

Annual Report to the Pennsylvania Public Utility Commission

Phase III of Act 129
Program Year 8
(June 1, 2016—May 31, 2017)
for Pennsylvania Act 129 of 2008
Energy Efficiency and Conservation Plan

Prepared by Cadmus for
PPL Electric Utilities

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The Cadmus Group LLC

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Acronyms

BDR	Behavioral Demand Response
C&I	Commercial and Industrial
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
CSP	Conservation Service Provider or Curtailment Service Provider
Cv	Coefficient of Variation
DLC	Direct Load Control
DR	Demand Response
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE&C	Energy Efficiency and Conservation
EM&V	Evaluation, Measurement, and Verification
EISA	Energy Independence and Security Act
EUL	Effective Useful Life
GNE	Government, Nonprofit, Education
HER	Home Energy Report
HIM	High Impact Measure
HOU	Hours of Use
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
IPMVP	International Performance Measurement and Verification Protocol
kW	Kilowatt
kWh	Kilowatt-hour
KPI	Key Performance Indicator
LED	Light-Emitting Diode
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and Verification
MMBTU	Million British Thermal Units
MW	Megawatt
MWh	Megawatt-hour
NPV	Net Present Value
NTG	Net-to-Gross
O&M	Operations and Maintenance
P3TD	Phase III to Date
PA PUC	Pennsylvania Public Utility Commission
PSA	Phase III to Date Preliminary Savings Achieved; equal to VTD + PYRTD

PSA+CO	PSA savings plus Carryover from Phase II
PY	Program Year: for example, PY8, from June 1, 2016, to May 31, 2017
PYRTD	Program Year Reported to Date
PYVTD	Program Year Verified to Date
PYTD	Program Year to Date
QA/QC	Quality Assurance/Quality Control
RTD	Phase III to Date Reported Gross Savings
SEER	Seasonal Energy Efficiency Rating
SWE	Statewide Evaluator
T&D	Transmission and Distribution
TRC	Total Resource Cost
TRM	Technical Reference Manual
VTD	Phase III to Date Verified Gross Savings
WRAP	Weatherization Relief Assistance Program

Types of Savings

Gross Savings: The change in energy consumption and/or peak demand that results directly from program-related actions taken by participants in an EE&C program, regardless of why they participated.

Net Savings: The total change in energy consumption and/or peak demand that is attributable to an EE&C program. Depending on the program delivery model and evaluation methodology, the net savings estimates may differ from the gross savings estimate due to adjustments for the effects of free riders, changes in codes and standards, market effects, participant and nonparticipant spillover, and other causes of changes in energy consumption or demand not directly attributable to the EE&C program.

Reported Gross: Also referred to as *ex ante* (Latin for “beforehand”) savings. The energy and peak demand savings values calculated by the EDC or its program Implementation Conservation Service Providers (ICSP), and stored in the program tracking system.

Unverified Reported Gross: The Phase III Evaluation Framework allows EDCs and the evaluation contractors the flexibility to not evaluate each program every year. If an EE&C program is being evaluated over a multi-year cycle, the reported savings for a program year where evaluated results are not available are characterized as unverified reported gross until the impact evaluation is completed and verified savings can be calculated and reported.

Verified Gross: Also referred to as *ex post* (Latin for “from something done afterward”) gross savings. The energy and peak demand savings estimates reported by the independent evaluation contractor after the gross impact evaluation and associated M&V efforts have been completed.

Verified Net: Also referred to as *ex post* net savings. The energy and peak demand savings estimates reported by the independent evaluation contractor after application of the results of the net impact evaluation. Typically calculated by multiplying the verified gross savings by a net-to-gross (NTG) ratio.

Annual Savings: Energy and demand savings expressed on an annual basis, or the amount of energy and/or peak demand an EE&C measure or program can be expected to save over the course of a typical year. Annualized savings are noted as MWh/year or MW/year. The Pennsylvania (PA) Phase III technical reference manual (TRM), hereafter referenced as the PA TRM, provides algorithms and assumptions to calculate annual savings, and Act 129 compliance targets for consumption reduction are based on the sum of the annual savings estimates of installed measures or behavior change.

Lifetime Savings: Energy and demand savings expressed in terms of the total expected savings over the useful life of the measure. Typically calculated by multiplying the annual savings of a measure by its effective useful life. The TRC Test uses savings from the full lifetime of a measure to calculate the cost-effectiveness of EE&C programs.

Program Year Reported to Date (PYRTD): The reported gross energy and peak demand savings achieved by an EE&C program or portfolio within the current program year. PYTD values for energy efficiency will always be reported gross savings in a semi-annual or preliminary annual report.

Program Year Verified to Date (PYVTD): The verified gross energy and peak demand savings achieved by an EE&C program or portfolio within the current program year as determined by the impact evaluation findings of the independent evaluation contractor.

Phase III to Date (P3TD): The energy and peak demand savings achieved by an EE&C program or portfolio within Phase III of Act 129. Reported in several permutations described below.

- **Phase III to Date Reported (RTD):** The sum of the reported gross savings recorded to date in Phase III of Act 129 for an EE&C program or portfolio.
- **Phase III to Date Verified (VTD):** The sum of the verified gross savings recorded to date in Phase III of Act 129 for an EE&C program or portfolio, as determined by the impact evaluation finding of the independent evaluation contractor.
- **Phase III to Date Preliminary Savings Achieved (PSA):** The sum of the verified gross savings (VTD) from previous program years in Phase III where the impact evaluation is complete plus the reported gross savings from the current program year (PYTD). For PY8, the PSA savings will always equal the PYTD savings because PY8 is the first program year of the phase (no savings will be verified until the PY8 final annual report).
- **Phase III to Date Preliminary Savings Achieved + Carryover (PSA+CO):** The sum of the verified gross savings from previous program years in Phase III plus the reported gross savings from the current program year plus any verified gross carryover savings from Phase II of Act 129. This is the best estimate of an EDC's progress toward the Phase III compliance targets.
- **Phase III to Date Verified + Carryover (VTD + CO):** The sum of the verified gross savings recorded to date in Phase III plus any verified gross carryover savings from Phase II of Act 129.

1 Introduction

Pennsylvania Act 129 of 2008, 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). Phase II of Act 129 began in 2013 and concluded in 2016. In late 2015, each EDC filed a new energy efficiency and conservation (EE&C) plan with the Pennsylvania Public Utility Commission (PA PUC) detailing the proposed design of its portfolio for Phase III. These plans were updated based on stakeholder input and subsequently approved by the PA PUC in 2016.

Implementation of Phase III of the Act 129 programs began on June 1, 2016, and runs until May 2021 (five program years—PY8–PY12). This report documents the progress and effectiveness of the Phase III EE&C accomplishments for PPL Electric Utilities in the first program year of Phase III, Program Year 8 (PY8, June 2016–May 2017), as well as the cumulative accomplishments of the Phase III programs since inception (also June 2016–May 2017).

This report details the participation, spending, reported gross savings, verified gross savings, and verified net savings impacts of the energy efficiency programs in PY8. Compliance with Act 129 savings goals are ultimately based on verified gross savings. This report also includes estimates of cost-effectiveness according to the Total Resource Cost test (TRC).¹

PPL Electric Utilities has retained Cadmus as an independent evaluation contractor for Phase III of Act 129. Cadmus is responsible for the measurement and verification of the savings and calculation of gross verified and net verified savings.

Cadmus also conducted a process evaluation to examine the design, administration, implementation, and market response to the Act 129 EE&C programs. This report presents the key findings and recommendations identified by the process evaluation and documents any changes to program delivery that PPL Electric Utilities is considering, based on the recommendations.

Phase III of Act 129 includes a demand response goal for PPL Electric Utilities. Demand response events are limited to the months of June through September starting June 2016, which are the first four months of the Act 129 program year. Because the demand response season is completed early in the program year, it is possible to complete the independent evaluation of verified gross savings for demand response sooner than is possible for energy efficiency programs. However, no demand response events occurred in PY8. The first events occurred in PY9 and, therefore, are not discussed in this PY8 report.

¹ The Pennsylvania TRC Test for Phase I was adopted by PUC order at Docket No. M-2009-2108601 on June 23, 2009 (2009 PA TRC Test Order). The TRC Test Order for Phase I later was refined in the same docket on August 2, 2011 (2011 PA TRC Test Order). The 2013 TRC Order for Phase II of Act 129 was issued on August 30, 2012. The 2016 TRC Test Order for Phase III of Act 129 was adopted by PUC order at Docket No. M-2015-2468992 on June 11, 2015.

1.1 Executive Summary

PPL Electric Utilities successfully implemented the Phase III Act 129 programs launched in PY8. Programs are ramping up and operating effectively and are meeting program objectives. Therefore, Cadmus does not suggest any major course corrections. Recommendations suggest minor tuning and possible areas of inquiry in future years.

Verified energy savings achieved in PY8 exceed those projected for the phase to date shown in PPL Electric Utilities' EE&C plan.² Specifically, PPL Electric Utilities exceeded the PY8 projected estimate of 313,024 MWh/yr, achieving 331,344 MWh/yr in verified savings, or 106% of PY8 projections. An additional 27,432 MWh/yr were reported in PY8 and will be verified in PY9 and PY10.

PPL Electric Utilities delivered programs for 81% of the PY8 projected budget estimated in the EE&C Plan, expending \$50,599,000. The acquisition cost in PY8 is \$0.15 per annual kWh (EDC expenditures/first year savings). The portfolio level cost of conserved energy (TRC costs/net present value [NPV] lifetime kWh, at generation) is \$0.04.

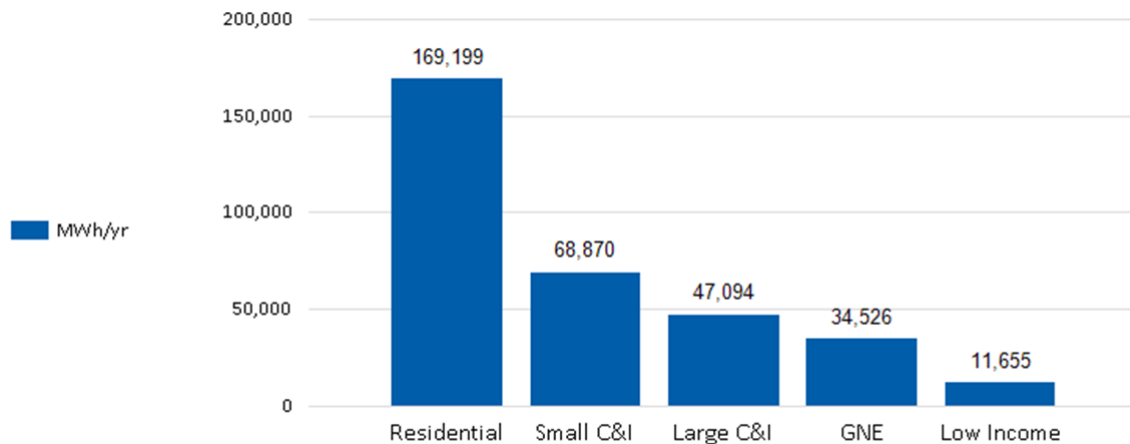
Achieved savings in PY8 (331,344 MWh/yr) contributed 23% to the Phase III overall five-year compliance target of 1,443,035 MWh/yr. PPL Electric Utilities is on track to meet the Phase III overall compliance target.

PPL Electric Utilities is also on track to meet compliance targets for the low-income and government, nonprofit, education (GNE) sectors. The low-income savings target is 79,367 MWh/yr of verified gross energy savings. PPL Electric Utilities achieved 15% of the Phase III low-income energy-savings target. An additional 16 MWh/yr reported in PY8 will be verified in PY10, and 1,800 MWh/yr were completed in PY8 and will be reported in PY9. The Phase III GNE savings target is 50,507 MWh/yr of verified gross energy savings. PPL Electric Utilities has achieved 68% of the target.

Figure 1 shows PPL Electric Utilities' program year-to-date (PYTD) verified savings by sector.

² Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864 (*Phase III Implementation Order*), entered June 11, 2015.

Figure 1. PYTD Verified Savings by Sector



Note: Total residential verified MWh/yr has been adjusted to account for Home Energy Education Program savings uplift.

A portfolio is cost-effective if the TRC benefit-cost ratio exceeds 1.0. The PY8 portfolio is cost-effective, with a portfolio level TRC of 1.67.

Free ridership is low across the PY8 programs where it was estimated. The evaluated net-to-gross (NTG) ratio, including some spillover attributable to the programs, is 0.83. Program offerings do not need modification to address free ridership.

In Phase III, PPL Electric Utilities established a goal to achieve 80% or greater of *very satisfied* and *somewhat satisfied* customers in each sector.³ Respondents to participant satisfaction surveys across all three sectors showed high levels of satisfaction with the programs. Including the combined *very satisfied* and *somewhat satisfied* responses, the low-income (n=2,203) and nonresidential (n=91) sectors achieved customer satisfaction of 97%, followed by 86% for the residential sector (n=18,727). All three sectors exceeded the customer satisfaction goal of 80%. Portfolio satisfaction for PY8 is 90%; an increase from the PY7 result of 88%.⁴

³ The customer satisfaction goal is stipulated in PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania Public Utility Commission on December 5, 2016, Section 1.2.2.

⁴ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

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2 Summary of Achievements

2.1 Carryover Savings from Phase II of Act 129

Figure 2 compares PPL Electric Utilities' Phase II verified gross savings to the Phase II compliance target. The PA PUC's Phase III Implementation Order allowed EDCs to carry over savings in excess of the overall (portfolio) Phase II savings compliance target, in excess of the Phase II GNE savings compliance target and in excess of the Phase II low-income savings compliance target.^{5,6} PPL Electric Utilities did not have carry over savings for the portfolio but did exceed its Phase II compliance targets for GNE and low-income. However, in the August 3, 2017, Compliance Order,⁷ the PA PUC determined that because PPL Electric Utilities did not obtain Phase II savings in excess of its Phase II consumption reduction requirement, PPL Electric Utilities was not entitled to any GNE or low-income sector carryover savings into Phase III.

