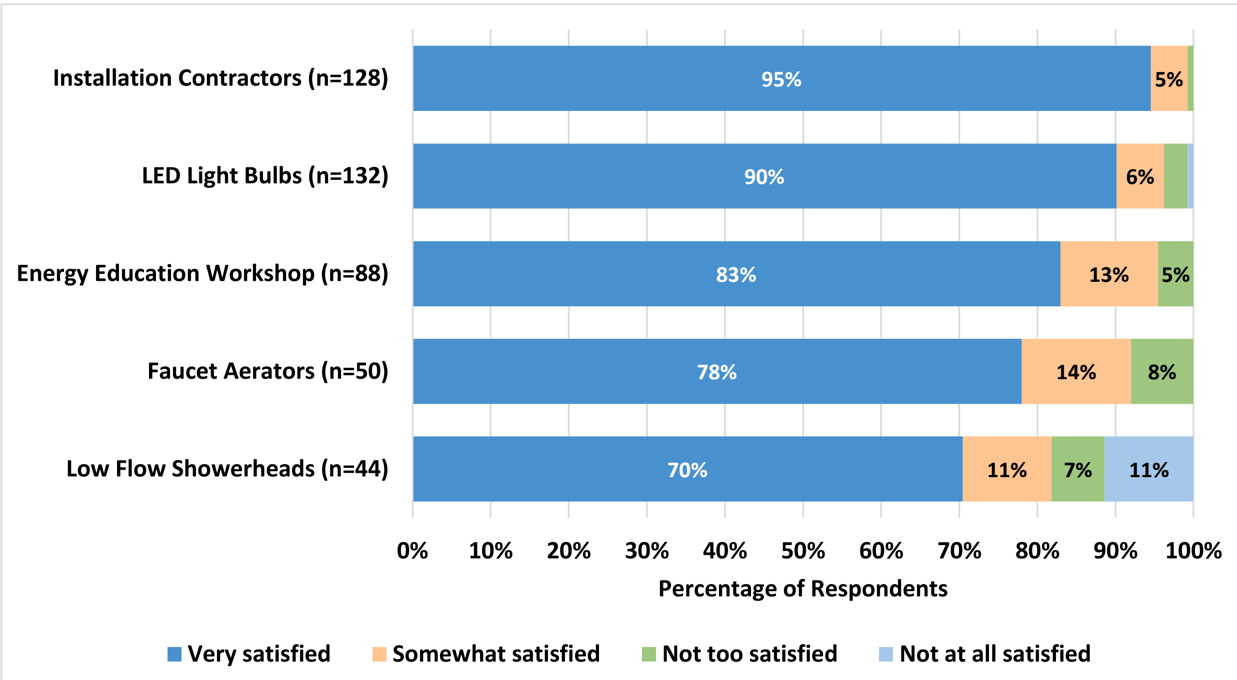
10.4.7 Satisfaction

10.4.7.1 Program Satisfaction

Tenants who responded to the leave-behind survey reported high levels of satisfaction (Figure 10-3). More than 80% of the respondents reported being *very satisfied* with the installation contractor, LED light bulbs, and the energy education workshop. Only faucet aerators and low-flow showerheads had less than 80%. Five respondents (11%, n=44) reported they were *not satisfied at all* with low-flow showerheads.

The postcard provided room to write comments. However, no respondents provided comments.

Figure 10-3: Tenant Satisfaction with Program Elements and Products

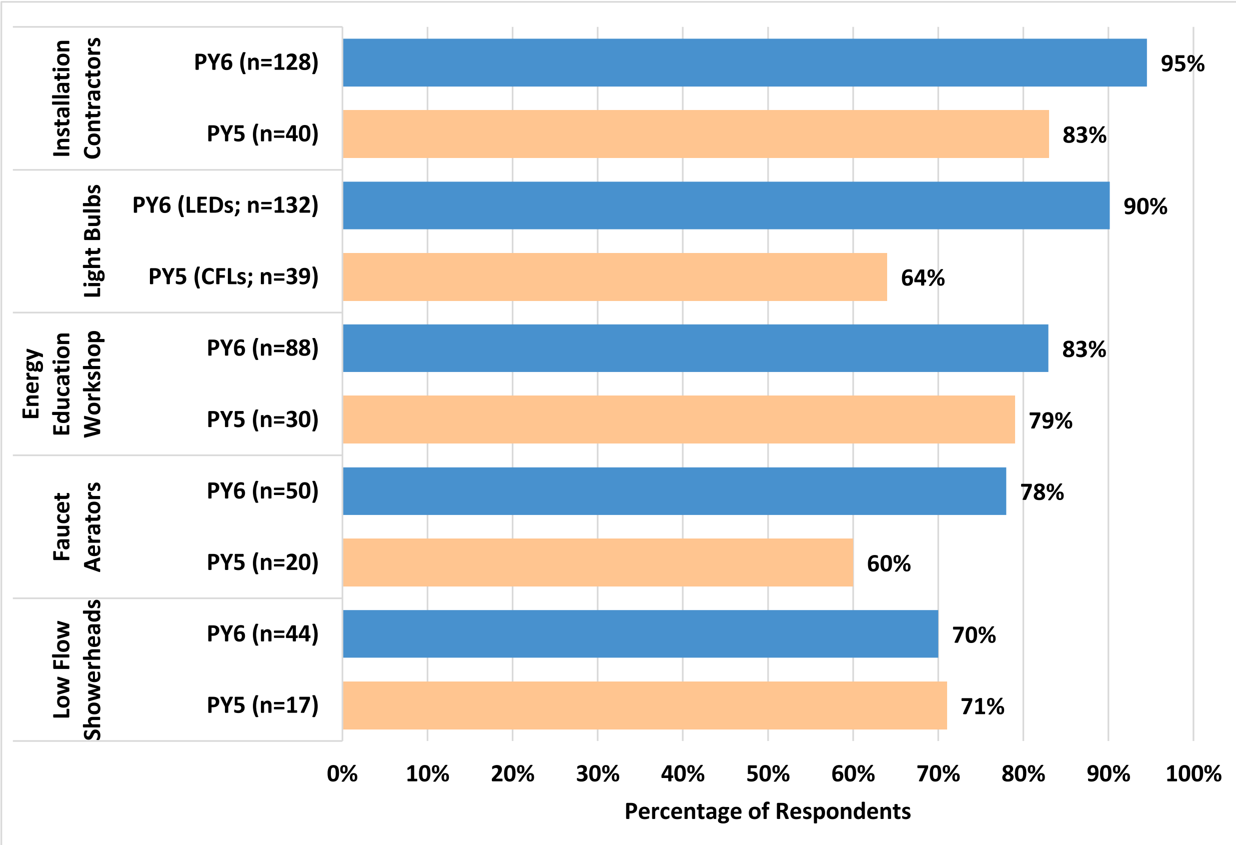


Source: Tenant Leave-Behind Postcard Survey Question 1. "How satisfied were you with…."

Satisfaction increased in PY6 over PY5 for all products or program elements except one. Figure 10-4 compares PY5 and PY6 results for respondents who said they were *very satisfied*. Among other products and elements, the figure compares satisfaction with energy-efficient light bulbs; however, the comparison is not direct because in PY5, tenant participants received a CFL but in PY6 they received an LED. Nevertheless, the figure shows higher levels of satisfaction with the LED bulbs compared to CFLs.

The percentage of tenants in PY6 reporting they were *very satisfied* with installation contractors improved by 12% over PY5. The percentage of tenants reporting they were *very satisfied* with faucet aerators has improved by 18% from PY5. There was virtually no change in satisfaction for low-flow showerheads.

Figure 10-4: PY5 and PY6 Satisfaction – Respondents Reporting *Very Satisfied*



Source: Tenant Leave-Behind Postcard Survey Question 1. "How satisfied were you with…." Includes respondents who say *very satisfied*. In PY5, tenants received CFLs and in PY6, they received LEDs.

Survey respondents' satisfaction with the program is very high and in line with anecdotal data collected during site visits. All seven property decision-makers who responded to questions about program satisfaction reported they were *very satisfied* with the program overall. They also reported very similar levels of satisfaction with these program elements:

- The overall quality of the work performed by the contractor in common areas (6 respondents, n=7)
- The performance of the equipment installed by the contractor in common areas (6 respondents, n=7)
- Contractor interaction with tenants during equipment installation and energy education seminars (7 respondents, n=7)
- The overall quality of the work performed by contractor in the tenant apartments (6 respondents, n=7)
- The performance of the equipment installed by contractor in tenant apartments (7 respondents, n=7)

10.4.7.2 Satisfaction with PPL Electric

Overall satisfaction with PPL Electric Utilities as a provider of electric service is also very high. Six of seven participating property decision-makers rated their satisfaction as eight or higher (on a scale of 1 to 10); the other property decision-maker did not know. Five respondents indicated their high opinion of PPL Electric Utilities has not changed because of program participation; one indicated his or her opinion had improved, and one did not know.

10.4.7.3 Experience with LEDs

In PY6, LEDs replaced CFLs as the eligible efficient lighting product for screw base residential lighting applications. Screw base LEDs in apartments and common areas are installed most frequently through the program because they are easy to install and offer high savings. Owners and operators said tenants prefer the way LEDs look because they are more similar in shape to incandescent light bulbs than CFLs and also because they are brighter and turn on instantly. Owners and operators prefer LEDs because disposal is less of a concern; unlike CFLS, there is no mercury in LEDs.

10.4.8 Marketing and Outreach

10.4.8.1 PPL Electric Utilities and ICSP Marketing

Overall, marketing and outreach are working well. In PY5, the marketing materials did not clearly indicate that this program was offered by PPL Electric. In PY6, the ICPS has emphasized that the program is offered by PPL Electric, and PPL Electric Utilities and the ICSP staff believes credibility for the program has increased.

The ICSP's marketing outreach emphasizes available incentives through PPL Electric Utilities rebate programs, and messaging is focused on reducing operating costs in multifamily facilities. In PY6, PPL Electric Utilities presented case studies that describe how energy and cost savings are achieved through participation in the program.

To identify potential project opportunities, the ICSP has generated a master list of properties that meet program eligibility requirements. This list is a working document and is reviewed and adjusted often. Among the ICSP's successful strategies was contacting advocacy groups and attending relevant gatherings such as the Pennsylvania Housing Finance Agency (PHFA) conference. The ICSP has started attending county commissioner meetings to build relationships with housing directors. Finally, it reaches out to property owners and operators through e-mail messages, direct mail, and cold calls. The ICSP has attended board meetings at organizations owning or managing low-income multifamily properties to increase interest in the program. The ICSP believes it will uncover additional opportunities and that, overall, marketing and outreach is working well.

10.4.8.2 Program Awareness

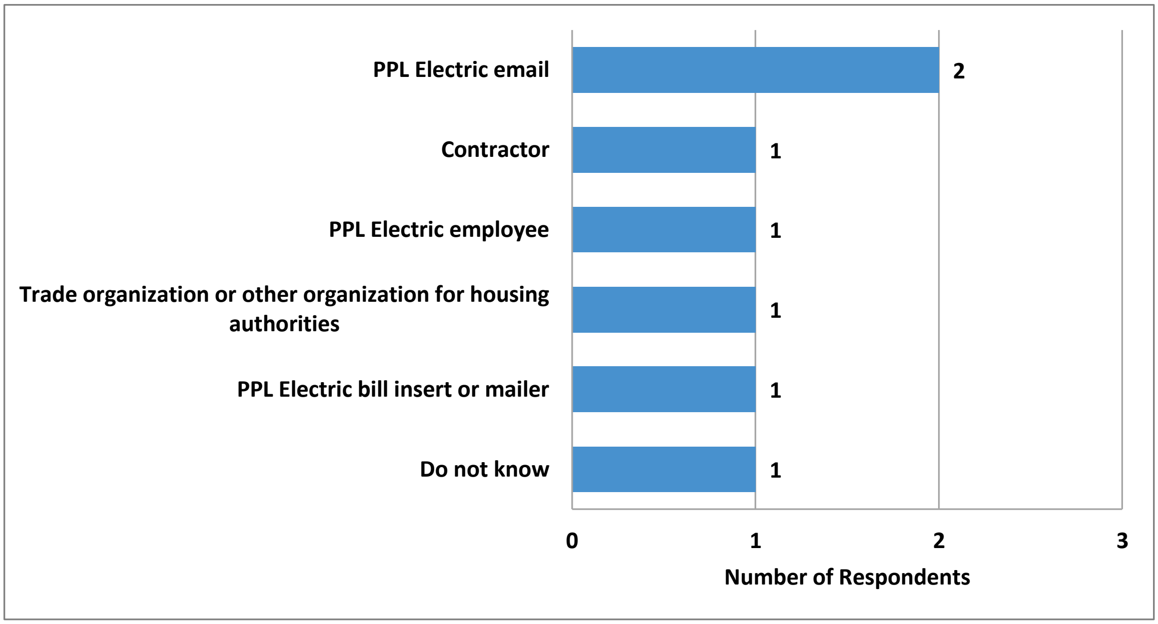
Cadmus asked participating property decision-makers how they heard of the program (n=7). Six were directly contacted by the ICSP and one heard through its contractor (n=7). The EEMIS records confirm this observation; 33 out of 41 properties participating in the program (80%) heard about the program through a cold call (most likely by the ICSP). Five properties (12%) responded to PPL Electric Utilities marketing materials, four (10%) were referred to the program by another customer, and one property responded to the ICSP's marking material. [124]

10.4.8.3 Preferred Method of Contact

When asked about the best way for PPL Electric Utilities to inform its customers about energy efficiency programs, all seven property decision-makers recommended e-mails, personal visits from PPL Electric Utilities, and bill inserts, among others. Figure 10-5 provides a summary of responses.

[124] Cadmus aggregated the responses provided to "How did you hear about the program?" for 49 projects in EEMIS. For two properties that had more than one distinct CSP job number associated with them, two different responses are recorded for each in EEMIS.

Figure 10-5: Recommended Energy Efficiency Program Market Channels



Source: Decision-Maker Survey Question E2, "What do you think is the best way for PPL Electric Utilities to inform the companies like yours about energy efficiency programs?" (n=7)

10.4.9 Tenant Education

The ICSP conducted tenant energy education workshop at all 19 properties for which Cadmus interviewed a property decision-maker. Five of seven respondents said that over 50% of their tenants attended the workshops. At two workshops, where participation levels were under 50%, both property owners said tenants needed more incentive to attend, such as food and drinks.

When property decision makers were asked if they attended the workshops, four said they did. Of these, three said that they found the whole presentation useful and one particularly liked that the presentation emphasized the energy savings from lighting installations.

10.4.10 Decision-Making Factors in Project Planning

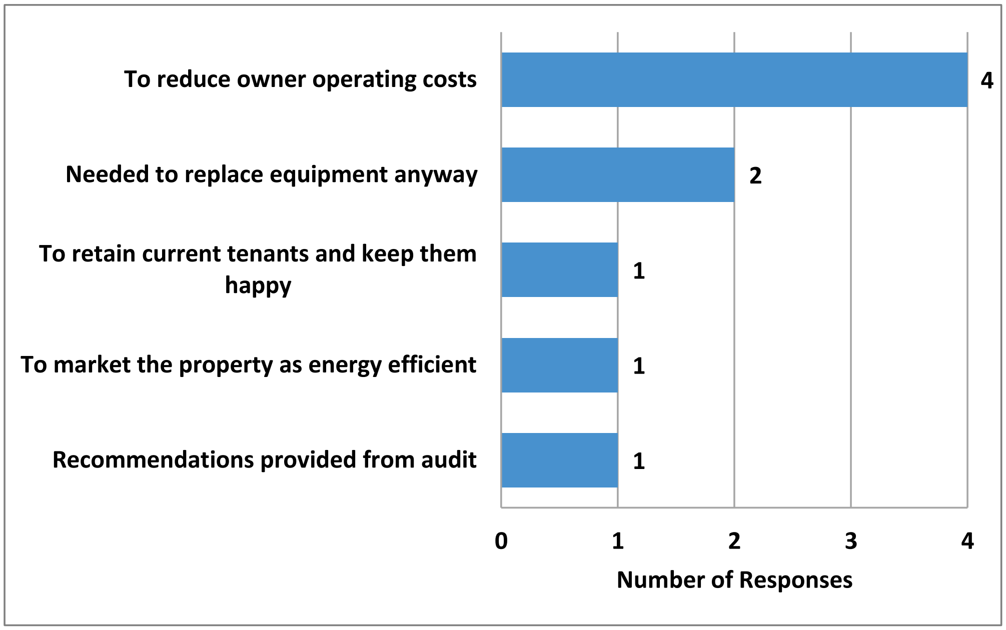
10.4.10.1 Financing

Participating property decision-makers reported that they paid for the energy-efficient upgrades through multifamily organization's savings from either a general fund or a replacement reserve account. That is, they did not apply for nor receive financing from sources outside of the program, to pay for the out-of-pocket costs of the rebated measures.

10.4.10.2 Reasons for Participating

Property decision-makers reported participating in the program for a variety of reasons, including the desire to reduce operating costs and save electricity. Figure 10-6 lists respondents' motivations for participation.

Figure 10-6: Motivations for Participating



Source: Decision Makers Survey Question E3, "Why did you decide to participate in the PPL Electric Utilities Master Metered Multifamily Program?" (n=7) Multiple responses were allowed.

Energy Efficiency Challenges

All seven respondents said that a lack of capital and being able to coordinate funding with opportunities to make upgrades are factors that made it difficult to improve energy efficiency. Five respondents also stated that lack of access to financing or favorable financing terms made upgrade or improvements difficult.

10.4.11 Market Effects

"Market effects" are changes in the market or behavior of participants attributable to an energy efficiency incentive program.[125] An assessment of a program's effect on the market can provide evidence that a market barrier has been partially or fully mitigated. To understand whether PPL's programs are contributing to market transformation, we first identify the baseline to the extent possible, then define the market effects we expect to see and metrics to measure effects, and third, gather data and assess changes over time, PPL's influence, and permanency of changes in the marketplace.

PPL Electric Utilities developed the Master Metered Low-income Multifamily Program in response to Pennsylvania PUC's Phase II implementation order to target aging and underserved multifamily housing stock. The program encourages energy efficiency retrofits in multifamily buildings that house low-income customers (typically nonprofit or institutional buildings). The program's objectives are designed to change the GNI housing market by offering free and rebated energy-efficient products to increase the number of installations of high-efficiency equipment in low-income multifamily buildings.

---

[125] Eto, Joseph, Prahl, Ralph, and Schlegel, Jeff. 1996. *A Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs.* Prepared for the California Demand-Side Management Committee.

Though not an explicit objective of the program, Cadmus also assumes that the program is affecting the market by increasing awareness about energy efficiency and energy-efficient technologies among property decision-makers of existing multifamily buildings.

Cadmus conducted surveys in PY5 and PY6, collecting data to explore the baseline and effects of the program in increasing awareness and purchasing behavior among participating property decision makers. Survey questions examined knowledge level, previous program participation, purchasing behavior, and purchasing motivation.

In PY5 and PY6, all respondents (n=7 in PY6; n=6 in PY5) learned about the Master Metered Low-Income Multifamily Housing Program through contact from PPL Electric Utilities or the ICSP. None were seeking information or preparing for energy-efficient upgrades. All reported they plan projects five or more years in the future, obtain board approval, and consider cost as the primary factor influencing decisions to replace or upgrade equipment mentioned energy efficiency as a factor). All respondents stated that coordinating funding with opportunities to make energy-efficient upgrades or improvements is challenging. Further, when asked if the efficiency upgrades would have been completed without PPL Electric Utilities' assistance, all respondents (n=6 in PY5) stated it was *not too likely* or *not at all likely*.

In PY6, while five of seven respondents stated buildings or equipment had undergone some level of upgrade in the last ten years, the upgrades were not comprehensive energy efficiency upgrades. Further, when asked about the likelihood that the current PPL-funded efficiency upgrades would have been completed without PPL's assistance, all but one respondent (n=7) stated it was *not too likely* or *not at all likely*. When asked what would have happened without PPL's rebate for the energy-efficient common area lighting, only one respondent said they would have done the same thing (1 of 13 in PY5 and PY6).

Given these responses in PY5 and PY6, it is clear that upgrading the energy efficiency of buildings and equipment is not standard practice in the low-income multifamily sector, and PPL's assistance is a significant factor in the upgrades. PPL's program offerings assist building owners and managers to upgrade equipment and buildings.

The PY5 and PY6 surveys asked property decision makers about increases in their knowledge of energy efficiency and actions with participation. In PY5, Cadmus asked property decision makers whether the information learned from PPL Electric's program marketing materials increased their understanding of energy efficiency—three of seven said it did. Asked whether the information prompted them to take any action, six out of seven said that it did, that is, they participated in the program. In PY6, Cadmus asked whether property decision makers felt they were more knowledgeable about energy efficiency in their buildings as a result of the program. All seven respondents responded *yes*. These results suggest that participating in the program is increasing awareness about building energy efficiency among property decision makers. As the ICSP continues to contact and reach potential participants, increases in knowledge and interest in energy efficiency can be expected.

10.5 CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Overall, the program processes are working smoothly and customers are satisfied with the quality of the work performed by the ICSP and with the technologies installed as part of the program retrofits. However, the program did not achieve its PY6 planned savings and this appears to be the program's primary challenge. To increase participation, PPL Electric is considering building types other than multifamily and nursing homes with potentially eligible occupants in its territory. PPL Electric is also pursuing potential savings in common area spaces of individually metered multifamily facilities that are nonprofit and low-income. PPL Electric has indicated that the program pipeline in PY7 should be enough to meet the program's Phase II planned savings.

Recommendation
To increase program participation in PY7, Cadmus agrees that PPL Electric should review the savings potential in common area spaces of individually metered multifamily facilities and if necessary, in other building types that may be eligible for program participation, such as college dormitories, prisons, and substance abuse treatment centers.

Recommendation
If the program is offered in Phase III, Cadmus recommends that its Phase III savings target for multifamily buildings be carefully established in collaboration with the Pennsylvania Housing Finance Agency (PHFA), and/or other agencies, to estimate energy savings potential in master metered low-income multifamily buildings in PPL Electric Utilities' territory.

Recommendation
If the program is offered in Phase III, Cadmus recommends extending the program eligibility requirements beyond the GNI (nonprofit) and low-income sectors.

Conclusion
In the tenant leave-behind surveys, fewer than 80% of respondents reported they were *very satisfied* with faucet aerators and low-flow showerheads. Eleven percent of the respondents (5, n=44) reported they were *not satisfied at all* with low-flow showerheads. In PY6, low-flow showerheads were installed with thermostatic shower restriction valves. The tenant survey asked only about the low-flow showerheads. Therefore, Cadmus cannot conclude if dissatisfaction is tied to the showerheads or restriction valves (or both). Low levels of satisfaction could lead tenants to remove the aerators and the showerheads. Note that in other programs, E-Power Wise and Student and Parent Energy-Efficiency Education, these items have low installation rates when self-installed. To collect additional information in PY7, Cadmus added thermostatic shower restriction valves to products referenced in the tenant leave-behind survey.

Recommendation
The ICSP should consider providing more information about the benefits of faucet aerators, low-flow showerheads, and thermostatic shower restriction valves during the tenant energy education workshop and/or in leave-behind materials.

Recommendation
PPL Electric Utilities could consider further review of the persistence of installations of faucet aerators, low-flow showerheads, and thermostatic shower restriction valves in participating apartments. A follow-up survey could ask tenants whether they kept or removed the items.

10.5.1 Status of Recommendations for Program

Table 10-20 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 10-20: Master Metered Low-Income Multifamily Housing Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Master Metered Low-Income Multifamily Housing Program	
Review the program saving potential in common areas of individually metered multifamily buildings and if necessary, in other building types that may be eligible for program participation.	Under consideration for Phase III.
For Phase III, establish program saving targets based on an updated estimate of the remaining saving potentials in the eligible master metered multifamily sector.	Rejected. There will not be a separate multifamily program in Phase III. Multifamily buildings will be served by other programs (residential, low-income, nonresidential).
For Phase III, extend program eligibility requirements beyond GNE and low-income.	Will be implemented in Phase III.
Consider providing additional educational materials about faucet aerators, low-flow showerheads, and thermostatic shower restriction valves.	Under consideration for Phase III.
Consider a review of measure persistence for low-flow aerators and thermostatic shower restriction valves.	Under consideration for Phase III.

10.6 FINANCIAL REPORTING

A breakdown of the Master Metered Low-Income Multifamily Housing Program finances is presented in Table 10-21.

Table 10-21: Summary of Master Metered Low-Income Multifamily Housing Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$303	$458
2	EDC Incentives to Participants	$231	$443
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$72	$15
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$424	$909
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$424	$909
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$229
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$727	$1,597
13	Total NPV Lifetime Energy Benefits	$964	$2,052
14	Total NPV Lifetime Capacity Benefits	$61	$112
15	Total NPV O&M Saving Benefits	$62	$142
16	Total NPV TRC Benefits[4]	$1,087	$2,305
17	TRC Benefit-Cost Ratio[5]	1.50	1.44

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

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

ADDENDUM A. DECISION-MAKER PARTICIPANT SURVEY METHODOLOGY

Dialing Instructions

PPL Electric Utilities provided dialing instructions for conducting surveys. Customers cannot be contacted within a year of the last time they completed a survey (with PPL Electric Utilities or Cadmus). Any customer who has requested to be removed from the sample frame for any survey cannot be contacted again. Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Cadmus coordinated with PPL Electric Utilities' subcontractor to screen the sample and remove customer records called in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) and those who requested not to be contacted again.

In some instances, multiple custom projects were initiated or completed by the same customer. This required that we generate a final survey sample of unique property decision makers to ensure that no customer contact was called more than once for the same survey. Table 10-22 lists total number of records used as part of the sample frame and the outcome (final disposition) of each record.

Table 10-22: Survey Sample Attrition

Description of Call Outcomes	Number of Records
Number of Projects	24
Total Population (unique decision makers) [1]	13
Not attempted	0
Records Attempted	13
No answer/answering machine/phone busy	6
Completed survey [2]	7

[1] The number of unique decision makers represents 19 properties with 24 projects.
[2] One of the surveys included in the analysis was partially completed.

ADDENDUM B. LOGIC MODEL

A program's theory informs its development, implementation, and evaluation. A program logic model identifies relationships between activities and expected results. As logic models make the underlying theory explicit, they serve as useful tools for implementers and evaluators.

The program theory for the Master Metered Low-Income Multifamily can be summarized as follows:

> By providing a free walkthrough audit, direct-install products, and rebates for high-efficient lighting products, the program will increase market saturation and acceptance of high-efficiency equipment in this market segment. Customers will learn about the energy benefits, and achieve energy and demand savings by installing qualifying equipment. Increased market penetration of high-efficiency equipment will further increase sales, achieving additional energy and demand savings.

The logic model's elements include:

- **Activities the program undertakes** include management and strategic direction, marketing, eligibility verification, education, walkthrough audits performed, direct-install products installed, the purchase and installation of equipment by the customer or by a contractor, and rebate processing and payment.
- **Program Inputs** include the target customers, support from PPL Electric Utilities staff, support from the CSP, and the efficient equipment.
- **Outputs produced by program activities** include marketing materials distributed, customers verified as eligible, walkthrough audits performed, direct-install products installed, prescriptive or custom products installed, customers submitting forms, and the number and amount of rebates paid.
- **Short-term outcomes** include increased program awareness, increased customer awareness of energy-efficient equipment, increased energy savings from direct-install products, and an increase in the installations of energy-efficient equipment. Rebated equipment is installed, leading to immediate energy and demand savings.
- **Intermediate outcomes** of the program include a reduction in annual energy consumption and peak load, and lower electric bills for program participants.
- **Long-term outcomes** include continued reductions in energy consumption and peak demand.

11 CONTINUOUS ENERGY IMPROVEMENT PROGRAM

The Continuous Energy Improvement (CEI) Program targets school districts, for which PPL Electric Utilities provides technical support for schools to develop and implement a Strategic Energy Management Plan (SEMP). PPL Electric Utilities identified 10 school districts in mid-year PY5 to participate in the program. A CEI advisor—an ICSP—assists each district in selecting one school or facility to participate and to develop a strategic energy management plan to implement during PY6 and PY7.

Each district also identifies an energy manager, who may be a facility manager, energy expert, teacher, or administrator. The districts work together during monthly meetings, workshops, and conference calls led by the ICSP, during which best practices are shared. By the end of the program, each district will have developed an energy reduction goal, a methodology for measuring energy savings, and a plan to continually improve its energy performance. During PY7, all buildings within the school district will be able to implement a SEMP, based on the experience gained at the first pilot building during PY6.

The SEMP will include improvements in equipment and operation and maintenance (O&M) and changes in staff faculty and student behavior. Most equipment upgrades will be eligible for a rebate through other PPL Electric Utilities programs, such as the Prescriptive Equipment Program and the Custom Program.

11.1 PROGRAM OBJECTIVES

The objectives of the CEI Program are to:

- Encourage customers to identify energy-saving opportunities by focusing on behavioral changes and fostering sustainability through individual engagement
- Assist school districts in defining an energy vision, resources, and goals of their own energy efficiency program
- Demonstrate how the Program fits into the school districts' structure and use a systematic approach to quantify the success of energy management
- Raise employee and student engagement surrounding activities that directly influence the amount of energy consumed by systems and the schools
- Promote other PPL Electric energy-efficiency programs
- Provide partial funding to offset a portion of the salary for school energy champion personnel
- Achieve participation with eight schools/school districts through 2016, with a total reduction of approximately 3,150 MWh/yr

An executive summary of cumulative Phase II program metrics can be found in Table 11-1.

Table 11-1: Phase II Continuous Energy Improvement Executive Summary

Program	Phase II Reported Energy Savings (MWh/yr) [1]	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr)	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost [2] ($/Annual kWh)	Cost of Conserved Energy [3] (TRC Costs/ Lifetime kWh)	Phase II Participants
Continuous Energy Improvement	0	1,390	1,159	1.00	0.46	$632	$0.55	$0.20	0
Total	**0**	**1,390**	**1,159**	**1.00**	**0.46**	**$632**	**$0.55**	**$0.20**	**0**

[1] CEI participants and their PY6 energy and energy savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until the first quarter (Q1) of PY7. The savings reported in PY7 for PY6 are referred to as PY6 adjust ex ante energy savings.
[2] Total EDC Costs divided by first year kWh savings.
[3] Total TRC Costs divided by levelized lifetime kWh savings.

11.2 Program Updates

Initially, the CEI Program planned for 10 school districts to participate during PY6 and PY7; however, two school districts dropped out just after the program started in PY6. The ICSP decided to continue with eight school districts but retained the same planned savings as for 10 schools.

The ICSP will not recruit more school districts for PY7 since the program was designed for two program years of participation. As described in the EE&C Plan,[126] the energy efficiency opportunities are to be implemented in one school in each participating district in PY6, and then rolled out to the other schools in the district in PY7. The ICSP expects that SEMPs will apply to 40 to 50 buildings in PY7.

11.2.1 Definition of Participant

A participant in the CEI Program is defined as a school district.

11.3 Impact Evaluation Gross Savings

Table 11-2 shows the reported energy savings and demand reduction for the CEI Program in PY6. There were eight participants; however, these participants and their PY6 energy and demand savings were not reported in EEMIS, PPL Electric Utilities' tracking database, until the first quarter (Q1) of PY7. The ICSP determines energy savings using a billing analysis, which requires billing data covering all of PY6. Therefore, the energy savings were not reported by the ICSP until after the deadline for uploading the PY6 EEMIS data; the ICSP reported the PY6 energy savings in PY7 Q1.

Table 11-2: Phase II CEI Reported Results by Customer Sector

Sector	Phase II Participants	Phase II Reported Gross Energy Savings (MWh/yr)	Phase II Reported Gross Demand Reduction (MW)	Incentives ($1,000)
Government, Nonprofit, and Educational	0	0	0	$0
Phase II Total	**0**	**0**	**0**	$0

[126] PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.178.

11.3.1 EM&V Sampling Approach

Cadmus included all eight school districts in the impact evaluation, as shown in Table 11-3. In PY6, each school district chose one school to implement continuous energy improvement. Cadmus conducted a documentation review and billing analysis separately for the selected school from each district.

Table 11-3: CEI Sampling Strategy for PY6

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
School District	8	N/A	8	8	Documentation review, billing analysis
Program Total	**8**	**N/A**	**8**	**8**	

11.3.1.1 Adjusted *Ex Ante* Methodology

The energy savings for the eight participating schools were received too late to be reported in PPL Electric Utilities' PY6 database. However, the ICSP provided Cadmus with each school's PY6 energy savings and demand reduction and these are shown in Table 11-4 as the adjusted *ex ante* savings.

11.3.2 *Ex* Post Adjustment Methodology and Findings

11.3.2.1 Ex Post Adjustment Methodology

PPL Electric Utilities provided Cadmus with hourly interval billing data, which was used to conduct a billing analysis to quantify annual energy savings and demand reduction. The billing analysis conformed to IPMVP Option, whole facility report.[127] Cadmus specified separate regression models for each participating school to determine site-specific energy savings that could be compared to the *ex ante* energy savings. Cadmus also specified separate models for energy savings and for demand reduction.

For the energy savings models, hourly interval data were rolled up to daily values. The models included weather and the school's schedule (by using a variable indicating if each day was a school day). The baseline period was defined as the year before the school district joined the program, and the test period was the year of participation. The ICSP used monthly billing data in its regression analysis, and Cadmus used daily data that coincided with the date range of monthly billing data used by the ICSP. Some CEI Program participants applied for rebates from other PPL Electric Utilities' programs such as the Prescriptive Equipment Program. In these cases, Cadmus subtracted the equipment's savings from the participant's savings found by the regression analysis to avoid double counting.

For the demand reduction models, Cadmus used hourly interval data and added an indicator variable to signify each hour within the coincident peak demand period as defined by the 2014 Pennsylvania TRM.[128] Weather and the school schedule were also included in the model. Like the energy savings models, the baseline period to determine reduction in demand was the year before the school district joined the

---

[127] Efficiency Valuation Organization. *International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings*, *Volume 1*. January 2012. Page 25. (EVO 10000 – 1:2012) Available online: http://www.evo-world.org/.

[128] Table 1-3 of the 2014 Pennsylvania TRM defines the coincident peak demand period as 2:00 p.m. to 6:00 p.m. during July through August, excluding weekends and holidays.

program, and the test period was the year of participation. This differs from the method used by the ICSP, which calculated demand reduction by applying a coincidence factor to the annual energy savings.

Cadmus did not conduct site visits in PY6 because equipment specifications and operating hours did not need to be verified to determine energy savings.

11.3.3 Summary of Evaluation Results

Table 11-4 summarizes the energy savings results. PPL Electric Utilities did not report energy savings for PY6 in the EEMIS database; however, the ICSP provided documentation showing the savings for each of the eight schools, as shown in Table 11-4, as the adjusted *ex ante* energy savings. Cadmus verified savings of 1,208 MWh per year and an 87% realization rate.

Table 11-4: PY6 CEI Summary of Evaluation Results for Energy

Stratum	PYTD Reported Gross Impact (MWh/yr)	PYTD Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)[1]	PYTD Verified Gross Energy Savings (MWh/yr) [2]	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
School District	-	1,390	86.93%	1,208	N/A	29.0%
Program Total	**-**	**1,390**	**86.93%**	**1,208**	N/A	29.0%

[1] The realization rate was calculated using the adjusted *ex ante* savings.
[2] Adjusted *ex ante* multiplied by the realization rate will not equal verified gross energy savings due to rounding.

Table 11-5 summarizes the reported and verified demand reduction. PPL Electric Utilities did not report demand reduction for PY6 in its database; however, the ICSP provided documentation showing the demand reduction for each of the eight schools, which is shown in Table 11-5 as the adjusted *ex ante* demand savings. Cadmus verified 0.718 MW of demand reduction and a 425% realization rate.

Table 11-5: PY6 CEI Summary of Evaluation Results for Demand

Program	PYTD Reported Gross Demand Savings [1] (MW)	PYTD Adjusted *Ex Ante* Demand Savings [2] (MW)	Demand Realization Rate (%)[3]	PYTD Verified Gross Demand Savings [2] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
School District	-	0.169	425%	0.718	N/A	28%
Program Total	**-**	**0.169**	**425%**	**0.718**	N/A	28%

[1] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[2] Adjusted *ex ante* and verified gross demand reductions include T&D losses.
[3] The realization rate was calculated using the adjusted *ex ante* savings.

Cadmus calculated the precision of savings estimates for energy and demand using the standard error of the regression coefficient(s) that determine savings. The resulting precision of a regression model is difficult to predict or control. Additional sample points cannot be added, and the evaluator has little control over the variability of the results. The precision on the CEI Program modeling is primarily influenced by two factors: model specification and sample size. For the CEI Program, model specification is largely determined by what information or variables are provided to the evaluation team by the individual sites. In many cases, we are able to add a limited amount of information (e.g., weather variables such as heating degree days or cooling degree days). Changes that occur on site which affect energy usage or potential variable omission can lead to model misspecification, where a portion of the error in the model is left unaccounted for. This pilot study also is constrained in sample size, with only 8 schools participating. The evaluation team anticipates that as more schools participate in the CEI Program and additional, site-specific information is provided to the evaluation team, the program precision will show improvement.

11.4 IMPACT EVALUATION NET SAVINGS

Cadmus reviewed survey responses to determine net savings for the CEI Program. Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance plans are met using verified gross savings.

11.4.1 Net-to-Gross Ratio Methodology

Freeridership is a measure of the savings that participants would have achieved on their own without the program's treatment; these savings are subtracted from verified gross savings. Participant spillover on the other hand credits additional savings that participants achieved on their own, where their experience with the program was highly influential. Participant spillover adds to gross savings. Because the savings for the CEI Program were determined using a billing analysis, all spillover savings were already captured.

The SWE defined the methods used to determine net savings, including instructions provided in the Evaluation Framework and Guidance Memos. For this program, Cadmus collected data through participant telephone surveys to assess these metrics.

11.4.2 Net-to-Gross Ratio Sampling

Cadmus interviewed all participants, as shown in Table 11-6, to determine the program's influence on their decision to participate in the CEI Program and implement continuous energy improvement activities.

Table 11-6: CEI Sampling Strategy for PY6 NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted e[1]
School District	School District	8	N/A	N/A	8	8	100%
Program Total		**8**	**N/A**	**N/A**	**8**	**8**	**100%**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete surveys..

11.4.3 Net-to-Gross Ratio Findings

Table 11-7 shows the net-to-gross ratio for the CEI Program participants. Freeridership was estimated to be zero because all participants reported that the ICSP was extremely influential in their decision to participate and develop tools used to support their strategic energy management plans. Additionally, all participants reported that the program was *very* or *extremely influential* in their decision to implement operational or behavioral activities.[129]

No savings are attributed to spillover, as all energy savings impacts at participating schools are captured using the billing analysis.

Table 11-7: PY6 CEI Summary of Evaluation Results for NTG Research

Stratum	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
School District	0%	0%	100%	N/A	N/A
Program Total	**0%**	**0%**	**100%**	**N/A**	**N/A**

11.5 PROCESS EVALUATION

11.5.1 Research Objectives

The purpose of this evaluation is to assess Continuous Energy Improvement Program processes and recommend improvements in program operation efficiency, delivery infrastructure, and customer response, including adoption of the program. The PY6 evaluation involved these research objectives:

- Assess program processes and make recommendations for improving program operation.
- Assess the program's effectiveness in generating awareness and disseminating information.
- Assess the program's effectiveness to encourage school districts to implement energy-efficiency projects.
- Evaluate participant satisfaction with the program and identify any opportunities and barriers recommended by participants.

11.5.2 Evaluation Activities

The PY6 process evaluation activities were:

- Program staff and implementer interviews (n=2)
- Participant surveys (n=8)
- Database and quality assurance/quality control (QA/QC) review of records

The research activities were consistent with the evaluation plan. Cadmus planned to complete surveys with a census of participants and interview the program manager at PPL Electric Utilities and the ICSP (Table 11-8).

[129] All respondents gave a 4 or 5 response when asked about operational or behavioral energy-efficiency projects in response to the following: "Please rate how influential the CEI Program was on your school district's decision to implement the following types of projects using a scale from 1, meaning no influence, to 5, meaning the CEI Program was extremely influential."

Table 11-8: CEI Program Process Evaluation Sampling Strategy for PY6

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or Cv in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Population Frame Contacted [1]	Evaluation Activities
PPL Electric Program and ICSP Staff	Staff	2	N/A	N/A	2	2	2	100%	Process
School Districts	Participants	8	N/A	N/A	8	8	8	100%	Process, NTG

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of sample frame called complete surveys.

11.5.3 Methodology

For the PY6 process evaluation, Cadmus examined whether the Continuous Energy Improvement Program was operating efficiently and effectively. We relied on annual reviews of program documentation, interviews with program staff and the ICSP, and surveys with program participants. The participant surveys focused on the school's experiences with the program and included questions about participation in and awareness of other PPL Electric Utilities programs.

The process evaluation also involved a limited study of the program's effect on the market. This study involved documenting the baseline to the extent possible, preparing a simple market change theory including metrics to assess change, and assessing progress toward meeting these metrics. Cadmus collected data through primary and secondary research.[130]

11.5.3.1 Program Staff and Implementer Interviews

Cadmus conducted interviews with program management staff at PPL Electric Utilities and the ICSP in March and April 2015. The interviews discussed program objectives, program design changes, key performance indicators, and implementation successes and challenges.

11.5.3.2 Participant Surveys

Cadmus completed a telephone survey with eight energy managers, one from each participating school district. The primary purpose of the surveys was to assess satisfaction with the program, gather details about implementing the SEMP, and assess the program's influence on decision-making. The data about the program's influence were used to determine net savings and inform the discussion about market effects. The survey also asked about participants' awareness of the program's purpose and its key implementation steps. These surveys were completed during July and August 2015.

11.5.3.3 Database and Records Quality Control Review

Cadmus inspected PY6 participant records to verify customer information and electric and demand savings data (Table 11-9). These data for all eight participating school districts were reported in the Energy Efficiency Management Information System (EEMIS) database as required.

130 The statewide evaluator (SWE) *Phase 2 Evaluation Framework* discusses Market Effects Studies in Section 3.6.2.3 and 4.5.1.4.

Table 11-9: CEI Program Process Evaluation Database Review

Stratum	Population Size	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Used For Evaluation Activities (Impact, Process, NTG)
Database Review	8	N/A	8	8	Process, Impact, Database review
Program Total	**8**	**N/A**	**8**	**8**	

11.5.4 Achievements Against Plan

Table 11-10 contains the program's planned energy savings and the progress through PY6.

Table 11-10: CEI Program Savings

	PY5 Verified [1]	PY6 Only			Phase II: PY5–PY7		
		Planned	Verified	Percentage of Planned	Planned [2]	Verified	Percentage of Planned
MWh/yr	0	583	1,159	199%	3,150	1,159	37%
MW	0	0.10	0.72	720%	0.52	0.72	138%
Participation	0	8	8	100%	8	8	100%

[1] There were no savings in PY5 because the participants were chosen but did implement activities until PY6.
[2] Planned savings are based on PPL Electric's revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table U6, p.183.

There are several possible reasons why the program exceeded its planned energy and demand savings for PY6. These include:

- The eight participating school districts had higher consumption than what was assumed when designing the program plans for savings. Because the schools had higher consumption, it was easier to find ways to save energy.
- Some schools implemented capital projects which did not receive a rebate from PPL Electric Utilities prescriptive rebate programs, and therefore savings were attributed to CEI.
- The school districts have been very engaged in the program and exceeded the ICSP's expectations in terms of awareness and information dissemination.

11.5.5 Program Delivery

Overall, program staff reported that the CEI Program is operating well. Engaging the facility managers as energy managers has been key to the program's success because facility managers oversee operational changes and can motivate kitchen personnel or other school staff to change behaviors to save energy. The ICSP moderates a meeting with the energy managers from all participating schools. This meeting became a highlight of the program as a forum for energy managers to share their successes and learn from the other schools, and the ICSP reported that the group intends to continue these meetings after the program ends. Lastly, although the program was designed for one school from each district to implement CEI in PY6 and then expand to other schools during PY7, some energy managers wanted to implement activities at other schools right away and the ICSP did not want to discourage this.

The ICSP mentioned a challenges two schools experienced with their energy teams.

- One school had a student-organized energy team, where students decided on projects and raised awareness, however the ICSP reported that there was large turnover each semester and this format was not as successful as they anticipated.

- The energy manager for a second school was the director of facilities; however, he was a contractor rather than an employee of the school. This posed challenges because he did not have as much influence with school staff and was not able to make changes happen quickly.

In addition, the ICSP found high school students tended to be actively involved in raising awareness by making announcements, posters, YouTube videos, etc., yet found it more difficult to find opportunities to involve elementary school students. This posed challenges to engaging students in elementary schools.

11.5.5.1 Process Map and Logic Model

Cadmus reviewed the logic model developed in PY5 and found that the program evolved as described. It is presented in Addendum B. Logic Model. In PY6, Cadmus developed a process map; see Addendum D. Process Map at the end of this report.

11.5.5.2 Key Performance Indicators

The key performance indicators for the CEI Program include the energy and demand savings plans and participant satisfaction metrics, as shown in Table 11-11. The ICSP quantifies and reports energy savings and demand reduction annually, and uploads these to EEMIS. Cadmus assesses customer satisfaction annually through participant surveys.

Table 11-11: CEI Program KPIs

Key Performance Indicator	Metric	Target	PY6 Result
Energy Savings	583 MWh/yr in PY6	Meet or exceed PY6 energy savings of 583 MWh/yr	Evaluated energy savings were 199% of the PY6 plan.
Demand Reduction	0.10 MW in PY6	Meet or exceed PY6 demand reduction of 0.10 MW	Evaluated energy savings were 720% of the PY6 plan.
Customer Satisfaction	Percent of satisfied customers	80% or more of customers participating in any PPL Electric program are satisfied with their experience	100% of program participants were *very satisfied* or *somewhat satisfied* with their overall experience with the CEI Program.

PPL Electric Utilities and its ICSP are exceeding all metrics for this program. Verified energy savings for PY6 were nearly twice as high as the planned savings and verified demand reduction for PY6 was over six times the plan. Additionally, all participants reported that they were satisfied with their program experience.

11.5.5.3 Participant Profile

The eight participating schools in the Continuous Energy Improvement Program in PY6 varied in type:

- 4 high schools
- 1 high/middle school
- 1 middle school
- 1 elementary school
- 1 career and technical institute

11.5.5.4 Marketing and Outreach

PPL Electric Utilities and the ICSP started outreach activities by presenting a webinar to school districts to explain the purpose and benefits of the Continuous Energy Improvement Program. The program was offered exclusively to schools that had participated in PPL Electric Utilities' School Benchmarking Program. Twelve school districts showed interest after the webinar. The ICSP gave a more detailed presentation to each of these school districts to encourage their participation in the program and to clarify the requirements during the two program years, which included signing a participation agreement. Once the school districts signed up, the ICSP gathered data on buildings and selected one school from each district to prepare and implement the SEMP during PY6.

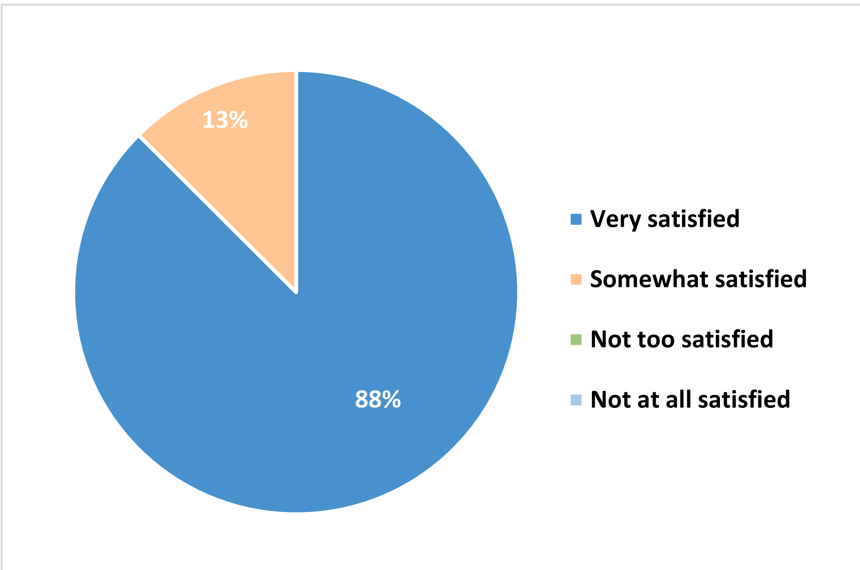
The program met its planned participation of 10 school districts, according to the EE&C Plan; however, two school districts subsequently decided to drop out. No further changes to participation are expected; the ICSP reported that the eight school districts are fully committed to the Continuous Energy Improvement Program and anticipates they will continue to participate in PY7.

11.5.6 Satisfaction

11.5.6.1 Program Satisfaction

Program satisfaction was very high in PY6. All but one respondent (88%, n=8) was *very satisfied* with the program overall. One respondent was *somewhat satisfied* due to challenges engaging students who do not attend the school full time. Figure 11-1 shows program satisfaction.

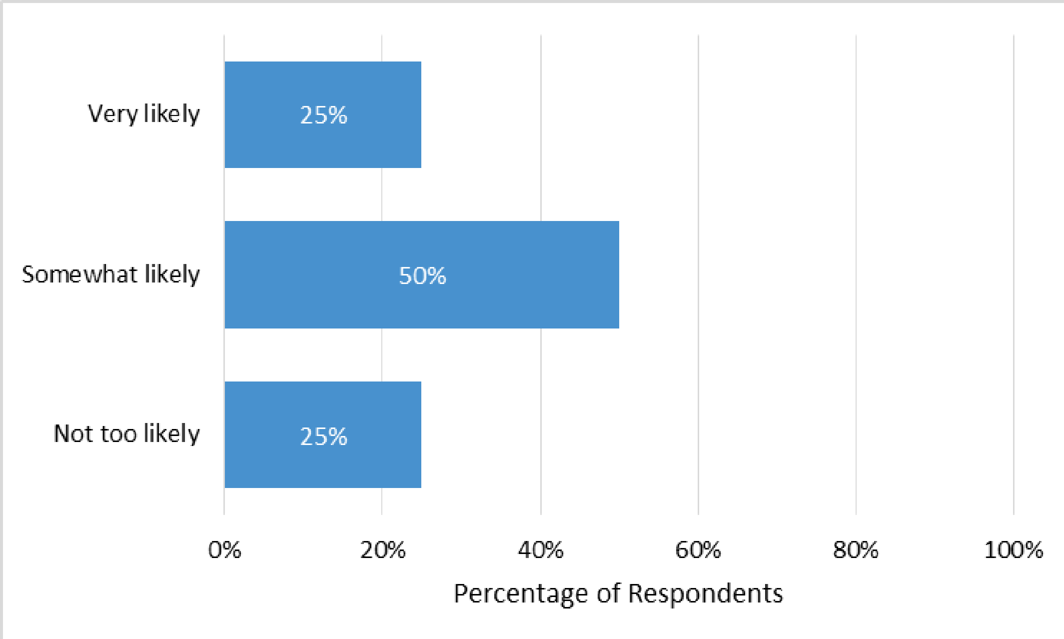
Figure 11-1: Program Satisfaction



Source: Question G1, "Thinking about your overall experience with the Continuous Energy Improvement Program, how would you rate your satisfaction? Are you…." (n=8). Percentage exceeds 100% due to rounding.

Six of the eight school districts reported that overall they were satisfied with the amount of the incentives provided by PPL Electric Utilities. Two of the respondents (25%) said they would be *very likely* and four (50%) said they were *somewhat likely* to participate in the program even without an incentive. Figure 11-2 shows the participants' willingness to participate to the CEI Program without an incentive.

Figure 11-2: Willingness to Participate in the CEI Program Without an Incentive



Source: Question G11, "How likely would you have been to participate if PPL did not provide an incentive?" (n=8)

When asked what challenges energy managers experienced with the program, six respondents referred to difficulties involving the school community and two said time was limited. These are some comments:

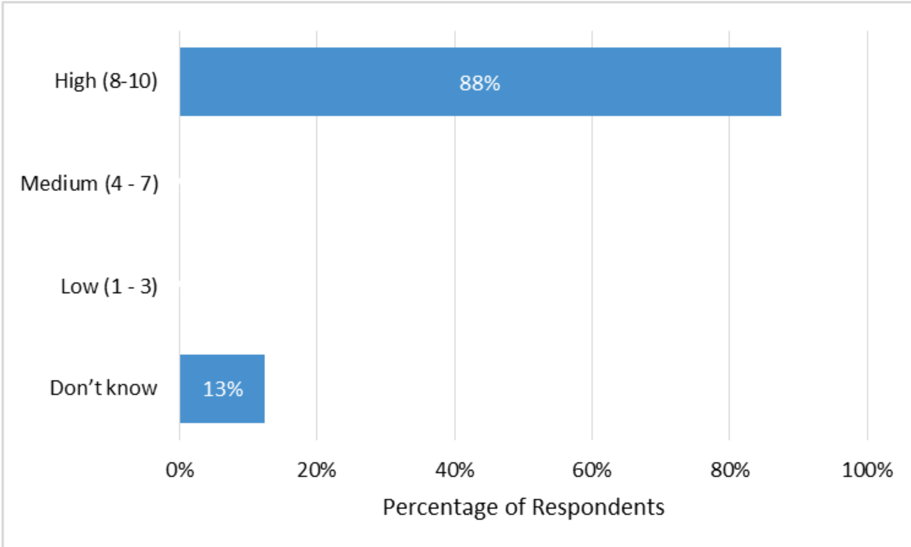
- *"Awareness among staff, need to get all custodial staff aware of how to save money."*
- *"Implementation staff availability."*
- *"Integration with educators. Teachers don't get any prep time so difficult to integrate."*
- *"A little isolated. Schools that send kids here are more passionate about home school than this school. So kids don't care as much about this school as other [neighborhood] schools."*

11.5.6.2 Satisfaction with PPL Electric Utilities

Seven respondents (88%, n=8) reported high overall satisfaction with PPL Electric Utilities as a provider of electric service to their school district while one respondent did not know, as shown in Figure 11-3.

In PY6, seven respondents interacted with PPL Electric Utilities and one respondent did not. All seven respondents who interacted with PPL Electric Utilities' representatives (100%) reported they were *very satisfied*.

Figure 11-3: Satisfaction with PPL Electric Utilities



Source: Question G15, "Using a 10-point scale where 1 means unacceptable and 10 means outstanding, using any number from 1 to 10, how do you rate PPL Electric overall as a provider of electric service to your school district?" (n=8) Percentage exceeds 100% due to rounding.

11.5.6.3 Satisfaction with the ICSP

Participant's satisfaction with the ICSP was also very high in PY6. All survey respondents (100%, n=8) reported that they were *very satisfied* working with the ICSP.

11.5.7 Adoption of CEI

Cadmus surveyed participants about their adoption of specific elements of CEI, as defined by the Consortium for Energy Efficiency.[131]

- Customer commitment consists of development and communication of the energy goals, and implementation and frequency of meetings of the energy team.
- Planning and implementation measured the use of energy maps, energy management assessments, employee engagement, and reassessment of goals and the SEMP.
- Finally, the system for measuring and reporting energy performance criteria included energy measurement and tracking techniques, updates with the CEI advisor, and frequency of communicating progress to others within the school district.

Participants that implemented all CEI activities received a CEI adoption score of *full*. The detailed methodology for scoring CEI adoption from the participant survey responses is included in Addendum C. CEI Adoption Scoring Methodology.

[131] Consortium for Energy Efficiency (CEE). Strategic Energy Management Minimum Elements. 2014. Can be found online at http://library.cee1.org/sites/default/files/library/11283/SEM_Minimum_Elements.pdf

The CEI adoption results are shown in Table 11-12. Overall CEI adoption was high across all program participants, with all of the school districts having *some* or *full* adoption.

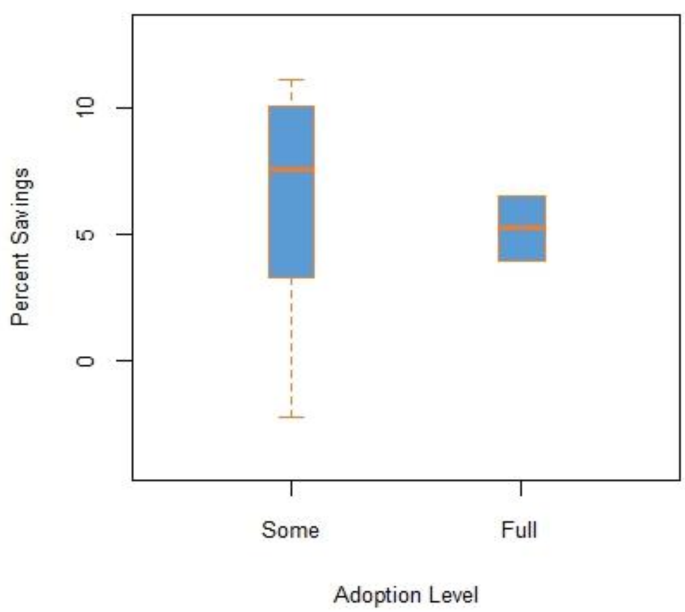
- Six of eight school districts met all criteria for customer commitment by setting an energy performance goal and dedicating resources to energy efficiency projects.
- Two of eight school districts met all criteria for planning and implementation.
  - All districts completed an energy management assessment, a SEMP, and implemented projects.
  - Six of the districts did not implement other criteria for this element.
    - Four reported that they did not complete an energy map,
    - One did not engage employees, and
    - One did not reassess their goals or update their project list.
- All eight school districts fully implemented a system for measuring and reporting energy performance by using their MT&R workbook provided by the ICSP and reporting progress regularly to the ICSP and to others within the district.

Table 11-12: CEI Adoption Level by Element and Overall

CEI Element	Full Adoption	Some Adoption	No Adoption
Customer Commitment	6	2	0
Planning and Implementation	2	6	0
System for Measuring and Reporting Energy Performance	8	0	0
Overall	**2**	**6**	**0**

Cadmus also reviewed whether CEI adoption influenced energy savings. Figure 11-4 shows the evaluated energy savings by CEI adoption level. Interestingly, the school with negative savings (increase in energy consumption) had also adopted the least number of CEI activities. In general there does not seem to be a relationship between adoption level and savings and the sample size is small, making it difficult to draw any conclusions.

Figure 11-4: CEI adoption and Percent Savings



11.5.8 Market Effects

"Market effects" are changes in the market or behavior of participants attributable to an energy efficiency incentive program.[132] An assessment of a program's effect on the market can provide evidence that a market barrier has been partially or fully mitigated. To understand whether PPL Electric's programs are contributing to market transformation, we first identify the baseline to the extent possible, then define the market effects we expect to see and metrics to measure effects, and third, gather data and assess changes over time, PPL Electric's influence, and permanency of changes in the marketplace.

The program's objectives are designed to identify energy-savings opportunities through cultural change which drives behavioral and business process changes and fosters sustainability through individual engagement.

Cadmus conducted surveys in PY6 (n=8), collecting information to explore the baseline and effects of the program in increasing operational and behavior change among participating schools.

When asked to rate the influence of various factors on their decision to participate in the program, all respondents stated that the ICSP staff were extremely influential in their decision, rating this factor as 5 on a scale of 1 to 5.

All but one of the schools planned energy-efficiency improvements before they decided to participate in the program (7 of 8). One of these seven schools said they were considering behavioral changes and one said they were planning to tighten their HVAC scheduling procedures and install new lighting equipment. The remaining five schools were planning only capital improvements such as lighting upgrades, replacing HVAC equipment, or making improvements to windows and doors. Survey respondents identified energy-efficiency improvements and activities they implemented since participating in the program. All but one of the schools implemented operational and behavioral changes after participating in the program.

The majority of respondents (5 of 8) said the Continuous Energy Improvement program was *extremely influential* [133] in their decision to implement behavioral energy-efficiency projects, four respondents said the program was *extremely influential* [134] on their decision to implement operational energy-efficiency projects while none of the respondents said the program was *extremely influential* [135]on their decision to make capital energy-efficiency projects.

Given these responses, it is clear that while implementing capital projects appears to be standard practice, implementing operational and behavioral energy-efficiency projects is not standard practice among school districts, and the ICSP, through the program, as well as PPL Electric's assistance is a significant factor in this focus. Therefore, the program appears to be instrumental in moving school districts to consider operational and behavioral changes to reduce energy use. None of the schools would have taken

---

132 Eto, Joseph, Prahl, Ralph, and Schlegel, Jeff. 1996. *A Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs.* Prepared for the California Demand-Side Management Committee.

133 Rated influence as a 5 using a scale of 1 to 5 where 1 meant *no influence* and 5 meant *highly influential*.

134 Ibid.

135 Ibid.

the same approach to energy management in the absence of the program, and none would have developed the MT&R; therefore, there is no freeridership.

11.6 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, we suggest PPL Electric Utilities consider the following recommendations in PY7.

Conclusion
The CEI Program is performing well and it was highly influential in participants' decision-making. Participants reported that the program was very influential in their decision to implement operational and behavioral energy efficiency activities, resulting in a net-to-gross ratio of 100%. Additionally, the CEI Program is exceeding its plans for energy savings, and the ICSP's regression models based on monthly billing data are performing well when compared to Cadmus' regression models using daily interval data. The ICSP's energy savings estimation was within the confidence interval of Cadmus' energy savings.

Recommendation

- The ICSP should continue using its current regression methods and could consider a few improvements. The current method is working well, so these recommendations should only be implemented if they do not create a significant burden for the energy manager in continuing to consistently update the Measurement, Tracking, and Reporting (MT&R) workbook.
- The ICSP could consider replacing the number of irregular days with the number of school days, since the number of school days are driving energy consumption.
- The ICSP could consider requesting a list of rebated projects from PPL Electric for each school's building that has implemented CEI so that these projects can be accounted for in the regression model during the baseline or program period, as appropriate.

Conclusion
Although there is no Phase II compliance target or requirement for demand reduction, the ICSP calculates demand reduction. The calculation applies a coincidence factor to the energy savings. The verified demand reduction was 425% of the ICSP's value, indicating that this coincidence factor is greatly underestimating the demand savings.

Recommendation
Should the ICSP continue to calculate and report demand reduction, the ICSP should revisit the coincidence factor and consider increasing it to be more in line with a coincidence factor calculated by dividing the verified demand reduction by the verified energy savings. Using the verified demand and energy savings results in a coincidence factor of 0.00062.

Conclusion
Overall, PPL Electric Utilities' Continuous Energy Improvement Program operated well in PY6. Energy managers at each school district, the ICSP, and PPL Electric Utilities program management staff are all very content with the program. The ICSP had been very successful in engaging energy managers from each participating school district by creating a dynamic and motivating environment in which energy managers learn from each other and improve operations in their own school districts.

However, survey participants reported that some improvements could be made to engage the school communities within each school district. In PY7, the Continuous Energy Improvement Program will involve more school buildings, and subsequently, PPL Electric Utilities could see more savings, particularly from behavioral activities, if the school communities are more engaged.

Conclusion

The superintendent of each participating school district was required to sign a participation agreement. In some cases, the school community (of teachers and staff) had little influence on the decision to participate in the program. Hence, the participant survey respondents reported integration with educators and teachers, awareness among staff, and implementation of staff participation as the main challenges with the program in PY6.

Recommendation

The energy managers of the participating school districts praised the dynamic, motivating, and competitive environment that the ICSP created in PY6. PPL Electric Utilities could consider ways to create the same engaging and competitive environment within each school district to better motivate teachers, school staff, and students of individual schools. For example, it could organize logo and video competitions focused on energy-saving messages to encourage more participation from the school community. It could also share information and progress frequently and set up meetings with all stakeholders to keep everyone who is involved with the program aware of the importance of personal dedication.

Conclusion

School districts attempted to engage staff and students in different ways, and some school districts had difficulties involving students due to:

- Students at a technical school did not attend that school full time and were less inclined to take ownership of the energy efficiency efforts
- Schedule conflicts and not enough teacher involvement
- Challenges with communicating to elementary school students about energy efficiency

Recommendation

Consider investigating opportunities for creating self-sustaining organizations such as student clubs with a focus on energy efficiency to minimize the required amount of teacher engagement and maintain the continuity of the behavioral energy efficiency efforts. The organization should consider working directly with the energy manager to design collaborative activities to meet the school's plans for energy performance.

Consider providing educational materials geared toward elementary and middle schools. (This may be an opportunity to borrow from--coordinate with--the Student and Parent Energy Efficiency Program and their materials for primary students.) Additionally, energy managers should share success stories and new ideas to engage students and staff with other districts.

PPL Electric Utilities and the ICSP may want to consider schools by type or operational model and limit or tailor the program accordingly. For example, in technical schools where students do not attend full time, the ICSP may consider involving students to a lesser extent, or relying less on student-led activities to meet program objectives.

Conclusion

School districts would have participated in the program without the incentive. Two of the respondents (25%) said they would be *very likely* and four (50%) said they were *somewhat likely* to participate in the program even without an incentive because they found the technical assistance provided by the program to be valuable.

Recommendation

Consider reducing the incentive amount, eliminating the incentive in the second year, or eliminating the incentive altogether. Offering an incentive may encourage school districts to sign up for the program, but they quickly realize the value of the program once they begin and the incentive in the second year may not be required to keep them engaged.

11.6.1 Status of Recommendations for Program

Table 11-13 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 11-13: Continuous Energy Improvement Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Continuous Energy Improvement Program	
The ICSP should continue using its current regression methods and could consider a few improvements.	Being considered.
The ICSP should revisit the coincidence factor and consider increasing it to be more in line with a coincidence factor calculated by dividing the verified demand reduction by the verified energy savings.	Being considered.
The energy managers of the participating school districts praised the dynamic, motivating, and competitive environment that the ICSP created in PY6. PPL Electric Utilities could consider ways to create the same engaging and competitive environment within each school district to better motivate teachers, school staff, and students of individual schools.	Under consideration for Phase III.
Consider investigating opportunities for creating self-sustaining organizations such as student clubs with a focus on energy efficiency to minimize the required amount of teacher engagement and maintain the continuity of the behavioral energy efficiency efforts.	Under consideration for Phase III.
Consider reducing the incentive amount, eliminating the incentive in the second year, or eliminating the incentive altogether.	Under consideration for Phase III.

11.7 FINANCIAL REPORTING

A breakdown of the Continuous Energy Improvement Program finances is presented in Table 11-14.

Table 11-14: Summary of Continuous Energy Improvement Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$32	$29
2	EDC Incentives to Participants	$0	$0
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$32	$29
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$413	$601
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$413	$601
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$445	$630
13	Total NPV Lifetime Energy Benefits	$218	$201
14	Total NPV Lifetime Capacity Benefits	$97	$90
15	Total NPV O&M Saving Benefits	$0	$0
16	Total NPV TRC Benefits[4]	$315	$291
17	TRC Benefit-Cost Ratio[5]	0.71	0.46

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

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report

ADDENDUM A. PARTICIPANT SURVEY ATTRITION AND FINAL DISPOSITION

Dialing Instructions

PPL Electric Utilities provided dialing instructions for conducting surveys. Customers cannot be contacted for a telephone survey until a year has passed since they last completed a survey (with PPL Electric Utilities or Cadmus). Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Cadmus included all program participants in the survey call list. Table 11-15 lists total number of records and the outcome (final disposition) of each record.

Table 11-15: Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Population (Number of Rebates)	8
Survey Sample Frame	8
Not attempted	0
Records Attempted	8
Completed Survey	**8**

ADDENDUM B. LOGIC MODEL

The program theory for the CEI Program can be summarized as follows:

> The CEI Program helps school districts manage and reduce their energy consumption. This helps the schools save on their utility bills and lessens baseload demand. School staff will learn energy management skills, which they can continue to use and expand to other schools in the district once their participation in the CEI Program ends.

The program logic model elements are:

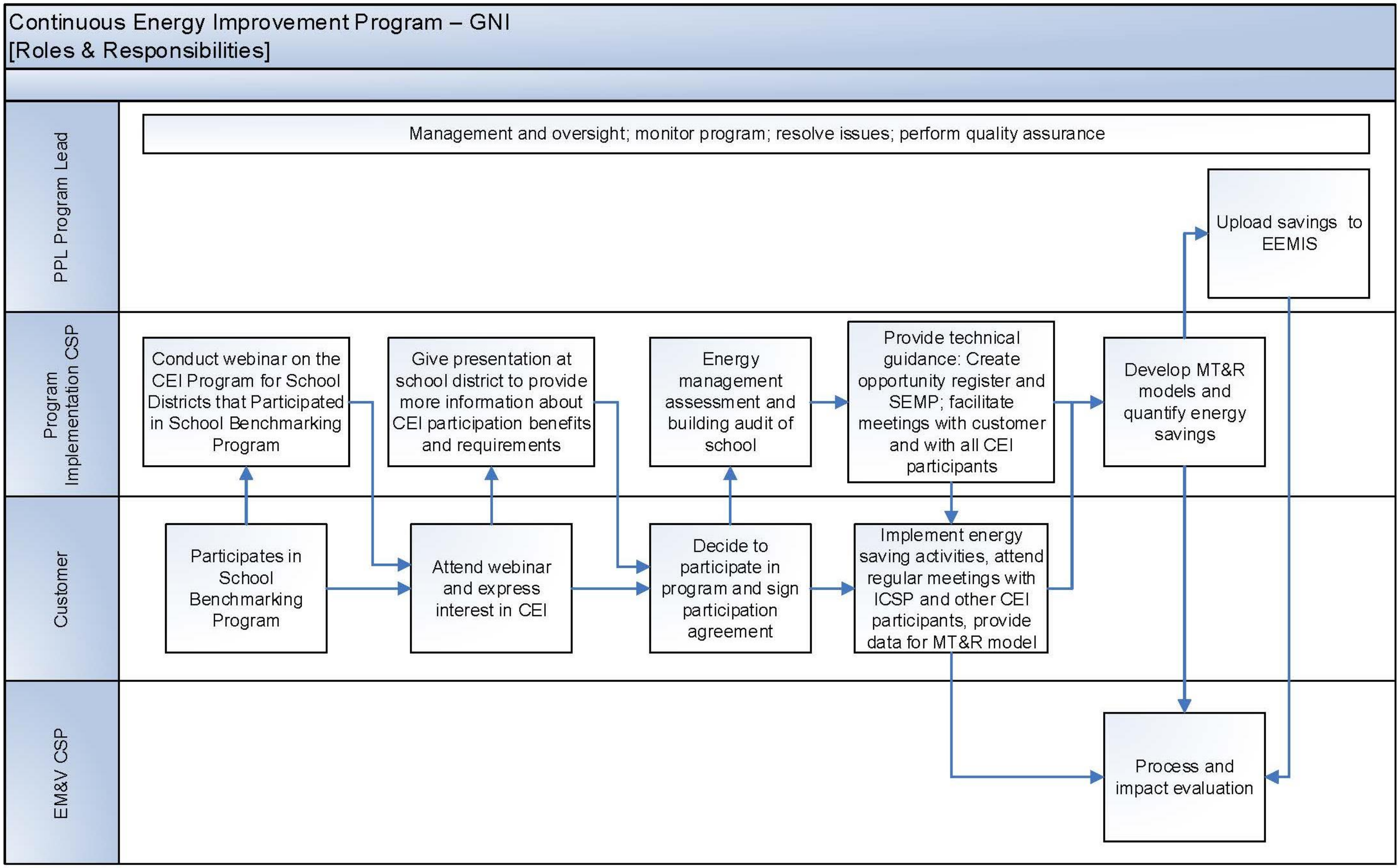
- **Activities the program undertakes** include marketing and outreach (including cross-program referrals), training an energy manager at each school district, developing a SEMP within each participating district, implementing the SEMP at the pilot sites, and identifying how to roll out the SEMP beyond the pilot sites.
- **Outputs produced by program activities** include marketing materials produced, the number of school districts participating, and the SEMPs produced for each district.
- **Short-term outcomes** resulting from customers participating in the program include assigning an energy manager to represent each school district, conducting an Opportunity Assessment to identify capital, operations and behavior savings, developing the SEMP, and increasing customer awareness of other PPL Electric energy-efficiency and conservation (EE&C) programs that may be leveraged when implementing the SEMP.
- **Intermediate outcomes** consist of implementing the SEMP, which entails installing equipment, providing energy training and awareness events, implementing operational and behavioral opportunities, and leveraging incentives offered through other PPL Electric EE&C programs to improve the payback period for equipment products.
- **Long-term outcomes** for this program include the school districts continuing energy-management practices on their own, expanding their CEI practices to other schools and facilities within the district, and the program achieving energy and demand-saving targets of approximately 3,150 MWh/yr and 0.52 MW from the 8 participating school districts.

ADDENDUM C. CEI ADOPTION SCORING METHODOLOGY

CEI Element	Survey Question(s)	Level of CEI Implementation		
		Full	Some	None
1a. Policy and Goals	▪ Did you define goals for improving energy performance in the school that you focused on during the past year? ▪ Have the energy performance goals been communicated to teachers and staff at the participating school building in the district or students and parents at the participating school building?	Have goals and they have been communicated to teachers and staff or to students and parents	Any other response combination	Don't have a goals (or DK) and have not been communicated to teachers or staff or students and parents (or DK).
1b.Resources	▪ Do you have an energy team at your school district? ▪ How frequently does the energy team meet?	Have an energy team that meets quarterly or more frequently.		No energy management team (or DK) and or team meets less frequently than quarterly.
2a.Energy Management Assessment	▪ Our records show that an energy management assessment was conducted for your school district as part of your participation in CEI. Is that correct?	Conducted an energy management assessment	Any other response combination	Did not conduct an energy management assessment (or DK)
2b. Energy Map	▪ Have you or your energy team developed an energy map for the participating buildings in your school district to identify the key energy drivers and end uses?	Have developed an energy map		Did not develop an energy map (or DK)
2c. Metrics and Goals	▪ Does the MT&R model use energy performance indicators to measure progress toward goals?	The MT&R model tracks progress toward goals.		The MT&R model does not track progress toward goals.
2d. Project Register	▪ The ICSP developed an Opportunity Register for all participants, and so project documentation was used to assess this element	Opportunity Register was developed		An Opportunity Register was not developed
2e. Employee Engagement	▪ Have you or your energy team conducted any specific school staff engagement activities?	Conduct specific school staff engagement opportunities		Did not conduct specific school staff engagement opportunities (or DK)
2f. Implementation	▪ Have you completed any of the potential opportunities listed in the Opportunity Register?	Completed one or more projects in opportunity register		Did not complete any projects in opportunity register
2g. Reassessment	▪ Have you reviewed the goals since they were set to ensure they still align with energy performance priorities of the program? ▪ How often do you update the Opportunity Register?	Have reviewed goals and updated the Opportunity Register regularly or occasionally		Have not updated goals (or DK), and almost never or never update opportunity register (or DK)

<table>
<tr><th rowspan="2">CEI Element</th><th rowspan="2">Survey Question(s)</th><th colspan="3">Level of CEI Implementation</th></tr>
<tr><th>Full</th><th>Some</th><th>None</th></tr>
<tr><td>3a. Measurement</td><td rowspan="3">▪ Are you currently using the Monitoring, Targeting and Reporting or MT&R model and workbook developed by SEG to track your energy use?
▪ Are you using another type of electronic system to track your energy use over time?
▪ How frequently are the MT&R model and workbook reviewed?</td><td rowspan="3">Using MT&R, or something else to track energy use and the model is reviewed quarterly or more frequently</td><td rowspan="4">Any other response combination</td><td rowspan="3">Not using MT&R or other model (or DK) and model is reviewed less frequently than quarterly (or DK)</td></tr>
<tr><td>3b. Data Collection and Availability</td></tr>
<tr><td>3c. Analysis</td></tr>
<tr><td>3d. Reporting</td><td>▪ Does your CEI Advisor require regular updates from the energy team?
▪ How often is energy use data shared with others at your school district?</td><td>Regular updates are provided to the ICSP and energy use data are shared regularly with others within the school district</td><td>Regular updates are not provided to the ICSP (or DK) and energy use data are not shared regularly with others within the school district (or DK)</td></tr>
</table>

ADDENDUM D. PROCESS MAP



12 RESIDENTIAL ENERGY-EFFICIENCY BEHAVIOR AND EDUCATION PROGRAM

PPL Electric Utilities offered the Residential Energy-Efficiency Behavior & Education Program in Phase I of Act 129. After a hiatus in PY5, the program launched again in the middle of PY6. The program informs customers about their home energy consumption and encourages them to adopt energy-saving home improvements and behaviors. The program does not provide any financial incentives for participating.

Customers receive a home energy report sent by mail every other month. Each report contains the customer's household energy-use data, a neighbor comparison of energy use, and three energy-saving action steps. Customers with valid e-mail addresses also receive the home energy reports via e-mail every month.[136]

Not all eligible customers receive the home energy reports. The program uses an experimental design, called a randomized control trial, wherein customers are randomly assigned to either a treatment group (recipients of home energy reports) or a control group (non-recipients). The control group is not made aware of the home energy reports. This group acts as a comparison for measuring the treatment group's energy savings resulting from the program.

PPL Electric Utilities contracted with Opower, the ICSP, to select eligible customers for the program and to produce and distribute the home energy reports. Cadmus, Cadmus, provided the random assignment of the eligible customers to the treatment or control group.

At its re-launch in the middle of PY6, the program had 130,626 treatment group customers and 71,118 control group customers. The customer population is divided into two waves for both groups—the legacy wave contains customers who were part of the Phase I program and the expansion wave contains customers who are new to the program in Phase II. At the outset of the PY6 re-launch, the treatment group's legacy wave had a long history of receiving the home energy reports. Nonetheless, the program did not operate in PY5, providing a one-and-a-half year gap in which no home energy reports were sent.

By the end of PY6 (May 31, 2015), most treatment group customers would have received four paper home energy reports by mail and seven e-mail reports.

The objectives of the Residential Energy-Efficiency Behavior & Education Program are to:[137]

- Provide customers with a home energy report that encourages them to adopt energy-efficient behaviors, install energy-efficiency products, and become more aware of how their behavior and practices affect their energy usage

---

136 E-mail home energy reports feature only the neighbor comparison. E-mail reports, because they are sent monthly, are intended to provide more current information on neighbor energy use than can be provided in the two-month intervals of the paper reports.

137 Program objectives are stipulated in PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.67.

- Educate customers about free or low-cost products and behavior changes that may reduce energy consumption
- Educate customers about PPL Electric Utilities' online resources
- Promote other PPL Electric Utilities energy efficiency programs
- Obtain participation of approximately 128,000 customers through 2016, with a total reduction of approximately 31,000 MWh/yr

An executive summary of Phase II program metrics is presented in Table 12-1. Because energy savings for PY6 were not reported in EEMIS until PY7 Q1, no reported savings are shown for PY6. However, Cadmus adjusted the reported *ex ante* savings for PY6 of zero to 30,424 MWh/yr reported in PY7. These are referred to as the *adjusted ex ante* savings. No other adjustments were made to the ICSP-reported savings.

Table 12-1: Phase II Residential Energy-Efficiency Behavior & Education Program Executive Summary Table

Program	Phase II Reported Energy Savings (MWh/yr)	Phase II Adjusted *Ex Ante* Energy Savings (MWh/yr) [1]	Phase II Verified Gross Energy Savings (MWh/yr)	Phase II Net-to-Gross Ratio	Phase II TRC Ratio	Phase II EDC Expenditures ($1,000)	Program Acquisition Cost ($/Annual kWh)	Cost of Conserved Energy[2] (TRC $/kWh)	Phase II Participants
Residential Energy Efficiency Behavior and Education	0	30,424	29,568	1.00	1.29	$1,959	$0.07	$0.063	130,626
Total	**0**	**30,424**	**29,568**	**1.00**	**1.29**	**$1,959**	**$0.07**	**$0.063**	**130,626**

[1] Residential Energy-Efficiency Behavior and Education energy savings for PY6 were not reported in EEMIS until PY7 Q1. Cadmus considered the PY6 savings reported in PY7 as the adjusted *ex ante* savings for PY6.
[2] Total TRC Costs divided by levelized lifetime kWh savings.

12.1 Program Updates

In PY6, the Residential Energy-Efficiency Behavior & Education Program sent Home Energy Reports to about 130,000 homes. There were three groups receiving reports.

- Legacy Group 1: received their first reports in PY2, April 2010
- Legacy Group 2: received their first reports in PY3, June 2011
- Expansion group: received their first reports in PY 6, October or December 2014

Each legacy and expansion group home that did not opt out of the program and whose account remained active in PY6 received four paper reports during PY6. In addition, customers with valid e-mail addresses received seven electronic energy reports. The Residential Energy-Efficiency Behavior & Education Program did not operate in PY5 and was launched again in PY6. There were no program changes from PY5 to PY6, and the program did not implement any changes during PY6.

Cadmus made two recommendations in PY5 and conducted research in PY6:

- PPL Electric Utilities could consider a persistence study on legacy customers. In the PY6 evaluation, Cadmus included a savings analysis and survey analysis comparing legacy and expansion customers.
- PPL Electric Utilities could track and evaluate the e-mail home energy reports. The ICSP tracked PY6 e-mail metrics such as open rates and click rates, and Cadmus included questions about engagement with the e-mail home energy reports in the customer survey.