⁵ Pennsylvania Public Utility Commission, *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2014-2424864, (*Phase III Implementation Order*), entered June 11, 2015.

⁶ Proportionate to those savings achieved by dedicated low-income programs in Phase III.

⁷ The Order addresses the EDCs' compliance with the Phase II energy reduction targets and the Petitions for reconsideration of the April 6, 2017, Compliance Order filed by Duquesne, PECO, and PPL Electric Utilities. Pennsylvania Public Utility Commission. Act 129 Phase II Final Compliance Order. Docket No. M-2012-2289411. Adopted August 3, 2017. Available online: http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/energy_efficiency_and_conservation_ee_c_program.aspx

Figure 2. Carryover Savings from Phase II of Act 129



2.2 Phase III Energy Efficiency Achievements to Date

Table 1 shows the achievements to date since the beginning of PY8 on June 1, 2016. Table 2 shows the Phase III achievements to date. The savings represent 23% of the May 31, 2021, energy savings compliance target of 1,443,035 MWh/yr.

Table 1. PY8 Energy Efficiency Achievements to Date

PY8 Only	Gross Reported Savings (PYRTD)	Gross Verified Savings (PYVTD)	Unverified ^[1] (PYRTD)
Energy Savings (MWh/yr)	380,028	331,344 ^[2]	27,432
Peak Demand Savings (MW/yr)	100.81	46.81	3.09

^[1] The Weatherization Relief Assistance Program (WRAP), Custom Incentive Program, and the Efficient Equipment Program's Distributor Discount delivery channel reported unverified savings in PY8. The Custom Program and Distributor Discount verification activities will be completed and reported in PY9. The WRAP analyses will be completed and reported in PY10.

^[2] Total verified MWh/yr has been adjusted to account for Home Energy Education Program energy savings uplift (see 7.5 *Uplift Analysis*). Uplift results in savings counted in more than one program; therefore, an adjustment is made to prevent double counting.

Table 2. Phase III Energy Efficiency Achievements to Date

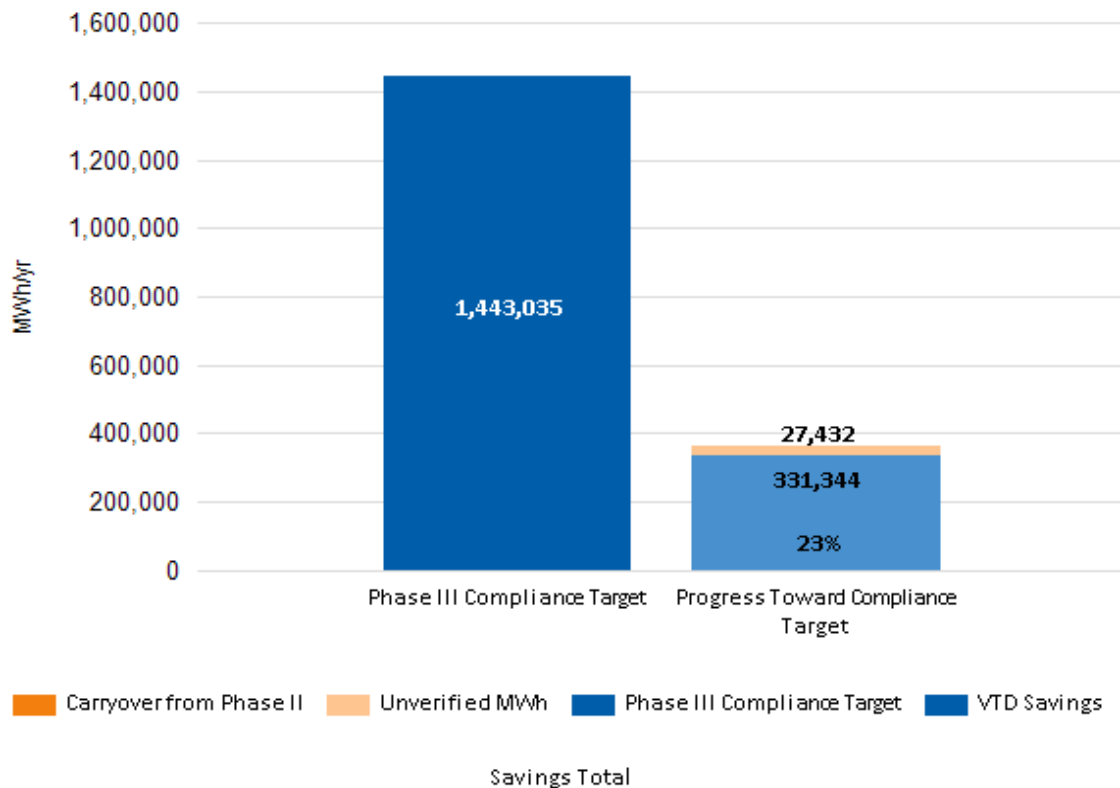
Phase III	Gross Reported Savings (P3RTD)	Gross Verified Savings (P3VTD)	Unverified ^[1] (P3RTD)
Energy Savings (MWh/yr)	380,028	331,344 ^[2]	27,432
Peak Demand Savings (MW/yr)	100.81	46.81	3.09
<p>^[1] The WRAP, Custom Incentive Program, and the Efficient Equipment Program's Distributor Discount delivery channel reported unverified savings in PY8. The Custom Program and Distributor Discount verification activities will be completed and reported in PY9. The WRAP analyses will be completed and reported in PY10.</p> <p>^[2] Total verified MWh/yr has been adjusted to account for Home Energy Education Program energy savings uplift (see Appendix C). Uplift results in savings counted in more than one program; therefore an adjustment is made to prevent double counting.</p>			

Figure 3 summarizes PPL Electric Utilities' progress toward the Phase III portfolio compliance target. Savings for three Custom Equipment Program projects are classified as unverified in PY8 because they require post-installation billing analysis that extends into PY9. Therefore, verified savings for those projects will be reported in the PY9 annual report. Additional details about these projects are in chapter 6 *Custom Program*.

Savings for full-cost jobs in the Winter Relief Assistance Program (WRAP) were not verified in PY8 because they require one year of post-installation billing analysis. These jobs will be verified in the second quarter (Q2) of PY10. Savings will be reported in the PY10 Annual Report. Additional details about this are in chapter 12 *Weatherization Relief Assistance Program*.

Activities are in progress to verify savings achieved through the Efficient Equipment Program's Distributor Discount (midstream) delivery channel. The verified savings will be reported in the PY9 Interim Report, delivered in January 2018. Additional details about these projects are included in section 5.3.3 *Distributor Discount* in chapter 5 *Efficient Equipment Program*.

Figure 3. EE&C Plan Performance Toward Phase III Portfolio Target



The Phase III Implementation Order directed the EDCs to offer conservation measures to the low-income customer sector based on the proportion of electric sales attributable to low-income households. The proportionate number of measures target is 9.95% for PPL Electric Utilities.⁸ PPL Electric Utilities offers a total of 82 EE&C measures (products and equipment) to its residential and nonresidential customer classes.⁹ It makes 18 measures available to the low-income customer sector at no cost to the customer. This represents 22% of the total number of measures offered in the EE&C plan and exceeds the target for the proportionate number of measures.

The PA PUC also established a low-income energy savings target of 5.5% of the portfolio savings goal.¹⁰ The low-income savings target for PPL Electric Utilities is 79,367 MWh/yr of verified gross energy savings. Figure 4 compares the verified-to-date (VTD) performance for the low-income customer sector to the Phase III savings target. Considering only PY8 verified savings, PPL Electric Utilities has achieved

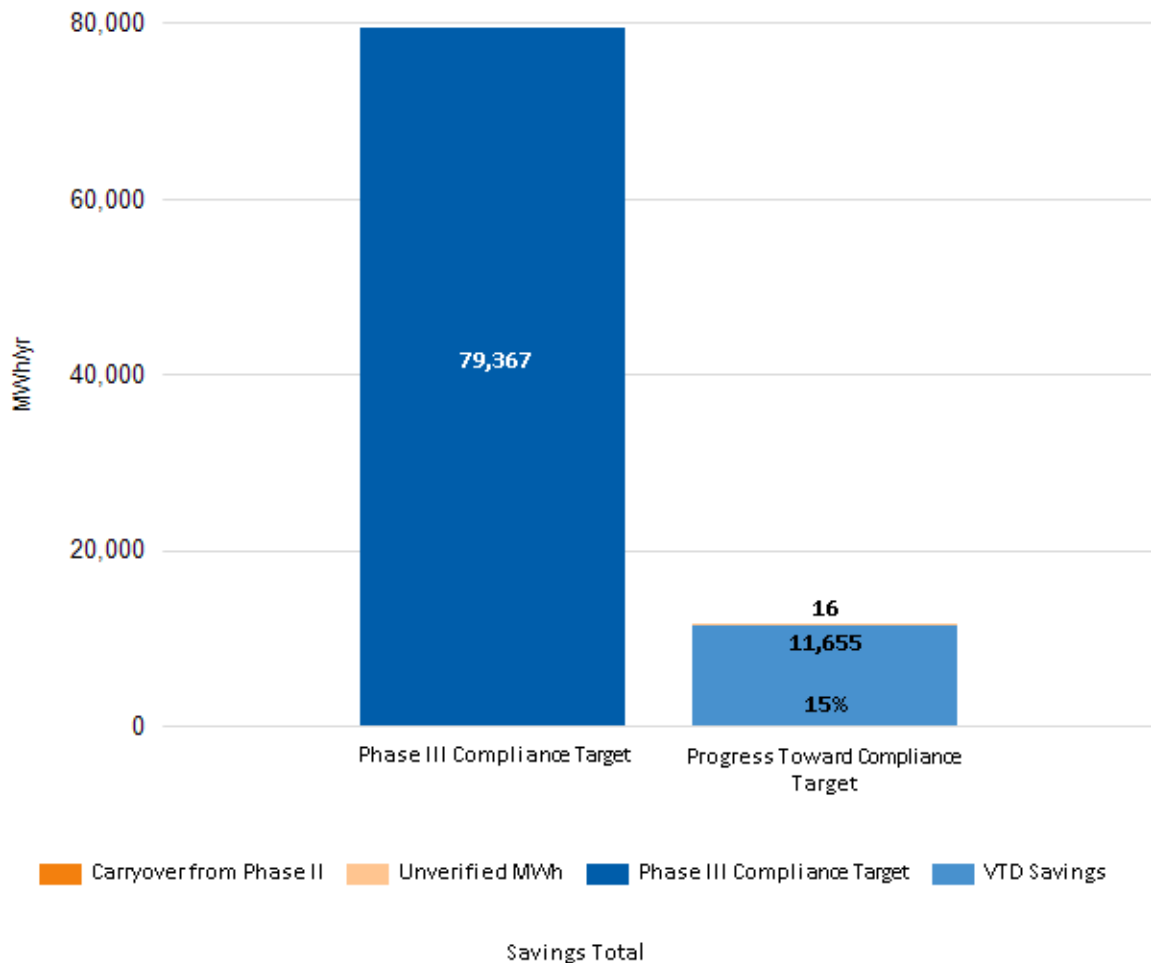
⁸ Pennsylvania Public Utility Commission. *Phase III Implementation Order*. Docket No. M-2014-242-2424864. Dated June 11, 2015.

⁹ PPL Electric Utilities. *PPL Electric Utilities Energy Efficiency and Conservation Plan Act 129 Phase III*. Before the Pennsylvania Public Utility Commission. Docket No. M-2015-2515642. Compliance filing December 5, 2016.

¹⁰ Pennsylvania Public Utility Commission. *Phase III Implementation Order*. Docket No. M-2014-242-2424864. Dated June 11, 2015

15% of the Phase III low-income energy-savings target. This figure also shows 16 MWh/yr of unverified savings that will, once verified, contribute to the Phase III low-income energy-savings target. There were approximately 1,501 WRAP jobs with total reported savings of 1,804 MWh/yr that were installed in PY8 but missed the PY8 deadline for uploading into PPL Electric Utilities' tracking system. Therefore, these will be reported and evaluated in PY9.

Figure 4. EE&C Plan Performance Toward Phase III Low-Income Compliance Target

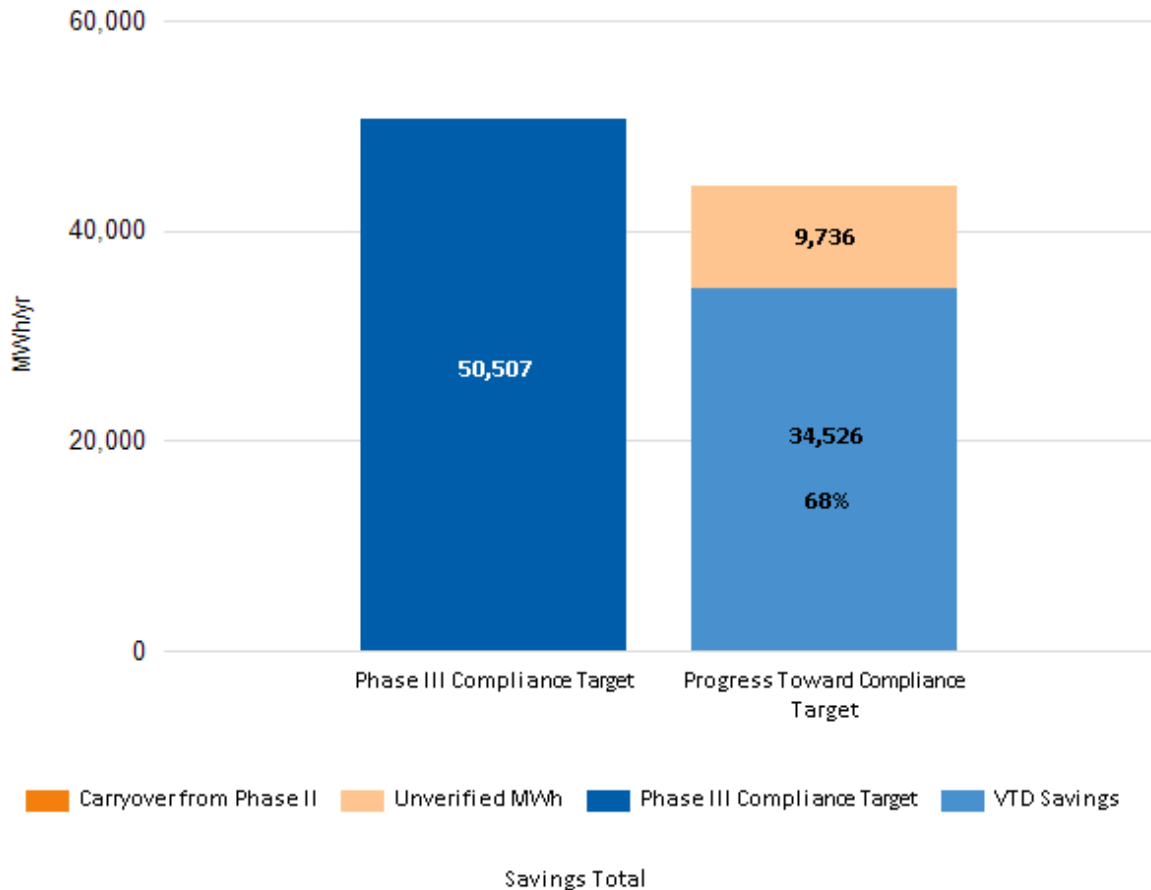


The Phase III Implementation Order established a GNE energy savings target of 3.5% of the portfolio savings goal.¹¹ The GNE savings target for PPL Electric Utilities is 50,507 MWh/yr of verified gross energy savings. Figure 5 compares the VTD performance for the GNE customer sector to the Phase III GNE savings target. Considering only PY8 verified savings, PPL Electric Utilities has achieved 68% of the Phase

¹¹ Pennsylvania Public Utility Commission. *Phase III Implementation Order*. Docket No. M-2014-242-2424864. Dated June 11, 2015.

III GNE energy savings target. This figure also shows 9,736 MWh/yr of unverified savings that will, once verified, contribute to the Phase III GNE energy-savings target.

Figure 5. EE&C Plan Performance Against Phase III GNE Compliance Target



2.3 Phase III Demand Response Achievements to Date

PPL Electric Utilities did not implement curtailment events in PY8. The program's implementation conservation service provider (ICSP) enrolled customers during PY8 (June 1, 2016, to May 31, 2017) and initiated events during the summer of PY9.

2.4 Phase III Performance by Customer Sector

Table 3 presents the participation, savings, and spending by customer sector for PY8. The residential, small commercial and industrial (C&I), and large C&I sectors are defined by EDC tariff and the residential low-income and GNE sector were defined by statute (66 Pa. C.S. § 2806.1). The residential low-income sector is a subset of the residential customer class, and the GNE sector includes customers within the Residential, Small C&I, and Large C&I rate classes. The savings, spending, and participation values for the low-income and GNE sectors have been removed from the parent sectors in Table 3.

Table 3. Program Year 8 Summary Statistics by Customer Sector

Parameter	Residential	Low-Income	Small C&I	Large C&I	GNE	Total ^[1]
Number of Participants	549,640	14,600	18,845	182	782	584,049
PY8 Energy Realization Rate ^[2]	98%	85%	87%	98%	97%	95%
PYVTD MWh/yr	173,594 ^[3]	11,655	68,870	47,094	34,526	335,739 ^[3]
PY8 Demand Realization Rate ^[2]	33%	108%	81%	94%	89%	48%
PYVTD MW/yr (Energy Efficiency)	23.66	1.15	11.74	5.71	4.54	46.81
PYVTD MW/yr (Demand Response)	-	-	-	-	-	-
PY8 Incentives (\$1000)	\$12,180	\$0 ^[4]	\$4,159	\$3,555	\$2,563	\$22,458

^[1] Total may not sum due to rounding.
^[2] Realization Rates Exclude Unverified Savings. The Realization Rate includes reported (*ex ante*) savings only for the projects that were verified.
^[3] The residential verified savings have not been adjusted to account for energy savings uplift (double counting) in the Home Energy Education Program.
^[4] The cost of measures provided to low income participants at no cost is treated as an administrative cost, not incentives.

Table 4 summarizes plan performance by sector since the beginning of Phase III. The Phase III and PY8 tables are the same, since PY8 is the first year of Phase III.

Table 4. Phase III Summary Statistics by Customer Sector

Parameter	Residential	Low-Income	Small C&I	Large C&I	GNE	Total ^[1]
Number of Participants	549,640	14,600	18,845	182	782	584,049
P3TD Energy Realization Rate ^[2]	98%	85%	87%	98%	97%	95%
P3VTD MWh/yr	173,594 ^[3]	11,655	68,870	47,094	34,526	335,739 ^[3]
P3TD Demand Realization Rate	33%	108%	81%	94%	89%	48%
P3VTD MW/yr (Energy Efficiency)	23.66	1.15	11.74	5.71	4.54	46.81
P3VTD MW/yr (Demand Response)	-	-	-	-	-	-
P3 Incentives (\$1000)	\$12,180	\$0 ^[4]	\$4,159	\$3,555	\$2,563	\$22,458

^[1] Total may not sum due to rounding.
^[2] Realization Rates Exclude Unverified Savings. The Realization Rate includes reported (*ex ante*) savings only for the projects that were verified.
^[3] The residential verified savings have not been adjusted to account for energy savings uplift (double counting) in the Home Energy Education Program.
^[4] The cost of measures provided to low income participants at no cost is treated as an administrative cost, not incentives.

2.5 Summary of Participation by Program

Participation is defined differently for certain programs depending on the program delivery channel and data tracking practices. The nuances of the participant definition vary by program and are summarized by program in Table 5, which provides the current participation totals for PY8 and Phase III. PPL Electric

Utilities' tracking database assigns unique job identifiers to rebated projects. These correspond to participants as noted in this table.

Table 5. EE&C Portfolio Participation by Program

Program	Participant Definition	PYTD Participation	P3TD Participation
Appliance Recycling (ARP)	Unique job number; corresponds with each unique appliance decommissioned through the program during the program year	11,368	11,368
Custom	Unique job number; commercially operable job that received an incentive payment between June 1, 2016 and May 31, 2017 ^[1]	71	71
Demand Response ^[2]	Unique job number; corresponds to a customer that participated in a demand response event	-	-
Efficient Equipment	<i>Lighting and Equipment:</i> Unique job number; corresponds to each unique job that received a rebate <i>Distributor Discount:</i> Unique job number; corresponds to each purchase of discounted products For process evaluation purposes, distributors are considered the participants (n=12)	1,751	1,751
Efficient Lighting	Person or business purchasing discounted bulbs; estimated by dividing the total number of bulbs ^[4] discounted or given away by a bulb-per-participant count derived from residential and commercial customer telephone survey data collected in PY8	336,221	336,221
Energy-Efficiency Kits and Education ^[3]	Unique job number; corresponds to an energy-savings kit delivered to an income-eligible customer through the agency or the direct-mail delivery channel	12,117	12,117
Energy Efficient Home (EE Home)	Unique job number; corresponds to a rebated project Households could have more than one rebated project	11,401	11,401
Home Energy Education (HEE)	Unique bill account number and household that receives a home energy report	184,257	184,257
Low-Income Winter Relief Assistance Program (WRAP)	Unique job number; corresponds to an income-eligible household that receives an audit and program services	2,718	2,718
Student Energy Efficient Education (SEEE)	Number of participants is counted as the number of kits delivered	24,145	24,145
Portfolio Total		584,049	584,049

^[1] Projects for which customers submitted an application during PY8 but did not receive an incentive are not counted as participants.

^[2] PPL Electric Utilities did not implement curtailment events in PY8.

^[3] Participation is determined by the unique job numbers. Returned kits are assigned two unique job numbers: one for the distributed kit, and one for the returned kit. Note that this is just for record keeping purposes and the number of unique kits distributed by the ICSP in PY8 that were not returned is 12,058.

^[4] PPL Electric Utilities sold 3,527,673 bulbs through the program in PY8, of which 10% are estimated to have been purchased by small-commercial customers. See *Appendix D Evaluation Detail—Efficient Lighting Program* for additional details.

2.6 Summary of Impact Evaluation Results

During PY8, Cadmus completed impact evaluations for many of the energy efficiency programs in the portfolio. Table 6 summarizes the realization rates and NTG ratios by program or evaluation initiative.

Table 6. Impact Evaluation Results Summary

Program	Energy Realization Rate	Demand Realization Rate ^[1]	Net-to-Gross Ratio	Percentage of Total Portfolio Verified Gross	
				Verified MWh/yr	Verified MW/yr
Appliance Recycling	98%	99%	0.66	4%	3%
Custom	100%	83%	0.79	14%	11%
Demand Response ^[2]	-	-	-	0%	0%
Efficient Equipment	96%	102%	0.77	21%	21%
Efficient Lighting	97%	89%	0.83	43%	42%
Energy Efficiency Kits and Education	88%	118%	1.0 ^[3]	3%	2%
Energy Efficient Home	94%	92%	0.68	3%	4%
Home Energy Education	85%	12% ^[4]	1.0 ^[5]	10%	14%
Low Income WRAP	76%	86%	1.0 ^[3]	1%	1%
Student Energy Efficient Education	89%	106%	1.0 ^[3]	1%	1%
Total ^[6]	95%	48% ^[4]	0.83 ^[7]	100%	100%

^[1] Realization rates exclude unverified savings.

^[2] PPL Electric Utilities did not implement curtailment events in PY8.

^[3] No free ridership is expected, nor measured, per the evaluation plan. Therefore, the NTG ratio is 1.0.

^[4] Reported demand savings for the Home Energy Education program were based on the demand reduction reported in PY7, which were unreasonably high, skewing the demand realization rate for this program and for the portfolio overall. Reported savings for this program in future years will be updated to use evaluation results.

^[5] Savings are determined using a randomized control trial and the NTG ratio is irrelevant.

^[6] Total may not match sum of rows due to rounding.

^[7] Weighted by PY8 program verified gross energy savings.

Findings from net savings research are not used to adjust compliance savings in Pennsylvania. Instead, this research provides directional information for program planning purposes. Table 7 presents findings for high-impact measures studied in PY8. Findings were determined using data collected in self-report surveys for commercial lighting and residential HVAC. A demand elasticity model determined free ridership for upstream lighting. (See *Section 4.4 Net Impact Evaluation* for additional details.) Residential upstream lighting represented 67% of the total high-impact measures verified gross energy savings. Overall, high-impact measures accounted for 65% of the total portfolio verified gross energy savings.

Table 7. High-Impact Measure Net-to-Gross

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Efficient Equipment Commercial Lighting	23%	0%	0.77
Efficient Lighting Residential Upstream Lighting	17%	0%	0.83
Energy Efficient Home HVAC	44%	7%	0.63
Total	19%^[1]	0%^[1]	0.81^[1]
^[1] Weighted by verified gross energy savings of high-impact measure population.			

2.7 Summary of Energy Impacts by Program

Act 129 compliance targets are based on annualized savings (MWh/yr). Each program year, the annual savings achieved by EE&C program activity are recorded as incremental annual, or “first-year” savings, and added to an EDC’s progress toward compliance. Incremental annual savings estimates are presented in section 2.7.1. Lifetime energy savings incorporate the effective useful life (EUL) of installed measures and estimate the total energy savings associated with EE&C program activity. Lifetime savings are used in the TRC test, by program participants when assessing the economics of upgrades, and by the statewide evaluator (SWE) when calculating the emissions benefits of Act 129 programs. Section 2.7.2 presents the lifetime energy savings by program.

2.7.1 Incremental Annual Energy Savings by Program

Figure 6 presents a summary of the program year-to-date (PYTD) energy savings by program for PY8. The energy impacts in this report are presented at the meter level and do not reflect adjustments for transmission and distribution losses. The verified gross savings are adjusted by the energy realization rate, and the verified net savings are adjusted by both the realization rate and the NTG ratio.