Table 12-2: PY6 Residential Energy-Efficiency Behavior & Education Program Design

Group and Wave	Year First Launched	Delivery Frequency	Number of Customers at Start of Launch
Treatment Group			
Legacy Wave	2010-2011	Bi-monthly paper reports; monthly e-mail reports	82,927
Expansion Wave	2014	Bi-monthly paper reports; monthly e-mail reports	47,699
Total Treatment Group			**130,626**
Control Group			
Legacy Wave	2010-2011	--	58,725
Expansion Wave	2014	--	12,393
Total Control Group			**71,118**
Source: E-mail communication from the ICSP in December 2014.			

12.1.1 Definition of Participant

Participants are defined as residential customers who received home energy reports during PY6. Legacy Group 1 included about 38,500 residential customers with active accounts. Legacy Group 2 included about 44,000 customers. The Expansion Group included the remaining 47,000 customers.

12.2 Impact Evaluation Gross Savings

Table 12-3 shows the PY6 reported number of participants by quarter. The quarterly results reflect a reporting convention, as participants received their first reports during PY6 in Q2 or Q3, but savings are reported only annually. The ICSP reported gross *ex ante* savings for PY6 of 30,424 MWh/yr in PY7 Q1.

Table 12-3: PY6 Residential Energy-Efficiency Behavior & Education Program Reported Results by Quarter

Reporting Period	Participants	Adjusted Gross Energy Savings (MWh/yr)[1] [2]	Reported Gross Demand Reduction (MW) [3]	Incentives ($1,000)
Quarter 1	N/A	N/A	N/A	**$0**
Quarter 2	N/A	N/A	N/A	**$0**
Quarter 3	N/A	N/A	N/A	**$0**
Quarter 4	130,626	30,424	N/A	**$0**
PY6 Total	**130,626**	**30,424**	N/A	**$0**
CPITD Total[1]	**130,626**	**30,424**	N/A	**$0**

[1] Legacy Group 1 and Legacy Group 2 only include savings that occurred after homes received first reports in PY6, because, in the Pennsylvania TRM, home energy reports have a one-year measure life.
[2] Residential Energy-Efficiency Behavior and Education energy savings for PY6 were not reported in EEMIS until PY7 Q1. Cadmus considered the PY6 savings reported in PY7 as the adjusted *ex ante* savings for PY6.
[3] The ICSP did not report peak demand savings for PY6.

The ICSP also reported gross energy savings in PY6 by population track. Table 12-4 shows the cumulative reported results through the end of PY6 for the combined legacy groups and Expansion Group.

Table 12-4: Residential Energy- Efficiency Behavior & Education Program Reported Results by Population Track

Program Segment	Participants[1]	Adjusted Gross Energy Savings (MWh/yr) [2] [3]	Incentives ($1,000)
Legacy	82,927	23,591	$0
Expansion	47,699	6,763	$0
PY6 Total	**130,626**	**30,424**	**$0**
CPITD Total[1]	**130,626**	**30,424**	**$0**

[1] Count of participants at the beginning of program launch in PY6.
[2] Legacy Group 1 and Legacy Group 2 only include savings that occurred after homes received their first reports in PY6, because, in the Pennsylvania TRM, home energy reports have a one-year measure life.
[3] Residential Energy-Efficiency Behavior and Education energy savings for PY6 were not reported in EEMIS until PY7 Q1. Cadmus considered the PY6 savings reported in PY7 as the adjusted *ex ante* savings for PY6.

12.3 EM&V SAMPLING APPROACH

To estimate the energy savings, Cadmus analyzed monthly PPL Electric customer electric bills (showing monthly consumption) of the census of program treatment group and control group homes. Cadmus analyzed energy use of Legacy Group 1 (between June 2009 and May 2015), Legacy Group 2 (between May 2010 and May 2015), and Expansion Group (between October 2013 and May 2015).

According to the Pennsylvania TRM, savings attributable to home energy reports have a measure life of one year. Therefore Cadmus' estimate includes savings that occurred after homes received their first reports in PY6.[138]

Table 12-5 shows the number of homes in the Legacy Group 1, Legacy Group 2, and Expansion treatment groups and the number used in the savings estimation.

Table 12-5: PY6 Residential Energy-Efficiency Behavior & Education Program Energy Savings Sampling Strategy

Stratum	Strata Boundaries	Population Size[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Legacy Group 1	Treatment group customers who received first home energy report in PY2	39,009	N/A[2]	Census	38,658	Regression analysis of customer average daily consumption
	Control group customers	39,047	N/A[2]	Census	38,579	
Legacy Group 2	Treatment group customers who received first home energy report in PY3	44,745	N/A[2]	Census	44,180	Regression analysis of customer average daily consumption
	Control groups customers	20,257	N/A[2]	Census	19,987	
Expansion Group	Treatment group customers who received first home energy report in PY6	47,494	N/A[2]	Census	47,122	Regression analysis of customer average daily consumption
	Control groups customers	12,344	N/A[2]	Census	12,246	
Program Total		**202,896**	**N/A[2]**	**Census**	**200,772 [3]**	

[1] Population counts taken when first energy reports were delivered in fall of PY6. Counts exclude homes for which it was not possible to generate or deliver a report or homes not part of the randomized control trial, e.g., those occupied by a PPL Electric employee who requested a report.

[2] This evaluation included all program treatment group and control group homes. As a result, the final savings estimate is not subject to sampling error.

[3] Count of Legacy and Expansion Treatment and Control group customers. Cadmus excluded customers that were not part of the randomized control trial or for whom it was not feasible to deliver a report to exclude these customers.

138 Energy savings from home energy reports often persist after treatment ends (Khawaja and Stewart, 2014). Legacy group customers, who had received reports for two or three years, appear to have saved energy during PY5 and between June 2014 and September 2014 of PY6 when no reports were delivered. However, because Pennsylvania assumes a one-year measure life for savings attributable to home energy reports, PPL Electric could not claim savings between June 2014 and September 2014 for PY6.

The impact analysis energy savings estimation included homes that opted out of the program and homes whose accounts became inactive during the treatment period.[139] Table 12-6 shows the numbers of treatment and control group homes in the estimation sample, that is, -the homes included in the billing analysis.

Table 12-6: Final Estimation Sample: Number of Homes by Group

Sample	Legacy Group 1	Legacy Group 2	Expansion
Treatment Group Homes	38,658	44,180	47,122
Control Group Homes	38,579	19,987	12,246
Total Homes[1]	**77,237**	**64,167**	**59,368**
[1] Cadmus analyzed the monthly energy consumption bills of the census of the randomized control trial (RCT) treatment and control group homes in PY6. Savings estimate included savings during all months with an active account in homes whose accounts became inactive during PY6. See 0Appendix F| Energy-Efficiency Behavior & Education Program Savings Counted in Other PPL Electric Energy-Efficiency Programs.			

12.3.1 *Ex Ante* Adjustments Methodology and Findings

The ICSP determined the gross savings in PY6 were 30,424 MWh/yr, based on regression analysis of monthly energy use of program treatment and control group customers. However, the ICSP reported savings in PY7 Q1, therefore Cadmus adjusted the PY6 reported *ex ante* of zero to 30,424 MWh/yr. The PY6 ICSP-reported savings are referred to as *adjusted ex ante* savings. No other changes or adjustments were made to the ICSP's report.

12.3.2 *Ex Post* Adjustment Methodology and Findings

Identification of the program energy savings derives from the randomized control trial (RCT) design. The ordinary least squares (OLS) regression estimate of program savings is expected to be unbiased because of the random assignment of eligible homes to treatment and control groups. Also, the large size of the treatment and control groups and the availability of measurements of consumption before and after the treatment mean that even small average treatment effects (< 1%) can be detected.

The evaluation methodology is based on Option C, Whole Facility of the International Performance Measurement and Verification Protocol (IPMVP; section 3.4.3, Billing Regression Analysis) for annual energy and demand reduction.[140] Billing analysis—using monthly energy use data in treatment group and

139 Homes that opted out of the program were kept in the analysis sample to preserve the equivalence of the treatment and control groups. In order to remove opt-out homes, Cadmus would have to know which control group homes would have opted out if they had received a report and to drop these homes. Also, even homes that opted out of the pilot may have saved energy because of the program.

140 Efficiency Valuation Organization. *International Performance Measurement & Verification Protocol (IPMVP); Concepts and Options for Determining Energy and Water Savings: Volume 1*. September 2009. EVO 10000 – 1:2009. Available online: www.evo-world.org. Cadmus approach is also consistent with the SEE Action Network and DOE UMP protocols. See State and Local Energy Efficiency Action Network. 2012. *Evaluation, Measurement, and Verification of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations.* Prepared by A. Todd, E. Stuart, S. Schiller, and C.

control group homes before and after the treatment—was used to estimate the program savings. Cadmus conducted separate regression analyses of the energy use of Legacy Group 1, Legacy Group 2, and Expansion Group homes.

To estimate the program energy savings, Cadmus employed regression of customer average daily electricity consumption using the approach of Allcott and Rogers (2014).[141] The details of the regression analysis are fully described in 0Appendix L|Residential Energy-Efficiency Behavior & Education Program Impact Analysis Details.

12.3.3 Savings Realization Rate Methodology

Cadmus calculated the realization rate as the ratio of *ex post* verified gross savings to reported savings.

12.3.4 Summary of Evaluation Results

Table 12-7 shows the program energy savings and realization rate in PY6. The ICSP reported program gross energy savings of 30,424 MWh/yr. These savings included savings for eight months between October 2014 and May 2015. The *ex post* verified savings were estimated as 29,568 MWh/yr, which provides a realization rate of 97.2% in PY6. However, the 90% confidence interval for the *ex post* verified savings [27,012 MWh, 32,115 MWh] includes the ICSP's reported savings, so the ICSP's estimate cannot be ruled out.

Table 12-7: PY6 Residential Energy-Efficiency Behavior & Education Program Summary of Evaluation Results for Energy

Stratum	Reported Gross Energy Savings (MWh/yr)	Adjusted *Ex Ante* Energy Savings (MWh/yr)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)[1]	Observed Coefficient of Variation (Cv) or Proportion in Sample Design	Relative Precision at 85% C.L.
Legacy Group 1	N/A	8,449	100.4%	8,847	N/A[2]	8.4%
Legacy Group 2	N/A	15,142	101.9%	15,430	N/A[2]	8.4%
Expansion	N/A	6,763	83.6%	5,651	N/A[2]	34%
Program Total	**N/A**	**30,424**	**97.2%**	**29,568**	**N/A[2]**	**7.5%**

[1] Legacy Group 1 and Legacy Group 2 only include savings that occurred after homes received first reports in PY6, because in Pennsylvania TRM, home energy reports have a one-year measure life.
[2] This evaluation analyzed the census of RCT treatment and control group homes. As a result, the final savings estimate is not subject to sampling error. Verified gross energy savings based on regression analysis of monthly average daily consumption. Standard errors were adjusted for correlation over time in a customer's consumption using Huber-White robust standard errors.

The ICSP did not report program demand savings. As shown in Table 12-8, Cadmus did not evaluate demand savings in PY6.

Goldman, Lawrence Berkeley National Laboratory. Available at https://www4.eere.energy.gov/seeaction/system/files/documents/emv_behaviorbased_eeprograms.pdf. Also, see Residential Behavior Protocol. The Uniform Methods Project. Prepared by J. Stewart and A. Todd, National Renewable Energy Laboratory. Available at: http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter17-residential-behavior.pdf.

141 Allcott, Hunt, and Todd Rogers. 2014. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review*, 104(10): 3003-37.

Table 12-8: PY6 Residential Energy-Efficiency Behavior & Education Program Summary of Evaluation Results for Demand [1]

Stratum	Reported Gross Demand Savings [2] (MW)	Adjusted Ex-Ante Demand Savings [3] (MW)	Demand Realization Rate (%)	Verified Gross Demand Savings [3] (MW)	Sample Coefficient of Variation (Cv), Error Ratio (ER), or Proportion	Relative Precision at 85% C.L.
Legacy Group 1	N/A	N/A	N/A	N/A	N/A	N/A
Legacy Group 2	N/A	N/A	N/A	N/A	N/A	N/A
Expansion	N/A	N/A	N/A	N/A	N/A	N/A
Program Total	N/A	N/A	N/A	N/A	N/A	N/A

[1] Cadmus did not evaluate demand savings in PY6.
[2] Reported gross demand reductions do not include the gross-up to reflect T&D losses.
[3] *Ex Ante* and Verified gross demand reductions include T&D losses.

12.4 IMPACT EVALUATION NET SAVINGS

12.4.1 Net-to-Gross Ratio Methodology

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

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

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

Table 12-9: PY6 Residential Energy-Efficiency Behavior & Education Sampling Strategy NTG Research

Stratum	Stratum Boundaries	Population Size	Assumed CV or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Percent of Sample Frame Contacted
Residential Energy Efficiency Behavior and Education	Program	200,772 [1]	N/A	N/A	N/A	N/A	N/A

[1] Count of Legacy and Expansion Treatment and Control group customers. Cadmus excluded customers that were not part of the randomized control trial or for whom it was not feasible to deliver a report. We relied on a flag in the data from the ICSP to exclude these customers.

Table 12-10: PY6 Residential Energy-Efficiency Behavior & Education Summary of Evaluation Results for NTG Research

Target Group or Stratum (if appropriate)	Estimated Freeridership	Estimated Participant Spillover	NTG Ratio	Observed Coefficient of Variation or Proportion	Relative Precision
Residential Energy Efficiency Behavior and Education	N/A	N/A	100%	N/A	N/A

12.5 Process Evaluation

12.5.1 Research Objectives

The evaluation of the program involved these research objectives:

- Assess the effectiveness of the energy efficiency and behavior program model
- Assess the level of influence the home energy reports have on customers
- Identify the energy-saving improvements and behavioral actions taken by customers in response to information provided through the home energy reports
- Determine the readership of and reception to the home energy reports
- Identify attitudes toward and barriers to saving energy and any differences between the control and treatment groups
- Evaluate customer satisfaction with the home energy reports and with PPL Electric Utilities

12.5.2 Evaluation Activities

In PY6, Cadmus conducted these process evaluation activities:

- Program staff and implementer interviews (n=4)
- Customer surveys
  - Treatment group (n=361)
  - Control group (n=180)
  - Database and records quality control review

The research activities were consistent with the PY6 evaluation plan. Cadmus increased the survey completion quotas for the treatment group and control group to improve the statistical power of detecting differences between the two groups and the two waves. Table 12-11 shows the sampling strategy for the Residential Behavior and Education Program.

12.5.3 Methodology

This section presents the process evaluation activities and methodology. Additional information including sampling details and survey attrition tables is provided in Addendum A. Customer Survey Attrition and Final Disposition.

12.5.3.1 Program Staff and Implementer Interviews

Cadmus conducted interviews with the program management staff from PPL Electric Utilities and the ICSP in December 2014 and March 2015. The December interviews followed up on the outcomes of recommendations made in the PY5 report and focused on any program design changes and implementation successes and challenges. The March interviews focused on key performance indicators and a general discussion of the program implementation in PY6.

Table 12-11: PY6 Residential Energy-Efficiency Behavior & Education Program Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted [1]	Evaluation Activities
PPL Electric Utilities Program and ICSP Staff	Staff	4	N/A	N/A	4	4	4	100%	Process, program staff interview, census
Treatment Group	Legacy Wave	82,759	0.5	90/10	180	4,500 [2]	181	81%	Process, customer survey, stratified random sample
	Expansion Wave	47,122	0.5	90/10	180	4,500 [3]	180	80%	
Control Group	Legacy Wave	58,645	0.5	90/10	90	1,800 [4]	90	78%	Process, customer survey, stratified random sample
	Expansion Wave	12,246	0.5	90/10	90	1,800 [5]	90	77%	
Program Total		**200,776 [6]**	**N/A**	**N/A**	**544**	**12,604**	**545**	**N/A**	**N/A**

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews.
[2] Cadmus selected a random sample of 4,500 records and removed 816 because they were duplicates, were included in other sample frames, were inactive customers, were incomplete records, completed a survey in the past year, or requested not to be contacted.
[3] Cadmus selected a random sample of 4,500 records and removed 332 because they were duplicates, were included in other sample frames, were inactive customers, were incomplete records, completed a survey in the past year, or requested not to be contacted.
[4] Cadmus selected a random sample of 1,800 records and removed 278 because they were duplicates, were included in other sample frames, were inactive customers, were incomplete records, completed a survey in the past year, or requested not to be contacted.
[5] Cadmus selected a random sample of 1,800 records and removed 106 because they were duplicates, were included in other sample frames, were inactive customers, were incomplete records, completed a survey in the past year, or requested not to be contacted.
[6] This is the total number of stakeholders interviewed and the number of Legacy and Expansion Treatment and Control group customers at the beginning of PY6. Cadmus excluded customers that were not part of the randomized control trial or for whom it was not feasible to deliver a report. We relied on a flag in the data from the ICSP to exclude these customers.

12.5.3.2 Customer Surveys

In May and June 2015, Cadmus administered two similar surveys over the telephone, one with treatment group customers and the other with control group customers, to correspond with the program's experimental design. Cadmus selected a stratified random sample of legacy and expansion wave participants for both surveys (treatment and control). The two surveys asked the same questions about familiarity with energy efficiency and other PPL Electric Utilities programs, recent energy-saving improvements made, energy-saving behaviors taken, attitudes toward and barriers to energy efficiency, and satisfaction with the utility. The treatment group survey also asked questions about the content of the home energy reports. The control group survey also asked questions about awareness of energy-saving tips.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We attempted to mitigate these sources of bias by applying random sampling whenever possible and using survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they could be implemented consistently across interviewers and surveys. Cadmus also attempted to reach respondents multiple times over several days at different times of the day and scheduled callbacks whenever possible.

12.5.3.3 Survey Sampling

Because of the program design's group and wave stratifications, Cadmus used stratified random sampling. To prepare the sample frames, we divided the population first by group (treatment or control) and then by wave (legacy or expansion). Next, we removed customers ineligible for the survey according to these criteria:

- Home energy report opt-outs
- Inactive accounts
- Accounts without valid phone numbers
- Accounts with phone number entry errors
- Accounts with no home energy report date generated (indicating that reports were not sent)

After removing these ineligible customers, Cadmus randomly selected the sample frames at the wave level and completed standard sample cleaning procedures described in Addendum A. Customer Survey Attrition and Final Disposition.. Table 12-11 above summarizes the sampling strategy for the customer surveys.

12.5.3.4 Survey Analysis

Cadmus used a t-test to compare proportions and means to determine if statistically significant differences exist between two independent groups. We tested at the 5% ($p \leq 0.05$) and 10% ($p \leq 0.10$) significance levels.. All references to significant findings in this chapter mean statistically significant findings at the 5% or 10% levels.

12.5.3.5 Database and Records Quality Control Review

Cadmus reviewed the database of PPL Electric Utilities residential customers assigned to either the program treatment group or control group. The database included records for 241,419 customers in the Legacy Group 1, Legacy Group 2, or Expansion tracks. For each population track, we verified that the number of customers in the treatment and control groups in the database matched the counts provided by PPL Electric and the ICSP. Cadmus also verified that all of the customer information required to perform the impact and process evaluations. The number of customers in the database exceeded the number of customers who received reports or were eligible to receive reports (control group customers) because it was not possible to generate reports for some customers selected for the program. Table 12-12 summarizes the sampling methodology of other evaluation activities.

Table 12-12: Residential Energy-Efficiency Behavior & Education Program Process Evaluation Database Review

Stratum	Population Size[1]	Assumed Levels of Confidence & Precision	Target Sample size	Achieved Sample Size	Evaluation Activities
Database Review	241,419	N/A	Census	241,419	Database review, Census, Process, Impact
Program Total	241,419	N/A		241,419	

[1] Includes all customer accounts that received reports in PY6 or in a previous program year including customers from Legacy groups whose accounts became inactive.

12.5.4 Achievements Against Plan

The Residential Energy-Efficiency Behavior & Education Program exceeded its PY6 planned MWh/yr verified savings and participation (Table 12-13).[142] At the end of PY6, the program had achieved:

- 96% of its 30,749 MWh/yr three-year planned savings
- 102% of its three-year planned participation of approximately 128,000 customers

Table 12-13: Residential Energy-Efficiency Behavior & Education Program Savings

Unit	PY6			PY5–PY7 [1]		
	Planned	Verified	Percentage of Planned	Planned [2]	Verified	Percentage of Planned
MWh/yr	10,925	29,568	271%	30,749	29,568	96%
Participation [3]	128,000	130,626	102%	128,000	130,626	102%

[1] The program was not delivered in PY5.
[2] Planned savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table G6, p.66.
[3] Number of households receiving home energy reports at the end of PY6.

Two possible reasons the program met its planned savings for PY6 are:

- **Long history with customers receiving the home energy reports.** Two-thirds (63%) of the customers receiving the home energy reports are legacy customers who were part of the Phase I program. Many of the legacy customers have been receiving the reports since 2010-11, allowing time for customers

142 Planned savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, Table G6, p.66.

to adopt and implement various energy-savings actions. A Cadmus white paper states that savings typically increase over the first three or four years customers receive the home energy reports. [143]

- **Savings decay during the gap period was low.** The program did not operate for one and a half years, and a gap period has generally shown to have an effect on savings persistence. A Cadmus white paper states that discontinuing the reports can result in an annual savings decay of 11% to 32%.[144] Sacramento Municipal Utility District's home energy reports program saw a savings decay of 32% one year after the discontinuation of the reports. PPL Electric's program saw a low savings decay of 7%-13% between PY4 and PY5. The low savings decay allowed the program to resume in PY6 with a good start.

12.5.5 Program Delivery

Because PPL Electric Utilities had already implemented the program in Phase I, the Residential Energy-Efficiency Behavior & Education Program ran smoothly in PY6 for the most part. However, changes in the number of participants in the Low-Income Energy-Efficiency Behavior & Education Program caused some delay. The program was launched in two parts—the first in late September with 121,000 customers and the second in early December 2014 with 9,600 customers. The program delivered the paper and e-mail home energy reports as planned.

12.5.6 Logic Model

During PY5, Cadmus developed the program logic model, which identifies the relationships between activities and expected results (Addendum B. Logic Model). In PY6, we reviewed the logic model and found that the program operates as described.[145]

12.5.7 Key Performance Indicators

In addition to the program's energy savings, PPL Electric Utilities and the ICSP track three key performance indicators that measure program progress and effectiveness. Table 12-14 shows the PY6 results for these key performance indicators. The program maintained the number of customers receiving the home energy reports above the planned participation count despite a high number of inactive accounts and opt-outs.

---

143 Cadmus. "Long-Run Savings and Cost-Effectiveness of Home Energy Report Programs." Winter 2014-15. Available online: http://www.cadmusgroup.com/papers-reports/long-run-savings-cost-effectiveness-home-energy-report-programs/.

144 Cadmus. "Long-Run Savings and Cost-Effectiveness of Home Energy Report Programs." Winter 2014-15. Available online: http://www.cadmusgroup.com/papers-reports/long-run-savings-cost-effectiveness-home-energy-report-programs/.

Note that a savings decay is defined as a reduction in savings relative to what occurred while participants received the home energy reports.

145 PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015.

Table 12-14: Residential Energy-Efficiency Behavior & Education Program Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY6 Result
Home Energy Report Recipients	Number of home energy report recipients	Maintain or stay above 128,000 recipients	Met goal; 130,626 customers continue to receive reports
Opt-Outs	Number of treatment group customers who opt out of the program	Minimize the number of opt-outs so that participation does not fall below 128,000 recipients	Met goal despite the program having an opt-out rate of 1.1%
Call Center	Number of calls received, number of calls that get routed to PPL Electric Utilities, length of call time, and documentation of customer issue	No goals established even though call center metrics are tracked	N/A

12.5.8 Program Attrition

Program attrition refers to the voluntary and involuntary loss of treatment group customers through opt-outs and inactive accounts (e.g., customers moved, stopped paying their bills, or died). The majority of attrition (n=23,169) came from inactive accounts compared to opt-outs. In PY6, the program experienced a high opt-out rate of 1.1% (1,766 out of 153,812 customers) and a high 14% inactive account rate (21,403 out of 153,812), which likely affected the program's performance.

12.5.9 Participant Profile

Based on the demographic data collected through the customer surveys (n=357), the majority of treatment group customers:

- Live in a single-family home (92%)
- Have an average household size of 3.1 people
- Have completed at least some college education (72%)
- Have an annual household income of at least $60,000 (67%)

12.5.10 Readership of the Home Energy Reports

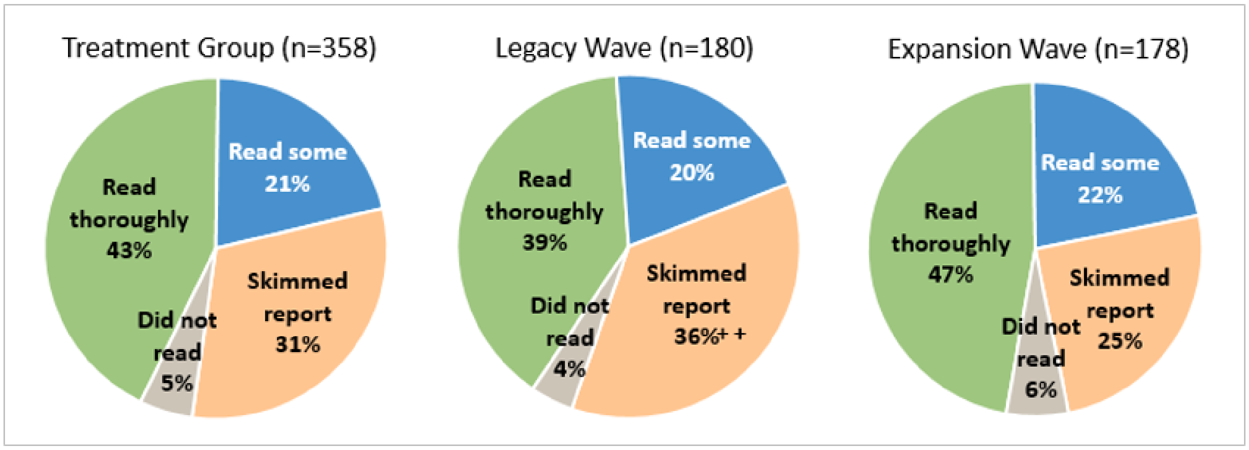
A total 130,626 customers (treatment group) received the paper home energy reports in PY6. Of these, around 53% also received e-mail home energy reports.

12.5.10.1 Paper Home Energy Reports

The survey responses showed high overall readership of the paper home energy reports (95%, n=358), although the time and level of attention that participants paid to the reports varied. Specifically, 43% of treatment group respondents said they *read the report thoroughly,* 21% said they *read some of the report*, and 31% said they *skimmed the report*. Only 5% of respondents said they *did not read the report*. There was no significant difference between the legacy respondents and expansion respondents on overall readership. However, significantly more legacy respondents (36%) than expansion respondents (25%) said they *skimmed the report*.[146] Figure 12-1 shows the readership level of the paper home energy reports.

[146] Significant wave difference at the 0.05 level.

Figure 12-1: Readership of Paper Home Energy Reports



++ Significant wave difference at the 0.05 level.
Question, *"Which of the following statements best describes what you did with the last report you received?"* (n=358)

Cadmus' survey question about readership did not directly ask if the respondent had *ever* read the home energy reports; instead, the question asked what respondents did with the *last* report received. Although 5% said they did not read the last report received, it is possible they read the first, second, or third report. Therefore, respondents who said they did not read the last report received were not excluded from answering the remaining survey questions about the report. This and the survey screener, which targeted customers who were familiar with the home energy reports, ensured that survey respondents would not have difficulty answering questions.

12.5.11 E-Mail Home Energy Reports

Among the treatment group respondents (n=351), 10% said they received e-mail home energy reports.

- Of these (n=35), 97% said they *read some* or *all* of the e-mail reports.
- Two-thirds (63%) said they use the e-mail reports as a reference to help them save energy.
- About one quarter (23%) said they forward the e-mail reports to others.
- Even though respondents used and shared the e-mail reports, in the end, 71% said they deleted them.

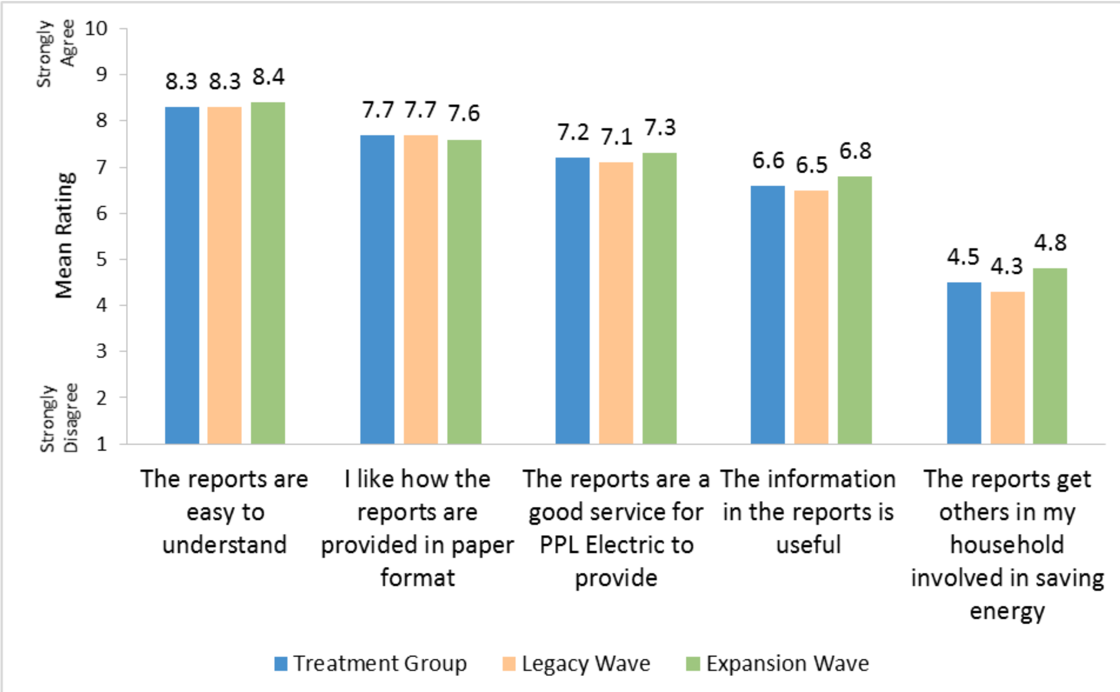
The legacy and expansion respondents in the treatment group did not differ in their responses on the e-mail report.

12.5.12 Reception of the Home Energy Reports

The survey asked treatment group respondents (n=353) to provide attitudinal ratings for five statements on a 10-point scale where 1 meant *strongly disagree* and 10 meant *strongly agree*. In general, they found the home energy reports were easy to understand (mean 8.3), liked the paper format of the reports (mean 7.7), and thought the reports are a good service for PPL Electric Utilities to provide (mean 7.2).

However, treatment group respondents in general found the information in the reports was only *somewhat useful* (mean 6.6) and did not think the reports got their household members involved in saving energy (mean 4.5). Legacy respondents (n=178) and expansion respondents (n=175) gave similar attitudinal ratings across all five statements. Figure 12-2 shows respondents' mean attitudinal ratings of the home energy reports.

Figure 12-2: Attitudes Toward the Home Energy Reports



Question, "*Using a scale from 1 to 10 where 1 means strongly disagree and 10 means strongly agree, to what extent do you agree or disagree with the following statements about the Home Energy Reports…*" (treatment group n=353, legacy wave n=178, expansion wave n=175)

Despite efforts to explain the neighbor comparison featured in the home energy reports, customers still believed the neighbor comparison was inaccurate. On average, treatment group respondents (n=292) gave an attitudinal rating of 4.8 for the statement *"I believe the neighbor comparison is accurate*." In PY4, 18% of respondents believed the neighbor comparison was accurate.

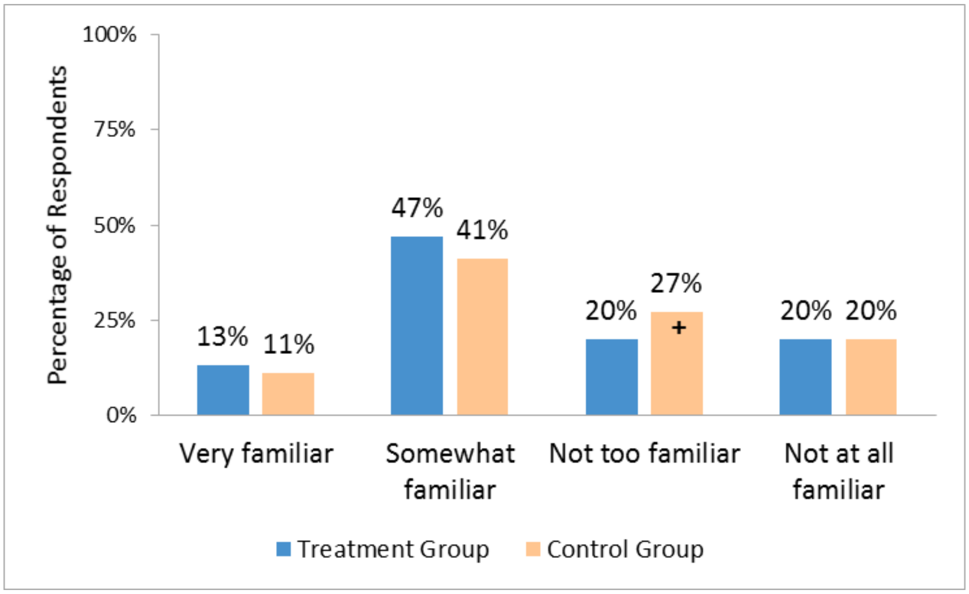
12.5.13 Awareness of Energy efficiency Programs

The home energy reports do not appear to influence customers' awareness of energy efficiency programs. As shown in Figure 12-3, more treatment group respondents (60%, n=361) than control group respondents (53%, n=179) reported being familiar with energy efficiency programs or rebates from PPL Electric Utilities; however, this difference was not significant.

A significant difference emerged by group—more control group respondents (27%) than treatment group respondents (20%) reported being *not too familiar* with energy efficiency programs.[147] However, when *very familiar* and *somewhat familiar* responses were combined to represent "familiar" and *not too familiar* and *not at all familiar* responses were combined to represent "not familiar," we found no significant differences between treatment and control group respondents.

147 Significant group difference at the 0.10 level.

Figure 12-3: Familiarity with Energy Efficiency Programs or Rebates



+ Significant group difference at the 0.10 level.
Question, *"How familiar are you with energy efficiency rebates or programs from PPL Electric Utilities that help you with ways to use less energy? Would you say you are..."* (treatment group n=361, control group n=179)

Forty percent of respondents in the two groups combined (n=424) could not name an energy efficiency program (Figure 12-4). More control group respondents (44%, n=142) than treatment group respondents (38%, n=282) could not name a program, though not a significant difference. Legacy respondents and expansion respondents in the treatment group reported the same level of familiarity with energy efficiency programs and showed identical responses in naming programs.

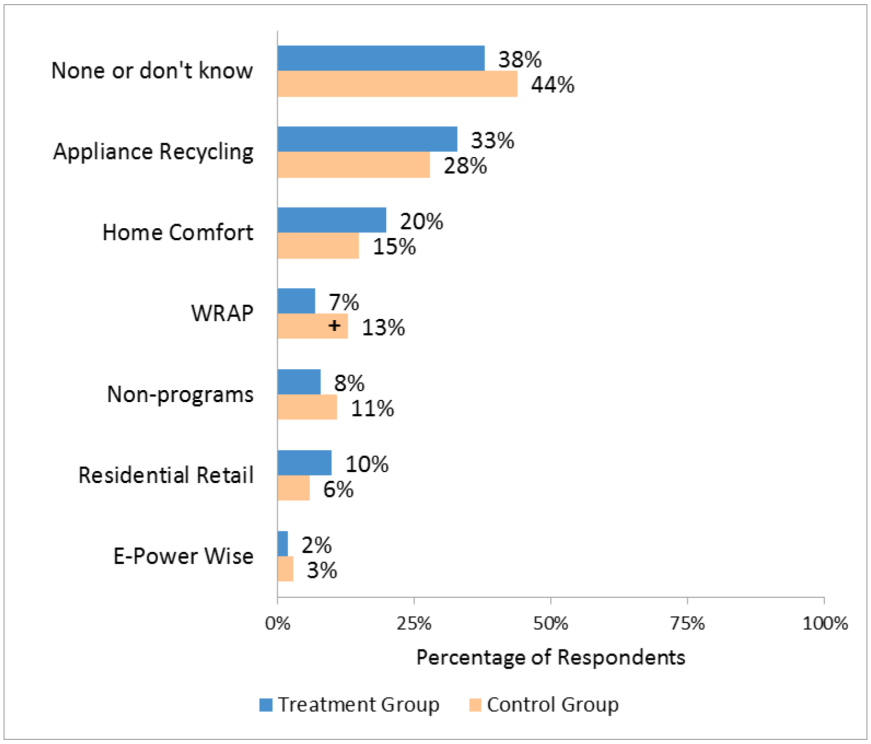
12.5.13.1 Cross-Program Marketing

The home energy reports also promoted three programs: the Appliance Recycling, Home Comfort, and Residential Retail programs. Cadmus expected to see group differences in awareness of these three programs. Although Figure 12-4 shows that a higher proportion of treatment group respondents than control group respondents mentioned these three programs, the differences were not significant. Notably, a significantly higher proportion of control group respondents (13%, n=142) than treatment group respondents (7%, n=282) mentioned the Winter Relief Assistance Program (WRAP).[148]

The awareness levels shown in Figure 12-4 do not neatly align with the impact evaluation's participation uplift results. The participation uplift analysis showed that the home energy reports provided a small, positive lift for the Appliance Recycling, WRAP, and Residential Retail programs. Two out of the three programs (Appliance Recycling and Residential Retail) promoted in the home energy reports saw a participation uplift. The Home Comfort Program did not see an uplift in participation.

[148] Significant group difference at the 0.10 level.

Figure 12-4: Awareness of Energy Efficiency Programs from PPL Electric Utilities



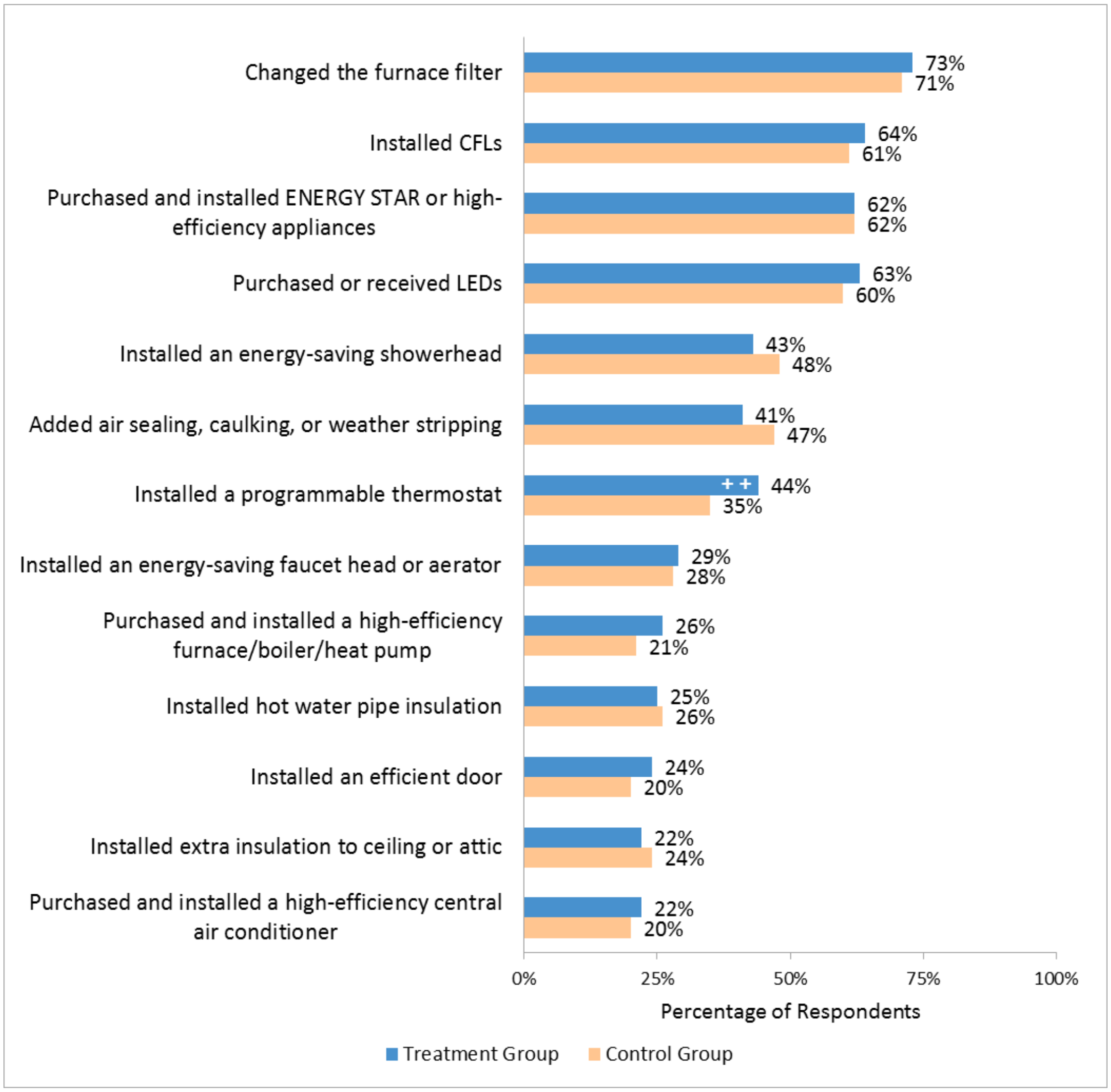
+ Significant group difference at the 0.10 level.
Question, *"What energy saving rebates or programs, have you heard about that PPL Electric Utilities offers? [MULTIPLE RESPONSE]"* (treatment group n=282, control group n=142).

12.5.14 Energy-Saving Improvements

The survey asked respondents about implementing 13 energy-saving improvements since the date of the first home energy report. For 12 out of 13 improvements, shown in Figure 12-5, we found no significant differences between treatment and control group respondents. A significant difference emerged only for the installation of a programmable thermostat.[149] More treatment group respondents (44%, n=358) than control group respondents (35%, n=179) reported installing a programmable thermostat.

149 Significant group difference at the 0.05 level.

Figure 12-5: Group Comparison of Reported Energy-Saving Improvements Made

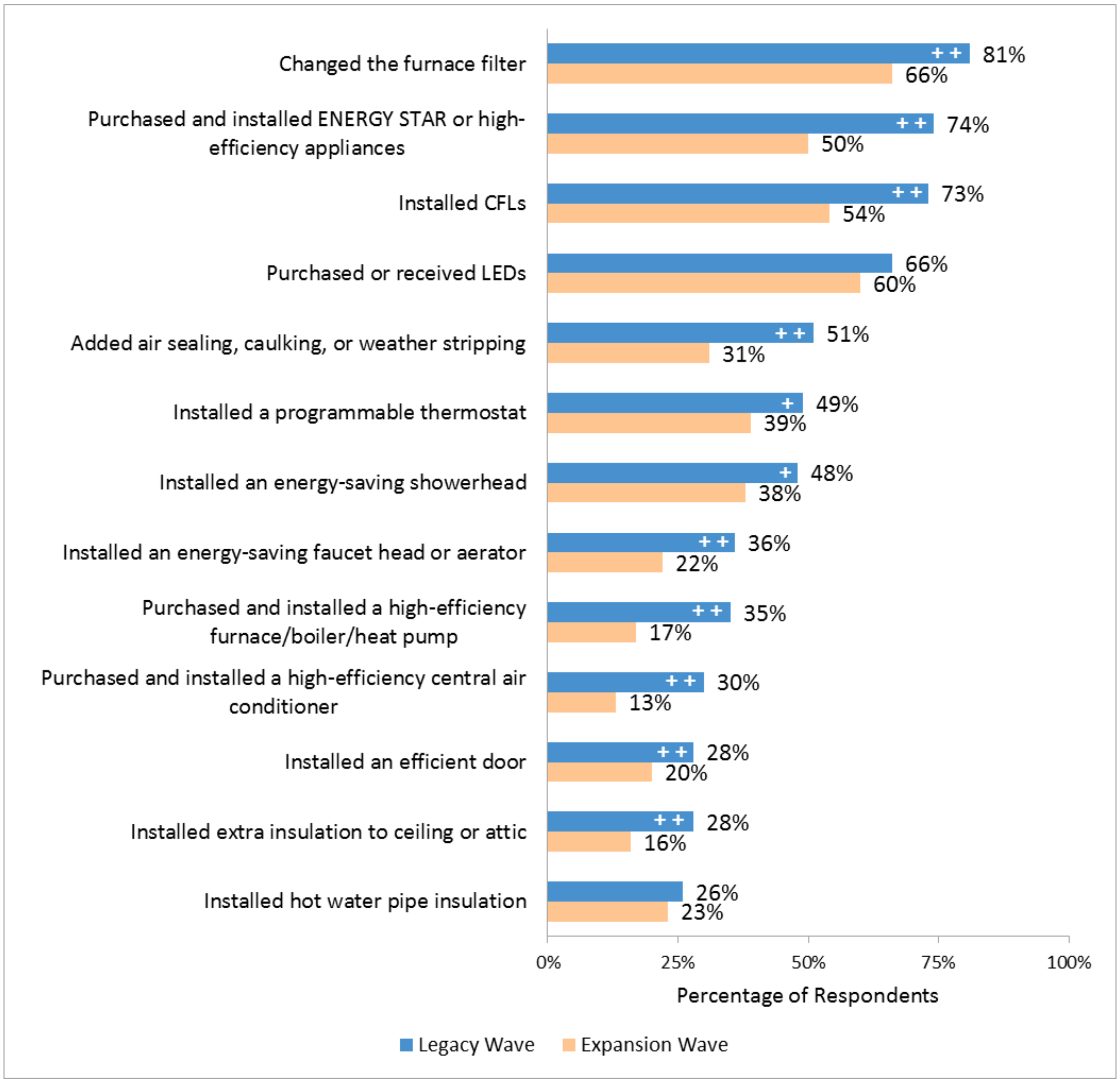


++ Significant group difference at the 0.05 level.
Question, *"Now I would like to understand more about some of the things you might have done to save energy in your home. I will read you a list of energy-saving improvements. Tell me if you have done any of the following in your home since [DATE]."* (treatment group n=358, control group n=179)

The survey also asked treatment group respondents to rate the importance of the reports in prompting them to make energy-saving improvements. On average, treatment group respondents (n=334) gave a rating of 4.9 on a 10-point scale where 1 means *not at all important* and 10 means *very important*. The home energy reports do not appear to influence customers to make energy-saving improvements.

However, the treatment group shows some differences between expansion and legacy waves for 11 out of the 13 energy-saving improvements, as shown in Figure 12-6. In all 11 improvements, more legacy respondents (n=180) than expansion respondents (n=178) reported making improvements. For the control group, more legacy respondents (n=89) than expansion respondents (n=89) reported making eight of the improvements.

Figure 12-6: Treatment Group's Wave Comparison of Reported Energy-Saving Improvements Made



+ Significant wave difference at the 0.10 level.

++ Significant wave difference at the 0.05 level.
Question, *"Now I would like to understand more about some of the things you might have done to save energy in your home. I will read you a list of energy-saving improvements. Tell me if you have done any of the following in your home since [DATE]."* (legacy wave n=180, expansion wave n=178)

The three improvements unique to the treatment group's legacy respondents were:

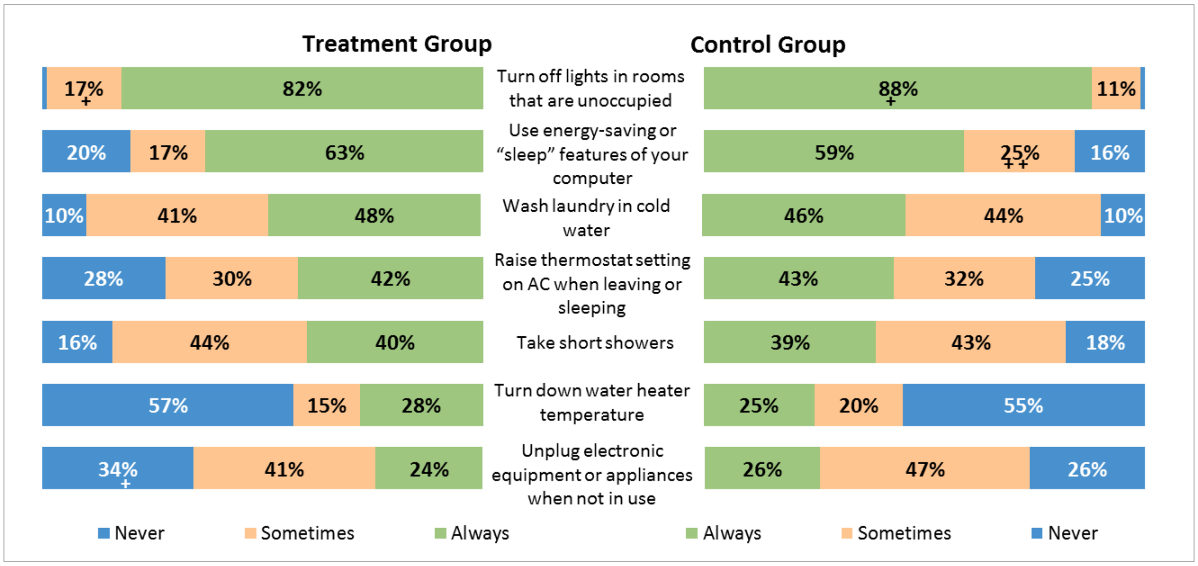
- Installation of CFLs
- Adding air sealing, caulking, or weather stripping
- Installation of an energy-saving faucet head or aerator

There was no significant difference between legacy and expansion respondents in how they rated the reports' importance in prompting them to make energy-saving improvements. The treatment group's legacy respondents (n=177) gave an average rating of 4.8 and expansion respondents (n=157) gave an average rating of 4.9 on a 10-point scale where 1 means *not at all important* and 10 means *very important*.

12.5.15 Energy-Saving Behaviors

The home energy reports do not appear to influence customers to take any of the seven energy-saving behaviors. As shown in Figure 12-7, treatment and control group respondents show similar frequencies. The results were unexpected for several behaviors. For example, 88% of control group respondents (n=180) and 82% of treatment respondents (n=361) said they *always* turn off lights in unoccupied rooms.[150] In another example, 34% of treatment group respondents and 26% of control group respondents said they *never* unplug equipment or appliances when not in use.[151]

Figure 12-7: Frequency of Taking Energy-Saving Behaviors



+ Significant group difference at the 0.10 level.

++ Significant group difference at the 0.05 level.

Question, *"I will read through some energy-saving actions you may have heard or read about. Please let me know if you always, sometimes, or never have taken these actions in your home."* (treatment group n=361, control group n=180)

No significant differences emerged. Legacy and expansion respondents in both the treatment group and the control group reported nearly identical frequencies of taking the seven energy-saving behaviors.

12.5.16 Attitudes Toward and Barriers to Energy Efficiency

The home energy reports do not appear to improve customers' attitude toward energy efficiency. The survey asked respondents to agree or disagree with six statements, as shown in Figure 12-8. Treatment and control group respondents differed on only one statement—more control group respondents (38%, n=178) than treatment group respondents (29%, n=356) agreed with *"Information about energy efficiency is confusing or overwhelming."*[152] Legacy and expansion respondents in the treatment group showed similar agreement for all six statements.

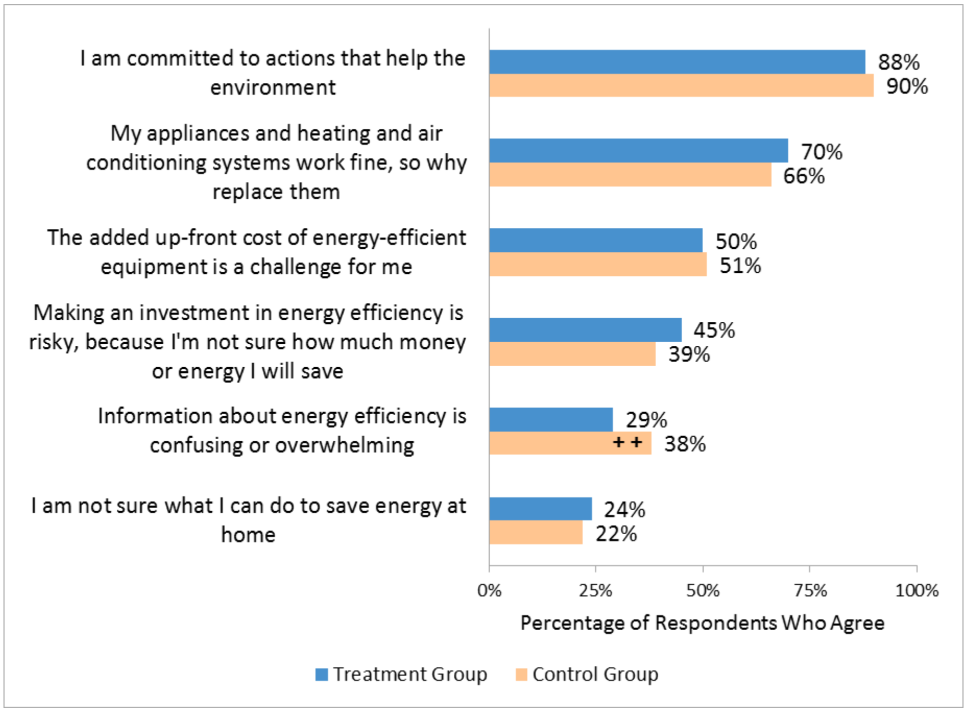
---

150 Significant group difference at the 0.10 level.

151 Significant group difference at the 0.10 level.

152 Significant group difference at the 0.05 level.

Figure 12-8: Agreements with Statements About Energy Efficiency



++ Significant group difference at the 0.05 level.
Question, *"I'm going to read a list of scenarios that people might face when purchasing new appliances or considering energy-efficient improvements to their home. Please tell me whether you agree with these statements…"* (treatment group n=360, control group n=180)

Cadmus asked an additional question of control group respondents—had they seen or heard any energy-saving tips within the past six months. We found that 57% (n=178) reported having seen or heard of energy-saving tips. Of these (n=96), 39% saw tips in bill inserts, 24% saw tips from news stories, and 22% saw tips from PPL Electric Utilities resources (e-mails, e-newsletters, and website). Although we did not ask these control group recipients a follow-up question about the helpfulness of these sources, the findings show that customers have sources of information about energy efficiency other than the home energy reports.

The home energy reports also do not appear to improve customers' ease of saving energy in the home. On a 10-point scale where 1 means *extremely difficult* and 10 means *extremely easy*, control group respondents (n=177) gave a significantly higher mean rating (6.3) than the treatment group respondents (5.8, n=346) on the ease of saving energy in the home.[153]

12.5.17 Online Engagement

One-third (32%) of treatment and control group respondents combined (n=536) reported visiting the PPL Electric Utilities website to look for ways to save money on their electric bill. Moreover, 23% of treatment and control group respondents combined (n=534) reported agreeing with the statement *"My access to the Internet is very limited at home."*

153 Significant group difference at the 0.05 level.

This proportion is lower than other similar programs with e-mail home energy report deliveries that Cadmus has evaluated, which indicates that online access is not necessarily a barrier to using the PPL Electric Utilities website as a resource.[154]

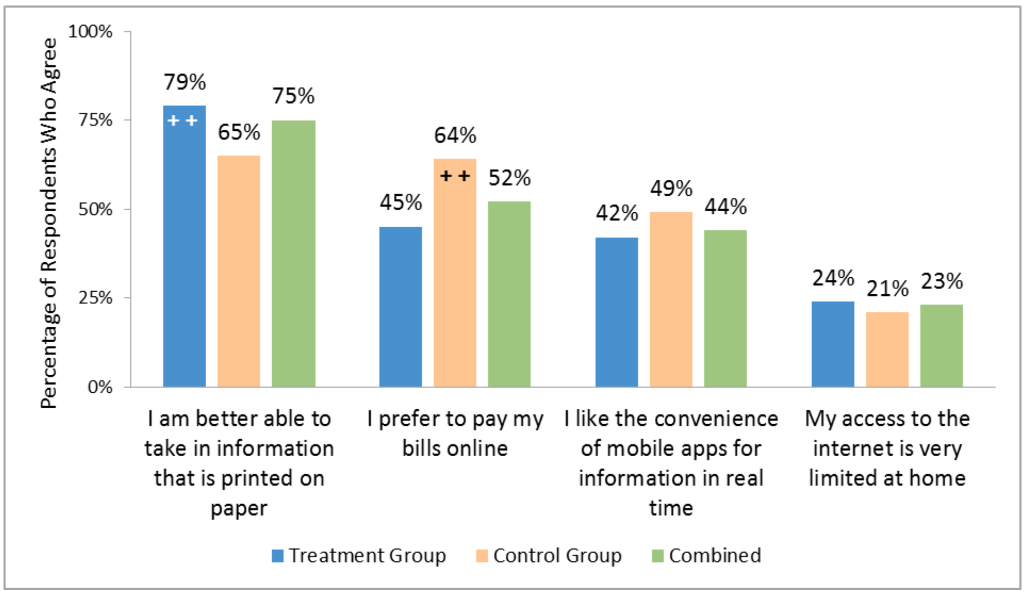
As shown in Figure 12-9, Cadmus found several differences between the preferences of treatment and control groups about online material.

- Significantly more treatment group respondents (79%, n=350) than control group respondents (65%, n=170) agreed with the statement *"I am better able to take in information that is printed on paper*."[155]
- Significantly more control group respondents (64%, n=177) than treatment group respondents (45%, n=354) agreed with the statement *"I prefer to pay my bills online*."[156]
- More control group respondents (49%, n=171) than treatment group respondents (42%, n=331) agreed with the statement *"I like the convenience of mobile apps";* however, this difference was not significant.

Interestingly, these survey findings suggest that overall, the control group is more receptive to online material than the treatment group, although the reasons are unclear.

We did not find any significant differences between legacy and expansion respondents in the two groups on this topic.

Figure 12-9: Agreement with Statements About Online Access and Preferences



++ Significant group difference at the 0.05 level.
Question, *"Please tell me if you agree or disagree with each of these statements."* (treatment group n=358, control group n=178)

---

[154] In a recent evaluation of a home energy reports program for a Midwest utility, Cadmus found that 40% of respondents agreed with the statement "*My access to the internet is very limited at home*." This evaluation is not publically available.

[155] Significant group difference at the 0.05 level.

[156] Significant group difference at the 0.05 level.

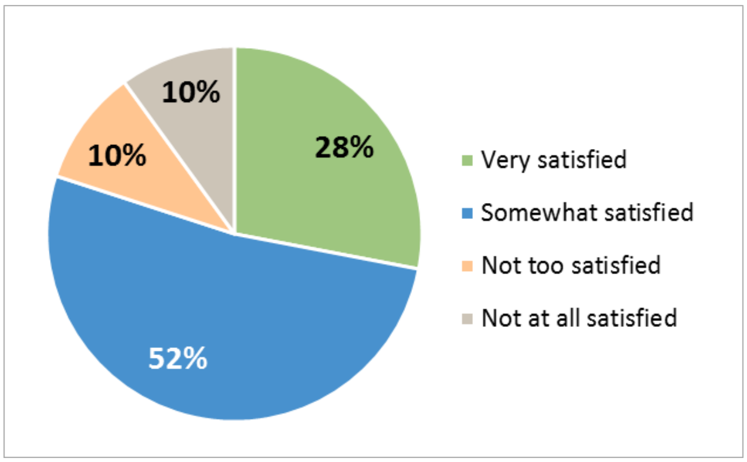
12.5.18 Satisfaction

12.5.18.1 Satisfaction with Home Energy Reports

In PY6, the majority of treatment group respondents (80%, n=355) reported they were satisfied with the home energy reports, as shown in Figure 12-10. Specifically, 52% were *somewhat satisfied* and 28% were *very satisfied*. There were no significant differences between legacy and expansion respondents in the treatment group on satisfaction with the reports.

Customer satisfaction with the home energy reports has improved slightly since Phase I. In the PY4 customer survey results, 74% of respondents (n=137) reported they were satisfied with the reports, 50% said they were *somewhat satisfied,* and 24% said they were *very satisfied*.

Figure 12-10: Satisfaction with Home Energy Reports



Question, "How satisfied are you with the Home Energy Reports? Would you say..." (treatment group n=355)

Due to the length of the survey, Cadmus did not include a follow-up question to capture the reasons behind satisfaction ratings that were less than *very satisfied*. We did allow respondents to make comments at the end of the interview and found that 56% of the comments (n=32) pertained to the neighbor comparison. Respondents believed the neighbor comparisons were either inaccurate or unfair. One respondent said:

> *"[The report] compares me to houses in the neighborhood that are heated with propane, oil and coal. Does not compensate for this. Makes us look like energy hogs. It's not accurate."*

Respondents' comments suggested customers were still not clear on how the neighbor comparisons were made.

12.5.18.2 Satisfaction with PPL Electric Utilities

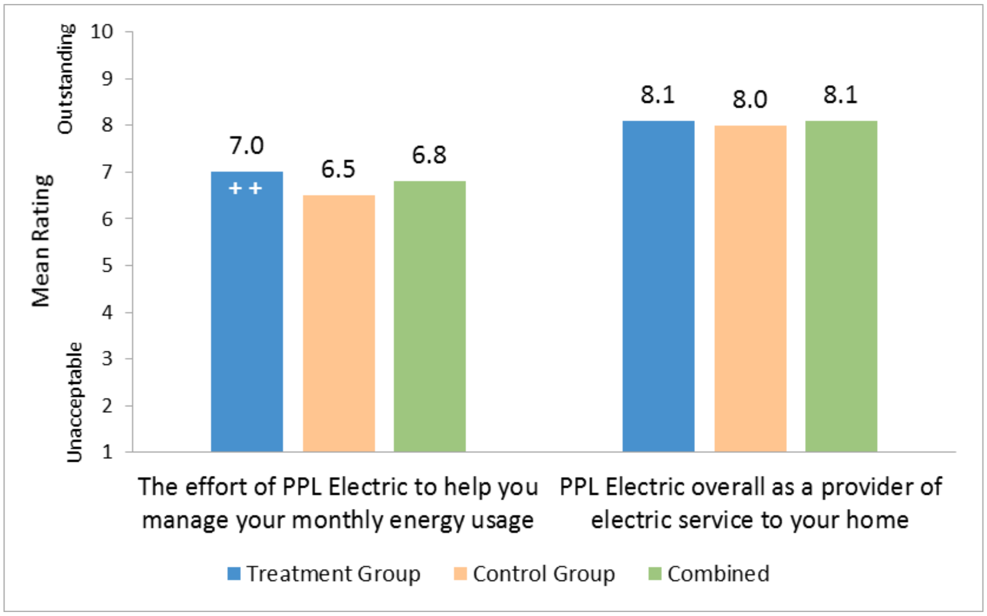
In PY6, treatment and control group respondents combined (n=532) gave an average rating of 8.1 out of 10 for overall satisfaction with PPL Electric Utilities as an electric service provider. We found no significant differences in mean ratings between treatment and control group respondents nor between legacy and expansion respondents. In PY4, respondents gave an average rating of 7.7 (n=322). In PY6, 74% of respondents gave PPL Electric Utilities a rating of 8, 9, or 10, an increase from 62% in PY4.

The majority of treatment group respondents (64%, n=358) did not change their opinion of PPL Electric Utilities after receiving the home energy reports. A third (32%) reported that their opinion of PPL Electric

Utilities had improved after receiving the home energy reports; 4% reported their opinion had decreased. The treatment group's legacy and expansion respondents reported similar opinions of PPL Electric Utilities.

The survey also asked customers about their satisfaction with PPL Electric Utilities' efforts to help customers manage their monthly energy usage. Results show a significant difference between treatment and control groups. Treatment group respondents gave a significantly higher mean rating (7.0, n=351) than control group respondents (6.5, n=166).[157] No differences emerged between legacy and expansion respondents. Figure 12-11 shows respondent's satisfaction with PPL Electric Utilities' effort to help manage energy usage and overall as an electric service provider.

Figure 12-11: Satisfaction with PPL Electric Utilities



++ Significant group difference at the 0.05 level.

Question, *"Using a 10-point scale where 1 means 'unacceptable' and 10 means 'outstanding,' how would you rate the effort of PPL Electric Utilities to help you manage your monthly energy usage?"* (treatment group n=351, control group n=166). Question, *"Using the same scale, how do you rate PPL Electric Utilities overall as a provider of electric service to your home?"* (treatment group n=355, control group n=177).

12.6 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, Cadmus suggests PPL Electric Utilities consider the following recommendations in PY7.

Conclusion

The Residential Energy-Efficiency Behavior & Education Program exceeded its PY6 planned savings because of customers' long history with receiving the reports that allowed them time to implement various energy-saving actions.

[157] Significant group difference at the 0.05 level.

Recommendation

Continue delivering the paper and e-mail home energy reports as planned and closely monitor the monthly savings.

Conclusion

Based on the customer survey responses, the home energy reports did not influence customers to undertake energy-saving improvements or behaviors. For 12 out of the 13 improvements investigated with the surveys, we found no significant differences between treatment and control group respondents in reported implementation of energy-saving improvements, with one exception. More treatment group respondents than control group respondents reported installing a programmable thermostat. The treatment group also did not undertake more energy-saving behaviors than the control group and, in fact, some data indicated control group participants were more likely to take some energy-saving actions, which does not align with the program theory.

Conclusion

The home energy reports showed some subtle, gradual influence over time in getting customers to make energy-saving improvements; at the same time, another factor besides the home energy reports may be influencing customers in general. For 11 out of the 13 improvements asked about in the surveys, we found significant differences between the treatment group's legacy and expansion waves. In all 11 instances, more legacy respondents than expansion respondents reported making improvements. However, the control group showed a similar pattern—a higher proportion of its legacy respondents than expansion respondents reported making improvements for eight improvements. Only the installation of CFLs, the adding of air sealing/caulking/weather stripping, and the installation of an energy-saving faucet head or aerator were found to be uniquely implemented more often by the treatment group's legacy respondents.:

Conclusion

The home energy reports provided a small uplift in participation in other PPL Electric Utilities energy efficiency programs. The surveys showed that the home energy reports did not significantly increase the awareness of PPL Electric Utilities energy efficiency programs; however, the participation uplift analysis showed a small, positive lift for the Appliance Recycling, WRAP, and Residential Retail programs. The reports promoted the Appliance Recycling, Home Comfort, and Residential Retail programs, so we expected to see a positive uplift in these three programs. Two out of the three programs (Appliance Recycling and Residential Retail) promoted in the home energy reports saw a participation uplift.

Recommendation

Continue to promote PPL Electric Utilities energy efficiency programs through the home energy reports to inform customers about energy-saving opportunities.

Conclusion

Customers showed higher engagement with the paper home energy reports than the e-mail reports. The customer survey responses showed that overall readership of the paper home energy reports was very high (95%). Only 5% of respondents said they did not read the report. Ten percent of treatment group respondents said they received e-mail home energy reports. Of these respondents, 97% said they read some or all of the e-mail reports.

Conclusion

The home energy reports did not provide a boost to overall customer satisfaction. Customer satisfaction with the home energy reports and overall satisfaction with PPL Electric Utilities has improved since the program was last evaluated in PY4 of Phase I. In PY6, 80% of respondents reported they were satisfied with the home energy reports, a slight increase from 74% in PY4. Treatment and control group respondents combined, on average, gave a rating of 8.1 out of 10 for overall satisfaction with PPL Electric Utilities as an electric service provider. Yet we found no significant differences in mean ratings between treatment and control group respondents.

Recommendation

PPL Electric could consider ways such as personalization, gamification,[158] and online services to deliver a better customer experience with the home energy reports to continue to increase customer satisfaction with PPL Electric Utilities. .

12.6.1 Status of Recommendations for Program

Table 12-15 contains the status of each PY6 process recommendation made to PPL Electric Utilities.

Table 12-15: Residential Energy Efficiency Behavior and Education Program Status Report on Process and Impact Recommendations

Recommendations	EDC Status of Recommendation (Implemented, Being Considered, Rejected AND Explanation of Action Taken by EDC)
Residential Energy Efficiency Behavior and Education Program	
Continue delivering the paper and e-mail home energy reports as planned.	Implemented.
Continue to promote PPL Electric Utilities energy efficiency programs through the home energy reports to inform customers about energy-saving opportunities.	Will be implemented in Phase III.
Focus on ways to deliver a better customer experience with the home energy reports by having early discussions with the Phase III ICSP on personalization, gamification, and online services.	Will be considered for Phase III.

158 Gamification is defined as the application of game-playing elements (points, tokens, competition, rules, etc.) to elicit fun, engagement, and motivation in the user.

12.7 FINANCIAL REPORTING

A breakdown of the Residential Energy Efficiency Behavior and Education Program finances is presented in Table 12-16.

Table 12-16: Summary of Residential Energy Efficiency Behavior and Education Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$0	$0
2	EDC Incentives to Participants	$0	$0
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$0	$0
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$1,251	$1,865
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$1,251	$1,865
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$1,251	$1,865
13	Total NPV Lifetime Energy Benefits	$2,612	$2,415
14	Total NPV Lifetime Capacity Benefits	$0	$0
15	Total NPV O&M Saving Benefits	$0	$0
16	Total NPV TRC Benefits[4]	$2,612	$2,415
17	TRC Benefit-Cost Ratio[5]	2.09	1.29

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

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report

ADDENDUM A. CUSTOMER SURVEY ATTRITION AND FINAL DISPOSITION

Dialing Instructions

PPL Electric Utilities provided dialing instructions for conducting surveys. Customers cannot be contacted for a telephone survey until a year has passed since they last completed a survey (with PPL Electric Utilities or Cadmus). Telephone survey calls cannot take place on Sundays or national holidays.

Sample Cleaning and Attrition

Prior to the start of survey data collection, Cadmus coordinated with PPL Electric Utilities' survey subcontractor to screen the sample and remove records of any customers who were called in the past year (whether for a Cadmus survey or a PPL Electric Utilities survey) or who requested not to be contacted again.

Duplicate records across all groups in the program were removed along with records with incomplete information. Cadmus selected all remaining records and sent them to the survey subcontractor. Table 12-17 lists the total number of records submitted and the final outcome of each record.

Table 12-17: Survey Sample Attrition Table

Description of Call Outcomes	Total Records	Treatment Legacy	Treatment Expansion	Control Legacy	Control Expansion
Population (Number of Customers) [1]	**200,772**	**82,759**	**47,122**	**58,645**	**12,246**
Selected for Sample Frame	**12,600**	**4,500**	**4,500**	**1,800**	**1,800**
Removed because completed survey in past year	141	56	53	17	15
Removed because incomplete or bad phone number	66	5	38	10	13
Removed because inactive customer or selected for a different survey	431	169	140	69	53
Removed because duplicate	67	18	27	8	14
Removed because on do not call list	111	84	20	2	5
Survey Sample Frame (Sent to Survey Subcontractor)	**11,784**	**4,168**	**4,222**	**1,694**	**1,700**
Not Attempted [2]	**1,584**	**568**	**722**	**294**	**0**
Records Attempted	**10,200**	**3,600**	**3,500**	**1,400**	**1,700**
Nonworking number	1,697	626	534	256	281
Wrong number, business	259	99	85	34	41
Refusal	2,437	829	774	400	434
Language barrier	38	10	14	7	7
Ineligible; PPL Electric Utilities or market research employee	59	24	18	5	12
Ineligible; no one in household familiar with reports	420	193	227	0	0
No answer/answering machine/phone busy	3,147	1,102	1,110	404	531
Nonspecific or specific callback scheduled	1,465	480	510	194	281
Partial complete	137	56	48	10	23
Completed Survey	**541**	**181**	**180**	**90**	**90**
[1]					

Description of Call Outcomes	Total Records	Treatment Legacy	Treatment Expansion	Control Legacy	Control Expansion

[1] This is the total number of stakeholders interviewed and the number of Legacy and Expansion Treatment and Control group customers at the beginning of PY6. Cadmus excluded customers that were not part of the randomized control trial or for whom it was not feasible to deliver a report. We relied on a flag in the data from the ICSP to exclude these customers.
[2] These records were not needed because the interview target was reached before they were attempted.

ADDENDUM B. LOGIC MODEL

A program's theory informs its development and implementation as well as its evaluation. A program logic model identifies the relationships between activities and expected results. As a logic model's design makes a program's underlying theory explicit, it offers useful tools for implementers and evaluators.

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

> By sending the HERs that provide specific messaging designed to make customers more aware of their energy consumption and more knowledgeable about how to reduce their energy use, customers will change their behaviors to reduce their energy use. Energy savings will likely result from these behavioral changes.

The following lists the logic model for the program:

- **Activities the program undertakes** include developing customer education and normative messaging about energy use.
- **Outputs produced by program activities** include paper home energy reports and e-mail home energy reports, which will be delivered to treatment group customers in PY6 and PY7.
- **Short-term outcomes** resulting from the program include residential customers becoming better informed about their energy use and more aware of energy efficiency.
- **Intermediate outcomes** result from customers taking actions to reduce their energy use through behavioral changes and no- or low-cost products.
- **Long-term outcomes** for this program include reductions in energy use through behavioral changes and installation of low-cost products.

13 SCHOOL BENCHMARKING PROGRAM

The School Benchmarking Program works with school administrators to evaluate total building energy use using the Portfolio Manager tool from the U.S. Environmental Protection Agency (EPA).[159] The program provides school administrators the information they need to evaluate short- and long-term goals and paybacks for energy efficiency investment opportunities. A turnkey ICSP, TRC Environmental Corp (TRC), manages the program, which will be offered to up to 25 schools each program year. The ICSP also explains PPL Electric Utilities' rebates and incentives.

For each participating school, the Portfolio Manager tool produces a report of specific characteristics and energy indicators, including total energy use per square foot, electric utilities use per square foot, heating fuel use per square foot and per heating degree day, and energy cost per square foot and per student. Schools also receive assistance in developing action plans to reduce energy consumption.[160]

13.1 PROGRAM OBJECTIVES

The School Benchmarking Program's objectives are to:[161]

- Provide an opportunity for school districts within the PPL Electric Utilities' territory to participate in benchmarking.
- Train school staff to use the EPA's Portfolio Manager tool and encourage and assist schools in achieving the ENERGY STAR® label (awarded if the school is in the top 25% compared to peers).
- Educate school staff about the school's energy use, recommend how energy can be used more wisely, and explain PPL Electric Utilities rebates and incentives.
- Collaborate with the U.S. Department of Energy and the Pennsylvania Department of Environmental Protection on their benchmarking initiatives.
- Promote other PPL Electric Utilities Energy Efficiency and Conservation (EE&C) programs.
- Obtain participation of up to 75 schools through 2016.
- Develop and implement an LED exit sign component for participating schools and as an incentive to encourage other schools to participate in the School Benchmarking Program. These savings are claimed under the Prescriptive Equipment Program.

---

159 ENERGY STAR. "Energy Strategies for Buildings & Plants." Available online: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

160 Participation in the School Benchmarking and Continuous Energy Improvement (CEI) programs is intended to be mutually exclusive. However, past participants of the School Benchmarking Program may be recruited into the CEI Program in a later year.

161 Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2012-2334388) approved by the Pennsylvania PUC on June 05, 2015, p.173.

13.2 PROGRAM UPDATES

PPL Electric Utilities developed an LED exit sign promotion to encourage school participation and included it in its January 2015 EE&C Plan revision. Note that the savings from the LED exit signs are claimed in the Prescriptive Equipment Program.

13.2.1 Definition of Participant

Participants are defined by unique CSP job numbers assigned to each participating school.

13.3 IMPACT EVALUATION GROSS SAVINGS

The program does not generate energy savings.

13.4 IMPACT EVALUATION NET SAVINGS

The program does not generate energy savings.

13.5 PROCESS EVALUATION

13.5.1 Research Objectives

The objective of this process evaluation was to gather insights into program design and delivery and assess customer satisfaction.

13.5.2 Evaluation Activities

Because the School Benchmarking Program does not generate energy savings, Cadmus conducted a process evaluation at the beginning of PY6 that covered PY5.[162] Cadmus completed these process evaluation activities:

- Program staff and implementer interviews (n=3)
- Participant surveys (n=3)
- Program literature review and benchmarking
- Process map development (Addendum A)

[162] Because this program does not claim energy savings, Cadmus will not complete an impact or additional process evaluation in Phase II. This decision was made jointly with PPL Electric Utilities.

Table 13-1: PY5 School Benchmarking Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Population Size	Assumed Proportion or CV in Sample Design	Assumed Levels of Confidence & Precision	Target Sample Size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Contacted [1]	Evaluation Activities
PPL Electric Utilities Program and ICSP Staff	Staff	3	N/A	N/A	3	3	3	100%	Process, Program Staff Interview, Census
Schools	Unique Participants	28	N/A	N/A	3	8 [2]	3	100%	Process, Participant Survey, Probability Sample
Program Total		**31**			**6**	**11**	**6**		

[1] Sample frame is a list of contacts that have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete interviews.
[2] This is the number of unique contacts.

13.5.3 Methodology

13.5.3.1 Program Staff and Implementer Interviews

Cadmus conducted telephone interviews with PPL Electric Utilities program staff and with ICSP staff to review the programs goals, roles and responsibilities, and challenges. Cadmus used the information to create the program's process map.

13.5.3.2 Participant Surveys

In June 2015, Cadmus received the School Benchmarking Program data as part of the PY5 fourth quarter (Q4) quarterly program data uploaded from EEMIS, PPL Electric Utilities' database. These data included contact information for the 22 schools that had participated and for six other schools that had participated but whose data had not yet been uploaded into EEMIS. Cadmus found that some schools were represented by the same contact—ultimately, eight contacts represented the 28 schools—so it generated the final sample of unique decision makers to ensure no one was contacted more than once for the same survey. Cadmus attempted to reach all eight contacts in September and October 2015.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. We addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys were designed to include questions that were not leading or ambiguous, were not double-barreled, and provided clear interviewing and programming instructions so that they were implemented consistently. Cadmus attempted to reach all unique customers by contacting them multiple times over several days at different times of the day and scheduled callbacks when possible.

13.5.4 Achievements Against Plan

During Phase II, the School Benchmarking Program is not expected to yield energy savings.

One of the School Benchmarking Program's objectives aims for up to 75 schools to participate. In PY5, 28 schools participated. An additional 9 schools participated in PY6 for a total Phase II participation of 37 schools [163].

13.5.5 Program Delivery

During the interviews, staff from PPL Electric Utilities and the ICSP reported minimal challenges in the School Benchmarking Program. PPL Electric Utilities and the ICSP had collaborated on a similar school benchmarking program prior to Act 129 and were comfortable with the program's progress and expectations.

13.5.6 Program Satisfaction

Of the eight unique decision makers (representing 28 schools), three completed surveys. These three indicated a high level of program satisfaction. Two of the three were *very satisfied* and one was *somewhat satisfied*. All three respondents were *very satisfied* with the ICSP. Two of the three respondents rated their satisfaction with PPL Electric Utilities as an electric utility as *outstanding* (a 10 on a 10-point scale). All respondents reviewed the School Benchmarking Program report during a meeting with the ICSP and said the report was *very informative*.

Cadmus asked respondents about the EPA benchmarking scores. Two respondents said the ability to compare their schools against other schools and districts was useful. Two respondents said they were surprised by their schools' low benchmarking scores. All three believed the recommendations from the benchmarking report were generic and only one respondent was updating monthly energy data in Portfolio Manager. At the time of the interview, no respondents had pursued certification for ENERGY STAR-eligible schools.

13.5.7 Energy Efficiency Knowledge, Challenges, and Actions

One respondent said he or she was *somewhat knowledgeable* about how to save energy at schools. The other two reported they were *very knowledgeable*. In addition, two respondents said that energy efficiency was *very important* to capital upgrades and building operations and maintenance; the other respondent said *somewhat important*. Only one of three school districts had a corporate energy policy.

13.5.8 Benchmarking Against Other Programs

Since the School Benchmarking Program was new to PPL Electric Utilities' portfolio, Cadmus conducted secondary research and presented an overview of the lessons learned from similar programs in a memorandum dated August 1, 2013 (Addendum B. Benchmarking Memo). Cadmus reviewed evaluations completed for the California Public Utilities Commission (CPUC) School Energy Efficiency (SEE) Program, the New York State Energy Research and Development Authority (NYSERDA) Energy Smart Schools Program, and the New Hampshire EnergySmart Schools Program. Lessons learned by others suggest that the program should:

- Anticipate a labor-intensive data validation process
- Actively market through school boards
- Adapt outreach to academic calendars
- Account for variation in energy use patterns between different types of educational facilities

[163] Six of the 15 participants included in EEMIS in PY6 were actually participants in PY5.