Figure 6. PY8TD Energy Savings by Program

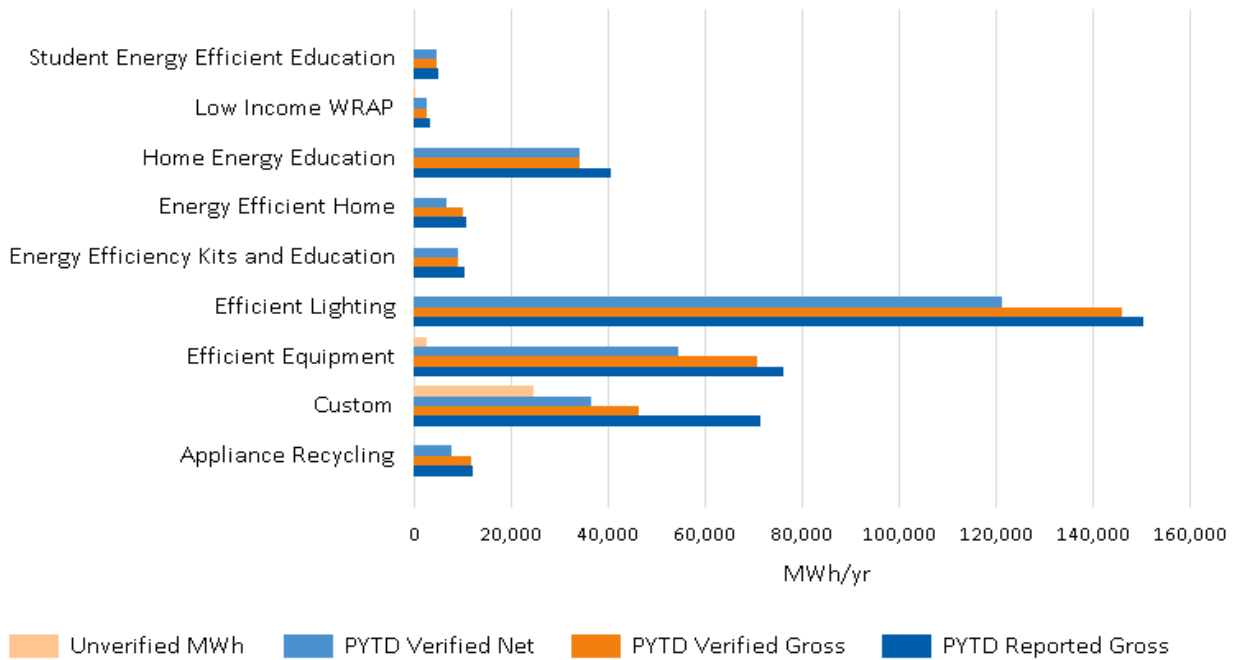
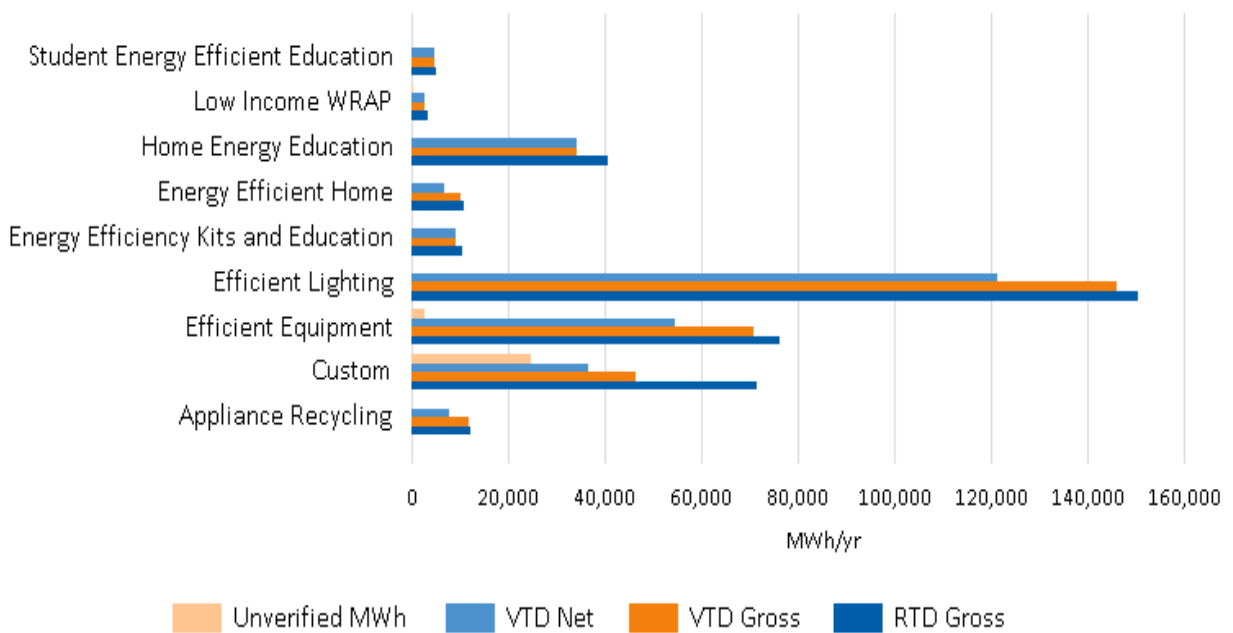


Figure 7 presents a summary of the energy savings by program for Phase III of Act 129.

Figure 7. P3TD Energy Savings by Program



A summary of energy impacts by program through PY8 is presented in Table 8.

Table 8. Incremental Annual Energy Savings by Program (MWh/Year)

Program	Program Year 8				Phase III			
	Reported to Date Gross (PYRTD)	Verified to Date Gross (PYVTD)	Unverified	Verified to Date Net (PYVTD)	Reported to Date Gross (RTD)	Verified to Date Gross (VTD)	Unverified	Verified to Date Net (VTD)
Appliance Recycling	12,035	11,844	-	7,770	12,035	11,844	-	7,770
Custom	71,332	46,368	24,815	36,631	71,332	46,368	24,815	36,631
Efficient Equipment	76,169	70,917	2,601	54,643	76,169	70,917	2,601	54,643
Efficient Lighting	150,376	145,929	-	121,121	150,376	145,929	-	121,121
Energy Efficiency Kits and Education	10,420	9,219	-	9,219	10,420	9,219	-	9,219
Energy Efficient Home	10,621	9,943	-	6,736	10,621	9,943	-	6,736
Home Energy Education	40,467	34,326	-	34,326	40,467	34,326	-	34,326
Low Income WRAP	3,491	2,652	16	2,652	3,491	2,652	16	2,652
Student Energy Efficient Education	5,118	4,539	-	4,539	5,118	4,539	-	4,539
Total ^[1]	380,028	335,739	27,432	277,638	380,028	335,739	27,432	277,638
Adjustment for Home Energy Education Program Energy Savings Uplift		(4,395)				(4,395)		
Adjusted Portfolio Total ^{[1][2]}		331,344				331,344		

^[1] May not sum due to rounding.
^[2] See Section 7.5 Uplift Analysis, which discusses methods to determine energy savings uplift (adjusting for double-counted savings).

2.7.2 Lifetime Energy Savings by Program

Table 9 presents the PYTD and P3TD lifetime energy savings by program. Lifetime savings are adjusted to account for reduced lighting savings following the 2020 Energy Independence and Security Act (EISA) backstop. Specifically, after the 2020 EISA implementation, year-one savings are reduced to the difference in energy usage between the efficient bulb and the new baseline. No savings are included beyond 15 years, for any rebated item, per the Pennsylvania TRC Order.¹²

¹² The 2016 TRC Test Order for Phase III of Act 129 was adopted by PA PUC order at Docket No. M-2015-2468992 on June 11, 2015.

Table 9. Lifetime Energy Savings

Program	Program Year 8		Phase III	
	PYVTD Gross Lifetime (MWh)	PYVTD Net Lifetime (MWh)	VTD Gross Lifetime (MWh)	VTD Net Lifetime (MWh)
Appliance Recycling	94,108	61,735	94,108	61,735
Custom	695,520	549,461	695,520	549,461
Efficient Equipment	1,036,290	798,441	1,036,290	798,441
Efficient Lighting	1,260,912	1,046,557	1,260,912	1,046,557
Energy Efficiency Kits and Education	46,815	46,815	46,815	46,815
Energy Efficient Home	131,759	87,200	131,759	87,200
Home Energy Education	34,326	34,326	34,326	34,326
Low Income WRAP	14,234	14,234	14,234	14,234
Student Energy Efficient Education	33,999	33,999	33,999	33,999
Portfolio Total ^[1]	3,347,963	2,672,766	3,347,963	2,672,766
^[1] Total may not match sum of rows due to rounding.				

2.8 Summary of Demand Impacts by Program

PPL Electric Utilities' Phase III EE&C programs achieve peak demand reductions in two primary ways. The first is through coincident reductions from energy efficiency measures, and the second is through dedicated demand response offerings that exclusively target temporary demand reductions on peak days. Energy efficiency reductions coincident with system peak hours are reported and used in the calculation of benefits in the TRC test, but they do not contribute to Phase III peak demand reduction compliance goals. Phase III peak demand reduction targets are exclusive to demand response programs.

The two types of peak demand reduction savings are also treated differently for reporting purposes. Peak demand reductions from energy efficiency are generally additive across program years, meaning that the P3TD savings reflect the sum of the first-year savings in each program year. Demand reduction stemming from energy efficiency programs do not contribute to the Act 129 demand response requirements.

Demand response goals are based on average portfolio impacts across all events called in dedicated demand response programs, so cumulative demand response performance is expressed as the *average* performance of each of the demand response events called in Phase III to date. Because of these differences, demand impacts from energy efficiency and demand response are reported separately in the following subsections.

2.8.1 Energy Efficiency

Act 129 defines peak demand savings from energy efficiency as the average expected reduction in electric demand from 2:00 p.m. to 6:00 p.m. EDT on non-holiday weekdays from June through August. Unlike Phase I and Phase II Act 129 reporting, the peak demand impacts from energy efficiency in this

report are presented at the meter level and do not reflect adjustments for transmission and distribution losses. Figure 8 presents a summary of the PYTD demand savings by energy efficiency program for PY8.

Figure 8. PYTD Demand Savings by Energy Efficiency Program¹³

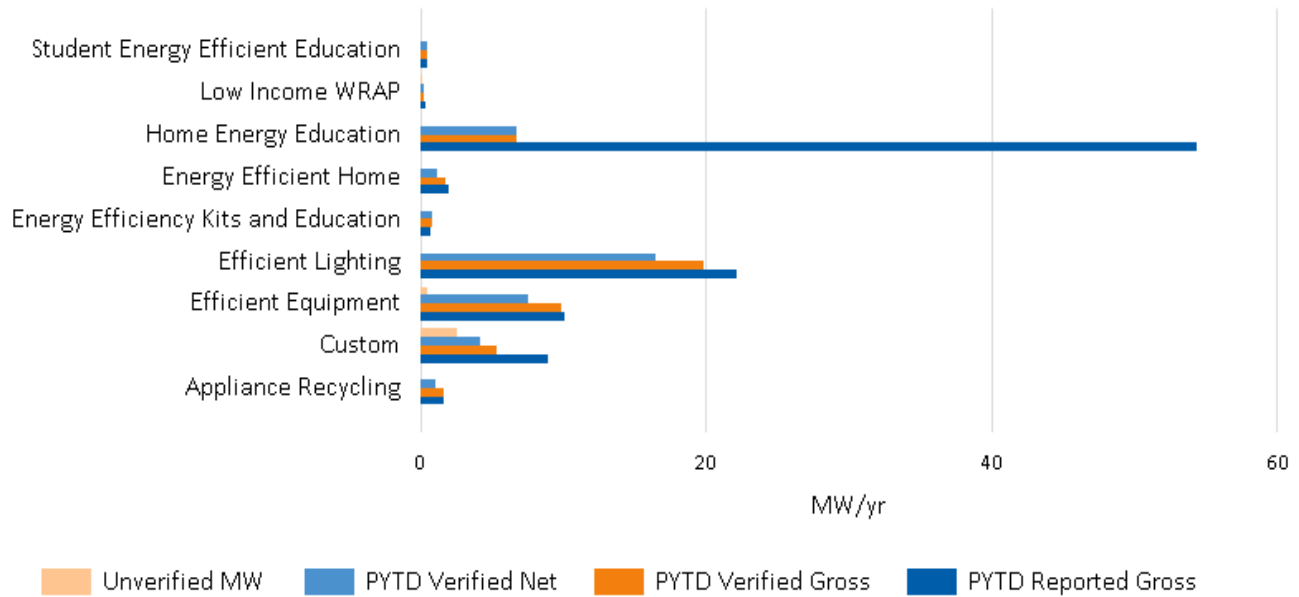
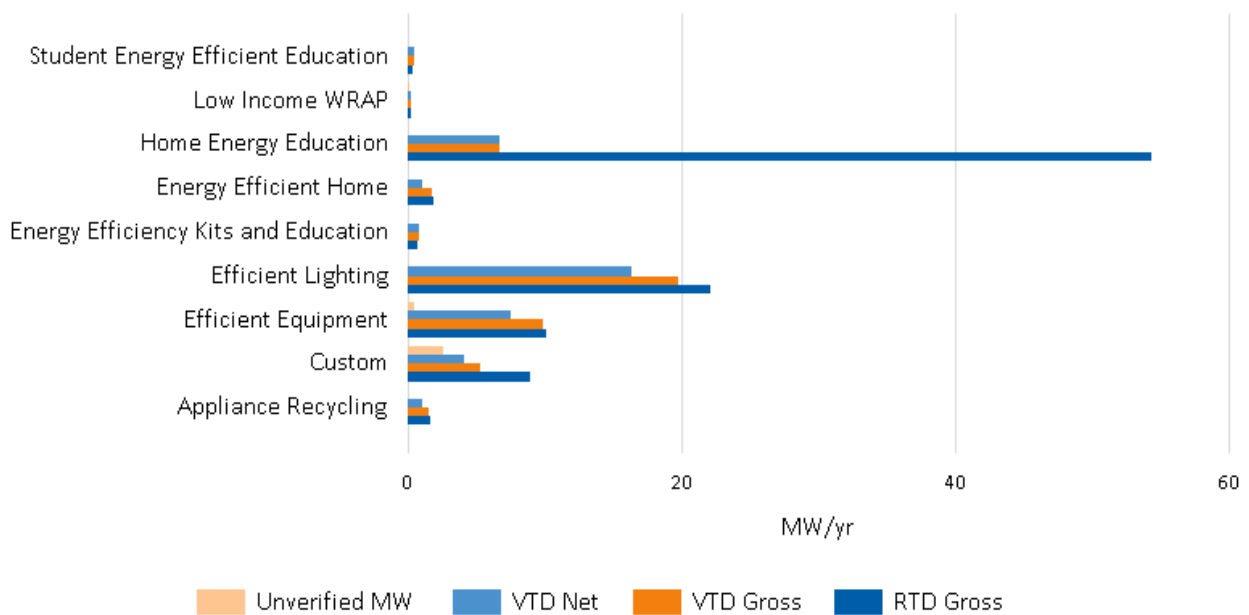


Figure 9 presents a summary of the P3TD demand savings by energy efficiency program for Phase III of Act 129.

¹³ Reported demand savings for the Home Energy Education Program were based on the demand reduction reported in PY7, which were unreasonably high, skewing the demand realization rate for this program and for the portfolio overall. Reported savings for this program in future years will be updated to use evaluation results.

Figure 9. P3TD Demand Savings by Energy Efficiency Program¹⁴

A summary of the peak demand impacts by energy efficiency program through the current reporting period is presented in Table 10.