13.6 CONCLUSIONS AND RECOMMENDATIONS

Cadmus determined that through PY5 the program was working as planned. Cadmus and PPL Electric Utilities staff decided not to plan further evaluation activities because the program does not contribute energy savings.

13.7 FINANCIAL REPORTING

A breakdown of the School Benchmarking Program finances is presented in Table 13-2.

Table 13-2: PY6 Summary of School Benchmarking Program Finances

Row	Cost Category	Actual PYTD Costs ($1,000)	Actual Phase II Costs[6] ($1,000)
1	Incremental Measure Costs (Sum of rows 2 to 4)	$0	$0
2	EDC Incentives to Participants	$0	$0
3	EDC Incentives to Trade Allies	-	-
4	Participant Costs (net of incentives/rebates paid by utilities)	$0	$0
5	Program Overhead Costs (Sum of rows 6, 7, 8, 9, 10)	$126	$268
6	Design & Development	$0	$0
7	Administration, Management, and Technical Assistance[1]	$126	$268
8	Marketing[2]	$0	$0
9	EDC Evaluation Costs	$0	$0
10	SWE Audit Costs	$0	$0
11	Increases in costs of natural gas (or other fuels) for fuel switching programs	$0	$0
12	Total TRC Costs[3] (Sum of rows 1, 5 and 11)	$126	$268
13	Total NPV Lifetime Energy Benefits	$0	$0
14	Total NPV Lifetime Capacity Benefits	$0	$0
15	Total NPV O&M Saving Benefits	$0	$0
16	Total NPV TRC Benefits[4]	$0	$0
17	TRC Benefit-Cost Ratio[5]	0.00	0.00

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

[1] Includes rebate processing, tracking system, general administration, EDC and CSP program management, general management and legal, and technical assistance.
[2] Includes the marketing CSP and marketing costs by program CSPs.
[3] Total TRC Costs includes Total EDC Costs and Participant Costs.
[4] Total TRC Benefits equals the sum of Total Lifetime Energy Benefits and Total Lifetime Capacity Benefits. Based upon verified gross kWh and kW savings. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction. NOTE: Savings carried over from Phase I are not to be included as a part of Total TRC Benefits for Phase II.
[5] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
[6] Phase II Costs in this table are discounted back to PY5, thus will not match cumulative costs reported in the PY6 Q4 quarterly report

ADDENDUM A. PROCESS MAP

Figure 13-1: Process Map of Roles and Responsibilities: Customer Awareness

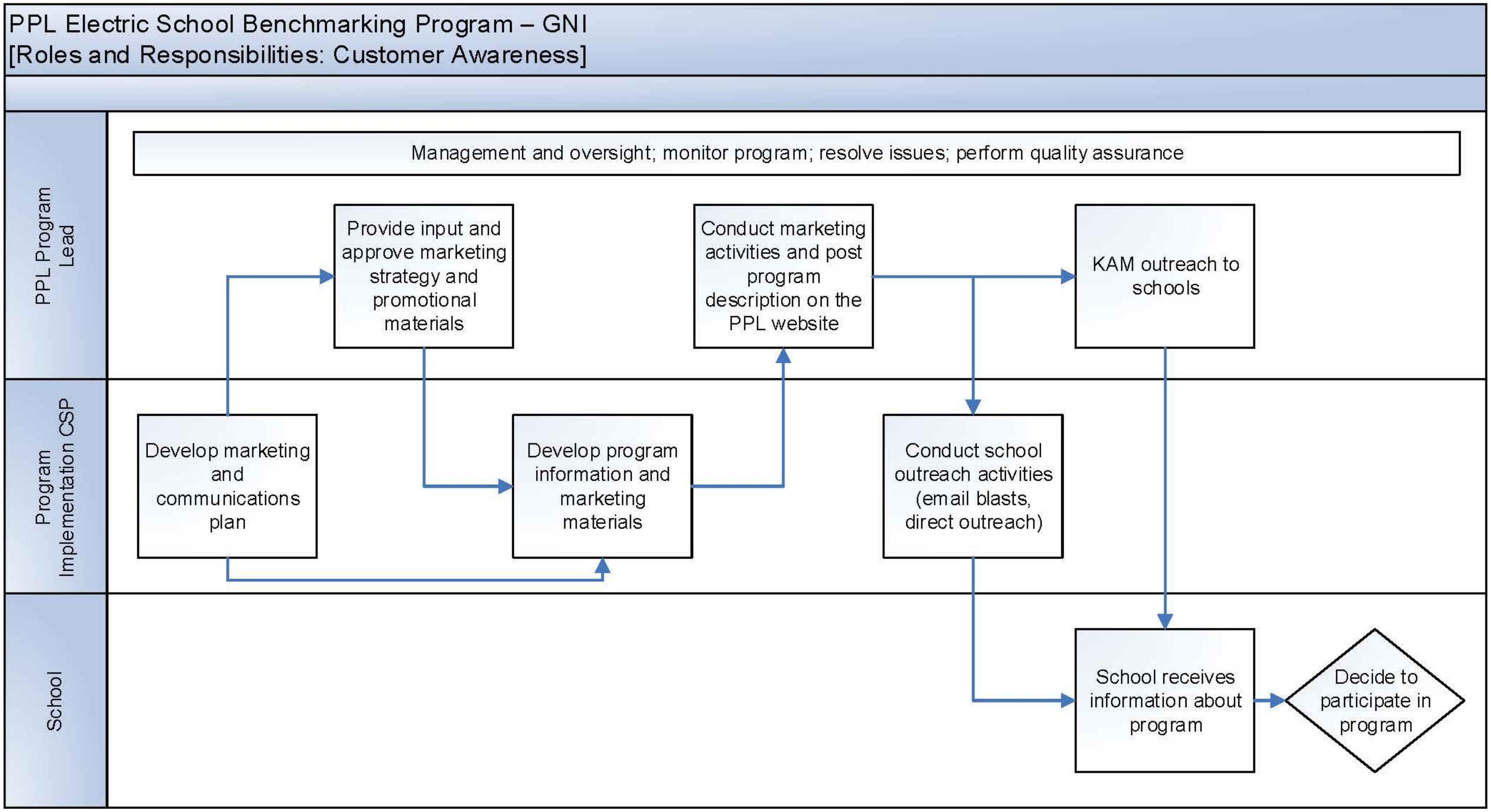


Figure 13-2: Process Map of Roles and Responsibilities: Application Process

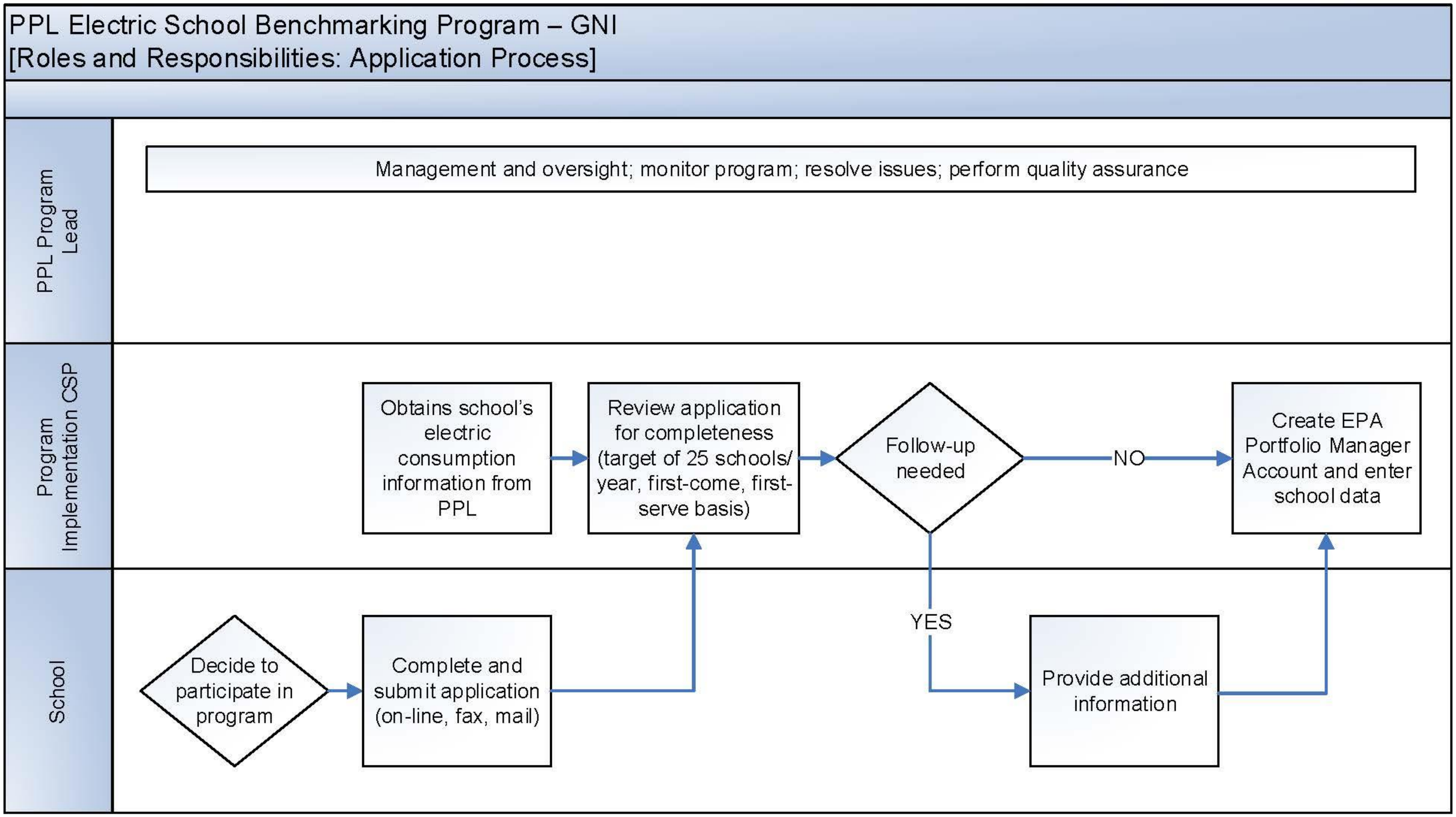


Figure 13-3: Process Map of Roles and Responsibilities: Benchmarking Report Process

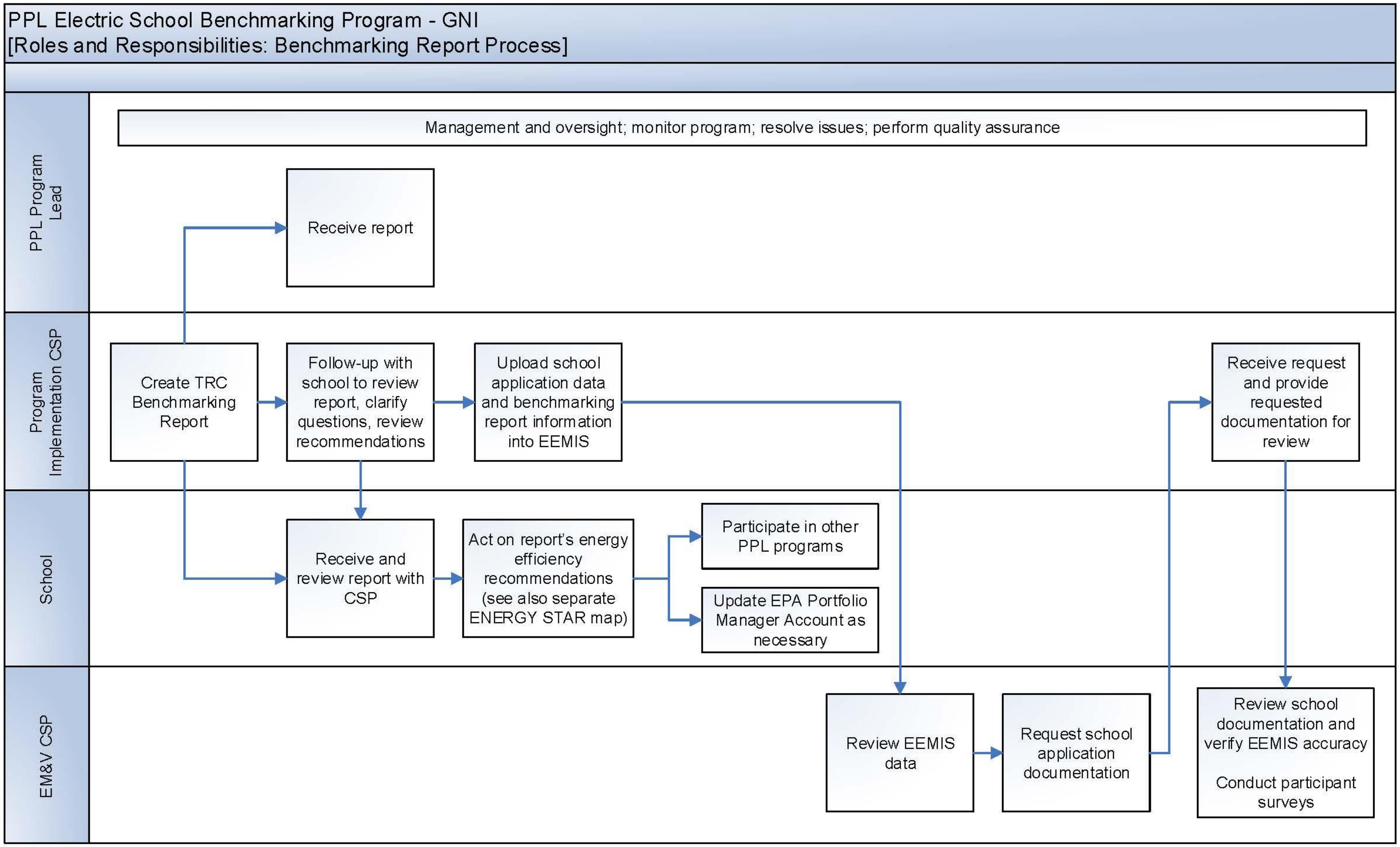
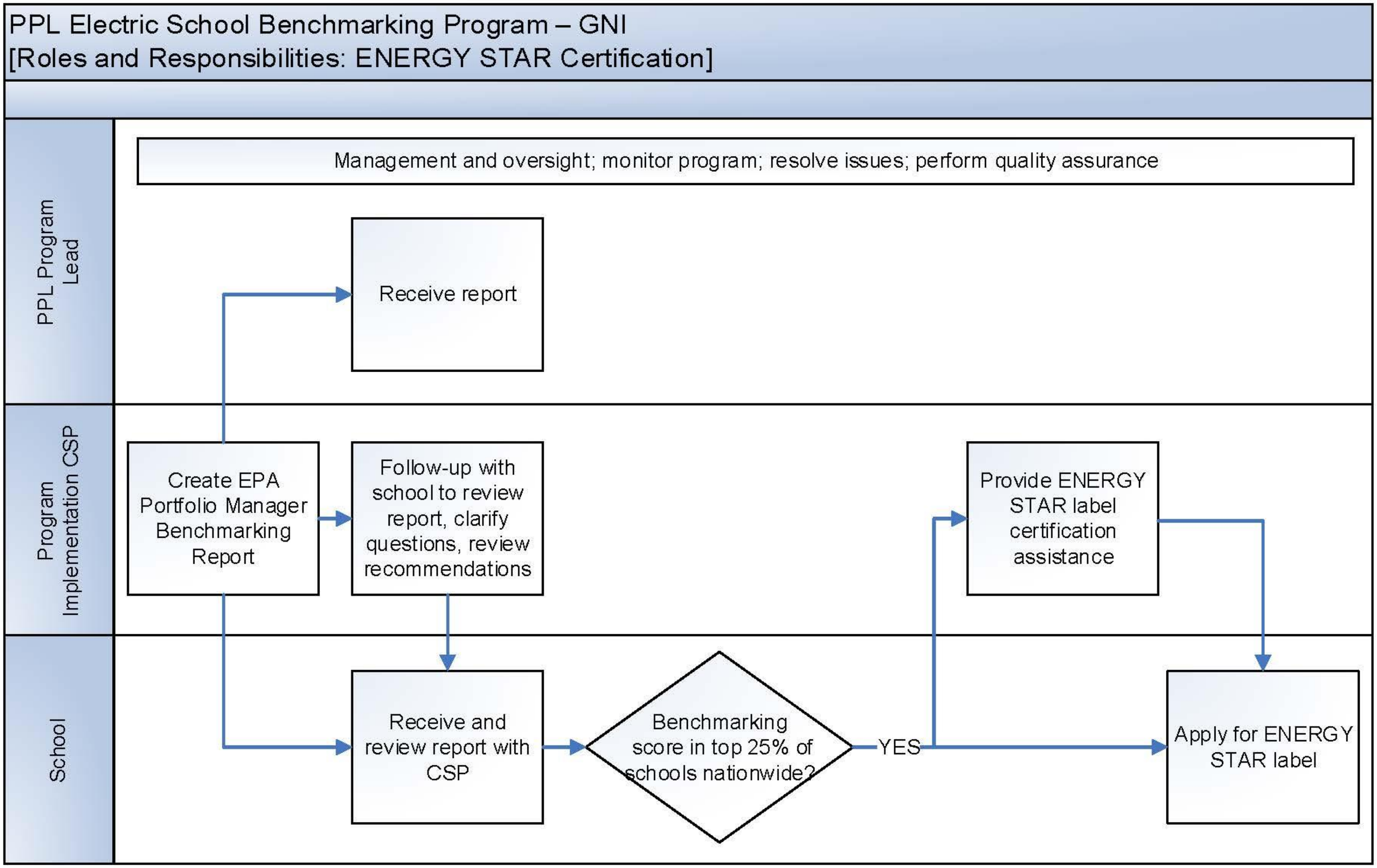


Figure 13-4: Process Map of Roles and Responsibilities: ENERGY STAR Certification



Addendum B. Benchmarking Memo

MEMORANDUM

Subject: Phase 2 New Program Benchmarking: School Benchmarking Program

Date: August 1, 2013

This memo provides an overview of the lessons learned from programs similar to PPL's School Benchmarking Program. Cadmus reviewed evaluations completed for the California Public Utilities Commission (CPUC) School Energy Efficiency (SEE) Program, the New York State Energy Research and Development Authority (NYSERDA) Energy Smart Schools Program, and the New Hampshire EnergySmart Schools Program. Key program characteristics are summarized while noting differences from PPL's program.

Overview of Other School Benchmarking Programs

Cadmus reviewed available literature for three school benchmarking programs similar to PPL's School Benchmarking Program. PPL launched its program June 1, 2013. Table 1 presents key characteristics of each comparable program.

Table 1. Overview of Other School Benchmarking Programs

Program	Year Program Began	Year Program Ended	Year Participation Recorded	Number of Schools Participating as of Report Year
PPL	2013	2016 (anticipated)	N/A	Up to 75 schools (planned)
California Public Utilities Commission School Energy Efficiency Program[1]	Mid-2004	Mid-2006	2006	89 schools
New York State Energy Research and Development Authority Energy Smart Schools Program[2]	2003	2012	2006	500+ schools[4]
New Hampshire EnergySmart Schools Program[3]	2009	2011	2011	209 schools

[1] Itron. *Evaluation of the School Energy Efficiency Program.* October 2006. Prepared for D&R International and the California Public Utilities Commission.

[2] G. Coleman, TRC Energy Services and M. Brown, New York State Energy Research and Development Authority. *Program Design and Implementation: Targeting New York State K-12 Schools*. August 2006. 2006 ACEEE Summer Study on Energy Efficiency in Buildings Proceedings (Pacific Grove, CA).

[3] TRC. *New Hampshire EnergySmart Schools Initiative, Regional Greenhouse Gas Initiative*. Prepared for the New Hampshire Public Utilities Commission.

[4] We were unable to determine the final number of schools participating in the NYSERDA Energy Smart Schools program; the number cited here was reported in 2006.

California Public Utilities Commission School Energy Efficiency Program[164]

The California PUC's SEE program, implemented from mid-2004 through June 2006 by D & R International, was designed to promote increased awareness of energy efficiency in K-12 public schools across the state. The program aimed to educate students about energy consumption and the benefits of various energy efficiency measures, while providing administrators with feedback on areas where they might reduce their school's energy consumption. To accomplish the latter goal, D & R held educational workshops and energy-efficient technology demonstrations to supplement benchmarking and auditing efforts. Benchmarking was conducted using the Environmental Protection Agency's ENERGY STAR® Portfolio Manager tool, which will also be used in PPL's School Benchmarking Program. The scope of the CPUC SEE program differed significantly from the PPL program; SEE did not give support to schools seeking an ENERGY STAR® label, and the increased interaction provided by the educational and auditing component of the program falls outside the scope of PPL's program. Because the SEE program was an informational only program, Itron's evaluation was not required to verify energy and demand savings.

New York State Energy Research and Development Authority Energy Smart Schools Program[165][166]

The NYSERDA Energy Smart Schools program, which TRC Energy Services began implementing in the 2002-2003 school year, used the EPA's ENERGY STAR® Portfolio Manager for its critical benchmarking component. In addition to requesting key data for Portfolio Manager, the NYSERDA program also requested a year of utility billing data from each school so that energy consumption and cost data could be included in the benchmarking analysis. TRC used the energy use scores generated by Portfolio Manager to assemble a New York Benchmarking Database, which was then analyzed for consistent trends across all benchmarked schools. Reports provided to schools focused on energy costs and cost per student, and listed all other NYSERDA programs available for a given facility. In 2006, preliminary analysis showed a 12+% reduction in total energy use per square foot in benchmarked schools participating over the past three years.

New Hampshire EnergySmart Schools Program[167]

In 2009, TRC began implementing New Hampshire's Schools Benchmarking Project under its EnergySmart Schools Program. The program used ENERGY STAR® Portfolio Manager to benchmark 209 schools through the program's conclusion in 2011, with potential savings of 15 million kWh and 109,960 MMBTU. In addition to the data required by Portfolio Manager, energy consumption data were collected from school meters or directly from the utility. All recorded data were stored in a TRC database so that building performance could be evaluated over prolonged periods of time in addition to

---

164 http://www.calmac.org/publications/SEE_Evaluation_1190-04.pdf

165 http://www.eceee.org/library/conference_proceedings/ACEEE_buildings/2004/Panel_4/p4_6/paper

166 http://www.eceee.org/library/conference_proceedings/ACEEE_buildings/2006/Panel_4/p4_4/paper

167 http://www.puc.nh.gov/Sustainable%20Energy/GHGERF/GHGERF%20Funding%20Group%201%20Reports/TRC%20NH%20Energy%20SmartSchools%20-%20Final%20Report.pdf

providing administrators with a snapshot of facility energy usage at the time of application. Beyond the benchmarking comparisons performed by the Portfolio Manager, participants were compared against other New Hampshire schools benchmarked by the program, giving additional context to school energy usage levels. Schools were provided with references for the most cost-effective energy efficiency measures applicable to their facilities, as well as any available state programs or incentives that might support project funding. If a school received a high score from Portfolio Manager, they were informed of potential eligibility for an ENERGY STAR® label, and given assistance in the application process if desired.

LESSONS LEARNED

Each of the three programs reviewed faced a number of hurdles in execution, although final reports were only available for the CPUC SEE program and New Hampshire's EnergySmart Schools program. A paper presented at 2004 ACEEE Summer Study on Energy Efficiency in Buildings provides background and practices for the NYSERDA Energy Smart Schools program.[168] These challenges and subsequent considerations for PPL are presented below.

- **Anticipate a labor-intensive data validation process.** Each of the programs reviewed named data validation as a central obstacle in program implementation. The ACEEE paper detailing the NYSERDA program discusses at length the difficulties faced in data acquisition and verification. Fuel cost and consumption data were often incomplete or contained inaccuracies. Moreover, school energy managers included unconditioned spaces in the reported facility square footage. Further difficulties were posed in the evaluation of savings on a "per student" basis, as accurate student counts were not always available. Of the 237 schools participating in New Hampshire's program, 28 (12%) could not be benchmarked due to missing data despite TRC's multiple attempts to get the information. [169] Furthermore, there was often a long time-lag involved in additional data requests, both from the school and from the utilities themselves. The 2006 evaluation of the CPUC SEE program report notes that several of the benchmarking scores appear to be outliers indicative of flaws in the data inputs, but the evaluator did not investigate further. PPL should anticipate a labor- and time-intensive data validation process, and seek to provide clear instructions at the onset and ongoing support for school energy managers in order to gather accurate and complete data.

  Many utilities are now moving toward automated data exchange services[170] where building energy use information can be automatically sent to EPA's ENERGY STAR Portfolio Manager. Previously known as Automated Benchmarking Services (ABS), the Department of Energy released a significant upgrade, the Portfolio Manager Data Exchange, in July 2013. More information about this upgrade can be located at: http://portfoliomanager.energystar.gov/webservices/home.

  Using an automated data exchange is likely to overcome some obstacles associated with gathering Electric Utilities utility data, but other challenges may remain, such as validating student counts and square footage.

---

168 http://www.eceee.org/library/conference_proceedings/ACEEE_buildings/2004/Panel_4/p4_6/paper

169 TRC, *New Hampshire EnergySmart Schools Program: Regional Greenhouse Gas initiative*, p7. Available at: http://www.puc.nh.gov/Sustainable%20Energy/GHGERF/GHGERF%20Funding%20Group%201%20Reports/TRC%20NH%20Energy%20SmartSchools%20-%20Final%20Report.pdf

170 Krukowski, A. and Majersik, C., Institute for Market Transformation. *Utilities' Guide to Data Access for Building Benchmarking*. March, 2013. http://s146206.gridserver.com/media/files/IMT_Report_-_Utilities_Guide_-_March_2013.pdf

- **Actively market through school boards.** In their quarterly reports, TRC often named marketing and outreach as its greatest hurdle in implementation of the New Hampshire Energy Smart Schools program. The CPUC SEE found that online presentations and board meetings for the County Office of Education were the most effective in improving program participation.
- **Adapt outreach to academic calendars.** Given the variation in availability of key staff based on the academic calendar, outreach efforts should be undertaken at times best suited for uptake by administrators. In the CPUC SEE program, this was in the fall at the start of the school year. The PPL program implementer should anticipate that administrators and other key staff may not be available during school vacations or exam periods.
- **Account for variation in energy usage patterns between different types of educational facilities.** The NYSERDA program found that comparisons made across different school types – specifically, between schools for students with special needs and other schools – often made certain types of institutions appear to be poor performers, because the needs of different school types were not taken into account.

Market Barriers

One barrier to participation found in the evaluations we reviewed is **limited time and resources at participating schools.** In New Hampshire, the program implementer noted that a main barrier to participation was the time commitment required to supply the necessary information to participate in the program. NYSERDA speaks to this difficulty in the description of its data request form design process, stating that:

> *"When a Data Request Form is sent to an energy manager; 12 consecutive, concurrent months of Electric Utilities and natural gas/fuel oil cost and use information is also requested. It is stressed to facility managers that all they need do is 'pull the utility bills from the file cabinet and mail them to us.' No additional effort on their part is requested and the facility managers are assured that their bills will be returned."*[171]

EPA's enhanced automated data exchange service is likely to reduce the burden of gathering Electric Utilities bills, and PPL already notes on the School Benchmarking application form that the participant does not need to submit their Electric Utilities bills. Streamlining other data requests and carefully communicating the expected time commitment and requirements of participating in the program may further help overcome this barrier to participation.

[171] Coleman, G. and Afshar, C, TRC Energy Services. *Building Performance Analysis: Energy Benchmarking of New York State Schools.* August, 2004. 2004 ACEEE Summer study. pp. 4-60. Available at: http://www.eceee.org/library/conference_proceedings/ACEEE_buildings/2004/Panel_4/p4_6/paper

APPENDIX A | EM&V INFORMATION

A.1 PARTICIPANT DEFINITIONS

Participant definitions discussed in each of the program chapters are summarized below.

Table A-1: PY6 Participant Definition by Program

Program	Participant Definition	Can there be more than one measure per participant?	Sample Defined By
Appliance Recycling	Unique CSP Job ID	Yes	Freezer and Refrigerators
Continuous Energy Improvement	CSP Job ID unique to each project	Yes	Projects
Custom Incentive	Customer project that received an incentive payment between June 1, 2014 and May 31, 2015	Yes	Large stratum are projects with reported savings > 500,000 kWh/year Small stratum are projects with reported savings <= 500,000 kWh/year
E-Power Wise	Unique CSP Job ID (receive 1 energy conservation kit per income eligible household)	No	Delivery method (agency or direct mail)
Low-Income Energy-Efficiency Behavior and Education	Income eligible household identified with unique CSP account ID	No	All participants in treatment/recipient group
Low-Income WRAP	Income eligible household; identified with unique CSP Job ID	Yes	Job type (baseload, low cost, full cost, heat pump water heater)
Master Metered Multifamily	CSP Job ID unique to each project	Yes	Random sample of projects (target 85/15)
Prescriptive Equipment -- Non-Lighting subcomponent	CSP Job ID unique to each project	Yes	Random sample of projects (target 90/10)
Prescriptive Equipment -- Lighting subcomponent	CSP Job ID unique to each project	Yes	Defined kWh thresholds (target 90/10)
Residential Energy-Efficiency Behavior and Education	Household identified with unique CSP account ID	No	All participants in treatment/recipient group
Residential Home Comfort	Unique CSP Job ID	Yes	Subprograms: audits, weatherization measures, equipment rebates, manufactured housing, new construction
Residential Retail – Equipment subcomponent	Unique CSP Job ID	Yes	Desk review of random sample of rebate forms, prorated by rebated equipment based on reported savings

Program	Participant Definition	Can there be more than one measure per participant?	Sample Defined By
Residential Retail -- Upstream Lighting subcomponent	Jobs are reported as weekly bulb sales by bulb type. Number of participants determined by dividing the total number of bulbs sold or distributed by a bulbs-per-participant estimate derived from general residential and small C&I population survey respondents who reported having purchased bulbs.	N/A	All records
School Benchmarking	CSP Job ID unique to each project	Yes	Projects
Student and Parent Energy Efficiency Education	Total number of kits handed out to each classroom; identified with unique CSP ID	Yes	3 classroom cohorts, 1 teacher cohort, 1 parent workshop cohort

A.2 PROGRAM YEAR 6 EVALUATION ACTIVITIES

Table A-2 summarizes actual evaluation activities completed in PY6.

Table A-2: PY6 Actual Evaluation Activities

Programs	Sectors	Records Review	Participant Surveys	Nonparticipant Surveys	Site Visits	Metering[1]
Appliance Recycling	All sectors	All records	Program-specific survey (140); Cross-program surveys (86)	147	N/A	N/A
Continuous Energy Improvement	GNI	All records	All 8 participants	N/A	N/A	N/A
Custom Incentive	C&I, GNI	Census of large stratum (12); sample of small stratum (10)	15 unique contacts (17 properties)	5	12 large stratum; 10 small stratum	10
E-Power Wise	Low Income	All records	All available returned paper surveys (605)	N/A	N/A	N/A
Low-Income Energy-Efficiency Behavior and Education	Low Income	All records	Opt-out survey (11)	N/A	N/A	N/A
Low-Income WRAP	Low Income	463 baseload jobs, 96 lot-cost jobs, 60 full cost jobs, 218 HPWH	71 baseload participants	N/A	N/A	N/A
Master Metered Multi-Family	GNI	All records	7 unique decision-makers representing 24 participants	N/A	23	N/A

Programs	Sectors	Records Review	Participant Surveys	Nonparticipant Surveys	Site Visits	Metering[1]
Prescriptive Equipment -- Non-lighting subcomponent	Small C&I, large C&I, and GNI	All records	3 online surveys	N/A	N/A	N/A
Prescriptive Equipment -- Lighting subcomponent		33	12 Direct Discount 60 Prescriptive Rebates	N/A	33	6
Residential Energy-Efficiency Behavior and Education	Residential	All records	Customer surveys (361 treatment and 180 control)	N/A	N/A	N/A
Residential Home Comfort	Residential	336	179	2	934	N/A
Residential Retail – Equipment subcomponent	Residential					
Residential Retail -- Upstream Lighting subcomponent	Residential; Small C&I					
School Benchmarking	GNI	N/A	N/A	N/A	N/A	N/A
Student & Parent Education	Residential	All records	All returned home energy worksheets (14,778); classroom teacher survey (n=145); teacher workshop survey (n=61); parent workshop survey (n=53)	N/A	N/A	N/A

[1] Does not include statistical billing analysis

APPENDIX B | TRC INCREMENTAL COSTS

B.1 PROGRAM YEAR 6 EVALUATION ACTIVITIES

For Program Year 6, the following measures had incremental measure costs that were not obtained from the SWE incremental cost database, as shown in Table B-1.

Table B-1: PY6 Actual Evaluation Activities

Program	Measure	Incremental Cost	Incremental Cost Source
Custom Incentive	All	$8,372,297	PY6 program verification of all project costs.
Prescriptive Equipment	New Construction Lighting: Small C&I	$756,777	Energy Trust of Oregon's average cost per square foot of $0.35 for 20% LPD reduction (used in EE&C Plan) adjusted linearly for project specific LPD reductions. Exterior lights used SWE incremental costs for LED street lighting and HID installations.
Prescriptive Equipment	New Construction Lighting: Large C&I	$311,487	Energy Trust of Oregon's average cost per square foot of $0.35 for 20% LPD reduction (used in EE&C Plan) adjusted linearly for project specific LPD reductions. Exterior lights used SWE incremental costs for LED street lighting and HID installations.
Prescriptive Equipment	New Construction Lighting: Gov't/Non-Profit	$454,441	Energy Trust of Oregon's average cost per square foot of $0.35 for 20% LPD reduction (used in EE&C Plan) adjusted linearly for project specific LPD reductions. Exterior lights used SWE incremental costs for LED street lighting and HID installations.
Prescriptive Equipment	Retrofit Cut Sheet Lighting Fixtures (Early Replacement)	$140	Invoice review of 20 PY5 projects with 1,168 unique measures ($35.84 labor and $104.16 fixture).
Prescriptive Equipment	Retrofit Cut Sheet Lighting Controls (Early Replacement)	$107	Invoice review of 20 PY5 projects with 1,168 unique measures ($56.63 labor and $50.78 materials).
Master Metered Multifamily Housing	Commercial Lighting measures	$71,856	Non-direct installation measure costs were estimated from 27 PY6 project records with customer contributions having an average cost of $0.08 per kWh then extrapolated to total kWh.
Residential Home Comfort	HERS Base Savings	$8,917	Source Linear Regression of two studies result; "Tolkin, Blake, Bonanno, Conant, Mauldin, Hoefgen, How Much More Does It Cost to Build an ENERGY STAR® Home? Incremental Cost Estimation Process, 2008 ACEEE Summer Study on Energy Efficiency in Buildings" and "ENERGY STAR V3 Cost and Savings Estimates, EPA 2013"

Program	Measure	Incremental Cost	Incremental Cost Source
Residential Home Comfort	Manufactured Home - Double (EnergyStar envelope and assumed 13 SEER ASHP)	$3,946	NREL incremental measure costs applied to ENERGY STAR's prototype mobile home designs
Residential Home Comfort	Manufactured Home - Single (EnergyStar envelope and assumed 13 SEER ASHP)	$2,753	NREL incremental measure costs applied to ENERGY STAR's prototype mobile home designs

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

PPL Electric Utilities determined the number of low-income households participating in programs that are open to all residential customers—that is, low-income participation in non-low income (general residential) programs. These were the Appliance Recycling, Residential Home Comfort, Residential Retail – Equipment, Residential Retail – Upstream Lighting, and Student and Parent Energy-Efficiency Education programs. Participant numbers were obtained according to the methodology approved by the Pennsylvania Public Utility Commission and described in the PPL Electric Utilities memo, *Method to Estimate Low-Income Savings in Non-Low-Income Programs*, dated June 1, 2011.

This analysis used survey data that included responses from participants who answered questions regarding the number of individuals in their household and estimated annual household income. Table C-1 lists the number of respondents in four programs and whether they answered income and household questions.

Table C-1: PY6 Percentage of Respondents Answering Income and Household Questions

Program	Completed Surveys	Income/Household Questions	
		Respondents Providing Demographic Responses	Percentage Who Refused to Answer
Appliance Recycling	226	165	27%
Behavior and Education	541	381	30%
Residential Home Comfort	177	115	35%
Residential Retail – Equipment	216	160	26%
Residential Retail – Lighting	301	27	91%
Total	1,461	848	58%

Source: Survey question, "Including yourself, how many people lived in your home full-time during the past 12 months? (If Necessary: full-time is considered more than 9 months in the past year.)" and survey question, "In 2014, was your annual household income before taxes above or below $50,000?" and survey question, "Was your annual household income before taxes above or below $25,000?" and survey questions, "Please stop me when I read your category. Was it…?"

The Student and Parent Energy-Efficiency Education Program was offered to schools in PPL Electric Utilities' service territory that offer free lunches to children from households with income below 120% of the federal poverty level (FPL), which is more conservative than 150% of the federal poverty level.

The Pennsylvania Department of Education publishes the percentage of student enrollment that qualifies for free lunches. Cadmus used these published data to determine the percentage of low-income participants in Student and Parent Energy-Efficiency Education Program and assumed that the percentage of students enrolled in the school free-lunch program was representative of the percentage within any particular classroom participating in the program. Across all participating schools with available data, the average percentage of students receiving free lunches in the 2014–2015 school district was 40%.

In program year 6 (PY6), participants below 150% of the federal poverty level were associated with verified gross savings of 10,851 MWh/year in non-low-income programs. Participation by program and PY6 savings are summarized in Table C-2. Federal poverty guidelines are shown in Table C-3. PY6 analyses use the

2014 guidelines. The PY5 analysis used the 2013 guidelines and for comparison, the PY5 FPL results are included in Table C-4.

Table C-2: PY6 Verified Gross Savings Attributable to Low-Income Participation in Non-Low-Income Programs

Program	Total Survey Respondents	Respondents Meeting FPL Guidelines	Percentage of Total Respondents	PY6 Verified Gross Impact (MWh/yr)	Savings Associated with FPL Population (MWh/yr)
Appliance Recycling	165	19	12%	6,445	742
Behavior and Education	381	22	6%	29,568	1,519
Residential Home Comfort	115	2	2%	4,083	71
Residential Retail – Equipment	216	7	26%	1,811	79
Residential Retail – Lighting	27	5	19%	33,959[1]	9,192
Student and Parent Energy-Efficiency Education	N/A	N/A	40%	5,376	2,150
Total	848	55	6%	81,249	10,851

Source: Survey question, "Including yourself, how many people lived in your home full-time during the past 12 months? (If Necessary: full-time is considered more than 9 months in the past year.)" and survey question, "In 2014, was your annual household income before taxes above or below $50,000?" and survey question, "Was your annual household income before taxes above or below $25,000?" and survey questions, "Please stop me when I read your category. Was it…?"

[1] Does not include verified savings for small commercial and industrial (C&I) upstream lighting component (cross-sector sales).

Table C-3: Federal Poverty Guidelines

Persons in Family	PY1	PY2	PY3	PY4	PY5	PY6
	2009 Continental U.S.[1]	2010 Continental U.S.[2]	2011 Continental U.S.[3]	2012 Continental U.S.[4]	2013 Continental U.S.[5]	2014 Continental U.S.[6]
1	$10,830	$10,830	$10,890	$11,170	$11,490	$11,670
2	$14,570	$14,570	$14,710	$15,130	$15,510	$15,730
3	$18,310	$18,310	$18,530	$19,090	$19,530	$19,790
4	$22,050	$22,050	$22,350	$23,050	$23,550	$23,850
5	$25,790	$25,790	$26,170	$27,010	$27,570	$27,910
6	$29,530	$29,530	$29,990	$30,970	$31,590	$31,970
7	$33,270	$33,270	$33,810	$34,930	$35,610	$36,030
8	$37,010	$37,010	$37,630	$38,890	$39,630	$40,090
For Each Additional Person Add	$3,740	$3,740	$3,820	$3,960	$4,020	$4,020

[1] U.S. Department of Health and Human Services. "2009 Poverty Guidelines." Available at: http://aspe.hhs.gov/2009-hhs-poverty-guidelines
[2] U.S. Department of Health and Human Services. "The HHS Poverty Guidelines for the Remainder of 2010 (August 2010)." Available at: http://aspe.hhs.gov/poverty/10poverty.shtml
[3] U.S. Department of Health and Human Services. "The 2011 HHS Poverty Guidelines." Available at: http://aspe.hhs.gov/poverty/11poverty.shtml
[4] Department of Health and Human Services. "The 2012 HHS Poverty Guidelines." Available at: http://aspe.hhs.gov/poverty/12poverty.shtml
[5] Department of Health and Human Services. "2013 Poverty Guidelines." Available at: http://aspe.hhs.gov/poverty/13poverty.cfm
[6] U.S. Department of Health and Human Services. "2014 Poverty Guidelines." Available at: http://aspe.hhs.gov/poverty/14poverty.cfm

Table C-4: PY5 Verified Gross Savings Attributable to Low-Income Participation in Non-Low-Income Programs

Program	Total Survey Respondents	Respondents Meeting FPL Guidelines	Percentage of Total Respondents	PY6 Verified Gross Impact (MWh/yr)	Savings Associated with FPL Population (MWh/yr)
Appliance Recycling	98	9	9%	9,255	850
Residential Home Comfort	118	4	3%	2,410	82
Residential Retail – Equipment	109	13	12%	2,875	343
Residential Retail – Lighting	129	12	9%	65,356[1]	6,080
Student and Parent Energy-Efficiency Education	N/A	N/A	33%	5,147	1,699
Total	641	84	N/A	85,043	9,053

Source: Survey question, "Including yourself, how many people lived in your home full-time during the past 12 months? (If Necessary: full-time is considered more than 9 months in the past year.)" and survey question, "In 2013, was your annual household income before taxes above or below $50,000?" and survey question, "Was your annual household income before taxes above or below $25,000?" and survey questions, "Please stop me when I read your category. Was it…?"