Table 10. Peak Demand Savings by Energy Efficiency Program (MW/Year)

Program	Program Year 8				Phase III			
	PYRTD-Gross	PYVTD-Gross	PY Unverified	PYVTD Net	RTD Gross	VTD Gross	Unverified	VTD Net
Appliance Recycling	1.65	1.63	-	1.07	1.65	1.63	-	1.07
Custom	8.96	5.30	2.59	4.19	8.96	5.30	2.59	4.19
Efficient Equipment	10.16	9.87	0.50	7.60	10.16	9.87	0.50	7.60
Efficient Lighting	22.15	19.82	-	16.45	22.15	19.82	-	16.45
Energy Efficiency Kits and Education	0.75	0.88	-	0.88	0.75	0.88	-	0.88
Energy Efficient Home	1.95	1.78	-	1.16	1.95	1.78	-	1.16
Home Energy Education	54.39	6.75	-	6.75	54.39	6.75	-	6.75
Low Income WRAP	0.34	0.29	0.00	0.29	0.34	0.29	0.00	0.29
Student Energy Efficient Education	0.46	0.49	-	0.49	0.46	0.49	-	0.49
Total ^[1]	100.81	46.81	3.09	38.88	100.81	46.81	3.09	38.88

^[1] May not match due to rounding.

¹⁴ Reported demand savings for the Home Energy Education Program were based on the demand reduction reported in PY7, which were unreasonably high, skewing the demand realization rate for this program and for the portfolio overall. Reported savings for this program in future years will be updated to use evaluation results.

2.8.2 Demand Response

PPL Electric Utilities did not implement curtailment events in PY8. The program's ICSP enrolled customers during PY8 (June 1, 2016, to May 31, 2017) and initiated events during the summer of PY9.

2.9 Summary of Fuel Switching Impacts

Act 129 allows EDCs to achieve electric savings by converting electric equipment to non-electric equipment. Table 11 summarizes key fuel switching metrics to date in Phase III.

Table 11. Fuel Switching Summary

Fuel Switching Measures Offered	Electric to Fossil Fuel Central Heating Electric to Fossil Fuel Water Heating
Fuel Switching Measures Implemented	Electric to Fossil Fuel Central Heating
VTD Energy Savings Achieved via Fuel Switching (MWh/yr)	610 MWh/yr
P3TD Increased Fossil Fuel Consumption Due to Fuel Switching Measures (MMBTU/yr)	5,275 MMBTU/yr
P3TD Incentive Payments for Fuel Switching Measures (\$1000)	\$13,000

2.10 Summary of Cost-Effectiveness Results

TRC benefit-cost ratios are calculated by comparing the total NPV TRC benefits and the total NPV TRC costs. It is important to note that TRC costs are materially different from the EDC spending and rate recovery tables presented later in the report. TRC costs include estimates of the full cost incurred by program participants to install efficient equipment, not just the portion covered by the EDC rebate. Table 12 shows the TRC ratios by program and for the portfolio. The benefits were calculated using gross verified impacts. PY8 benefits and costs are expressed in PY8 dollars as the analysis is completed using program years that align nominal calendar years values to a program year.

Table 12. PY8 Gross TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$4,032	\$1,945	2.07	\$2,087
Efficient Lighting	\$73,711	\$14,787	4.98	\$58,924
Energy Efficiency Kits and Education	\$2,380	\$1,894	1.26	\$485
Energy Efficient Home	\$6,176	\$12,315	0.50	(\$6,139)
Home Energy Education	\$1,611	\$845	1.91	\$766
Low Income WRAP ^{[1], [2]}	\$899	\$4,012	0.22	\$(3,113)
Student Energy Efficient Education	\$1,765	\$905	1.95	\$860
Residential (Including Low Income) Subtotal ^{[3] [4]}	\$90,574	\$36,703	2.47	\$53,871
Custom ^[1]	\$25,904	\$26,245	0.99	\$(341)
Efficient Equipment ^[1]	\$43,822	\$25,234	1.74	\$18,587
Nonresidential Subtotal ^[3]	\$69,725	\$51,479	1.35	\$18,246
Common Portfolio Costs	-	\$7,622	-	(\$7,622)
Portfolio Total ^[3]	\$160,299	\$95,804	1.67	\$64,495
^[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness. ^[2] The Low-Income WRAP costs reported in PY8 include a number of projects that were completed in PY8 but the savings were not reported in PPL Electric Utilities' tracking database until PY9. Therefore, the TRC ratio for PY8 is artificially low. ^[3] Total may not match sum of rows due to rounding. ^[4] Low-income is shown as a sub-sector of residential in this table.				

Table 13 presents PY8 cost-effectiveness using net verified savings to calculate benefits. Net results are determined by applying program level NTG ratios to all measures impacting their claimed energy savings, secondary energy savings, participant measure costs, and operations and maintenance (O&M) benefits.

Table 13. PY8 Net TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$2,645	\$1,945	1.36	\$700
Efficient Lighting	\$61,180	\$13,162	4.65	\$48,018
Energy Efficiency Kits and Education	\$2,380	\$1,894	1.26	\$485
Energy Efficient Home	\$4,073	\$9,126	0.45	(\$5,053)
Home Energy Education	\$1,611	\$845	1.91	\$766
Low Income WRAP ^{[1], [2]}	\$899	\$4,012	0.22	(\$3,113)
Student Energy Efficient Education	\$1,765	\$905	1.95	\$860
Residential (Including Low Income) Subtotal ^{[3] [4]}	\$74,553	\$31,889	2.34	\$42,664
Custom ^[1]	\$20,464	\$21,369	0.96	(\$905)
Efficient Equipment ^[1]	\$33,761	\$20,071	1.68	\$13,690
Nonresidential Subtotal ^[3]	\$54,225	\$41,440	1.31	\$12,785
Common Portfolio Costs	-	\$7,622	-	(\$7,622)
Portfolio Total ^[3]	\$128,778	\$80,951	1.59	\$47,827
^[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness. ^[2] The Low-Income WRAP costs reported in PY8 include a number of projects that were completed in PY8 but the savings were not reported in PPL Electric Utilities' tracking database until PY9. Therefore, the TRC ratio for PY8 is artificially low. ^[3] Total may not match sum of rows due to rounding. ^[4] Low-income is shown as a sub-sector of residential in this table.				

Table 14 summarizes cost-effectiveness by program for Phase III of Act 129. Benefits and costs are expressed in PY8 dollars.

Table 14. P3TD Gross TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$4,032	\$1,945	2.07	\$2,087
Efficient Lighting	\$73,711	\$14,787	4.98	\$58,924
Energy Efficiency Kits and Education	\$2,380	\$1,894	1.26	\$485
Energy Efficient Home	\$6,176	\$12,315	0.50	(\$6,139)
Home Energy Education	\$1,611	\$845	1.91	\$766
Low Income WRAP ^{[1], [2]}	\$899	\$4,012	0.22	\$(3,113)
Student Energy Efficient Education	\$1,765	\$905	1.95	\$860
Residential (Including Low Income) Subtotal ^{[3] [4]}	\$90,574	\$36,703	2.47	\$53,871
Custom ^[1]	\$25,904	\$26,245	0.99	\$(341)
Efficient Equipment ^[1]	\$43,822	\$25,234	1.74	\$18,587
Nonresidential Subtotal ^[3]	\$69,725	\$51,479	1.35	\$18,246
Common Portfolio Costs	-	\$7,622	-	(\$7,622)
Portfolio Total ^[3]	\$160,299	\$95,804	1.67	\$64,495
^[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness. ^[2] The Low-Income WRAP costs reported in PY8 include a number of projects that were completed in PY8 but the savings were not reported in PPL Electric Utilities' tracking database until PY9. Therefore, the TRC ratio for PY8 is artificially low. ^[3] Total may not match sum of rows due to rounding. ^[4] Low-income is shown as a sub-sector of residential in this table.				

Table 15 presents P3TD cost-effectiveness results using net verified savings to calculate benefits. Cost and benefits are expressed in PY8 dollars. Net results are determined by applying program level NTG ratios to all measures impacting their claimed energy savings, secondary energy savings, participant measure costs, and O&M benefits.

Table 15. P3TD Net TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$2,645	\$1,945	1.36	\$700
Efficient Lighting	\$61,180	\$13,162	4.65	\$48,018
Energy Efficiency Kits and Education	\$2,380	\$1,894	1.26	\$485
Energy Efficient Home	\$4,073	\$9,126	0.45	(\$5,053)
Home Energy Education	\$1,611	\$845	1.91	\$766
Low Income WRAP ^{[1], [2]}	\$899	\$4,012	0.22	(\$3,113)
Student Energy Efficient Education	\$1,765	\$905	1.95	\$860
Residential (Including Low Income) Subtotal ^{[3] [4]}	\$74,553	\$31,889	2.34	\$42,664
Custom ^[1]	\$20,464	\$21,369	0.96	(\$905)
Efficient Equipment ^[1]	\$33,761	\$20,071	1.68	\$13,690
Nonresidential Subtotal ^[3]	\$54,225	\$41,440	1.31	\$12,785
Common Portfolio Costs	-	\$7,622	-	(\$7,622)
Portfolio Total ^[3]	\$128,778	\$80,951	1.59	\$47,827

^[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.
^[2] The Low-Income WRAP costs reported in PY8 include a number of projects that were completed in PY8 but the savings were not reported in PPL Electric Utilities' tracking database until PY9. Therefore, the TRC ratio for PY8 is artificially low.
^[3] Total may not match sum of rows due to rounding.
^[4] Low-income is shown as a sub-sector of residential in this table.

2.11 Comparison of Performance to Approved EE&C Plan

Table 16 presents P3TD expenditures, by program, compared to the projected budget estimates set forth in the EE&C plan through PY8. All of the dollars in Table 16 are presented in PY8 dollars.

Table 16. Comparison of P3TD Expenditures to Phase III EE&C Plan (\$1,000)

Program	Phase III Estimates from EE&C Plan through PY8	Phase III Actual Expenditures through PY8	Ratio (Actual/Plan)
Appliance Recycling	\$2,113	\$1,945	92%
Custom	\$8,932	\$7,351	82%
Demand Response	\$1,192	\$647	54%
Efficient Equipment	\$10,896	\$7,279	67%
Efficient Lighting	\$13,759	\$13,162	96%
Energy Efficiency Kits and Education	\$1,262	\$1,894	150%
Energy Efficient Home	\$5,106	\$4,937	97%
Home Energy Education	\$1,845	\$845	46%
Low Income WRAP	\$7,504	\$4,012	53%
Student Energy Efficient Education	\$1,243	\$905	73%
Total Direct Program Costs ^[1]	\$53,852	\$42,977	80%
Common Portfolio Costs	\$8,620	\$7,622	88%
Portfolio Total ^[1]	\$62,472	\$50,599	81%

^[1] Total may not match sum of rows due to rounding.

Table 17 compares Phase III verified gross program savings to the energy savings projections filed in the EE&C plan.

Table 17. Comparison of Phase III Actual Program Savings to EE&C Plan Projections for Phase III

Program	Phase III MWh/yr Estimates from EE&C Plan through PY8	VTD Gross MWh/yr Savings through PY8	Ratio (Actual/Plan)
Appliance Recycling	13,120	11,844	90%
Custom	59,712	46,368	78%
Efficient Equipment	73,625	70,917	96%
Efficient Lighting	95,752	145,929	152%
Energy Efficiency Kits and Education	7,074	9,219	130%
Energy Efficient Home	7,357	9,943	135%
Home Energy Education	40,144	34,326	86%
Low Income WRAP	11,060	2,652	24%
Student Energy Efficient Education	5,180	4,539	88%
Portfolio Total ^[1]	313,024	335,739	107%
Adjustment for Home Energy Education Program energy savings uplift		(4,395)	
Adjusted Portfolio Total ^[2]	313,024	331,344	106%
^[1] Total may not match sum of rows due to rounding.			
^[2] See 7.5 Uplift Analysis, which discusses methods to determine energy savings uplift (adjusting for double-counted savings).			

The reasons program savings varied from projections estimated in the EE&C Plan are these:

- **Appliance Recycling (residential sector).** Appliance recycling achieved 90% of projected estimates. Equipment savings were just shy of projections because the share of actual units manufactured pre-1990 was slightly lower than the projections applied in the reported savings. Overall participation was 5% lower than estimated due to the ramp-up period after relaunching the program. The program lacked momentum from the prior program year, which stopped offering services midyear. Participation was lower than expected only for the first couple of months.
- **Custom (nonresidential sector).** The reported program savings exceeded projections for PY8. However, Cadmus could only verify most, not all, of the reported savings. The unverified projects were operational in PY8, but evaluation activities required post-treatment data and were not concluded in time to include in the annual report. Cadmus verified 78% of projected savings; once the unverified savings are verified, it will likely meet estimates projected for PY8.
- **Efficient Equipment (nonresidential sector).**
 - **Lighting and Equipment component.** The verified savings for the lighting and equipment components of the Efficient Equipment Program achieved 96% of the projected savings for PY8. Factors that may have contributed to savings lower than projected include these: the direct install delivery channel started slowly in PY8; a new ICSP took over program implementation in PY8, so there was a ramp-up period for the ICSP and the program; and

- there were minor discrepancies between reported and verified equipment types, quantities, and hours of use (HOU), which resulted in realization rates less than 100%.
- **Distributor Discount component.** Savings from this delivery channel are unverified in PY8. These will be verified in PY9.
 - **Efficient Lighting (residential sector).** The Efficient Lighting Program achieved 152% of the projected savings estimated for PY8. The realization rate of 97% is the result of *ex post* adjustments to update the cross-sector bulb sales proportion, commercial hours-of-use assumptions and mapping to the Pennsylvania (PA) Phase III technical reference manual (TRM), hereafter referenced as the PA TRM, building types, and baseline adjustments for some bulb types.
 - **Energy Efficiency Kits and Education (residential low-income sector).** The program savings achieved 130% of the estimated projections for PY8, primarily because the ICSP distributed 4,058 more kits than the 8,000 kits estimated in the EE&C Plan for PY8. PPL Electric Utilities and the ICSP made the decision to send more kits to offset the slow uptake of the Low-Income WRAP at the beginning of PY8.
 - **Energy Efficient Home (residential sector).** The program exceeded its projected energy savings for the year, achieving 135% of the estimated projections.
 - **Home Energy Education (residential sector).** Cadmus verified 86% of the estimated projections for PY8. The Phase III Expansion Wave added to the program in PY8 did not save energy as expected, achieving average daily savings of 0.3% compared to the control group. Therefore, the addition of this wave did not supplement the loss of savings from ceasing treatment for low-propensity customers, who were part of the strongest-savings waves. Additionally, treatment for low-income wave customers did not resume until May, 2017, allowing PPL Electric Utilities to claim only one month of savings from these waves.
 - **Low Income WRAP (residential low-income sector).** The program's verified savings met 24% of estimated savings projected for PY8. PPL Electric Utilities estimated treating 7,000 WRAP participants, but the program ended PY8 with 2,718 WRAP participants. However, 1,501 projects reporting 1,804 MWh/yr completed in PY8 were not reported in time to meet the PY8 timeline. These will be included in PY9, and the program is expected to be on track in PY9. In addition, several measures lowered the realization rate, although the effect is minor compared to the low program participation.
 - **Student Energy Efficient Education (residential sector).** Cadmus verified 88% of the estimates projected for PY8. The following factors led to variation between the reported and verified savings:
 - The ICSP reported nightlight savings; however, PPL Electric Utilities instructed all kit recipients across its programs to stop using nightlights because of a manufacturer recall, resulting in a lower realization rate for the Bright Kids and Take Action cohorts.
 - In-service rates (ISRs) were lower for showerheads, faucet aerators, and smart strips than the ICSP used in its planning calculations, resulting in lower realization rates for the Take Action and Innovation cohorts.

- There were differences between the PA TRM algorithm inputs the ICSP used for its planned savings calculations and the inputs Cadmus used for its evaluated savings calculations.

Program Changes Under Consideration

The following program changes are being considered based on observations in PY8.

- **Energy Efficient Home.** PPL Electric Utilities added dehumidifiers to this program beginning in PY9.
- **Home Energy Education.** The ICSP may resume treatment for low-income wave customers permanently beginning in November 2017.
- **Student Energy Efficient Education.** PPL Electric Utilities removed nightlights from the energy-savings kits in PY9. In addition, the ICSP is planning to pilot an augmented reality app in PY9 to further engage students to install kit items. In addition, PPL is working with the ICSP to improve the realization rates or to otherwise increase savings (per kit or by increasing participation).
- **WRAP.** PPL Electric Utilities is working with the ICSP to increase participation and improve the realization rates.

2.12 Summary of Process Evaluation Results

This section summarizes sector- and program-level results gathered from the participant surveys. Cadmus asked participants a set of core questions about program satisfaction, opinion of PPL Electric Utilities, awareness of other programs offered by PPL Electric Utilities, online engagement, and sources of energy efficiency information. Details about survey methodology are included in the individual program sections and appendices.

2.12.1 Program Satisfaction

This section summarizes responses to the survey question about program satisfaction. Further details on each program's survey methodology and results are provided in the individual program chapters and their respective appendices. Table 18 lists the programs for which Cadmus conducted participant surveys in PY8, by residential, low-income, and nonresidential sector.

Table 18. Participant Surveys Conducted in PY8

Residential Sector	Low-Income Sector	Nonresidential Sector
<ul style="list-style-type: none"> • Appliance Recycling (n=549) • Energy Efficient Home (n=292) • Home Energy Education (n=375) • Student Energy Efficient Education (n=17,995) 	<ul style="list-style-type: none"> • Energy Efficient Kits and Education (n=2,141) • WRAP (n=81) 	<ul style="list-style-type: none"> • Custom Equipment (n=15) • Efficient Equipment (n=76)

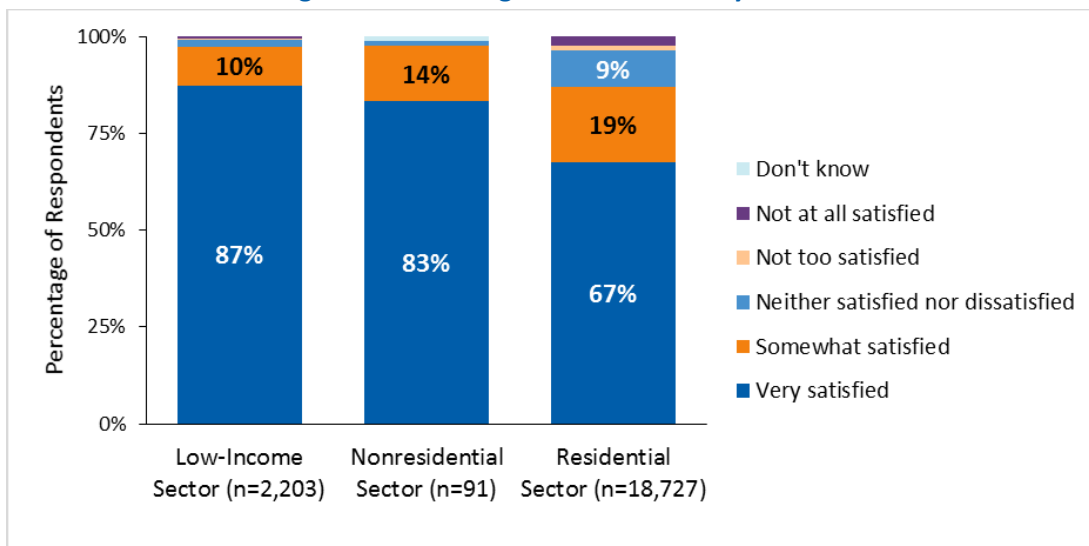
For Phase III, PPL Electric Utilities established a sector-level satisfaction goal to achieve 80% or greater of *very satisfied* and *somewhat satisfied* customers.¹⁵ Cadmus asked respondents how satisfied they were

¹⁵ The customer satisfaction goal is stipulated in PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016, Section 1.2.2.

with the program overall, using a 5-point word scale from *very satisfied* to *not at all satisfied* with a neutral midpoint. As shown in Figure 10, respondents across all three sectors showed high program satisfaction.

The low-income sector achieved the highest percentage of *very satisfied* respondents at 87% (n=2,203), compared to 83% for the nonresidential (n=91) and 67% for the residential sector (n=18,727). For *very satisfied* and *somewhat satisfied* combined, the low-income and nonresidential sectors achieved the highest customer satisfaction at 97%, followed by 86% for the residential sector. All sectors exceeded the customer satisfaction goal of 80% or greater.

Figure 10. PY8 Program Satisfaction by Sector



Note: The program satisfaction results include all responses to the satisfaction question.

Source: Participant survey question, "How would you rate your overall satisfaction with the program?"

At the program level, a large majority of respondents were satisfied with the program in which they participated. For *very satisfied* and *somewhat satisfied* combined, Custom (100%; n=15), Appliance Recycling (97%; n=559), and Efficient Equipment (97%; n=76) achieved the highest satisfaction. Home Energy Education had the lowest satisfaction compared to the other programs; nevertheless, 73% (n=485) of respondents were satisfied with the program.

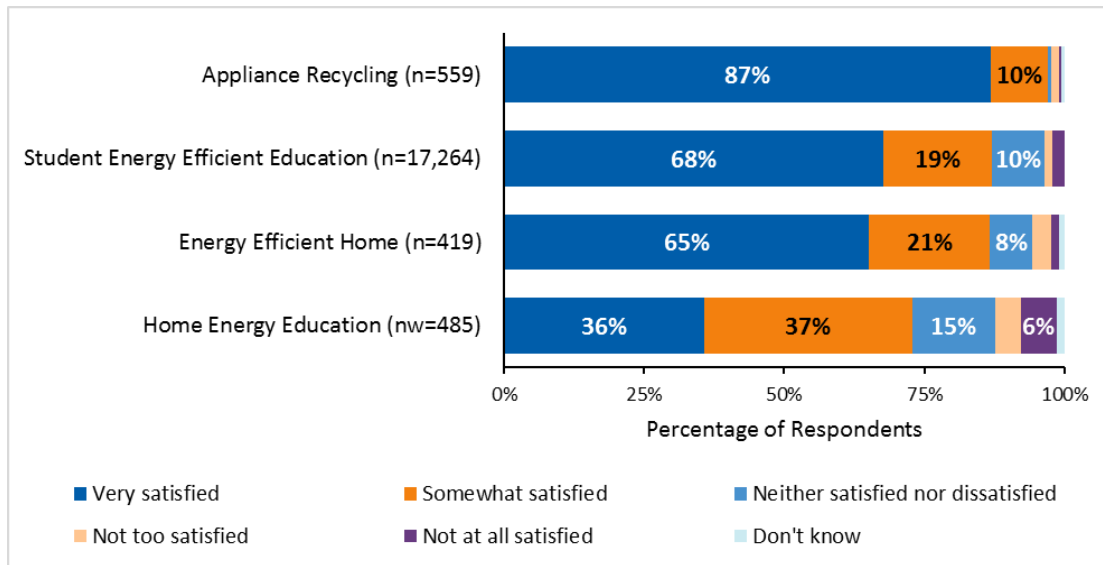
2.12.2 Residential Sector

The following describes key survey findings across the residential sector.

Program Satisfaction

Of the four residential programs, the Appliance Recycling Program achieved the highest customer satisfaction (97%; n=559). The Home Energy Education Program achieved the lowest customer satisfaction (73%; n=485). This type of program typically receives some of the lowest satisfaction scores because it does not offer the incentives that traditional rebate programs offer. Figure 11 shows the satisfaction results for the residential programs.

Figure 11. PY8 Residential Program Satisfaction



Notes: The program satisfaction results include all responses to the satisfaction question. Home Energy Education uses the notation n_w to indicate that survey results were weighted.

Source: Participant survey question, "How would you rate your overall satisfaction with the program?"

Net Promoter Score

The net promoter score (NPS) is a metric of brand loyalty that measures how likely customers are to recommend the program (or product) to others. Respondents rate their likelihood to recommend the program on a 10-point scale where 0 means "not at all likely" and 10 means "extremely likely." Respondents giving a rating of 9 or 10 are known as promoters, respondents giving a rating of 7 or 8 are known as passives, and respondents giving a 0 to 6 rating are known as detractors. The NPS is expressed as a number between -100 and +100 that represents the difference between the percentage of promoters and detractors. The passives are excluded from the calculation. An excellent NPS is 50 and above.¹⁶

The residential programs collectively generated a very good NPS of 43, which indicates more promoters than detractors. As shown in Table 19, respondents of the Appliance Recycling Program (NPS 87; n=548), Energy Efficient Home Program (NPS 71; n=171), and Student Energy Efficient Education Program (NPS 69; n=152) achieved an excellent NPS above 50. Only the Home Energy Education Program received a negative score (NPS -25; n=479), which indicates respondents were less likely to recommend the product (i.e., the home energy reports) to others. For the Appliance Recycling and Energy Efficiency Home programs, detractor respondents commonly said these programs can improve by speeding up the rebate processing time. For the Home Energy Education Program, detractor respondents were found to be customers who had been receiving the home energy reports the longest. Improving the NPS for

¹⁶ Net Promoter, NPS, and Net Promoter Score are trademarks of Satmetrix Systems, Inc., Bain & Company, and Fred Reichheld.

customers who have been habituated to the reports will be difficult, but improving these customers' perception of the accuracy of the reports is key to improving NPS.

Table 19. PY8 Net Promoter Score: Likelihood to Recommend Residential Program

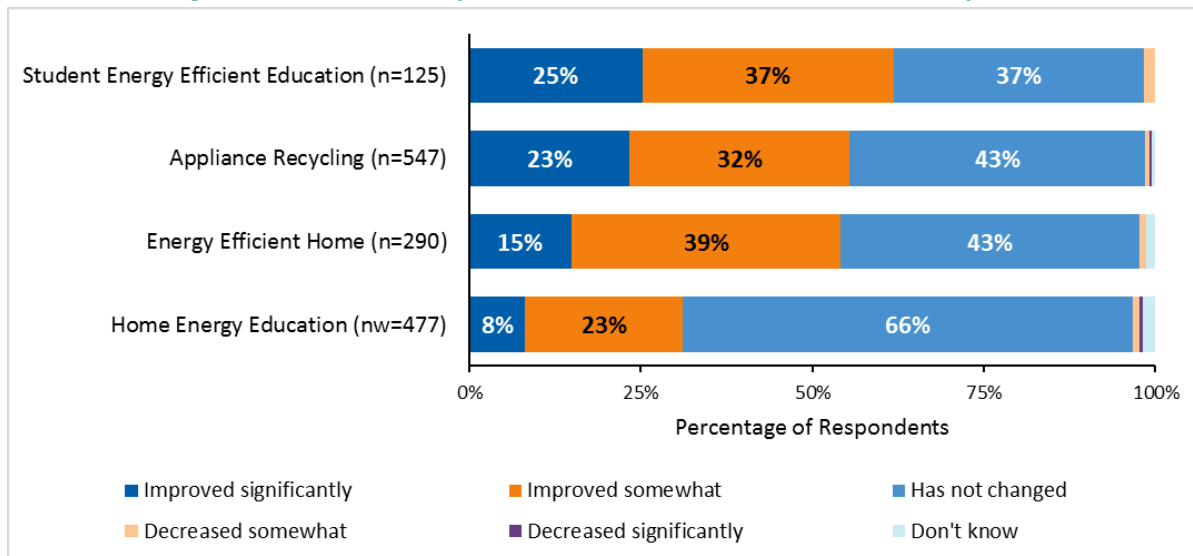
Program	Respondents (n)	Promoters (Rate 9-10)	Passives (Rate 7 - 8)	Detractors (Rate 0 to 6)	NPS ^[2]
Appliance Recycling	548	90%	7%	3%	87
Energy Efficient Home	171	77%	17%	6%	71
Student Energy Efficient Education	152	74%	21%	5%	69
Home Energy Education	479	25%	24%	50%	-25
Residential Sector Total	1,350	64%	16%	20%	43^[3]

Source: Participant survey question, "How likely is it that you would recommend [program name] to a friend, family member, or colleague? Use a 0 to 10 scale where 10 is extremely likely and 0 is not at all likely."
^[2] NPS = (Percentage of Promoters – Percentage of Detractors) x 100
^[3] The sector NPS is determined by calculating the total number of promoters and detractors and taking the difference between the two.