[1] Does not include verified savings for small commercial and industrial (C&I) upstream lighting component (cross-sector sales).

C.1 PY6 Survey Questions for Federal Poverty Level Guidelines

These questions were used to collect number of people in the household and household income. These data were used to determine low-income participation in non-low-income programs. (The letter and number sequence is taken directly from the survey instrument.)

D1. Including yourself, how many people lived in your home full-time during the past 12 months? (If Necessary: full-time is considered more than 9 months in the past year)

01. (1)
02. (2)
03. (3)
04. (4)
05. (5)
06. (6)
07. (7)
08. (8)
09. (9)
10. (10)
11. (11)
12. (12)
13. (Thirteen or more)
98. (Don't Know)
99. (Refused)

D2. In 2014, was your annual household income before taxes above or below $50,000?

1. (Below $50,000)
2. (Above $50,000) [SKIP TO D6]
3. (Exactly $50,000) [SKIP TO CLOSING]
98. (Don't Know) [SKIP TO CLOSING]
99. (Refused) [SKIP TO CLOSING]

[ASK IF D2=1]

D3. Was your annual household income before taxes above or below $25,000?

1. (Below $25,000)
2. (Above $25,000) [SKIP TO D5]
3. (Exactly $25,000) [SKIP TO CLOSING]
98. (Don't Know) [SKIP TO CLOSING]
99. (Refused) [SKIP TO CLOSING]

[ASK IF D3=1]

4. Please stop me when I read your category. Was it … [READ LIST]:

1. Under $10,000 [SKIP TO CLOSING]
2. $10,000 to under $15,000 [SKIP TO CLOSING]
3. $15,000 to under $20,000 [SKIP TO CLOSING]
4. $20,000 to under $25,000 [SKIP TO CLOSING]
98. (Don't Know) [SKIP TO CLOSING]
99.(Refused) [SKIP TO CLOSING]

[ASK IF D3=2]

D5. Please stop me when I read your category. Was it … [READ LIST]

1. $25,000 to under $30,000 [SKIP TO CLOSING]
2. $30,000 to under $35,000 [SKIP TO CLOSING]
3. $35,000 to under $40,000 [SKIP TO CLOSING]
4. $40,000 to under $45,000 [SKIP TO CLOSING]
5. $45,000 to under $50,000 [SKIP TO CLOSING]
98. (Don't Know) [SKIP TO CLOSING]
99. (Refused) [SKIP TO CLOSING]

[ASK IF D2=2]

6. Please stop me when I read your category. Was it … [READ LIST]

1. $50,000 to under $60,000
2. $60,000 to under $75,000
3. $75,000 to under $100,000
4. $100,000 to under $150,000
5. $150,000 to under $200,000
6. $200,000 or more

98. (Don't know)
99. (Refused)

APPENDIX D | RESIDENTIAL LIGHTING UPSTREAM PROGRAM CROSS-SECTOR SALES

D.1. INTRODUCTION

The upstream lighting component of PPL Electric Utilities' Residential Retail Program is intended for residential customers but, because incentives are paid directly to manufacturers, the actual participants are not known and small-business owners are assumed to make up a proportion of customers buying discounted bulbs from participating retailers. Because bulbs installed in commercial settings are subject to different assumptions that affect annual savings, in accordance with the Pennsylvania technical reference manual (TRM), the evaluation, measurement, and verification (EM&V) conservation service provider (CSP) conducted a study to estimate the proportion of the program bulbs purchased by commercial customers, referred to as "cross-sector sales."

D.2. METHODOLOGY

D.2.1 Surveys

Cadmus used data from general-population customer surveys, as well as from PPL Electric Utilities' customer records, to estimate the cross-sector sales proportion. Details regarding survey sampling and methodology can be found in the Residential Retail Process Report, Methodology section, and Addendum A. Participant Survey Attrition and Final Disposition.

Cadmus surveyed PPL Electric Utilities' general residential customer population and a subset of its small commercial customer base to estimate the percentage of customers (from each population) who purchased LEDs from a participating retailer in the previous six months.[172] Both surveys were conducted in the spring of 2015 to capture responses in roughly the same period of time and to avoid any potential bias due to seasonality, pricing changes, or other time-based factors that could contribute to changes in bulb-purchasing behavior.

D.2.2 Data Cleaning and Distribution Analysis

In reviewing and cleaning the resulting survey data, Cadmus considered responses to questions regarding business type, installation locations, and specific bulbs purchased. The EM&V excluded from the count of commercial respondents purchasing LEDs any who said they installed these bulbs in rental properties or any location other than their business. Also excluded from the count of LED purchasers were any residential respondents who appeared, based on responses to later questions, to have referred to CFLs rather than LEDs (i.e., they described the bulb shapes as "spiral" or "corkscrew" or either quoted a price consistent with a CFL or said all of their sockets had CFLs in them). Cadmus will take these observations into account when designing future survey instruments.

To ensure the appropriateness of applying the metrics gleaned from the small-commercial customer survey to PPL Electric Utilities' small commercial customer base, Cadmus compared the distribution of standard industrial classification (SIC) codes in the survey respondent group to the assumed population and found the distributions were similar. Cadmus excluded from the assumed customer base for this study records for customers with annual kWh usages outside of the range observed in the survey respondent

[172] Cadmus excluded customers with a GS3 rate code, as these larger businesses are not expected to purchase bulbs from retailers.

group and any customers with SIC code 4841, Cable and Other Pay Television Services, as these were determined to be fixed-usage accounts, not applicable to the assumed population. After making these adjustments to the population, a sum rank test of differences between the sample and the population was insignificant at 95% confidence.

D.2.3 Calculations

Cadmus computed metrics for the percentage of customers purchasing bulbs and the average number of bulbs they purchased, then multiplied these two metrics by each surveyed population's total customer base to compute a theoretical estimate of the number of bulbs purchased during the six-month period. Although these theoretical bulb purchases are not expected to be accurate—due mainly to recall bias about when respondents thought they made the purchase—such bias is expected to be similar between the two populations. Therefore, a relative proportion of bulbs purchased can be derived from these estimates. The computed metrics and resulting proportions are shown in Table D-1.

Table D-1: Metrics and Calculated Proportions, by Population

Population	Percentage of Respondents who Purchased LEDs from Participating Retailers		Average Number of LEDs Purchased per Respondent			PPL Customer Base	LEDs purchased from Participating Retailers by Small Commercial Customers	Percentage of Total (Cross-Sector Proportion)
	Estimate	n	Estimate	n	Std. Deviation		(% x Avg. # x Customer Base)	
Small Commercial	16%	385	12.20	61	25.90	126,000[1]	247,483	20%
Residential	14%	301	6.17	41	4.42	1,200,000	1,008,638	80%
Total						1,326,000	1,256,120	100%

[1]The small commercial customer base excludes rate codes not included in the survey sample, as well as static-usage customers (telecommunications accounts; SIC code 4841), and customers outside the kWh usage range observed in the survey respondent group.

D.2.4 Statistical Confidence and Final Recommendation for Proportional Adjustment

The cross-sector proportion is an estimate based on two variables derived from the customer survey—the percentage of respondents and the average number of bulbs purchased per respondent in each population. The percentage of purchasers in each population, based on a yes/no question, have large sample sizes (385 for commercial and 301 for residential), while the average number of bulbs is derived from the responses of a subset of each population, the respondents who actually purchased bulbs (n=61 commercial, n=41 residential), and these estimates have relatively large standard deviations.

To compute a statistical confidence interval, Cadmus ran simulations of the above computations, treating the distribution of the number of bulbs per respondent as a normally distributed random variable and the percentage of purchasers as a uniform random variable. At 90% confidence, the resulting cross-sector proportion lies between 11% and 29%.

Cadmus recommended that PPL Electric Utilities continue to use 12% as the assumed proportion of program bulbs being purchased by commercial customers (as it has been doing since the original analysis in PY4). Although this is very close to the bottom end of a relatively wide confidence range, given the uncertainty in the estimation of purchase behavior based on self-report survey data and the relatively significant effect on savings, as described in Section 0, below, it is appropriate to use a conservative estimate.

D.3 SAVINGS INPUTS AND IMPACT

The 2015 Pennsylvania TRM gives the following general equations for computing lighting energy savings:[173]

$$\Delta kWh/yr = \frac{Watts_{base} - Watts_{LED}}{1000\,\frac{W}{kW}} \times HOU_{effbulb} \times (1 + IE_{kWh}) \times 365\frac{days}{yr} \times ISR_{effbulb}$$

$$\Delta kW_{peak} = \frac{Watts_{base} - Watts_{LED}}{1000\,\frac{W}{kW}} \times CF \times (1 + IE_{kW}) \times ISR_{effbulb}$$

The assumptions regarding hours of use (HOU), coincidence factor (CF), and installation rate (ISR) vary by sector. These assumptions are deemed for the residential sector (HOU= 2.8 hrs/day; CF = 0.091; isr = 97%). For the bulbs assumed to be purchased by the small commercial sector, Cadmus used the HOU and CF assumptions, by building type from Table 3-6 in the 2015 TRM. Using these data, Cadmus computed a weighted average for each business type by (1) mapping the business types of respondents who purchased LEDs from participating retailers to a TRM building type, and (2) using the proportion of the total LEDs reported to have been purchased by the respondents associated with each building type. These assumptions, and the distribution of LEDs purchased by respondent business type, are shown in Table D-2.

Table D-2: Hours-of-Use (HOU) and Coincidence Factor (CF) Assumptions, by Building Type

Respondents Who Purchased LEDs from Participating Retailers			2015 TRM		
Business Type	% of Respondents	% of LEDs	HOU	CF	Source
Agriculture	8%	32%	3,118	0.57	Avg. of Ind. Manufacturing 1&2 Shifts, Office, Warehouse
Auto related	2%	1%	4,056	0.62	
Construction	6%	7%	2,567	0.61	
Education	2%	1%	1,990	0.54	Avg. of School/College/Univ
Grocery store/convenient store	3%	3%	4,660	0.87	
Healthcare/hospital	3%	2%	3,213	0.73	
Industrial/manufacturing	3%	7%	4,739	0.57	Avg. of 1,2,3 shifts
Libraries	2%	3%	2,566	0.62	
Lodging/hospitality	5%	2%	4,399	0.50	Avg. of Guest Rooms/Common Spaces
Office	16%	13%	2,567	0.61	

[173] The 2014 TRM uses the same algorithms.

Respondents Who Purchased LEDs from Participating Retailers			2015 TRM		
Business Type	% of Respondents	% of LEDs	HOU	CF	Source
Other	11%	4%	2,628	0.62	
Public Services (nonfood)	2%	0%	3,425	0.62	
Religious Worship/Church	2%	0%	1,810	0.62	
Restaurant	21%	16%	3,613	0.65	
Retail	15%	7%	2,829	0.73	
	Avg., weighted by % of LEDs		3,208	0.62	
	HOU/day (Avg. /365)		8.79		

Cadmus used survey data to compute an ISR by dividing the total number of recently purchased bulbs that were currently installed by the total number of recently purchased bulbs. The effect of the proportional split, and the different assumptions for the residential vs. commercial sector, are illustrated in Table D-3.

Table D-3. Assumptions Used and Savings Example

Sector	Delta W (13W A-Line LED)	HOU/day	ISR	CF	IEkWh Factor	IEkW	Per-Bulb kWh Savings	% of Bulbs	Savings per Program Bulb (kWh)	Proportion of Total Savings
Residential	30	2.8	97%	0.091	0.94	1.12	27.96	88%	24.60	68%
Commercial	30	8.79	89%	0.62	1.12	1.34	95.61	12%	11.47	32%
Total								**100%**	**36.07**	**100%**

D.4 CALCULATING UNCERTAINTY FOR RESIDENTIAL RETAIL PROGRAM LIGHTING SAVINGS

In this study of discounted LEDs, the estimate included a cross-sector sales (CSS) adjustment where population sizes, proportion of respondents who purchased bulbs (survey estimate), and the average number of bulbs they purchased at participating retailers (survey estimate) were combined into a ratio of the total commercial bulbs to total bulbs in both sectors. Because both the numerator and denominator of the CSS adjustment were estimated with uncertainty, the variance of the ratio has no closed form solution and commonly used methods were not applicable.

Therefore, we used a statistical simulation study to generate 100,000 realizations of the proportion of purchasers in each sector and respective bulb quantities purchased using means and variances equal to observed survey means and variances. We calculated the cross-sector sales adjustment and energy savings for each realization, and then estimated the variability in savings across the realizations. We estimated precision for energy savings by calculating the 5th and 95th percentile of their distribution which we used to estimate the confidence interval around the total savings and to report precision. We set the precision of the demand savings equal to that of the energy savings because demand savings were estimated by applying a fixed multiplier to the energy savings, depending on the customer sector and the TRM used. Based on the variance in the realizations, we estimated precision for energy and demand savings at 12%.

APPENDIX E | DEMAND ELASTICITY STUDY

To provide estimates of freeridership for the upstream lighting component of the Residential Retail program, Cadmus conducted demand modeling using bulb sales information from the program's implementation CSP, Ecova.

E.1 INTRODUCTION

Lighting products that incur price changes and promotion over the program period provide valuable information regarding the correlation between sales and prices. Using the price elasticity to estimate freeridership is the same principle in willingness-to-pay analyses using self-report survey responses as in Phase I. However, rather than relying on self-report data, elasticities are based on actual observed changes in purchasing behavior in response to program activity.

Demand elasticity modeling is based on the same economic principle driving program design: that a change in price and promotion generates a change in quantities sold (i.e., the upstream buy-down approach). Demand elasticity modeling uses sales and promotion information to achieve the following:

- Quantify the relationship of price and promotion to sales;
- Determine the likely sales level without the program's intervention (baseline sales); and
- Estimate freeridership by comparing modeled baseline sales with actual sales.

After estimating variable coefficients, Cadmus used the resulting model to predict: sales that would occur without the program's price impact; and, sales that would occur with the program (and should be close to actual sales with a representative model). Freeridership is then calculated using this formula:

$$FR\ Ratio = \left(\frac{Savings\ without\ Program}{Savings\ with\ Program}\right)$$

E.2 INPUT DATA

As the demand elasticity approach relies exclusively on program data, a model's robustness depends on data quality. Overall, available data achieved a sufficient quality to support the analysis; however, the data also presented several issues of note.

E.2.1 Data Quality Issues

Because price is the primary factor that represents program activity in the model it is critical that prices are measured consistently and accurately. Cadmus conducted preliminary modeling to verify the quality of the data and identify potential issues. The results of the preliminary modeling indicated several anomalies.

- Erratic price changes, for example, one product had an incentive of $7 per bulb for most months, then the incentive increased for a month by 11% to $7.75, then the following month the incentive decreased sharply by 43% to $4, then returned to $7. It's possible that the incentive was changed to slow sales down after a big sale, but the sharp increase in price for only one month then returning to the price prior to the big sale is a little suspect. Additionally, we would expect a sharp drop in sales with such a dramatic increase in price, which was not observed.
- In some instances at one particular retailer, sales declined sharply, dropping from near 2,000 packs per month to near zero for several months, shortly after a price drop and sales never rebounded.

- There were also some inexplicable spikes in sales that occurred across products at one particular retailer that were not related to price changes.
- Some products did not appear to be stocked consistently, with positive sales for a month or two consecutively, but then having zero or missing sales for multiple consecutive months, including months where prices decreased. Cadmus has learned from other similar evaluations that some retailers are franchises rather than corporate chains, which means that their stocking patterns are not centrally determined and can fluctuate. These products exhibited extreme elasticities, some positive, indicating price and sales were positively correlated, and some negative. Thus these products were removed from the analysis.

Cadmus reviewed all available additional data to try to resolve some of the anomalies in the data. Our efforts to resolve each of these anomalies are described below.

E.3 RESOLVING THE ANOMALIES

The monthly reports also included a pull sheet, which was a snapshot of products that were currently featured in the program within each retailer and the target price. Cadmus attempted to compare the prices captured in the monthly reports and those reported in the sales data used the analysis when there were anomalies. However, as the pull sheets were included as a picture in PDF document (and therefor difficult to extract the information from), and sometimes the sales data included sales for a product that was not featured in the pull sheets, Cadmus concluded that utilizing the pricing data from the pull sheets was not a viable alternative to supplant the information contained in the comprehensive sales data.

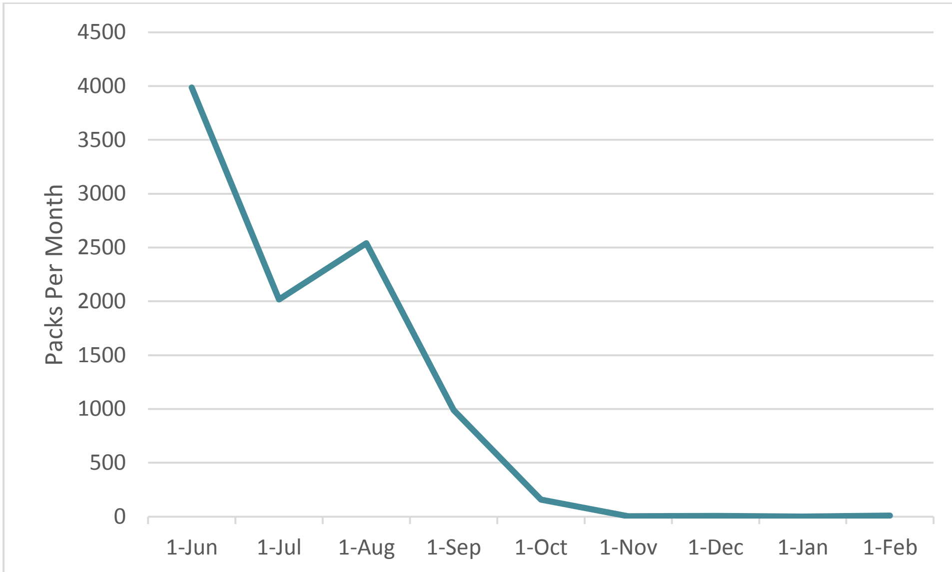
Additionally, because the sales data sometimes contained sales for products that were not captured in the pull sheets, and the difficult nature of compiling all of the pull sheets to do a comprehensive comparison, Cadmus also did not rely on the pull sheets to account for sales of products dropping to near zero.

Products with precipitous drops were assumed to have been out of stock if the sales dropped to zero or near zero and never rebounded before the end of the program year. All of the stocking issues were within one retailer. The most likely explanation for the stocking issues is that products were being replaced by the manufacturer as a similar product to the one featured in the example began selling in October of 2014 but has the opposite pattern. Sales begin slowly then take jump sharply starting in 2015. This is likely due to the retailer exhausting back-stock of the old product being phased out and the new product being phased in.

Figure E-1 shows an example of one product that was flagged as being out of stock beginning October of 2014.

All of the stocking issues were within one retailer. The most likely explanation for the stocking issues is that products were being replaced by the manufacturer as a similar product to the one featured in the example began selling in October of 2014 but has the opposite pattern. Sales begin slowly then take jump sharply starting in 2015. This is likely due to the retailer exhausting back-stock of the old product being phased out and the new product being phased in.

Figure E-1. Example of Stocking Issue



E.3.1 Price Variation

Cadmus identified instances where the reported promotional price was significantly different than the difference between the regular retail price and the program incentive. To resolve this discrepancy Cadmus created an assumed price that was equal to the regular price absent the program incentive.

Overall there was a substantial number of products that exhibited price variation within PY6. There was variation in price within most of the retailers as well as within all but one lamp style. The only style not represented in the model was the GU10 lamps, which only accounted for 113 total lamps out of over one million. The greater the level of price variation across retailers and lamp styles the more representative the elasticity estimates are when applied to the portion of the program that did not exhibit price variation, and therefore was not included in the model.

All available data were used for this analysis in PY6. Overall the model relied on products with price variation that accounted for 61% of total lamp sales in PY6[174].

E.3.2 Promotional Displays

Cadmus reviewed additional data from the ICSP included in their monthly reports of program activity. The monthly reports included descriptions of visits to retail locations and description of the table-top, customer engagement activities. One of the key pieces of information contained in these reports, at least for the reports in 2014, was whether any additional merchandising, defined as off-shelf placement (such as end caps) or special displays, occurred within a given store.

[174] Products with no price variation provide no information to quantify the relationship between sales and price and are therefore not included.

The monthly reports were limited in several key aspects, however. The reports were not comprehensive in that the ICSP visited only a sample of stores in any given month. The reports also did not capture specific products that were featured in the off shelf displays or promotions.

The descriptions of merchandising, though, again, not comprehensive, did show patterns across multiple locations within the same retail chain. This would be expected as corporate retailers often prioritize consistency across their stores. Therefore Cadmus assumed for the large retail chains that the off-shelf placements were in place across all locations within the indicated time periods.

Cadmus also assumed that all products from the stated manufacturer in the monthly reports were featured in the merchandising. This assumption has greater implications than the previous assumption of merchandising across all locations.

First, this assumption is likely to be untrue. Retailers often have minimum sales thresholds for products that they feature in the off-shelf displays and not all products from a given manufacturer are likely to qualify. This means that we are assuming a sales lift for products that are unlikely to be displayed, creating an upward bias.

However, the other impact of assuming across all products means that the average sales lift from merchandising is likely driven by only one or two products but averaged across many that were not. This creates downward bias and likely understates the sales lift generated by the merchandising.

Because the impact of merchandising is substantial, Cadmus believes that the above assumptions are reasonable to include in the model, though we are working with the ICSP to improve data tracking for subsequent program years to address this issue.

Through these reports Cadmus was able to identify several months where Cree products were featured on end cap displays or had special off-shelf, branded cardboard displays as well as a truckload sale at one particular retailer.

An important limitation, however, was that the level of detail in the reports was much more limited in 2015. The retailer visit descriptions contained much less detail and fewer pictures of the ICSP's table-top, customer engagement events. The change in the level of detail meant that no merchandising events were identified in 2015, so any program activity that occurred, other than price changes, could not be accounted for.

E.3.3 Seasonality Adjustment

In economic analysis, it is critical to separate data variations resulting from seasonality from those resulting from relevant external factors. For example, suppose prices had been reduced on umbrellas at the beginning of the rainy season. Any estimate of this price shift's impact would be skewed if the analysis did not account for the natural seasonality of umbrella sales.

To adjust for seasonal variations in sales, Cadmus used a monthly seasonal trend provided by a major national lighting manufacturer via the implementer for another recent evaluation. This represented national sales of CFLs. Ideally, a trend would derive from historical data on aggregate sales of lighting products (e.g., inefficient and efficient, program and non-program). Such data would represent overall trends in lighting product sales and would not suffer from potential confounding with programmatic activity to the same degree as CFL sales.[175] However, the trend provided represented aggregated, nationwide CFL sales for a specific manufacturer.

Presumably, the trend includes some activity from various programs across the nation which could affect the sales trend, potentially leading to underestimated program impacts. However, we assume that program activity is somewhat random across all of the programs that could be included in the sales data used to develop the trend. In that case, program activity would be spread through the year and the variation between months would be driven primarily by non-program factors. Nevertheless, not controlling for seasonal variations could lead to program impact being overestimated by falsely attributing seasonal trends to price impacts (to the degree that they co-varied), or vice versa.

For example, July tends to be a month with lower sales (presumably due to longer daylight hours) so if program activity increased sales in July, not controlling for seasonal variation would underestimate the program's impact. October, on the other hand, is a month with higher sales, and no control for seasonality would likely overestimate the impact of program activity occurring in that month.

Another option to account for seasonality considered was to use monthly fixed effects to control for differences between months and results were compared to the model using the trend. In the fixed effects case, however, some price changes and merchandising activity were concentrated within the same month, and using fixed effects attributed program impacts to monthly averages, therefore underestimating the program impacts. Additionally, the fit statistics (AIC and BIC) as well as the comparison of predicted and actual sales indicated the trend model was preferable.

E.3.4 Model Representativeness

The model utilized products accounting for 61% of total lamp sales. As shown in Table E-1, the model utilized data from products that accounted for a majority of sales within each lamp style, increasing the robustness and representativeness of the elasticity estimates. The model represented over half of A-line LED sales and 79% of reflector sales, which together account for 85% of all program sales.

[175] This assumes aggregate lighting sales did not change due to promotions; that is, customers simply substituted an efficient product for an inefficient one. While bulb stockpiling could occur during programmatic periods, this should smooth out over time, as the program would not affect the number of sockets in the home.

Table E-1. Proportion of Lamp Sales in Model by Lamp Style

Lamp Style	Total Sales in Model Data	Total Program Sales	Proportion of Sales Modeled
LED A-Line	300,075	556,163	54%
LED Candelabra	23,452	66,215	35%
LED Globe	37,629	51,130	74%
LED MR16	210	530	40%
LED PAR30	5,368	5,496	98%
LED Reflector	232,923	293,956	79%
LED Retro-Fit	10,513	29,013	36%

E.3.5 Model Specification

Cadmus modeled bulb and pricing data using an econometric model. The study modeled these data as a panel, with a cross-section of program package quantities for each unique retail location/SKU combination modeled over time as a function of price, retail channel (DIY, Big Box, Club), and bulb type (general purpose or specialty). This involved testing a variety of specifications to ascertain price impacts—the main instrument affected by the program—on the demand for bulbs. The team estimated the basic equation for the model as follows (for cross-section *i*, in month *t*):

Equation 1

$$\ln(Q_{it}) = \sum_{\pi}(\beta_{\pi} ID_{\pi,\mathrm{i}}) + \sum_{\theta,\delta}(\beta_{\theta 1,\delta 1}[ln(P_{it}) * (Retail\ Channel_{\delta}) * (Bulb\ Type_{\delta})]) + \beta_1 Display + \beta_2 OutofStock \ + \alpha Time\ Trend_t + \varepsilon_{it}$$

Where:

- ln = Natural log
- Q = Quantity of bulb packs sold during the month
- P = Retail price in that month
- Store Type = Retailer category (DIY, Big Box, Club)
- Bulb Type = Product category (General Purpose or Specialty)
- ID = Dummy variable equaling 1 for each unique retail location and SKU; 0 otherwise
- Display = Dummy variable equaling 1 if a products was featured in an off-shelf display in time period t
- OutofStock = Dummy variable equaling 1 if a products was assumed to have been out of stock in time period t
- Time Trend = Quantitative trend representing the impact of secular trends not related to the program[176]
- ε_{it} = Cross-sectional random-error term in time period *t*

---

176 The time trend for this analysis represents shifts in sales due to non-program related seasonality.

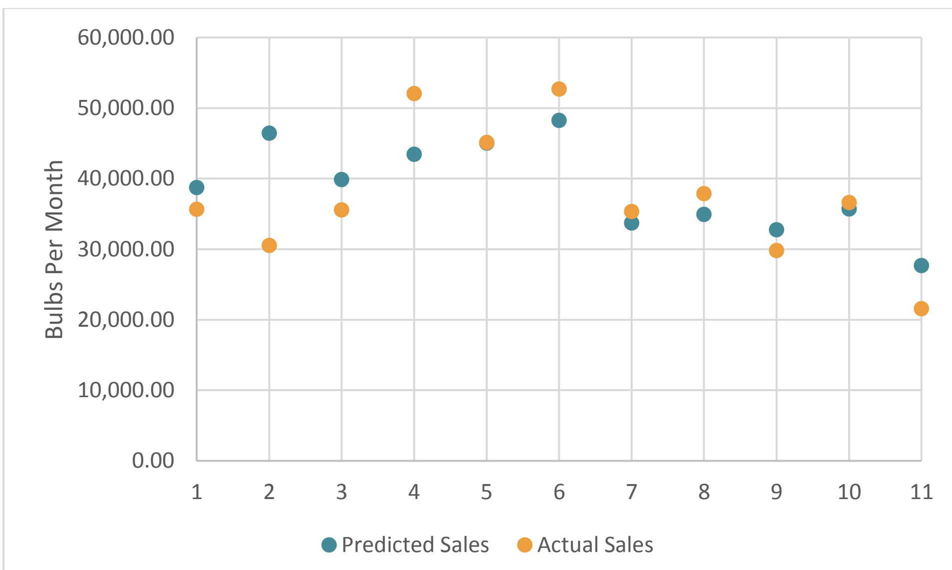
The model specification assumed a lognormal distribution. This distribution serves as the best fit of the plausible distributions (negative binomial, poisson, negative binomial, or gamma).

Cadmus ran numerous model scenarios to identify the model with the best parsimony and explanatory power using the following criteria:

- Model coefficient p-values (keeping values less than <0.1);[177]
- Explanatory variable cross-correlation (minimizing where possible);
- Model AIC (minimizing between models);[178]
- Utilizing the heteroskedastic consistent covariance matrix and clustered standard errors to account for hetroskedasticity;
- Minimizing multicollinearity; and
- Optimizing model fit.

The fit of the model can be examined by comparing the model-predicted sales with the actual sales. As can be seen in Figure E-2, the model-predicted sales match very closely the actual sales with no persistent bias in a single direction (over or under-predicting), indicating that the model is fitting the data well. The model does over predict in month two and under predict in months four and six, but overall the predictions fit actual sales well and over-predicts sales by 3%.

Figure E-2. Predicted and Actual Sales by Month



177 Where a qualitative variable had many states (such as bulb type), Cadmus did not omit variables if one of the states was not significant, but rather considered the joint significance of all states. The team used robust estimation of model standard errors to properly represent model accuracy and to guide the specification process. The error structure involved clustering around cross-sectional units.

178 Akaike's Information Criteria (AIC) was used to assess model fit, as the R-square statistic is undefined for nonlinear models. AIC also has the desirable property that it penalizes overly complex models, similar to the adjusted R-square.

The model coefficients varied depending on retail channel and lamp style. Lamps sold at big box retailers were the most sensitive to price changes and DIY lamps were least price sensitive. However, the DIY retailers had sufficient detail in the monthly reports to identify off-shelf placement. The display coefficient indicates that when a product is featured in a displays, sales increase by 68%, on average. All model coefficients were statistically significant.

Table E-2. Model Coefficient Estimates

Parm	Level1	Level2	Estimate	StdErr	LowerCL	UpperCl	Z-score	ProbZ
Elasticities	BigBox	Specialty	-2.47	0.83	-4.09	-0.85	-2.99	0.00
	BigBox	Gen Purpose	-2.61	1.08	-4.72	-0.49	-2.42	0.02
	Club	Specialty	-0.88	0.30	-1.47	-0.28	-2.88	0.00
	Club	Gen Purpose	-1.69	0.71	-3.08	-0.29	-2.37	0.02
	DIY	Specialty	-0.95	0.18	-1.31	-0.58	-5.11	<.0001
	DIY	Gen Purpose	-0.71	0.13	-0.97	-0.46	-5.52	<.0001
Display	-	-	0.68	0.04	0.60	0.75	17.61	<.0001
Out of Stock	-	-	-5.06	0.33	-5.71	-4.40	-15.18	<.0001

The big box retailers and club stores did not provide display data that enabled estimating separate impacts of displays and price. It is possible, in fact, likely, that there were off-shelf displays at the non-DIY retailers that were not captured. This could bias the elasticity estimates to the degree that off-shelf placement and prices co-varied.

E.4 FINDINGS

Cadmus estimated an overall net of freeridership ratio of 52% (Table E-3).

Table E-3: Modeling Results by Product Type

Store Type	General Purpose	Elasticity Estimate	Markdown	Sales with Merch Display	Net of Free Rider Sales
BigBox	No	-2.47	54%	0%	84%
	Yes	-2.61	66%	0%	90%
Club	No	-0.88	59%	0%	58%
	Yes	-1.69	47%	0%	67%
DIY	No	-0.95	37%	10%	39%
	Yes	-0.71	41%	26%	43%
Overall Program Net of Freeridership					52%

The results of the elasticity model suggest that freeridership varies by retail channel,[179] with Do-It-Yourself store shoppers being least price sensitive (or the prices are already competitive), and Mass Market and Club stores are more price sensitive. The model estimated freeridership to be roughly 14% for big box stores, roughly 40% for club stores, and roughly 58% for DIY stores. The differences may be due to differences in customer demographics, and the size of price discounts offered in the stores.

This estimate only accounts for freeridership estimated in PY6. The model cannot account for any spillover or market effects. The market effects could be particularly important at the DIY stores as one major store that accounted for nearly 40% of all program sales completely redesigned their lighting aisle to feature LEDs at the front. There is no way to quantify the program's impact on this decision. However, the program incentives have helped LEDs reach price points that, according to manufacturers and retailers, as well as the willingness-to-pay responses, are price thresholds at which many more potential customers are likely to consider purchasing LEDs.

The program also features customer engagement and education events, where implementation staff interact with customers to help them choose between all of the available options of bulbs and color temperatures. The model cannot distinguish customers who may have been convinced to try an LED via one of these events and then returned to purchase additional bulbs.

[179] The individual estimated coefficients – elasticities by channel as well as displays – and model results are presented in detail in Appendix E.

APPENDIX F| ENERGY-EFFICIENCY BEHAVIOR & EDUCATION PROGRAM SAVINGS COUNTED IN OTHER PPL ELECTRIC ENERGY-EFFICIENCY PROGRAMS

The Energy Efficiency Behavior & Education Program savings reflect both behavioral changes, such as turning off lights in unoccupied rooms and adjusting thermostat settings as well as investments in energy-efficiency measures, such as in high-efficiency furnaces and CFLs. In PY6, some customers who installed efficiency measures because of home energy reports (HERs) may have received rebates from PPL Electric for installing the measures. In such cases, home energy reports savings arising from installation of measures rebated through PPL Electric's energy efficiency programs will be counted by the Energy Efficiency Behavior & Education Program and the rebate program. These savings will be double counted unless they are subtracted from the residential portfolio savings.

This section estimates the impacts of the Energy Efficiency Behavior & Education Program on participation in PPL Electric's residential efficiency programs and the energy savings from participation. In PY6, the total Behavior and Education Program savings from efficiency program participation was 12.94 MWh/yr. These savings were subtracted from the residential portfolio, not from the Behavior and Education Program.

F.1 APPROACH FOR ESTIMATING HOME ENERGY REPORTS SAVINGS FROM PARTICIPATION IN PPL ELECTRIC RESIDENTIAL REBATE PROGRAMS

Estimating HER savings from PPL Electric efficiency program participation is relatively straightforward 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 benefits of installing Measure A, which is promoted by the utility. Customers in the treatment and control groups are assumed to have received the same marketing and incentives from the utility for the program promoting Measure A. Because customers were randomly assigned to the treatment and control groups, the program effect on installation of Measure A can be estimated as the difference between the groups in the installation of the measure, and the savings from any difference in installation rates of Measure A can be attributed to the behavioral program. If the difference is installations is Δn_A and the per-unit deemed savings are s_A, then the Behavior and Education savings from installation of Measure A would be $\Delta n_A * s_A$. We refer to any difference in the rate of participation and savings as "participation uplift" and "savings uplift."

F.2 DOWNSTREAM REBATE PROGRAMS

For measures promoted by utility programs and tracked at the customer level, the participation and savings uplift was estimated by matching Energy Efficiency Behavior & Education Program treatment and control group customers to the PY6 energy efficiency program participation data in EEMIS.[180] Next, the differences between treatment and control groups in PY6 rates of rebate program participation and rebated savings per home was calculated, and the difference in average savings per home was multiplied

[180] Each PY6 measure in EEMIS includes an estimate of the annual savings and records the date that the measure was installed. For the double-counting analysis, the annual savings were prorated using a simple formula to account for the fact that rebated measures were installed throughout PY6. The formula multiplied the annual savings by the percentage of PY6 that the measure was installed. The prorated savings may overstate savings for some weather-sensitive measures while understating them for other measures; however, it is expected that the prorated savings will be correct on average.

by the number of treated homes with active accounts in PY6. The result were estimates of Energy Efficiency Behavior & Education Program effect on the rate of efficiency program participation and the savings from participation in other PPL Electric programs.

Homes in the behavior program treatment and control groups could participate in five downstream PPL Electric rebate programs in PY6. The Appliance Recycling, E-Power Wise, Residential Retail, Low Income WRAP, and Residential Home Comfort.

Table F-1, Table F-2, and Table F-3 show the following for, respectively, the Legacy 1 Group, Legacy 2 Group, and Expansion Group:

- Savings uplift, that is, home energy report savings from participation in PPL Electric residential rebate programs (columns 5 and 6)
- Program uplift, that is, the effect of the behavior program on the participation rate in PPL Electric's efficiency programs (columns 7 and 8).

For each efficiency program, the tables present Behavior and Education Program participation and savings uplift estimates on a per home basis and for all treated homes. The bottom rows of the tables shows the estimates for each group across efficiency programs.

Table F-1: Behavioral and Education Program Savings for Legacy Group 1 Counted in Downstream Rebate Programs[1]

Program	Treatment Group		Control Group		Difference (Treatment - Control)			
	(1) Per Home *Ex post* Verified Savings (kWh/yr)	(2) Participation Rate	(3) Per Home *Ex post* Verified Savings (kWh/yr)	(4) Participation Rate	(5) Verified *Ex post* Net Verified Savings per Home (kWh/yr)	(6) Program *Ex post* Net Verified Savings (MWh/yr)	(7) Participation Uplift	(8) Percent Participation Uplift
Appliance Recycling	4.01	0.52%	4.03	0.52%	-.02	-76.89	0%	0%
E-Power Wise Program	0.22	0.04%	0.26	0.04%	0.18	69.20	0%	0%
Residential Retail	0.91	0.10%	0.60	0.05%	0.31	11.92	0.05%	1%
Low Income WRAP	1.13	0.09%	0.88	0.07%	0.25	96.11	0.02%	0.29%
Residential Home Comfort	2.96	0.28%	2.99	0.28%	-.03	-11.53	0%	0%
Total [2]	**9.22**	**1.01%**	**8.76**	**0.97%**	**0.46**	**17.69**	**0.04%**	**4.12%**

[1] *Ex post* savings (Columns 1 and 3) are PY6 verified gross savings in treatment and control group homes. Participation Rate (Columns 2 and 4) are PY6 rates of participation for treatment and control group homes. Columns 5-8 show the energy reports impacts on efficiency program participation and savings by taking the difference between treatment and control groups. Column 5 shows the average energy report savings per treated home from efficiency program participation. Column 6 shows the energy report savings from efficiency program participation for all treated customers. Column 7 shows the energy report effect on the rate of efficiency program participation. Column 8 shows the energy report percent effect on efficiency program participation, obtained by taking the ratio of Column 8 to Column 4.

[2] The sum of the rows may not add up to the row total because customers can participate in more than one program.

In Legacy Group 1, energy reports only increased overall efficiency program participation in PY6 by 0.04% and Behavior and Education Program savings by 18 MWh or just 0.2% of the energy reports savings (8,487 MWh/year). The participation and savings uplift was small for two reasons. First, the Behavior and Education Program only covered the final eight months of PY6. Second, many Legacy Group 1 treated customers had already participated in PPL Electric efficiency programs during Phase 1 of Act 129. Encouragement to participate in efficiency programs was expected to be less effective for customers that have previously received encouragement.

Table F-2: Behavioral and Education Program Savings for Legacy Group 2 Counted in Downstream Rebate Programs[1]

Program	Treatment Group		Control Group		Difference (Treatment - Control)			
	(1) Per Home *Ex post* Verified Savings (kWh/yr)	(2) Participation Rate	(3) Per Home *Ex post* Verified Savings (kWh/yr)	(4) Participation Rate	(5) Verified *Ex post* Net Verified savings per home (kWh/yr)	(6) Program *Ex post* Net Verified Savings (MWh/yr)	(7) Participation Uplift	(8) Percent Participation Uplift
Appliance Recycling	4.82	0.60%	4.68	0.58%	0.14	61.43	0.02%	0.03%
E-Power Wise Program	0.43	0.07%	0.56	0.10%	-0.13	-57.04	-0.03%	-0.30%
Residential Retail	1.23	0.12%	0.91	0.09%	0.32	14.04	0.03%	0.33%
Low Income WRAP	1.34	0.10%	1.12	0.08%	0.22	96.53	0.02%	0.25%
Residential Home Comfort	4.32	0.47%	6.04	0.46%	-1.72	-75.47	0.01%	0.02%
Total[2]	**12.14**	**1.33%**	**13.31**	**1.27%**	**-1.17**	**-51.34**	**0.06%**	**4.72%**

[1] *Ex post* savings (Columns 1 and 3) are PY6 verified gross savings in treatment and control group homes. Participation Rate (Columns 2 and 4) are PY6 rates of participation for treatment and control group homes. Columns 5-8 show the energy reports impacts on efficiency program participation and savings by taking the difference between treatment and control groups. Column 5 shows the average energy report savings per treated home from efficiency program participation. Column 6 shows the energy report savings from efficiency program participation for all treated customers. Column 7 shows the energy report effect on the rate of efficiency program participation. Column 8 shows the energy report percent effect on efficiency program participation, obtained by taking the ratio of Column 8 to Column 4.

[2] The sum of the rows may not add up to the row total because customers can participate in more than one program.

In the Legacy Group 2, energy reports increased efficiency program participation in PY6 by 0.06%, but the estimate of Behavior and Education Program savings from efficiency program participation was -51 MWh. Uplift savings were negative because control group customers participated in the E-Power Wise and Residential Home Comfort programs at higher rates than treatment group customers. Again, a likely explanation for this result is that treated customers had already received encouragement to participate in PPL Electric's rebate programs during Phase 1 of Act 129.

Table F-3: Behavioral and Education Program Savings for Expansion Group Counted in Downstream Rebate Programs [1]

Program	Treatment Group		Control Group		Difference (Treatment - Control)			
	(1) Per Home *Ex Post* Verified Savings (kWh/yr)	(2) Participation Rate	(3) Per Home *Ex Post* Verified Savings (kWh/yr)	(4) Participation Rate	(5) Verified *Ex Post* Net Verified savings per home (kWh/yr)	(6) Program *Ex Post* Net Verified Savings (MWh/yr)	(7) Participation Uplift	(8) Percent Participation Uplift
Appliance Recycling	3.54	0.44%	2.98	0.38%	0.56	26.34	0.06%	0.16%
E-Power Wise Program	0.15	0.03%	0.22	0.04%	-0.07	-32.94	-0.01%	-0.25%
Residential Retail	0.76	0.07%	0.36	0.07%	0.40	18.83	0%	0%
Low Income WRAP	0.44	0.03%	0.38	0.03%	0.06	28.23	0%	0%
Residential Home Comfort	3.82	0.42%	3.79	0.38%	0.03	14.11	0.04%	0.11%
Total[2]	**8.72**	**0.97%**	**7.73**	**0.87%**	**0.99**	**46.59**	**0.10%**	**11.49%**

[1] *Ex post* savings (Columns 1 and 3) are PY6 verified gross savings in treatment and control group homes. Participation Rate (Columns 2 and 4) are PY6 rates of participation for treatment and control group homes. Columns 5-8 show the energy reports impacts on efficiency program participation and savings by taking the difference between treatment and control groups. Column 5 shows the average energy report savings per treated home from efficiency program participation. Column 6 shows the energy report savings from efficiency program participation for all treated customers. Column 7 shows the energy report effect on the rate of efficiency program participation. Column 8 shows the energy report percent effect on efficiency program participation, obtained by taking the ratio of Column 8 to Column 4.

[2] The sum of the rows may not add up to the row total because customers can participate in more than one program.

In the Expansion Group, energy reports had the expected uplift in PY6, increasing efficiency program participation by 0.1% and Behavior and Education Program savings by 47 MWh or 0.8% of the energy reports savings (5,651 MWh/yr). The Behavior and Education Program had the greatest impacts on the Appliance Recycling and Residential Home Comfort programs.

The total Behavior and Education Program energy savings from participation in PPL Electric's downstream efficiency programs was about 13 MWh/yr or 0.04% of PY6 savings. Refer to Table F-4 for the program uplift energy savings.

Table F-4: PY6 Summary Table for Double-Counted Energy Savings

Program	Double Counted Energy Savings (MWh/yr)	PY6 Double Counted Savings as Percentage of Behavior and Education Program Savings
Legacy 1	17.69	0.2%
Legacy 2	-51.34	-0.3%
Expansion	46.59	0.8%
Total	**12.94**	**0.04%**

The program uplift savings were subtracted from PPL Electric's residential portfolio savings in PY6 to avoid double counting them.

F.3 UPSTREAM PROGRAMS (LEDS)

The overlap of Energy Efficiency Behavior & Education Program savings and the Residential Retail Program's upstream lighting savings was not estimated because the Residential Lighting program does not track participation at the customer level.

APPENDIX G | METHODOLOGY FOR DETERMINING SAVINGS FROM ENERGY-SAVINGS KITS

This appendix explains the criteria used to assign survey *ex post* savings for kit products and behaviorally based energy savings for the E-Power Wise Program and the Student and Parent Energy-Efficiency Education Program in PY6.

G.1 INTRODUCTION

Cadmus used an individual respondent-level savings methodology for calculating program savings associated with behavior change components and non-behavior-based products. With this methodology, survey-verified savings were applied only to respondents who met certain fuel type criteria and who answered questions on surveys and enrollment cards.

Cadmus assigned specific survey *ex ante* and survey-verified savings values to each respondent for each product using these variables:

- Whether or not the respondent answered the product-specific question (regardless of the answer)
- Home characteristics recorded on the respondent's enrollment card (i.e., gas versus electric heat)
- The respondent's answers to the installation and behavior questions

Measure-level survey *ex ante* savings were equal to the 2014 Pennsylvania Technical Reference Manual (in effect in PY6) adjusted *ex ante* savings for all product-specific questions answered except for energy education.[181] The survey *ex ante* calculation procedure for energy education and the updated behavior savings custom measure protocol (CMP) for the E-Power Wise Program can be found in Appendix H|E-Power Wise Behavior Savings Calculations.

Table G-1 and Table G-2 contain questions used to calculate survey-verified *ex post* savings.

[181] Pennsylvania Public Utility Commission. *Technical Reference Manual.* 2014. Available online: http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

Table G-1: Example Energy-Savings Kit Survey Questions for Products

Measure	Survey Question	Possible Responses
Furnace Whistle	Did you install your new FilterTone Alarm from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No
Smart Strip	Did you install the 7-Plug Smart Strip from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No
LED	How many LEDs from your Kit did you install?	Both
		One
		None
Faucet Aerator	Did you install the new Kitchen Faucet Aerator from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No
Low-Flow Showerhead	Did you install the new High-Efficiency Showerhead from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No
LED Nightlight	Did you install the LED Night Light from your Kit?	Yes, I installed it
		Yes, I plan to install it
		No

Table G-2: Example Energy-Savings Kit Survey Questions for Behavior Change

Behavior	Survey Question	Possible Responses
Home Thermostat Change	Did you lower your thermostat in winter?	Yes, I lowered it
	Did you raise your air conditioner thermostat in summer?	Yes, I plan to lower it
		No
Change in laundry volume washed in cold water	BEFORE the energy-efficiency education, what percent of your laundry was washed in cold water only?	None
		25%
	AFTER the energy-efficiency education, what percent of your laundry is washed in cold water only?	50%
		75%
		100%
Water Heater Temperature Change	Did you change the setting of your electric water heater?	Yes, I raised it (warmer)
		Yes, I lowered it (cooler)
		Yes, I plan to raise it
		Yes, plan to lower it
		No

Cadmus did not apply *ex ante* savings to calculate the overall realization rate for products corresponding to any questions the respondents did not answer. No *ex ante* savings were assigned to products corresponding to questions that respondents did *not* answer. These are excluded because we do not know why the customer did not answer the question, and, customers may have installed the item, or, they might not have installed the item. Rather than over or under estimating savings by assuming installation, these products are not included in the calculation of the *ex post* savings and realization rate. Additionally, one respondent answered some but not all of the survey questions. Table G-3 illustrates how Cadmus used this information to assign survey *ex ante* and survey-verified savings to this respondent. In this example, the total survey *ex ante* and the total survey-verified savings equal the sum of the values in each column after omitting items that are not applicable (N/A), a savings of 27 kWh/yr.

Table G-3: Example of PY6 Survey Verification Methodology for E-Power Wise Program

Measure	Question Answered? (Yes/No)	Survey *Ex Ante* Savings (kWh/yr)	Response	Survey-Verified Savings (kWh/yr)
Furnace Whistle	Yes	Varies based on TRM-adjusted *ex ante* values	Installed	Equal to TRM-adjusted *ex ante* savings
Smart Strip	Yes	66	Not installed	0
LED	No	N/A	N/A	N/A
Kitchen faucet Aerator	No	N/A	N/A	N/A
Low-Flow Showerhead	Yes	Varies based on TRM-adjusted *ex ante* values	Not installed	0
Energy Education (Initial)	Yes	Varies based on TRM-adjusted *ex ante* values	Installed	Each respondent received savings for behavior change that reflected self-reported activities
LED Nightlight	Yes	27	Installed	27

The PY6 methodology also calculates the variation among program participants by applying specific values to each survey respondent's answers to questions about products and characteristics of the home. The resulting realization rate reflects this variation and the precision captures any uncertainty associated with the participant-level variation and sampling.

G.2 ENERGY-SAVINGS KIT PRODUCT SAVINGS METHODOLOGY

The PY6 survey-verified savings depend on various criteria for each measure group.

For **LEDs, LED nightlights**, and **smart strips**, survey-verified savings depends on these criteria; as shown in Table G-4.

- The respondent returned a survey.
- The respondent answered the measure question.
- The respondent answered the question on the kit survey with an affirmation of installing the measure.

Table G-4: PY6 Methodology – LEDs Example

Question from Kit Survey	Question Answered? (Yes/No)	Possible Answers	Verification Action Conducted
How many LEDs from your kit did you install?	Yes	Both	Respondent receives survey-verified savings for both LEDs
		One	Respondent receives survey-verified savings for one LED
		None	Respondent survey-verified savings of zero for both LEDs
	No	N/A	N/A; respondent does not receive survey-verified savings

For **furnace whistles**, survey-verified savings depends on these criteria, as shown in Table G-5:

- The respondent returned a survey.
- The respondent answered the product question.
- The respondent is categorized into 2014 TRM deemed heating load hours by zip code of the city named on the enrollment card.
- The respondent answered the question on the kit survey about installing the product.

Table G-5: PY6 Methodology – Furnace Whistle Example

<table>
<tr><th>Question from Kit Survey</th><th>Question Answered? (Yes/No)</th><th></th><th>ZIP Code Mapping (by City) to Determine Heating Load Hours</th><th>Possible Answers</th><th>Verification Action Conducted</th></tr>
<tr><td rowspan="4">Did you install your new FilterTone Alarm from your Kit?</td><td rowspan="3">Yes</td><td></td><td rowspan="4">Allentown, Erie, Harrisburg, Philadelphia, Pittsburgh, Scranton, Williamsport</td><td>Yes, I installed it</td><td>Respondent receives survey-verified savings based on zip code mapping to closest city</td></tr>
<tr><td></td><td>Yes, I plan to install it</td><td>Respondent receives survey-verified savings of zero[1]</td></tr>
<tr><td></td><td>No</td><td>Respondent receives survey-verified savings of zero</td></tr>
<tr><td>No</td><td></td><td>N/A</td><td>N/A; Respondent does not receive survey-verified savings</td></tr>
<tr><td></td><td colspan="5">[1] Respondents received survey-verified savings of zero for planned actions because timing for installation was unverified and may have occurred outside of program year.</td></tr>
</table>

For **kitchen aerators**, survey-verified savings depends on these criteria, as shown in Table G-6:

- The respondent returned a survey.
- The respondent answered the measure question.
- The respondent indicated that the home has electric water heat on the enrollment card.
- The respondent answered the kit survey question about faucet aerators with an affirmation of installing the kitchen and/or bathroom aerator.

Table G-6: PY6 Methodology – Faucet Aerator Example

Question from Kit Survey	Question Answered? (Yes/No)	Water Heating Fuel Type (Enrollment Card Information)	Possible Answers	Verification Action Conducted
Which faucet aerator did you install?	Yes	Electric[1]	Installed both	Respondent receives survey-verified savings for both kitchen and bathroom aerators.
			Installed kitchen only	Respondent receives survey-verified savings for kitchen aerator only.
			Installed bathroom only	Respondent receives survey-verified savings for bathroom aerator only.
			Plan to install kitchen only	Respondent receives survey-verified savings of zero. [2]
			Plan to install bathroom only	Respondent receives survey-verified savings of zero. [2]
			Plan to install both	Respondent receives survey-verified savings of zero. [2]
			None	Respondent receives survey-verified savings of zero.
	No		N/A	N/A; respondent does not receive survey-verified savings.

[1] Savings were assigned only to respondents with electric water heating type.
[2] Respondents received survey-verified savings of zero for planned actions because timing for installation was unverified and may have occurred outside of program year.

For **low-flow showerheads**, survey-verified savings depends on these criteria, as shown in Table G-7:

- The respondent returned a survey.
- The respondent answered the measure question.
- The respondent indicated that the home has electric water heat on the enrollment card.
- The respondent's housing type designation on the enrollment survey (different savings levels applied to single-family and multifamily households).
- The respondent answered the survey question affirming installation of the showerhead.

Table G-7: PY6 Methodology – Showerhead Example

Question from Kit Survey	Question Answered? (Yes/No)	Enrollment Card Information		Possible Answers	Verification Action Conducted
		Water Heating Fuel Type	Housing Type		
Did you install the new high-efficiency showerhead from your kit?	Yes	Electric[1]	Single-family, multifamily	Yes, I installed it	Respondent receives survey-verified savings based on single-family housing type
					Respondent receives survey-verified savings based on multifamily housing type
				Yes, I plan to install it	Respondent receives survey-verified savings of zero [2]
				No	Respondent receives survey-verified savings of zero
	No			N/A	N/A; respondent does not receive survey-verified savings

[1] Savings were only assigned to respondents with electric water heating type.
[2] Respondents did not receive savings for planned actions because timing for installation was unverified and may have occurred outside of program year.

APPENDIX H | E-POWER WISE BEHAVIOR SAVINGS CALCULATIONS

This appendix describes the methodology for calculating the behaviorally based savings resulting from energy education and behaviorally based energy savings for the E-Power Wise Program. This appendix provides the inputs and calculations used in PY6. The methodology to calculate savings associated with products in the energy-savings kit is discussed in Appendix G.

H.1 BEHAVIOR SAVINGS METHODOLOGY

Electric consumption impacts associated with changes in behavior by customers who participated in the E-Power Wise Program are estimated from calculations presented in the 2012 custom measure protocol (CMP).[182] These calculations derive from a combination of engineering estimates, secondary research, and survey data.

Each energy-savings kit includes a paper survey with questions about three main components of savings from behavior change—adjusting water heater temperature, changing the amount of laundry washed in cold water, and adjusting home temperature by heating or cooling season. A respondent can perform one behavior change activity and not another. For example, a respondent may lower the temperature on the home's water heater but not raise the home temperature in the summer; the savings for this respondent would be lower than for a respondent who performed both actions.

Cadmus calculated savings for these behaviors reported by E-Power Wise Program participants in PY6:

- **Water Heater Energy Savings** were achieved by participants who reduced the temperature setpoint of the water heater and/or increased the percentage of loads of clothes washed in cold water.
- **Home Temperature Settings Savings** were achieved by participants who lowered their heating temperature setpoint and/or raised their cooling temperature setpoint according to the season.

The engineering algorithms to calculate verified savings for each behavior are discussed below and include a description of the interactions between some behaviors. Each survey respondent received a unique behavior savings value based on the combination of behavior change activities.

H.1.1 Water Heater Energy Savings

Water heater energy savings are estimated for participants who elect to reduce the temperature of the water heater and reduce the heat of the water when washing clothes. The equation to calculate water heater energy savings is represented as:

$$\textit{Electricity Impact (kWh)} = kWh_{wh} + kWh_{wm}$$

Where:

kWh_{wh} = Energy savings of water heater

kWh_{wm} = Energy savings of washing machine

---

182 Cadmus. *Final Annual Report to the Pennsylvania Public Utility Commission for the Period June 2011 through May 2012 - Program Year 3*; Appendix I - Custom Measure Protocol Measuring Impacts of Behaviorally Based Activities in Low-Income Energy Education/Energy Kit Programs. Prepared for PPL Electric and approved by the statewide evaluator (SWE). 2012.

The first component of this equation (kWh_{wh}) is the energy savings achieved by a reduction in the temperature setting of the water heater. If the participant said he or she reduced the water heater temperature, then these savings were applied. The second component of the equation (kWh_{wm}) is the energy savings from reducing the heat of the water when washing clothes. These savings can only be applied if the participant indicated the presence of a clothes washing machine in the household.

The energy savings for reducing the electric water heater temperature setting is calculated using the fixed savings variables from the "Water Heater Setting Savings" algorithm provided in the custom measure protocol. Savings were applied when respondents met these criteria:

- The respondent returned a survey.
- The respondent has an electric water heater.
- The respondent has a washing machine in the household.
- The respondent indicated he or she turned down the temperature on the water heater.

Table H-1 provides the savings assignment criteria based on respondent-level survey answers.

Table H-1: Water Heater Setting Savings Assignment Criteria

Question from Kit Survey	Question Answered? (Yes/No)	Water Heating Fuel Type (Enrollment Card Information)	Washing Machine On Site? (Yes/No)	Possible Answers	Verification Action Conducted
Did you change the setting on your water heater?	Yes	Electric	Yes	Lowered it	Respondent receives survey-verified savings for behavior change.
	Yes		Yes	Raised it	Respondent receives survey-verified savings of zero for behavior change.
	Yes		Yes	No change	Respondent receives survey-verified savings of zero for behavior change.
	Yes		No	N/A	N/A; respondent does not receive survey-verified savings.
	No		N/A	N/A	N/A; respondent does not receive survey-verified savings.

The savings algorithm is:

$$\textit{Water Heater Setting Savings } (\Delta kWh_{wh}) = (kWh_f + (kWh_{cw} \times CW)) \times ISR_{wh} \times ISR_{ewh}$$

The assumptions for variables used in this equation are provided in Table H-2. Showerheads do not produce additional water heater savings 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 prior to adjusting the water heater. The kilowatt-per-hour values are fixed assumptions, determined through calculations using custom measure protocol inputs and updates described in this appendix.

Table H-2: Water Heater Setting Savings (kWhwh) Calculation Inputs

Parameter	Description	Type	Inputs	Source
kWh_f	Energy Savings from Water Heater Temperature Reduction on Faucet Hot Water Use	Fixed	216 kWh	CMP (Section 0)
kWh_{cw}	Energy Savings from Water Heater Temperature Reduction on Clothes Washer Use	Fixed	49 kWh	CMP (Section 0)
CW	Respondent Verified Clothes Washing Equipment On-site	Variable	Variable	Kit Surveys
ISR_{wh}	ISR: Respondent Reported Water Heater Temperature Reduction	Variable	Variable	Kit Surveys
ISR_{ewh}	ISR: Respondent Reported Electric Water Heater	Variable	Variable	Kit Surveys

The second component of the water heater energy savings equation is washing machine savings (kWh_{wm}), which are achieved when participants wash their clothes in cold water. However, washing machine energy savings contain the potential for interactive effects, which are accounted for in the calculation by applying one of three calculations depending on if the participant also reduced the temperature of the water heater.

- If participants did not reduce water heater temperature but increased the percentage of loads washed in cold water, they received the washing machine savings. The calculation applies fixed energy savings of 195 kWh (Table H-4). This parameter assumes a water heater temperature of 125 degrees Fahrenheit (°F).
- If participants reduced the water heater temperature and increased the percentage of laundry loads washed in cold water, they receive washing machine savings of 49 kWh (Table H-4). The washing machine savings are lower for these participants because water heater savings are already accounted for in the first component of the water heater savings equation.
- If the participant reduced the water heater temperature, but already washed the same percentage of laundry loads in cold water, there are no additional washing machine savings. This is because the participant's laundry behavior did not change and the water heater savings are already accounted for in the first component of the water heater savings equation.

Respondents who switched from **washing clothes in hot water to washing clothes in cold water** could receive two types of savings—by reducing the home's water heater temperature and by washing clothes in cold water instead of hot water.

Scenario with a water heater adjustment:

- The respondent returned a survey.
- The respondent had an electric water heater.
- The respondent had a washing machine in the household.
- The respondent turned down the temperature on the water heater.
- The respondent indicated a change in the percentage of laundry loads washed in cold water after participating in the program. The respondent's assigned savings (positive or negative) were determined by the increase or decrease.

Scenario without a water heater adjustment:

- The respondent returned a survey.
- The respondent had an electric water heater.

- The respondent had a washing machine in the household.
- The respondent indicated a change in the percentage of laundry loads washed in cold water after participating in the program. The respondent's assigned savings (positive or negative) were determined by the increase or decrease.

Table H-3 provides examples of the savings assignment criteria based on respondent-level survey answers.

Table H-3. PY6 Methodology – Examples for Clothes Washing Behavior Change

Example Respondent	Water Heating Fuel Type (Enrollment Card Information)	Does the respondent have a washing machine on the site? (Yes/No)	Did you change the setting on your water heater? (Yes Raised It/ Yes Lowered It/ No Change)	Change in loads washed in cold water (before to after participation)[1]	Verification Action Conducted
Respondent 1	Electric	Yes	Lowered it	25%	Respondent receives survey-verified savings for behavior change WITH water heater temperature reduction.
Respondent 2			Lowered it	75%	Respondent receives survey-verified savings for behavior change WITH water heater temperature reduction.
Respondent 3			No change	50%	Respondent receives survey-verified savings for behavior change WITHOUT water heater temperature reduction.
Respondent 4		No	N/A	N/A	Respondent does not have a washer in the home and does not receive survey-verified savings.
Respondent 5	Gas	N/A	N/A	N/A	Respondent heats water with gas and does not receive survey-verified savings.

[1] Delta change is calculated by subtracting the survey-reported value for laundry washed in cold water AFTER program participation from the survey-reported value for laundry washed in cold water BEFORE program participation.

The water heater energy savings for the washing machine setting component is calculated by inputting the respondent-level in-service rate (ISR). This is determined by the energy-savings kit surveys in one of two algorithms provided in the custom measure protocol—with and without temperature adjustment:

Washing Machine Setting Savings, Without Water Heater Temperature Adjustment (ΔkWh_{wm}) =

$$ISR_{wm} \ X \ ((CW\%_{post} - CW\%_{pre}) \ X \ kWh_{cw2})) \ X \ ISR_{ewh}$$

Washing Machine Setting Savings, With Water Heater Temperature Adjustment (ΔkWh_{wm}) =

$$ISR_{wm} \ X \ ((CW\%_{post} - CW\%_{pre}) \ X \ kWh_{trcw}) - kWh_{cw}) \ X \ ISR_{ewh}$$

The assumptions for variables used in this equation are provided in Table H-4. The kilowatt-per-hour values are fixed assumptions, determined through calculations using inputs and updates described in in this appendix.[183]

Table H-4: Washing Machine Setting Calculation Inputs (kWh_{wm})

Parameter	Description	Type	Inputs	Source
ISR_{wm}	ISR: Respondent Reported Water Heater Temperature Reduction	Variable	Variable	Kit Surveys
$CW\%_{post}$	Respondent Reported: Percent of Clothes Washing Loads Washed in Cold Water Post-participation	Variable	Variable	Kit Surveys
$CW\%_{pre}$	Respondent Reported: Percent of Clothes Washing Loads Washed in Cold Water Pre-participation	Variable	Variable	Kit Surveys
kWh_{cw2}	Energy Savings from Laundering in Cold Water Without Reducing Water Heater Setting	Fixed	243 kWh	CMP (Section 0)
kWh_{trcw}	Energy Savings from Laundering in Cold Water After Reducing Water Heater Setting	Fixed	195 kWh	CMP (Section 0)
kWh_{cw}	Energy Savings from Water Heater Temperature Reduction on Clothes Washer Use	Fixed	49 kWh	CMP (Section 0)
ISR_{ewh}	Installation Rate: Respondent Reported of Electric Water Heater	Variable	Variable	Kit Surveys

The savings were applied to each respondent based on their survey answers, which confirmed they performed the behavior saving action and had an electric water heater in their home.

Water Heater Temperature Adjustment Demand Savings

Respondents received demand savings if they decreased their water heater temperature. Demand savings are calculated by applying a kilowatt ratio to the respondent-level kilowatt-per-hour savings. The demand ratio for water heater temperature adjustment is the kitchen faucet aerator kilowatts divided by the kitchen faucet aerator kilowatts per hour, as in this equation:

$$(\Delta kW_{wh}) = kW_{Kitchen}/kWh_{kitchen}$$

The demand ratio is calculated using the kitchen aerator savings because the water heater temperature adjustment will affect any adjustment to the water temperature in the kitchen sink. The energy-savings kit no longer offers a bathroom aerator so the kitchen aerator is the best measure for the demand ratio calculations. The variables used in this equation are provided in Table H-5.

Table H-5: Water Heater Setting Demand Savings Calculation Inputs (kW_{wh})

Parameter	Description	Type	Inputs	Source
$kW_{kitchen}$	kW for kitchen faucet aerators calculated from TRM	Fixed	0.0023 kW	2014 PA TRM Table 2.8.3
$kWh_{kitchen}$	kWh for kitchen faucet aerators calculated from TRM	Fixed	25 kWh	2014 PA TRM Table 2.8.3

---

[183] Cadmus. *Final Annual Report to the Pennsylvania Public Utility Commission for the Period June 2011 through May 2012 - Program Year 3*; Appendix I - Custom Measure Protocol Measuring Impacts of Behaviorally Based Activities in Low-Income Energy Education/Energy Kit Programs. Prepared for PPL Electric and approved by the statewide evaluator (SWE). 2012.

H.1.2 Adjust Home Temperature Energy Settings

Participants were encouraged to reduce the home's heating set point temperature in the winter and increase its cooling set point temperature in the summer. Surveys asked respondents to answer yes or no to making these changes. Because the savings for this behavior used deemed values that are based on documented research, survey questions were designed simply to establish the respondent-level in-service rate.

For the **home temperature setting** behavior change, a respondent could receive savings for changing the home's heating temperature, cooling temperature, or a combination of both actions if:

- The respondent returned a survey.
- The respondent had electric space heat.
- The respondent reported turning down the heating temperature on the thermostat in winter.

A respondent received survey-verified savings for a cooling change if:

- The respondent returned a survey.
- The respondent has air conditioning (not including ceiling fans).
- The respondent reported turning up the cooling temperature on the thermostat in summer.

Table H-6 provides the savings assignment criteria based on respondent-level survey answers.

Table H-6: PY6 Methodology – Examples of Home Temperature Behavior Change Savings

Example Respondent	Does the respondent have electric heat? (Yes/No)	Did you lower your heating temperature in the winter? (Yes/No)	Heating Verification Action Conducted	Does the respondent have AC? (Yes/No)	Did you raise your cooling temperature in the summer? (Yes/No)	Cooling Verification Action Conducted	Final Verification Action Conducted
Respondent 1	Yes	Yes	Respondent receives survey-verified savings for behavior change	Yes	Yes	Respondent receives survey-verified savings for behavior change	Respondent receives survey-verified savings for heating and cooling change
Respondent 2	Yes	Yes	Respondent receives survey-verified savings for behavior change	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Respondent receives survey-verified savings for heating change
Respondent 3	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Yes	Yes	Respondent receives survey-verified savings for behavior change	Respondent receives survey-verified savings for cooling change
Respondent 4	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Yes	No	Respondent receives survey-verified savings of zero for behavior change	Respondent receives survey-verified savings of zero for behavior change
Respondent 5	No	N/A	No electric heat; Respondent does not receive survey-verified savings	No	N/A	No AC; Respondent does not receive survey-verified savings	Respondent does not receive survey-verified savings

Energy savings are achieved by reducing heating temperature settings, and raising air conditioning temperature settings are calculated using this algorithm:

$$\textit{Home Temperature Setpoint Savings } (kWh_{temp}) = HT_{kWh} \text{ X } ISR_{HT} + AC_{kWh} \text{ X } ISR_{AC}$$

The variables used in this equation are provided in Table H-7. The kWh values are fixed assumptions, determined through calculations using inputs and updates that are described in this appendix in Section H.2 Custom Measure Protocol: Behavior Saving Inputs and Calculations.

Table H-7: Adjust Home Temperature Settings Energy Savings (kWh_{temp}) Calculation Inputs

Parameter	Description	Type	Inputs	Source
HT_{kWh}	kWh of Heating Temperature Reduced	Fixed	646 kWh	CMP (Section 0)
ISR_{HT}	ISR: Respondent Reported Heating Temperature Reduction	Variable	Variable	Kit Surveys
AC_{kWh}	kWh of Cooling Temperature Increased	Fixed	93 kWh	CMP (Section 0)
ISR_{AC}	ISR: Respondent Reported Cooling Temperature Increase	Variable	Variable	Kit Surveys

Adjust Home Temperature Demand Savings

Respondents received temperature adjustment demand reduction if they increased the cooling temperature on their air conditioning unit in the summer. Demand savings are calculated by applying a kilowatt ratio to the respondent-level kilowatt-per-hour savings. The demand ratio for the home temperature cooling adjustment is the calculation of respondents' average equivalent full load hours (EFLH) for cooling divided by the cooling factor from the central air conditioner and air source heat pump (high-efficiency equipment only) algorithm in the 2014 Pennsylvania TRM (section 2.1), as in this equation:

$$(\Delta kW_{temp}) = CF/EFLH_{avgcool}$$

The variables used in this equation are provided in Table H-8**.**

Table H-8: Home Temperature Cooling Setting Demand Savings Calculation Inputs (kW_{temp})

Parameter	Description	Type	Inputs	Source
CF	Demand Coincidence Factor	Fixed	0.70	2014 PA TRM Table 2-8
$EFLH_{avgcool}$	Average EFLH cooling hours from survey population	Variable	435 hours	Kit Surveys; 2014 PA TRM Table 2-8

H.2 CUSTOM MEASURE PROTOCOL: BEHAVIOR SAVING INPUTS AND CALCULATIONS

This section provides the inputs and calculations used to determine energy savings for the behavior change component of the E-Power Wise Program. This custom measure protocol was originally approved by the statewide evaluator in 2011. This section describes the updates to the custom measure protocol to conform to the 2014 Pennsylvania TRM.

H.2.1 Water Heater Temperature Setback

This protocol is for setting back the temperature on an electric water heater from 140°F to 125°F. This results in savings from using the faucet aerator and from washing clothes in warm or hot water. The water heater temperature setback specifications are shown in Table H-9.

Table H-9: Water Heater Temperature Setback Specifications

Measure Name	Water Heater Temperature Setback
Target Sector	Residential
Measure Unit	Home
Unit Energy Savings	Varies by presence of clothes washer in home and water temperature for washing clothes
Unit Peak Demand Reduction	None
Measure Life	1 year

Eligibility

This protocol assumes that there are no savings attributed to showering due to the water heater setback. The reasoning is that the user will adjust the hot water flow to compensate for the reduced temperature.

Algorithms

The measure savings algorithm is:

$$Total\ Savings = kWh_f \times kWh_{cw}$$

The faucet savings ($\mathrm{kWh_f}$) and clothes washer savings (kWh_{cw}) are calculated by these algorithms:

$$kWh_f = F \times T_{Person-Day} \times N_{per} \times 365 \times \Delta T \times U_H \times U_E \times RE \times DF$$

$$kWh_{cw} = Gal \times Cycles \times \Delta \mathrm{T} \times \mathrm{U_H} \times \mathrm{U_E} \times \mathrm{RE}$$

Definition of Terms

The parameters in the above equations are shown in Table H-10. See next page for sources listed in this table.

Table H-10: Calculation Assumptions for Water Heater Temperature Setback

Component	Type	Values	Source
F, flow rate in gallons per minute	Fixed	2.2 gpm	1
$\mathrm{T_{Person-Day}}$, Average time of hot water usage per person per day in minutes	Fixed	4.5 minutes	2
$\mathrm{N_{per}}$, Average people per household	Fixed	2.6	3
365 days per year	Fixed	365 days per year	Convention
$\Delta\mathrm{T}$, change in water heater temperature due to the setback	Fixed	15 degrees	Program Design
$\mathrm{U_H}$, Unit Conversion: 8.33Btu/(Gallons °F)	Fixed	8.33	Convention
$\mathrm{U_E}$, Unit Conversion: 1 kWh/3413 Btu	Fixed	1/3413	Convention
RE, Recovery efficiency of electric water heater	Fixed	0.98	4
DF, Percentage of wasted hot water	Fixed	50%	4
Gal, gallons of hot water used per washer cycle	Fixed	4	5
$Cycles$, washer cycles per year	Fixed	276	6

Default Savings

Table H-11: Energy Savings for Water Heater Reduction

Component	Energy Savings (kWh)
kWh_f	216
kWh_{cw}	49

Evaluation Protocols

The most appropriate evaluation protocol for the behavior change component is the paper survey included in the energy-savings kit or a phone survey. These surveys verify that the water heater temperature was set back and that the household has a washing machine.

Sources

1. Baseline gallons per minute (gpm) of replaced aerators is set to the federal minimum of 2.2 gpm. New aerators are set to the typical rated value of 1.5 gpm. Discounted flow rates were not applied because the "throttle factor" adjustment was found to have already been accounted for in the mixed water temperature variable. Additionally, the GPM_{Base} was set to a default value of 2.2 gpm due to the inability to verify the flow rate of the replaced faucet.

   Cadmus and Opinion Dynamics Evaluation Team. *Showerhead and Faucet Aerator Meter Study.* Prepared for Michigan Evaluation Working Group. June 2013.

2. If aerator location is known, use the corresponding kitchen/bathroom value. If unknown, use 6.1 min/person/day as the average length of use value, which is the total for the household: kitchen (4.5 min/person/day) + bathroom (1.6 min/person/day) = 6.1 min/person/day.

   Cadmus and Opinion Dynamics Evaluation Team. *Showerhead and Faucet Aerator Meter Study.* Prepared for Michigan Evaluation Working Group. June 2013.

3. *Pennsylvania 2012 Residential Baseline Study.*

4. Mid Atlantic TRM Version 2.0 (updated July 2011) and Ohio TRM updated August 2010.

5. Korn, D., and Mattison, L. "Do Savings Come Out in the Wash?" *Home Energy.* January/February 2012. http://www.cadmusgroup.com/wp-content/uploads/2014/02/Home-Energy-Magazine-January-2012-Mattison-Korn-article.pdf

6. Based on weighted average number of loads from EIA 2009 Residential Energy Consumption Survey (RECS) appliance data for Pennsylvania. U.S. Energy Information Administration. Accessed online September 2015: http://www.eia.gov/consumption/residential/index.cfm

H.2.2 Washing Clothes in Cold Water

This protocol is for switching from washing clothes in hot or warm water to washing clothes in cold water. Washing machine energy savings contain the potential for interactive effects with water heater temperature reduction. Therefore, two savings values are calculated to account for the water heater temperature reduction scenarios. Table H-12 shows the behavior change specifications for the washing clothes protocol.

Table H-12: Washing Clothes Behavior Change Specifications

Measure Name	Water Heater Temperature Setback
Target Sector	Residential
Measure Unit	Home
Unit Energy Savings	195 kWh without water heater temperature reduction 49 kWh with water heater temperature reduction
Unit Peak Demand Reduction	None
Measure Life	1 year

Eligibility

This protocol documents the energy savings attributed to switching from washing clothes in hot or warm water to washing clothes in cold water. This protocol could interact with setting back the temperature on an electric water heater from 140 °F to 125 °F.

Algorithms

The savings algorithm is:

$$Total\ Savings = kWh_{trcw} \times kWh_{cw}$$

The savings from washing clothes in cold water (kWh_{trcw}) and clothes washer savings from setting back the temperature on an electric water heater (kWh_{cw}) are calculated by these algorithms:

$$kWh_f = Gal \times Cycles \times \Delta T_{cold} \times U_H \times U_E \times RE$$

$$kWh_{cw} = Gal \times Cycles \times \Delta T_{WH} \times \mathrm{U_H} \times \mathrm{U_E} \times \mathrm{RE}$$

Definition of Terms

The parameters in the above equations are listed in Table H-13. See below for sources listed in this table.

Table H-13: Calculation Assumptions for Water Heater Temperature Setback

Component	Type	Values	Source
Gal , gallons of hot water used per washer cycle	Fixed	4 gallons	1
$Cycles$, washer cycles per year	Fixed	276 cycles	2
ΔT_{cold} , difference between hot water heater temperature setting and supply water temperature	Fixed	68 degrees	3
ΔT_{WH} , difference between the old and new hot water heater temperature settings	Fixed	15 degrees	Program Design
U_H , Unit Conversion: 8.33 Btu/(Gallons-°F)	Fixed	8.33 Btu	Convention
U_E , Unit Conversion: 1 kWh/3413 Btu	Fixed	1/3413	Convention
RE, Recovery efficiency of electric water heater	Fixed	0.90	4

Default Savings

Table H-14: Energy Savings for Water Heater Reduction

Component	Energy Savings (kWh)
kWh_{trcw}	195
kWh_{cw}	49

Evaluation Protocols

The most appropriate evaluation method for this protocol is to use self-report data collected in the paper survey included in the energy-savings kit or a phone survey of participants to verify that the water heater temperature was set back and that the household has a washing machine.

Sources

1. Korn, D., and Mattison, L. "Do Savings Come Out in the Wash?" *Home Energy.* January/February 2012. http://www.cadmusgroup.com/wp-content/uploads/2014/02/Home-Energy-Magazine-January-2012-Mattison-Korn-article.pdf

2. Based on weighted average number of loads from *EIA 2009 Residential Energy Consumption Survey* (RECS) appliance data for the state of Pennsylvania. Accessed online September 2015: http://www.eia.gov/consumption/residential/index.cfm

3. Temperature of hot water is 123 °F and the temperature of the cold water supply is 55 °F (Pennsylvania 2014 TRM, Table 2-4). *2012 SWE Residential Baseline Study.*

4. *CL&P and UI Program Savings Documentation for 2008 Program Year*. See Section 5.5.1 Water Heater Thermostat Setting. Available online: http://cbey.yale.edu/uploads/Environmental%20Venture%20Prize/Burke_Workshop_Program%20Savings%20Document_Assessing%20Environmental%20Benefit.pdf

H.2.3 Thermostat Setting Adjustment

This protocol is for adjusting the temperature downward in the heating season and upward in the cooling season, which results in savings from the heating and/or cooling systems. Specifications for the home temperature setting behavior change are shown in Table H-15.

Table H-15: Home Temperature Setting Change Specifications

Measure Name	Thermostat
Target Sector	Residential
Measure Unit	Home
Unit Energy Savings	Varies by location and by thermostat adjustment during the cooling season or the heating season, or both
Unit Peak Demand Reduction	None
Measure Life	1 Year

Algorithms

The measure savings algorithm is:

$$Total\ Savings = \Delta kWh_{heat} \times \Delta kWh_{cool}$$

The heating and cooling savings are calculated by these algorithms:

$$\Delta kWh_{heat} = \frac{CAP_{heat}}{1000} \times \left(\frac{1}{HSPF \times EFF_{duct}}\right) \times EFLH_{heat} \times SAV_{heat}$$

$$\Delta kWh_{cool} = \frac{\mathrm{CAP_{cool}}}{1000} \times \left(\frac{1}{\mathrm{SEER \times EFF_{duct}}}\right) \times \mathrm{EFLH_{cool}} \times \mathrm{SAV_{cool}}$$

Definition of Terms

The parameters in the above equations are listed in Table H-16. See below for sources listed in this table.

Table H-16: Calculation Assumptions for Water Heater Temperature Setback

Component	Type	Values	Source
$\mathrm{CAP_{heat}}$, capacity of the heating system in Btuh	Fixed	32,000 Btuh	1
CAP_{cool} , capacity of the cooling system in Btuh	Fixed	32,000 Btuh	1
HSPF , Heating seasonal performance factor of the heating unit.	Fixed	3.413 HSPF (equivalent to electric furnace COP of 1)	2
SEER , Seasonal energy-efficiency ratio of the cooling unit.	Fixed	11.9 SEER	1
EFF_{duct} , duct system efficiency	Fixed	0.8	3
$EFLH_{heat}$, equivalent full load hours for heating	Variable	Allentown Heating = 1,193 Hours Erie Heating = 1,349 Hours Harrisburg Heating = 1,103 Hours Philadelphia Heating = 1,060 Hours Pittsburgh Heating = 1,209 Hours Scranton Heating = 1,296 Hours Williamsport Heating = 1,251 Hours	4
$\mathrm{EFLH_{cool}}$, equivalent full load hours for cooling	Variable	Allentown Cooling = 487 Hours Erie Cooling = 389 Hours Harrisburg Cooling = 551 Hours Philadelphia Cooling = 591 Hours Pittsburgh Cooling = 432 Hours Scranton Cooling = 417 Hours Williamsport Cooling = 422 Hours	4
$\mathrm{SAV_{heat}}$, energy savings factor for heating	Fixed	4.88%	5
$\mathrm{SAV_{cool}}$, energy savings factor for cooling	Fixed	4.78%	5

Default Savings

There are no default savings for this measure.