Opinion of PPL Electric Utilities

The participant survey asked respondents how their opinion of PPL Electric Utilities had changed after participating in the program. Of the four residential programs, the majority of respondents from three programs said their opinion of PPL Electric Utilities improved (*improved significantly* and *improved somewhat* combined). For the Home Energy Education Program, a majority of respondents (66%; n=477) said their opinion of PPL Electric Utilities remained unchanged. Figure 12 shows the opinions of PPL Electric Utilities after participation in the residential sector programs.

Figure 12. Residential Opinion of PPL Electric Utilities After Participation

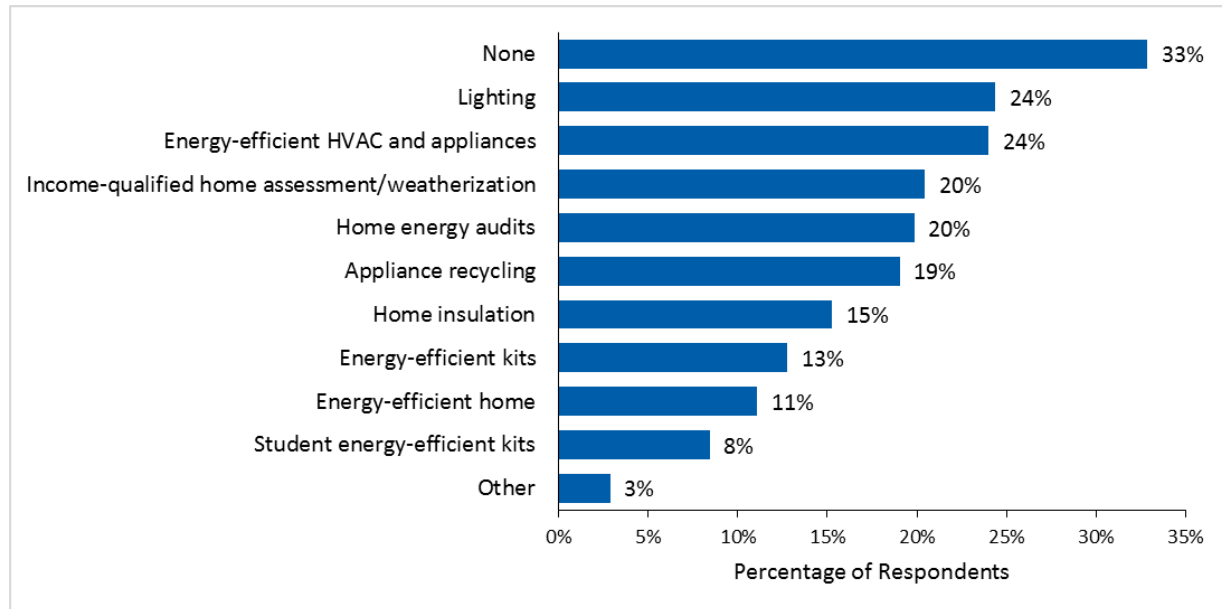


Source: Participant survey question, "After participating in the program, has your opinion of PPL Electric Utilities..."

Awareness of PPL Electric Utilities Energy Efficiency Programs

Without providing respondents with a list of program names, the participant survey asked respondents about what other PPL Electric Utilities programs they had heard of. As shown in Figure 13, residential respondents most frequently mentioned lighting and energy-efficient HVAC and appliances (n=1,698). Respondents were more likely to name components of a program rather than the program name. For example, 15% of respondents mentioned home insulation but only 11% mentioned the name of the program in which insulation belonged (Energy Efficient Home Program).

Figure 13. Residential Customers' Awareness of Other Programs



Note: Program names were not provided to respondents. The figure lists components, words, and program names that respondents mentioned in their responses; they may or may not match the official program names.

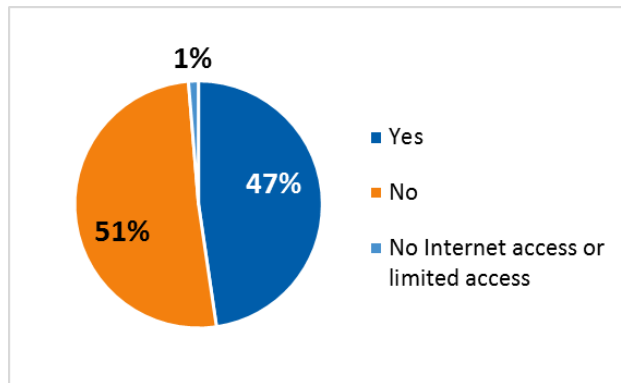
Source: Participant survey question, "What energy efficiency rebates or programs have you heard about that PPL Electric Utilities offers?" (n=1,863)

Online Engagement

Around half of the residential respondents (47%; n=1,456) reported having visited PPL Electric Utilities' website in the past six months (Figure 14). Specifically, the highest percentage of website visits were from respondents in the Energy Efficient Home Program (64%) and Appliance Recycling Program (61%). Respondents in the Home Energy Education Program, which is designed to encourage customers to visit the website, reported the fewest (34%).

This large difference may be the result of the survey mode; Cadmus administered the Home Energy Education Program participant survey over the telephone, whereas the other programs used a mix of telephone and online surveys. The telephone-only survey mode for the Home Energy Education's participant survey could have biased responses to the website visitation question by contacting customers who are less inclined to go online. The Student Energy Efficient Education Program participant survey did not ask the website visitation question.

Figure 14. PY8 Residential Sector Visits to PPL Electric Utilities' Website



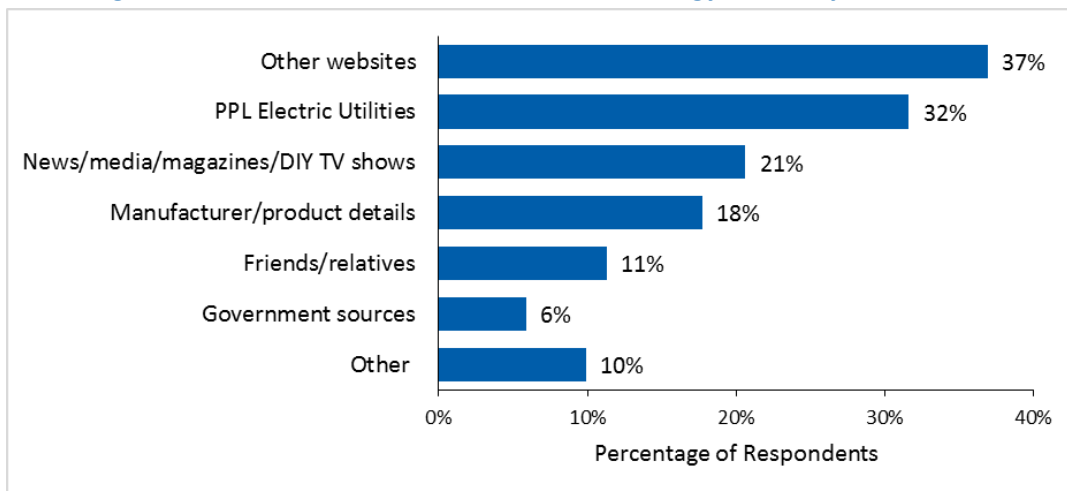
Source: Participant survey question, "Have you visited the PPL Electric Utilities' website in the past 6 months?" (n=1,456). Does not total 100% due to rounding.

The participant surveys also asked respondents if they had any suggestions for improving PPL Electric Utilities' website. Of the 278 residential respondents who had visited the website and made suggestions, 82% of these suggestions emphasized the website's usability. In particular, respondents requested making it easier to find things such as rebate and contractor information. Some respondents suggested simplifying the application forms (5%), providing more content on the website (4%), and improving the website's visual look (2%).

Sources of Energy Efficiency Information

To find more information about energy efficiency or ways to save energy, residential respondents relied more on other websites (37%; n=1,092) than on PPL Electric Utilities (32%), as shown in Figure 15. Nevertheless, respondents relied on PPL Electric Utilities more so than on most other information sources.

Figure 15. Residential Customers' Sources of Energy Efficiency Information



Source: Participant survey question, "Where do you look for information about energy efficiency or ways to save energy?" (n=1,092)

Residential Customer Segmentation Findings

Cadmus received residential customer segmentation data from PPL Electric Utilities to use in analyzing the participant survey data. Of the total PY8 residential participants, 32% had a segmentation code and those with a code were included in this analysis. PPL Electric Utilities stratifies its residential customers by the following seven segments:

- **Comfortable Conservative** requires loyalty and engagement to be earned
- **Community Steady** prefers predictability over uncertainty
- **Efficiency Focused** are interested in environmental causes and efforts
- **Mature Traditional** long-time customers who prefer the traditional forms of communication
- **Not Managing** do not have time to manage their bills
- **Power Stressed** tech-embracing customers who have high energy bills
- **Responsible Renter** customers without homeownership who have a good bill payment history

Participant survey results differed by customer segment in several of the key categories, as discussed in the paragraphs following the table. Cadmus found that these results were mostly consistent with segment descriptions.

Program satisfaction. Of the seven segments, *Not Managing* and *Efficiency Focused* respondents had the highest program satisfaction (97% and 96%, respectively). Consistent with their segment description (i.e., these customers are hard to win over), *Comfortable Conservative* respondents had the lowest program satisfaction at 82%, but a high program satisfaction nonetheless.

Net promoter score. *Efficiency Focused* respondents were the most likely to recommend a program (NPS 80). *Efficiency Focused* respondents had a significantly higher NPS than all other segments.¹⁷ In contrast, *Not Managing* and *Mature Traditional* respondents were the least likely to recommend a program (NPS 2 and NPS 4, respectively) despite these two segments reporting high program satisfaction.

Opinion of PPL Electric Utilities. *Efficiency Focused* and *Power Stressed* respondents' opinion of PPL Electric Utilities improved the most after participating in a program (51% and 50%, respectively). *Mature Traditional* respondents' opinion improved the least (35%).

Online engagement. A significantly higher percentage of *Power Stressed* respondents reported having visited PPL Electric Utilities' website in the past six months than most of the other segments.¹⁸ Even though this customer segment was more likely to visit the website, a significantly higher percentage of

¹⁷ Difference is statistically significant, $p \leq 0.05$. Cadmus ran t-tests for differences in proportions and means.

¹⁸ Difference is statistically significant, $p \leq 0.05$. Cadmus ran t-tests for differences in proportions and means.

respondents said the website was *not at all useful* (8%, n=39) compared to 0% to 2% for some of the other segments.¹⁹

Preferred way of being informed about programs and rebates. For all but one segment, bill inserts was the top way customers prefer to be informed about energy efficiency programs and rebates. *Power Stressed* respondents preferred emails, which is not a surprise considering their interest in technology.

Table 20 summarizes the participant survey results by the seven customer segments.

Table 20. PY8 Participant Survey Results by Customer Segment

Category	Comfortable Conservative	Community Steady	Efficiency Focused	Mature Traditional	Not Managing	Power Stressed	Responsible Renter
Program Satisfaction (very and somewhat satisfied combined)	82% (n=90)	88% (n=316)	96% (n=232)	91% (n=184)	97% (n=796)	94% (n=256)	90% (n=40)
Net Promoter Score	31 (n=82)	10 (n=197)	80 (n=162)	4 (n=135)	2 (n=43)	41 (n=63)	30 (n=17)
Opinion of PPL Electric Utilities after Participation (significantly and somewhat improved combined)	39% (n=83)	38% (n=202)	51% (n=173)	35% (n=137)	39% (n=44)	50% (n=69)	41% (n=17)
Visits to PPL Electric Utilities' Website in the Past Six Months	56% (n=79)	39% (n=192)	55% (n=158)	42% (n=132)	38% (n=42)	65% (n=62)	33% (n=15)
Preferred Way of Being Informed About Programs and Rebates	Bill insert 46% (n=79)	Bill insert 54% (n=193)	Bill insert 44% (n=158)	Bill insert 54% (n=129)	Bill insert 52% (n=42)	Email 52% (n=62)	Bill insert 56% (n=16)
Sources: Participant surveys. 2016 residential customer segmentation data from PPL Electric Utilities received on May 2017.							

2.12.3 Low-Income Sector

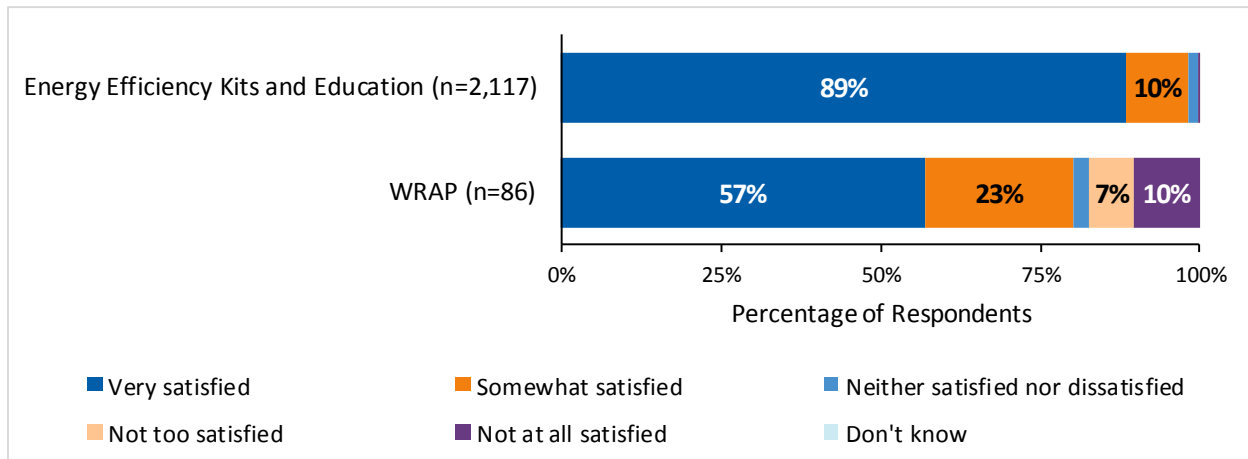
The following describes key survey findings for the low-income sector.