Evaluation Protocols

The most appropriate evaluation protocol for this measure is self-report data collected on the paper survey included within the kit or a phone survey verifying that the thermostat temperature was changed during the heating season and/or during the cooling season.

Sources

1. Data set is from the *2012 Pennsylvania Residential End-Use and Saturation Study*. Submitted to Pennsylvania PUC by GDS Associates, Nexant, and Mondre. Available online: http://www.puc.pa.gov/electric/pdf/Act129/PA_Residential_Baseline_Report2012.pdf.

2. Minimum federal standard for new central air conditioners/heat pumps between 1990 and 2006.

3. *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Measures in Commercial and Industrial Programs.* September 1, 2009.

4. Based on REM/Rate modeling using models from the Pennsylvania 2012 Potential Study. Equivalent full load hours (EFLH) calculated from kWh consumption for cooling and heating. Models assume 50% over-sizing of air conditioners and 40% oversizing of heat pumps.

   Neme, Proctor, and Nadal. "National Energy Savings Potential From Addressing Residential HVAC Installation Problems." ACEEE, February 1, 1999. Confirmed also by Energy Center of Wisconsin. *Central Air Conditioning in Wisconsin, a compilation of recent field research.* May 2008, amended December 15, 2010.

   Model assumes 40% oversizing of heat pumps.

   ACCA. "Verifying ACCA Manual S Procedures." Available online: http://www.acca.org/Files/?id=67).

5. Based on the energy savings for thermostat setting changes from the Iowa Energy Wise program evaluation reports from 2010 – 2014. The savings factors were calculated by taking the average percentage of savings for heating or cooling during 2010, 2011, 2012, and 2014.

   Cadmus*. Iowa 2014 Energy Wise Program.* Prepared for Iowa Utility Association. 2014.

APPENDIX I | ACT 129 WRAP BILLING ANALYSIS

Cadmus conducted two analyses to estimate savings for baseload, low-cost, and full-cost jobs and used them to cross-check estimates. It used the *ex post* evaluated energy savings estimates that had the smaller precision for baseload jobs (monthly fixed-effects model), because they provide the bulk of the savings. The method and analyses are described below.

I.1 METHODOLOGY

To estimate the *ex post* evaluated savings per job for jobs provided in PY6, Cadmus conducted a customer usage analysis of Phase I PY3 and PY4 participants for the period of January 2009 through February 2014. Cadmus received consumption histories for 8,076 accounts: 2,979 accounts where a baseload job had been provided, 1,545 accounts where a low-cost job had been provided, and 3,552 accounts where a full-cost job had been provided.

Cadmus reviewed these consumption histories and excluded records for 2,908 accounts for the reasons listed in Table I-1. To conduct a customer usage analysis, it is necessary to have a minimum of nine months of pre- and post-installation energy consumption data. Cadmus conducted a billing history screen examining the monthly consumption history for each customer, plotting each participant's monthly pre- and post-installation usage. Approximately two-thirds (68%) of the 2,908 excluded accounts had insufficient pre- or post-installation energy consumption data.

To avoid confounding the customer usage analysis, Cadmus removed accounts with outliers, vacancies, seasonal usage, and equipment changes in the pre- or post-installation periods. Another approximately one-third (29%) of the accounts were excluded primarily as a result of the consumption history screening.

Finally, Cadmus excluded records where HPWHs had been installed (3%) so that the savings represented those from the baseload, low-cost, and full-cost jobs alone. The customer usage analysis had a final dataset of 5,168 participants.

Table I-1: Phase 1 PY3 and PY4 Consumption Analysis Attrition Table

Attrition Reason	Baseload		Low-Cost		Full-Cost		Total	
	Number of Sites	Percent of Full Participant Number	Number of Sites	Percent of Full Participant Number	Number of Sites	Percent of Full Participant Number	Number of Sites	Percent of Full Participant Number
Full Participant Number	2,979	100%	1,545	100%	3,552	100%	8,076	100%
Insufficient Pre/Post Billing Data	791	27%	320	21%	857	24%	1,968	24%
Low Usage (Annual Usage < 1,200 kWh)	16	1%	1	0%	0	0%	17	0%
Account Changed Usage by More than 70%	31	1%	20	1%	9	0%	60	1%
Outliers	363	12%	172	11%	248	7%	783	10%
Heat Pump Water Heater Installed	0	0%	31	2%	39	1%	80	1%
Final Analysis Participant Number	**1,778**	**60%**	**1,001**	**65%**	**2,399**	**67%**	**5,168**	**64%**

Cadmus weather-normalized each customer's monthly kWh consumption for both the pre- and post-installation periods using these steps:

1. Obtained daily average temperature data from January 2009 through March 2014 for the National Oceanic and Atmospheric Administration (NOAA) weather stations that represented all the ZIP codes associated with PPL Electric Utility's service territory.
2. From daily temperatures, determined the 65°F reference temperature heating degree days (HDDs) and cooling degree days (CDDs) for each station.
3. Determined the nearest station for each ZIP code using a ZIP code mapping for all United States weather stations.
4. Matched usage data periods with the CDDs and HDDs from the associated stations.

Cadmus used both a monthly fixed-effects model and customer-specific models to estimate overall savings for all homes receiving baseload jobs. The monthly fixed-effects and customer-specific models produced similar savings estimates. The estimate produced by the monthly fixed-effects model had slightly better precision for the baseload job estimate where the majority of program savings were anticipated, so these estimates were used as the *ex post* evaluated savings per job. The estimates from the customer-specific model are provided in the following section, along with additional details about the modeling approaches.

I.1.1 Fixed-Effects Overall Models

Fixed-effects modeling is a method of estimating parameters from a panel dataset. Panel data is from a (usually small) number of observations over time on a (usually large) number of cross-sectional units, such as individuals, households, firms, or governments. The fixed-effects estimator is obtained by ordinary least squares on the deviations from the means of each unit or time period. This approach is relevant when one expects the averages of the dependent variable to be different for each cross-sectional unit, or for each time period, but expects the variance of the errors to be similar.[184]

To obtain overall model savings for the direct-install measures and major measure groups, Cadmus used the following fixed-effects model specification:

$$ADC_{it} = \alpha_i + \beta_1 * HDD_{it} + \beta_2 * CDD_{it} + \beta_3 * POST_{it} + \varepsilon_{it}$$

Where, for customer 'i' in usage month 't':

ADC_{it} = the average daily kWh consumption in the pre- and post-period

α_i = the average pre-period base load kWh usage for each customer; this is part of the fixed-effects specification

β_1 = the average pre-period kWh usage per HDD

HDD_{it} = the average daily base-65 HDD for the nearest weather station based on location

β_2 = the average pre-period kWh usage per CDD

CDD_{it} = the average daily base-65 CDD for the nearest weather station based on location

184 More details about this concept can be found online: http://economics.about.com/library/glossary/bldef-fixed-effects-estimation.htm.

β_3 = the average daily kWh savings for the direct-install measure or major measure group

$POST_{it}$ = an indicator variable that is 1 in the post-installation period and 0 in the pre-installation period

ε_{it} = the model error term

The following calculation shows how Cadmus derived the final savings estimates from the model coefficients:

$$\beta_3 * 365 = \text{Annual overall kWh savings for direct install or major products}$$

The model parameters and parameter estimates for the direct-install products' overall model are provided in Table I-2 through Table I-4. Cadmus estimated a separate intercept for each customer; because of space constraints, only the average of the intercepts for each job type is provided in Table I-2 through Table I-4.

Table I-2: Fixed-effects Model Parameters and Estimates – Baseload Jobs

Variable	Degrees of Freedom	Parameter Estimate	Standard Error	t Value	Pr > |t|
Average intercept	1,778	23.23	0.03	757.08	<.0001
HDD	1	0.63	0.02	28.64	<.0001
CDD	1	1.52	0.03	44.00	<.0001
POST	1	-2.71	0.16	-17.36	<.0001

Table I-3: Fixed-effects Model Parameters and Estimates – Low-Cost Jobs

Variable	Degrees of Freedom	Parameter Estimate	Standard Error	t Value	Pr > |t|
Average intercept	1,001	13.02	0.05	260.13	<.0001
HDD	1	0.90	0.03	26.80	<.0001
CDD	1	1.38	0.05	28.66	<.0001
POST	1	-2.90	0.24	-12.29	<.0001

Table I-4: Fixed-effects Model Parameters and Estimates – Full-Cost Jobs

Variable	Degrees of Freedom	Parameter Estimate	Standard Error	t Value	Pr > |t|
Average intercept	2,399	-15.08	0.02	-603.33	<.0001
HDD	1	1.97	0.03	72.90	<.0001
CDD	1	2.21	0.04	60.28	<.0001
POST	1	-3.72	0.17	-21.30	<.0001

I.1.2 Customer-Specific Models

Cadmus used customer-specific models (also known as the PRInceton Scorekeeping Method, or PRISM models) to develop a second set of estimates. These models provide an alternative weather-normalization methodology to compare with the fixed-effects savings estimates. In general, the customer-specific models provided savings estimates that were very similar to those produced by the fixed-effects models.

The advantage of the customer-specific models is that they weather-normalize the pre- and post-installation periods for each customer. The disadvantage of the models is that they do not provide easily obtained measure-level savings estimates.

Cadmus fixed the heating and cooling reference temperatures (τ or tau) at 65°F. In this approach, account-level models are run for the pre- and post-periods.

Cadmus specified the heating and cooling PRISM model as follows:

$$ADC_{it} = \alpha_i + \beta_1 * AVGHDD_{it} + \beta_2 * AVGCDD_{it} + \varepsilon_{it}$$

Where for each customer 'i' and month't':

ADC_{it}	=	the average daily kWh consumption in the pre- or post-program period
α_i	=	the participant intercept; this represents the average daily kWh baseload
β_1	=	the model space heating slope
$AVGHDD_{it}$	=	the base-65 average daily HDDs for the specific location
β_2	=	the model space cooling slope
$AVGCDD_{it}$	=	the base-65 average daily CDDs for the specific location
ε_{it}	=	the error term

From the model above, Cadmus computed the weather-normalized annual consumption (NAC) as follows:

$$NAC_i = \alpha_i * 365 + \beta_1 * LRHDD_i + \beta_2 * LRCDD_i + \varepsilon_i$$

Where for each customer 'i':

NAC_i	=	the normalized annual kWh consumption
α_i	=	the intercept that is the average daily or baseload for each participant; this represents the average daily baseload from the model
$\alpha_i * 365$	=	the annual baseload kWh usage (non-weather sensitive)
β_1	=	the heating slope; in effect, this is the usage per heating degree from the model above
$LRHDD_i$	=	the annual, long-term HDDs of a typical month year (TMY3) in the 1991-2005 series from NOAA, based on home location
$\beta_1 * LRHDD_i$	=	the weather-normalized, annual weather-sensitive (heating) usage, also known as HEATNAC
β_2	=	the cooling slope; in effect, this is the usage per cooling degree from the model above
$LRCDD_i$	=	the annual, long-term CDDs of a TMY3 in the 1991-2005 series from NOAA, based on home location

$\beta_2 * LRCDD_i$ = the weather-normalized, annual weather-sensitive (cooling) usage, also known as COOLNAC

ε_i = the error term

A NAC is modeled for both the pre- and post-installation period, and these values are denoted as PRENAC and POSTNAC, respectively. From these values, the customer-specific savings is given by PRENAC – POSTNAC, referred to as DNAC. Cadmus calculated overall average savings values for baseload, low-cost, and full-cost jobs and compared them to the estimates calculated using the fixed-effects panel model. These comparison estimates are shown in Table I-5.

Table I-5: PY6 Act 129 WRAP Comparison of Model Estimates

Analysis Group	Number of Sites in the Analysis	Fixed-Effects Model		Customer-Specific Model	
		Average Annual kWh Savings	Precision at 90% Confidence Level	Average Annual kWh Savings	Precision at 90% Confidence Level
PY3 and PY4 Baseload Participants	1,778	988	9.5%	957	10.1%
PY3 and PY4 Low-Cost Participants	1,001	1,057	13.4%	1,045	13.1%
PY3 and PY4 Full-Cost Participants	2,399	1,360	7.7%	1,488	7.2%

APPENDIX J | FUEL-SWITCHING ANALYSIS: FOSSIL FUELS TO ELECTRICITY

J.1 FUEL-SWITCHING REPORTING

On October 26, 2009, the Pennsylvania Public Utility Commission (PUC) entered an opinion and order approving PPL Electric Utilities' Act 129 plan. In the order, the PUC required PPL Electric Utilities to track and report the frequency of customers switching to electric appliances from non-electric appliances.

This appendix summarizes results from the analysis of data collected by PPL Electric Utilities from program year 6 (PY6) rebate forms, as well as responses to questions about fuel switching from surveys fielded by the evaluation, measurement, and verification (EM&V) conservation service provider (CSP) to participants. This analysis was designed to:

- Determine the percentage of participants who switched fuels when they installed program-rebated equipment
- Learn why customers switched fuels
- Assess whether the rebate program had a significant impact on fuel-switching behavior

J.2 FUEL SWITCHING EQUIPMENT

There are two programs in PPL Electric Utilities' Phase II portfolio that include equipment that could involve fuel switching—Residential Retail and Residential Home Comfort. Heat pump water heaters were the only equipment rebated through the Residential Retail Program. The Residential Home Comfort Program offered air source heat pumps and ductless mini-split heat pumps. Table J-1 shows the types, quantities, and percentages of equipment reported in PY6.

Table J-1. Potential Fuel-Switching Equipment in PY6

Equipment	Quantity	% of Total	Participants	% of Total
Air Source Heat Pump	1,753	28%	1,753	46%
Ductless Mini-Split Heat Pump	3,662	59%	1,177	31%
Heat Pump Water Heater	844	13%	844	22%
Total	**6,259**	**100%**	**3,774**	**100%**

J.3 TRACKING DATA

Cadmus reviewed data collected by the implementation conservation service provider (ICSP) and recorded in EEMIS, PPL Electric Utilities' database tracking system. These data came from rebate forms that included questions asking if a natural gas service was available to the customer's home and what the new electric equipment replaced.

However, not all customers completed these questions. In addition, some data were missing from the tracking system, mainly from the first quarter (Q1) of PY6 before the Residential Home Comfort ICSP had implemented changes to ensure these data were imported into EEMIS. Nonetheless, Cadmus received data for at least 78% of the records—4,909 records included a *yes* or *no* response to the question about natural gas service, and 5,017 records included a response to the question about the fuel used by the equipment they replaced.

Cadmus's analysis was based on the number of customers switching fuels, not the number of units. Out of 3,774 unique participants, 2,514 included a *yes* or *no* response to the question about natural gas service and 2,692 included a response to the question about replaced equipment.

The analysis revealed that:

- Nine percent of customers who received a rebate for one of the potential fuel-switching units (n=2,514) had natural gas service to their homes.
- Only 5.6% of the 2,394 customers who answered questions regarding both natural gas service and the equipment they replaced had natural gas service and switched from non-electric equipment.
- Of this 5.6%, the majority (3.4%, n=2,394) switched from propane equipment.
- Less than 1% (n=2,394) of customers had natural gas service and switched from natural gas, oil, or other fuel sources (the "other" response category is for fuels not specified in tracking data).

Of all non-electric equipment replaced—regardless of whether the customer had natural gas service (n=2,692):

- 15% of customers replaced propane equipment. Of these customers, the majority replaced a propane furnace with one or more ductless mini-split heat pumps (14%, n=2,692).
- Eleven percent replaced oil (5% replaced an oil water heater with a heat pump water heater and 6% replaced an oil furnace with an air source heat pump or a ductless mini-split heat pump).
- Fourteen percent of customers replaced other fuel sources (not specified in tracking data).

J.4 SURVEY DATA

In addition to reviewing EEMIS tracking data, Cadmus included questions in participant surveys about fuel-switching behavior. Questions were asked of 218 customers who received a rebate for possible fuel-switching equipment and were included in three different surveys—the cross-program participant survey, the Residential Retail Program participant survey, and a supplemental survey specifically for participants who installed possible fuel-switching equipment. The distribution of completed surveys, by equipment, is shown in Table J-2.

Table J-2. Completed Surveys, by Equipment

Equipment	Customers Surveyed	Percentage of Total
Air Source Heat Pump	31	14%
Ductless Mini-Split Heat Pump	79	36%
Heat Pump Water Heater	108	50%
Total	**218**	**100%**

J.4 SURVEY METHODOLOGY

Questions about fuel-switching equipment were included in three different surveys—the cross-program participant survey, the Residential Retail Program participant survey, and a supplemental survey specifically for participants who installed possible fuel-switching equipment. Sample attrition is in Table J-3.

Although, the primary purpose of the cross-program survey was to obtain a preliminary estimate of low-income participation in programs that are not specifically targeting this sector (i.e., programs that do not require income verification), Cadmus included questions about fuel switching. Cadmus selected a random sample (probability sampling) but did not stratify the sample by program. Customers were excluded if they participated in surveys within the last year, requested not to be contacted, were duplicates, had incomplete information, in sample selected for other program surveys, or were inactive accounts.

Residential Retail Program participants who installed their equipment and received a rebate in PY6 were contacted as part of a program specific survey. The primary purpose of this survey was to assess customer satisfaction, the effectiveness of the program, freeridership, and to support the analysis of fuel-switching behavior (heat pump water heater rebates). The sample excluded customers who had completed a survey in the past year (as required by PPL Electric Utilities) or requested not to be contacted. It also excluded any participants of the new homes component of the Residential Home Comfort Program to reserve them for inclusion in the limited sample pool for that program-specific survey. From this sample frame, Cadmus selected a simple random sample (probability sampling).

A supplemental telephone survey was conducted with 29 Residential Home Comfort Program participants who received rebates for replacing existing fossil fuel-fired space conditioning equipment with efficient air source or ductless heat pumps. The sample frame included customers who indicated natural gas distribution service was available at their home (reported on their rebate forms) and switched from a non-electric appliance to an electric appliance. Cadmus then excluded any customers who had participated in the cross-program survey or other surveys within the last year, who requested not to be contacted, inactive customers, or who indicated on their rebate forms they had electric heat.

Table J-3: Survey Sample Attrition

Description	Cross-Program Survey: Residential Home Comfort	Cross-Program Survey: Residential Retail	Program Survey: Residential Retail Equipment	Supplemental Survey: Residential Home Comfort
Total population (number of participants Q1-Q2)	2,937	2,731	1,405	199
Random sample selection	1,675	1,004	1,405	199
Removed incomplete or bad phone number, inactive customer, completed survey in past year, on "do not call" list, selected for a different survey, duplicate contact	263	298	215	66
Sent to Survey Subcontractor	1,412	706	1,190	133
Records Not Attempted [1]	52	35	312	0
Records Attempted	1,360	670	878	133

Description	Cross-Program Survey: Residential Home Comfort	Cross-Program Survey: Residential Retail	Program Survey: Residential Retail Equipment	Supplemental Survey: Residential Home Comfort
Nonworking number	45	28	31	9
Business/wrong number	31	9	15	5
Refusal	377	204	222	20
Language barrier	2	1	1	0
Ineligible; PPL or market research employment	20	9	17	1
Ineligible; did not participate in program	25	11	1	1
No answer/answering machine/phone busy	448	223	244	30
Nonspecific or specific callback scheduled	224	101	175	35
Partially completed survey	40	18	22	3
Completed Survey [2]	**148 [3]**	**66 [3]**	**150**	**29**

[1] These records were not needed because the overall survey target for the was reached before they were attempted.
[2] The number of completes represent the total number of completed surveys not those used in the fuel-switching analysis.
[3] The survey target for the cross-program survey was 300 and was not stratified by program (Appliance Recycling, Residential Home Comfort, and Residential Retail). Survey calls continued until the overall target of 300 was met; completing as many surveys within each program as possible.

J.5 SURVEY FINDINGS

Of these 218 customers responding to the surveys, 15% had natural gas available in their home, and 1.4%, each, both had natural gas and switched from oil or gas. Without regard to natural gas service, 1.4% of the 218 customers said they replaced gas, 5.5% replaced oil, and 2.3% replaced propane.

The distribution of equipment, by survey, is shown in Table J-4.

Table J-4. Distribution of Equipment, by Survey

Survey	Customers Surveyed	Percentage of Respondents (Three Surveys)
Cross-Program Survey	**114**	**52%**
Air Source Heat Pump	25	22%
Ductless Mini-Split Heat Pump	56	49%
Heat Pump Hot Water Heater	18	16%
Heat Pump Water Heater	15	13%
Residential Retail Survey	**75**	**34%**
Heat Pump Water Heater	75	100%
Fuel Switching Survey	**29**	**13%**
Ductless Mini-Split Heat Pump	23	79%
Air Source Heat Pump	6	21%
Grand Total	**218**	**100%**

Although there is a difference between the results from the tracking data and the survey responses about the overall rate of switching to electricity from propane or oil, both tracking and survey data indicate that only about 1% of customers switch to electric equipment from natural gas equipment.

Of the 23 customers who replaced a gas, oil, or propane system, only 4% said they did so to get a rebate. None of the three customers who replaced gas equipment said they did so to get a rebate. The most common reason given, of all 23 customers, was to save money on utility bills (43% of respondents), followed by the desire to install more efficient equipment (30% of respondents). One respondent each replaced broken equipment, was concerned about the availability of propane, added to existing equipment (not replacing main unit), or purchased as part of a remodel.

J.6 CONCLUSION

Based on the results of the phone survey and the tracking-data analysis, Cadmus concluded that a very small fraction (approximately 1%) of customers who participate in PPL Electric Utilities' Act 129 rebate programs switches from natural gas to electric fuel. The number of customers who switch from propane or oil to electricity is somewhat higher, but the fuel-switching behavior of these customers does not appear to be motivated by PPL Electric Utilities' rebate.

PY6 Survey Questions for Fuel Switching

These questions were used to determine the reason participants switched from a nonelectric measure to an electric one. (The sequence is taken directly from the survey instrument.)

A1. Is natural gas available in your home?

1. (Yes)
2. (No)
98. (Don't know)
99. (Refused)

A2. Did your new [MEASURE] replace an existing gas, oil, or propane heating system?

1. (Yes, gas)
2. (Yes, oil)
3. (Yes, propane)
4. (No) [SKIP TO NEXT SECTION]
98. (Don't know)
99. (Refused)

[ASK IF A2=1, 2, OR 3 (gas, propane or oil)]

A3. What was the reason you replaced your gas, oil, or propane water heater with the [MEASURE]? [RECORD ALL THAT APPLY]

1. (Didn't work right / old and in need of replacement)
2. (Broken/failed)
3. (To get a rebate)
4. (To get more efficient equipment)
5. (Save money on utility bill)
6. (Other) [SPECIFY]
98. (Don't know)
99. (Refused)

[ASK IF A3≠1]

A4. Just to make sure I understand, was the [MEASURE] you replaced old and in need of replacement?

1. (Yes)
2. (No)

98. (Don't know)
99. (Refused)

[ASK IF A3≠2]

A5. And was the [MEASURE] in working condition when you replaced it?

1. (Yes)
2. (No)

98. (Don't know)
99. (Refused)

A6. Other than what we've discussed, were there any other factors that influenced your decision to replace your water heater with the [MEASURE]?

1. (Yes) [ASK A6a]
   A6a. What were the factors ? [RECORD RESPONSE]
2. (No)

98. (Don't know)
99. (Refused)

APPENDIX K | FUEL-SWITCHING PILOT ANALYSIS: ELECTRICITY TO FOSSIL FUELS

In PY6, PPL Electric Utilities continued the fuel switching pilot program, which was offered for the first time in PY5. This program offered rebates to customers who used electric space or water heat and installed new efficient non-electric space or water heating equipment. Rebates were limited to the first 100 applicants (residential and nonresidential) in three programs—Residential Home Comfort, Residential Retail, and Prescriptive Equipment, but only customers in the Residential Retail and Residential Home Comfort Programs participated in PY6. The distribution of measures is shown in Table K-1.

Table K-1: PY6 Fuel Switching Equipment Rebated

Program	Equipment	PY6 Rebates
Residential Home Comfort	Fuel Switching Central Heat Gas	13
Residential Home Comfort	Fuel Switching Central Heat Propane	11
Residential Retail	Fuel Switching Water Heater Gas	5
Residential Retail	Fuel Switching Water Heater Oil	1
Residential Retail	Fuel Switching Water Heater Propane	2
Total		**32**

Of the 32 participants, only 10 were available for a follow-up phone survey and all who completed the survey were from the Residential Home Comfort Program. Of these, four installed a gas heating system and six installed a propane heating system.

Three survey respondents learned of the pilot program from a contractor, and three learned of it from PPL Electric Utilities' website. Of the other four respondents, one each learned of the program through a friend, relative, or colleague; a retail staff person; a PPL Electric Utilities employee; or another source. Data collected from rebate forms by the implementation conservation service provider (ICSP) and recorded in EEMIS, PPL Electric Utilities' database tracking system, was available for 17 out of the 32 total participants. Out of these 17 records, nine indicated that they learned of the pilot program from the Internet, three from PPL Electric Utilities' website, and one each from a PPL Electric Utilities employee, word of mouth, or a contractor.

Seven of the 10 respondents said they replaced their water heater or heating system to save money on their utility bill. Four replaced their equipment because it was broken or in need of replacement, and one wanted equipment that was more energy efficient. Their reasons are listed in Table K-2.

Table K-2: Reasons for Replacing Equipment[1]

Replacement Reason	Responses
Save money on utility bill	7
Didn't work right/old and in need of replacement/broken/failed	4
To get more energy efficient equipment	1

[1] N=10, multiple responses allowed.

Source: Question D2 "What was the reason you replaced the electric water heater/electric heating system?"

When asked why they decided to switch fuels from electric to gas when purchasing equipment, eight respondents gave reasons related specifically to the cost of electricity or their heating bill and two said their electric heating system was less efficient than a fossil-fuel system.

Respondents were split on whether the rebate offered through the pilot was important to their decision to install the equipment, as shown in Table K-3. (The three respondents who said the rebate was *not at all important* said they had already purchased or decided to purchase the equipment when they learned of the rebate.) However, when asked what would have happened if they had not received the rebate from PPL Electric Utilities, all 10 respondents said they would have purchased the same equipment without it.

Table K-3: Importance of Rebate to Replacement Decision

Response	Number of Respondents
Very important	2
Somewhat important	3
Not too important	2
Not at all important	3
Total	10
Source: Question D7 “Please think back to when you were considering the purchase of your ___. How important was getting a rebate from PPL Electric in your decision to install the___? Was it …?”	

Respondents were also asked to rate how much influence specific aspects of the program had on their decision to purchase the equipment. The distribution of responses is shown in Table K-4.

Table K-4: Influence on Decision to Purchase Equipment

Level of Influence	Rebate Amount (n=10)	PPL Electric Utilities’ Information about Energy Efficiency (n=10)	Opportunity to Change [Heating/Water Heating] Equipment through PPL Electric Utilities’ Program (n=10)
1 – No Influence	4		4
2	3	3	3
3	1		0
4	1	0	1
5 – Extremely Influential	0		1
Don’t know/Refused	1	1	1
Source: Question G2a/b/c “I’m going to read a list of items about PPL Electric’s rebate program. Please rate each item on how much influence it had on your decision to purchase the [MEASURE_NAME]. Please use a scale from 1 to 5, with 1 meaning “no influence,” and 5 meaning the item was “extremely influential” in your decision.”			

When asked what else was influential in their decision to switch fuels and purchase equipment, most participants reiterated the reasons they had already given regarding cost or efficiency.

Based on the results of the phone survey, Cadmus concluded that the availability of the pilot program has had a marginal impact on the customer’s decision to switch from electric to non-electric equipment.

APPENDIX L | RESIDENTIAL ENERGY-EFFICIENCY BEHAVIOR & EDUCATION PROGRAM IMPACT ANALYSIS DETAILS

L.1 DATA DEVELOPMENT

The Residential Energy Efficiency Behavior and Education Program impact evaluation involved analysis of three population tracks: Legacy Group 1, Legacy Group 2, and the Expansion Group. These populations were defined by when they received their first home energy reports:

- Legacy Group 1: PY1, April or May 2010
- Legacy Group 2: PY3, June 2011
- Expansion group: PY 6, October or December 2014

Cadmus collected customer billing and program participation data for each track and prepared the data for analysis. The monthly customer bills covered the 12 months preceding the delivery of the first energy report and all post-treatment months through the end of PY6.

To prepare the data for analysis, Cadmus first dropped residential customers who received energy reports but were not part of the program randomized control trial. For example, some PPL Electric employees received reports but were not randomly assigned to receive them. Cadmus also dropped customers who were assigned to the treatment or control group but for whom a report could not be generated or delivered to the home. The implementation CSP included a flag in the program customer database to indicate customers that should be excluded from the impact analysis.

Table L-1 shows details on the analysis sample data.

Table L-1: Data Preparation Summary

	Number of Observations from Billing Data		
	Legacy Group 1	**Legacy Group 2**	**Expansion**
Bills used in estimation	6,870,098	4,552,005	1,440,332
	Number of Customer Accounts		
Customer accounts in estimation	98,894	78,333	61,373
Treatment group	49,452	53,897	48,719
Control group	49,442	24,436	12,654
	Number of Customer Accounts in PY6[1]		
Customer accounts in estimation	77,237	64,167	59,367
Treatment group	38,658	44,180	47,122
Control group	38,579	19,987	12,245
[1] Number of customer accounts when first reports in PY6 were delivered.			

The data cleaning resulted in an unbalanced panel of 98,894 treatment and control group customers in Legacy Group 1, 78,333 customers in Legacy Group 2, and 61,373 customers in the Expansion Group. The panel was unbalanced because some legacy group customer accounts closed since the program started in PY2 (Legacy Group 1) or PY3 (Legacy Group 2). When customers received their first reports in PY6, there were 77,237 treatment and control group customers remaining in Legacy Group 1 and 59,367 customers remaining in Legacy Group 2.

Cadmus collected weather data from the weather station closest to each home and estimated the heating degree and cooling degree days for each customer billing cycle. After merging the weather and billing data, Cadmus allocated the billing cycle electricity consumption, HDDs, and CDDs to calendar months.

L.2 VERIFICATION OF BALANCED TREATMENT AND CONTROL GROUPS

A key assumption of the impact analysis is that homes eligible for the program were randomly assigned to the program treatment or control group. In Phase 1, the implementation CSP randomly assigned customers to the program treatment or control group. As part of the Phase 1 of Act 129 impact evaluation of the Residential Energy Efficiency Behavior and Education Program, Cadmus verified for the Legacy Group 1 and Legacy Group 2 populations that the treatment and control groups had equal pre-treatment energy use. Results of statistical tests can be found in the reports for PY2, PY3, and PY4.

In Phase 2, Cadmus randomly assigned eligible customers to the Expansion Group treatment or control group. At the time of the randomization, Cadmus also performed statistical tests to verify the equivalence of the two groups. Results of the tests are shown below in Table L-2.

Table L-2: Randomization Check for Expansion Group

	Treatment Group	Control Group	Difference	T-test statistic (p value)
Average annual electricity use per customer (kWh)	23,194.5 (5373.6)	23,195.0 (5360.8)	0.4676	0.01 (0.993)
Number of customers	47,652	12,383	N/A	N/A

The difference in average annual electricity use per customer between the treatment and control group was 0.5 kWh, and the difference was not statistically significant (p value=0.99).

L.3 ENERGY SAVINGS MODEL SPECIFICATION

To estimate the program energy savings, Cadmus employed regression analysis of monthly customer bills. We used the approach in Allcott and Rogers (2014), which involves regression analysis of post-treatment customer bills on a program treatment group indicator variable, month-by-year fixed effects, pre-treatment consumption, and pre-treatment consumption interacted with the month-by-year fixed effects.[185] The regression includes pre-treatment consumption to control for differences between customers in average energy use.

Specifically, we estimated the average daily savings per customer using the following regression model of electricity use:

$$adc_{it} = \alpha + \beta\ Part_{it} + \rho_H\ HDD_{it} + \rho_C\ CDD_{it} + \mu_{my} + \mathbf{Pre\text{-}adc}_i{'}\ \gamma + \mathbf{Pre\text{-}adc}_i \times \mu_{my}\ {'}\theta + \varepsilon_{it}$$

Equation E-1

where:

adc_{it} = Average daily electricity consumption of home 'i' in month 't' of the post-treatment period

185 Allcott, Hunt, and Todd Rogers. 2014. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review*, 104(10): 3003-37.

α	=	Intercept corresponding to average daily consumption per customer across customers and months.
$Part_{it}$	=	Indicator variable for receiving a home energy report (= 1 if the home was in the treatment group and received an energy report in month t or in a previous month; = 0 otherwise).
β	=	Coefficient indicating the conditional average treatment effect of the program (the average daily kWh savings per customer).
HDD_{it}	=	Average daily heating degrees for customer i in month t.
ρ_H	=	Coefficient indicating the average effect of HDD on consumption.
CDD_{it}	=	Average daily cooling degrees for customer i in month t.
ρ_C	=	Coefficient indicating the average effect of CDD on consumption.
μ_{my}	=	Month-by-year fixed effects to capture consumption effects specific to month.
$\mathbf{Pre\text{-}adc_i}$	=	Vector of variables summarizing energy use during 12 months before treatment, including annual average daily consumption, summer average daily consumption, and winter average daily consumption.
γ	=	Vector of coefficients indicating the average effect of pre-treatment consumption on post-treatment consumption.
θ	=	Vector of coefficients indicating the average effect of pre-treatment consumption on post-treatment consumption in post-treatment month *m* of year y.
ε_{it}	=	Error term for home ‘i’ in month ‘t.’

For the Expansion Group, Cadmus estimated Equation E-1 by OLS using post-treatment energy use data. The estimate of b is expected to be unbiased because of the random assignment of eligible homes to program treatment and control groups.

For the legacy group regression models, Cadmus estimated Equation E-1 with separate participation-year indicators for each program year between PY2 and PY5 (i.e., Part x PY2, Part x PY3, Part x PY4, Part x PY5). The legacy group models also included a *PY6 - pre-first report* indicator variable for June 2014 to September 2014 and a *PY6 post-first report* indicator for October 2014 to May 2015. The coefficient on *PY6 post-first report* indicates the average daily savings per customer after the first reports were delivered to customers in PY6. According to the Pennsylvania TRM, home energy reports have a measure life of one year. Therefore, PPL Electric can only claim savings for PY6 after the first reports in PY6 were delivered.

Accordingly, the EM&V contractor's estimate of savings only includes savings that occurred after homes received their first reports in PY6.[186]

L.4 PY6 BEHAVIOR AND EDUCATION REGRESSION ANALYSIS ESTIMATES

Table L-3 shows estimates of the average daily savings per customer for each track from estimation of Equation E-1. All of the models were estimated by ordinary least squares (OLS), and Huber-White robust standard errors were adjusted for correlation over time in a customer's consumption.[187]

Table L-3: Conditional Average Program Treatment Effects for Legacy Group 1

	Legacy 1	Legacy 2	Expansion
Participant x PY 2	-0.6732 (0.049)		
Participant x PY 3	-0.8831 (0.049)	-0.9663 (0.071)	
Participant x PY 4	-0.8831 (0.059)	-1.2592 (0.103)	
Participant x PY 5	(1.002) (0.072)	-1.2283 (0.123)	
Participant x PY 6			-0.6041 (0.124)
Participant x PY 6 – Pre First Report	-0.7884 (0.090)	-0.9195 (0.127)	
Participant x PY 6 – First Report	-0.918 (0.104)	-1.4594 (0.167)	-0.6041 -0.1236
Pre-treatment consumption	Yes	Yes	Yes
Month-by-Year Fixed Effects	Yes	Yes	Yes
Weather	Yes	Yes	Yes
N	5,153,331	3,287,548	472,431
Table shows estimates of average daily savings (kWh) per home for PY2 to PY6. See text for estimation details. Huber-White standard errors clustered on homes in parentheses.			

The Energy Efficiency Behavior and Education Program reduced average daily consumption of customers in each program year and track. The savings estimates are precisely estimated and statistically significant at the 5% level. In Legacy Group 1, the effect of the program in PY6 was to reduce average daily consumption per treated home by approximately 0.92 kWh. In Legacy Group 2, the program effect was

186 Energy savings from home energy reports often persist after treatment ends (Khawaja and Stewart, 2014). Legacy group customers, who had received reports for two or three years, saved energy during PY5 and between June 2014 and September 2014 of PY6. However, because Pennsylvania assumes a one year measure life for home energy reports, PPL Electric could not claim savings between June 2014 and September 2014 for PY6.

187 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.

to reduce average daily consumption per treated home by approximately 1.23 kWh. In the Expansion Group, the program effect was to reduce average daily consumption per home by 0.60 kWh.

Table L-4 shows the estimated annual treatment effects as a percent of annual consumption for each population track.

Table L-4. Percent Treatment Effects

	Legacy 1	Legacy 2	Expansion
Participant x PY 2	1.3%		
	(0.001)		
Participant x PY 3	1.8%	1.4%	
	(0.001)	(0.001)	
Participant x PY 4	2.0%	1.8%	
	(0.001)	(0.001)	
Participant x PY 5	1.7%	1.6%	
	(0.002)	(0.002)	
Participant x PY 6			0.8%
			(0.002)
Participant x PY 6 – Pre First Report	1.7%	1.7%	
	(0.002)	(0.002)	
Participant x PY 6 – First Report	1.8%	1.8%	
	(0.002)	(0.002)	
Table shows estimates of average daily savings per home as a percent of consumption. See text for estimation details. Huber-White standard errors clustered on homes in parentheses.			

Both the Legacy 1 and Legacy 2 groups exhibited ramping of saving during the initial program years. Savings of the Legacy Group 1 increased from 1.3% in PY2 to 1.8% in PY3 and then to 2.0% in PY4. Savings diminished in PY5 after PPL Electric stopped sending energy reports before rebounding slightly in PY6. Savings of the Legacy Group 2 followed a similar pattern. The Expansion Group saved 0.8% of consumption.

L.5 ANNUAL NET PROGRAM ENERGY SAVINGS

The evaluation CSP estimated total savings in PY6 for each population track. As noted above, because of the one-year measure life for home energy report in Pennsylvania, PPL Electric can only claim savings in PY6 occurring after the first reports were sent.

Cadmus used estimates of the average daily kWh savings per home to estimate the PY6 net savings. Specifically, the program savings were estimated as the product of the average daily kWh savings per home and the number of customer treatment days:

$$\text{PY6 Net savings} = -\beta \sum_j \text{Treatment Days in PY6}_j$$

where:

β = The average daily kWh savings during PY6 after the first reports were received from regression Equation E1.

Treatment Days_j = The number of treatment days for treatment group customer j in PY6. This is the number of days remaining in PY6 after receiving the first PY6 energy report.

Table L-5 shows the estimate of PY6 savings and average annual savings per home with 90% confidence intervals for each population track.

Table L-5: PY6 Energy Efficiency Behavior & Education Program Energy Savings Estimates

Program Net Savings			
	Point Estimate (MWh)	**90% Confidence Interval Lower Bound**	**90% Confidence Interval Upper Bound**
Legacy 1	8,487	7,675	9,299
Legacy 2	15,430	13,942	16,917
Expansion	5,651	3,749	7,553
Total Program	29,568	27,021	32,115
Average Home Net Savings			
	Point Estimate (kWh)	**90% Confidence Interval Lower Bound**	**90% Confidence Interval Upper Bound**
Legacy	220.9	179.7	262.1
Legacy 2	350.6	284.8	416.4
Expansion	122.6	81.3	163.9

In PY6, the Behavior & Education Program Legacy Group 1 saved about 8,500 MWh, with a 90% confidence interval of 7,675 MWh to 9,299 MWh. The Legacy Group 2 saved about 15,430 MWh, with a 90% confidence interval of 13,942 MWh to 7,553 MWh. The total PY6 program savings were estimated to be 29,568 MWh.

In the Legacy 1 Group, the average PY6 savings per home was 221 kWh. In Legacy Group 2, the average PY6 savings per home was 350 kWh. In the Expansion Group, the average PY6 savings per home was 122 kWh.

This page intentionally left blank