Program Satisfaction

Figure 16 shows the satisfaction results for the two programs dedicated to income-qualifying customers. For *very satisfied* and *somewhat satisfied* combined, the Energy Efficiency Kits and Education Program achieved 99% (n=2,117) and the WRAP achieved 80% (n=86).

¹⁹ Difference is statistically significant, $p \leq 0.10$. Cadmus ran t-tests for differences in proportions and means.

Figure 16. Low-Income Program Satisfaction



Note: The program satisfaction results include all responses to the satisfaction question.

Source: Participant survey question, "How would you rate your overall satisfaction with the program?"

Other Results for WRAP

The participant surveys for the WRAP and Energy Efficiency Kits and Education programs asked the program satisfaction question. However, the Energy Efficiency Kits and Education Program survey did not ask the other questions on opinion of PPL Electric Utilities, awareness of other programs offered by PPL Electric Utilities, online engagement, and sources of energy efficiency information.

The following is a summary of the results for WRAP (see *Appendix L*, section *L.2.2 Additional Findings* for detailed results):

- WRAP generated a very good NPS of 48 (n=81), indicating that respondents were very likely to recommend the program to others.
- Forty-six percent of respondents said their opinion of PPL Electric Utilities improved (*improved significantly* and *improved somewhat* combined). Specifically, 33% of respondents said their opinion *improved significantly* and 13% *improved somewhat*. Thirty-nine percent said their opinion *had not changed* and 13% decreased (*somewhat decreased* and *significantly decreased* combined).
- WRAP respondents most frequently mentioned energy-efficient HVAC and appliance programs and rebates.
- Twenty-eight percent of WRAP respondents had visited the website in the past six months. Significantly fewer WRAP respondents (28%) reported visiting PPL Electric Utilities' website compared to all residential respondents (47%).²⁰ The difference between these segments cannot be explained by lack of access to the internet; the participant surveys found no significant difference between low-income respondents (5%) and residential respondents (1%) on limited access to the internet.

²⁰ Difference is statistically significant, $p \leq 0.05$. Cadmus ran t-tests for differences in proportions and means.

- WRAP respondents most frequently relied on PPL Electric Utilities (41%) as a source for energy efficiency information, followed by other websites (28%) and friends/relatives (22%). Although more WRAP respondents relied on PPL Electric Utilities as an information source than residential respondents (32%), this difference was not statistically significant.

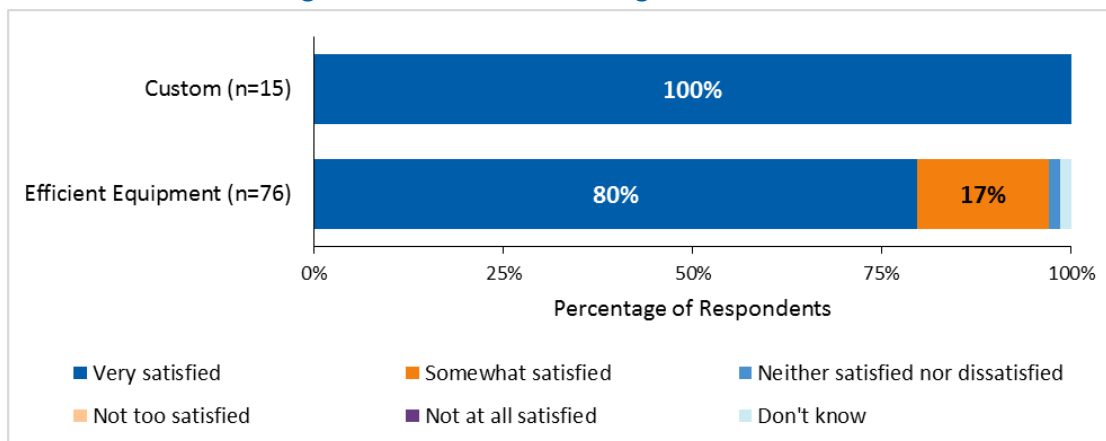
2.12.4 Nonresidential Sector

The following describes key survey findings for the nonresidential sector. Nonresidential participant surveys did not ask questions regarding awareness of PPL Electric Utilities programs and sources of energy efficiency information.

Program Satisfaction

Figure 17 shows the satisfaction results for the two nonresidential programs. The Custom Program achieved 100% customer satisfaction (n=15) and the Efficient Equipment Program achieved 97% (n=76). Respondents from both programs were very satisfied with the professionalism of program representatives.

Figure 17. Nonresidential Program Satisfaction



Note: The program satisfaction results include all responses to the satisfaction question.

Source: Participant survey question, "How would you rate your overall satisfaction with the program?"

Net Promoter Score

The two nonresidential programs generated a combined NPS of 79 (n=84), the highest NPS among the three sectors, which indicated participants were very likely to recommend these programs to others. As shown in Table 21, both programs achieved an excellent NPS above 50. The Efficient Equipment Program did not have any detractor respondents; passive respondents commonly said the program can improve by increasing the rebate amount and speeding up the rebate processing time. For the Custom Program, detractor respondents commonly said the program can improve by making it easier to submit the online application and speeding up the application process time.

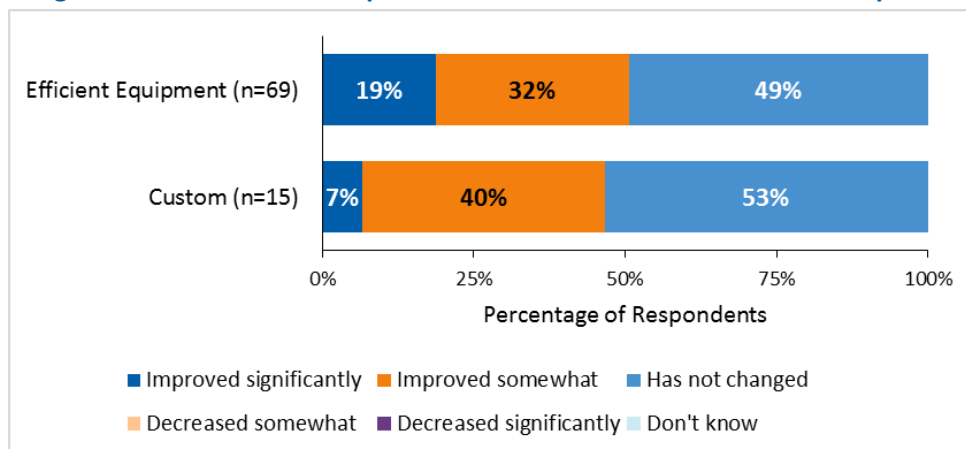
Table 21. Net Promoter Score: Likelihood to Recommend Nonresidential Program

Program	Respondents (n)	Promoters (Rate 9-10)	Passives (Rate 7 - 8)	Detractors (Rate 0 to 6)	NPS ^[2]
Efficient Equipment	69	82%	17%	0%	82
Custom	15	73%	20%	7%	66
Nonresidential Sector Total	84	80%	18%	1%	79

Source: Participant survey question, "How likely is it that you would recommend [program name] to a friend, family member, or colleague? Use a 0 to 10 scale where 10 is extremely likely and 0 is not at all likely."
^[2] NPS = (Percentage of Promoters – Percentage of Detractors) x 100
^[3] The sector NPS for the residential sector is determined by calculating the total number of promoters and detractors and taking the difference between the two.

Opinion of PPL Electric Utilities

As shown in Figure 18, 53% of the Custom Program (n=15) and 49% of Efficient Equipment Program respondents (n=69) said their opinion of PPL Electric Utilities remained unchanged. No respondents said their opinion of PPL Electric Utilities had decreased after participation.

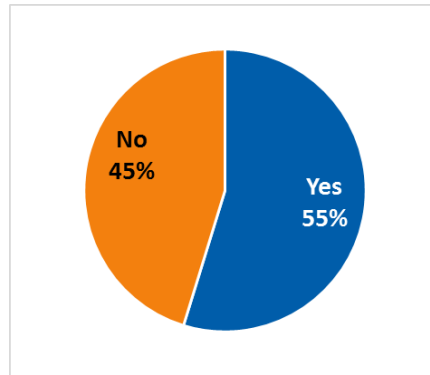
Figure 18. Nonresidential Opinion of PPL Electric Utilities After Participation

Source: Participant survey question, "After participating in the program, has your opinion of PPL Electric Utilities..."

Online Engagement

Similar to the residential sector, 55% of the nonresidential respondents (n=84) reported they had visited PPL Electric Utilities' website in the past six months (Figure 19). Efficient Equipment and Custom program respondents reported similar levels of website visits (53% and 55%, respectively). Cadmus expected to see a higher percentage of nonresidential respondents visiting the website because rebate applications are completed online. Respondents may not be associating the online rebate application with the PPL Electric Utilities website or it may be that contractors are mostly submitting the online rebate applications for the customer.

Figure 19. Nonresidential Visits to PPL Electric Utilities’ Website



Source: Participant survey question, “Have you visited the PPL Electric Utilities’ website in the past 6 months?” (n=84).

Only five nonresidential respondents who had visited the website made suggestions for improvement. Their suggestions mostly focused on the quality of program information, such as providing more details about the program process and tools for assessing possible projects.

2.13 Findings and Recommendations

The impact and process evaluation activities completed by Cadmus led to recommendations for program improvement. Table 22 lists the **overarching recommendations** that affect more than one program, the evaluation activity(s) that uncovered the finding, and Cadmus’ recommendation(s) to PPL Electric Utilities to address the finding.

Table 22. Summary of Evaluation Recommendations

Evaluation Activity	Finding	Recommendation	PPL Electric Utilities Status of Recommendation
Participant Surveys	The residential sector achieved lower customer satisfaction than the nonresidential and low-income sectors due to the Home Energy Education Program. Even so, the residential sector exceeded the satisfaction goal with 86% <i>very or somewhat satisfied</i> .	Consider prioritizing the Home Energy Education Program’s customer satisfaction to raise the residential sector’s customer satisfaction. This program is the largest with the most number of customers.	Agree. PPL Electric Utilities will strive to improve customers’ expectations and satisfaction with home energy reports (HERs).
Participant Surveys	Customers may not be visiting PPL Electric Utilities’ website as much because of usability issues. Half of residential and nonresidential respondents reported they visited PPL Electric Utilities’ website in the past six months. A significantly higher percentage of <i>Power Stressed</i> respondents said the website was <i>not at all useful</i> (8%, n=39) compared to 0% to 2% for some of the other segments.	Consider improving the overall usability of PPL Electric Utilities’ website and seek iterative feedback from tech-embracing customers. Usability should be focused on task completions such as how quickly a customer can find specific information on the website or how easily a customer can complete an online form.	Agree. PPL Electric Utilities plans to continuously improve its EE&C website (looks, engagement, easy of use, etc.)

3 Evaluation Results by Program

This chapter documents the gross impact, net impact, and process evaluation activities conducted in PY8 along with the outcomes of those activities. The list of programs is organized by the largest contributor to PY8 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. Table 23 lists the activities for each program included in PPL Electric Utilities' portfolio.

Table 23. Evaluation Activity Matrix

Program	Sector	Gross	Net	Process
Appliance Recycling (ARP)	Residential	✓	✓	✓
Custom	Nonresidential	✓	✓	✓
Efficient Equipment	Nonresidential	✓	✓	✓
Energy Efficient Home (EE Home)	Residential	✓	✓	✓
Energy Efficiency Kits and Education (EE Kits)	Low-Income	✓		✓
Efficient Lighting	Residential	✓	✓	✓
Home Energy Education (HEE)	Residential	✓	✓	✓
Student Energy Efficiency Education (SEEE)	Residential	✓		✓
Winter Relief Assistance Program (WRAP)	Low-income	✓		✓

3.1 Impact Evaluation

Impact evaluation activities varied by program in PY8. More detailed explanations of each programs' impact evaluation methodology and analyses are contained in the program chapters and their respective appendices. The main activities that Cadmus, the EM&V CSP, conducted were these:

- Database and records review for quality assurance and quality control (QA/QC)
- Records review
- Engineering analyses
- Billing analyses
- Site visits

Table 24 lists the impact evaluation activities conducted for each program in PY8 along with the number of site visits conducted for each program. The individual program chapters discuss the impact evaluation activities, methodology, and findings.

Table 24. PY8 Impact Evaluation Activities by Program

Program	Impact Evaluation Activity					
	Database Review	Records Review	Site Visits ^[1]	Metering	Engineering Analysis	Billing Analysis
Appliance Recycling	✓	✓	-	-	✓	-
Custom	✓	✓	44	✓	✓	✓
Efficient Equipment	✓	✓	139 ^[2]	✓	✓	-
Energy Efficient Home (EE Home)	✓	✓	20 ^[3]	-	✓	-
Energy Efficiency Kits and Education (EE Kits)	✓	✓	-	-	✓	-
Efficient Lighting	✓	✓	-	-	✓	-
Home Energy Education (HEE)	✓	✓	-	-	-	✓
Student Energy Efficiency Education (SEEE)	✓	✓	-	-	✓	-
WRAP	✓	✓	89 ^[4]	-	✓	-
^[1] Site visits completed by Cadmus, PPL Electric Utilities or the ICSP. ^[2] Includes 20 equipment visits, 68 lighting visits, and 51 Distributor Discount visits. ^[3] New homes visits. ^[4] Includes 24 baseload jobs, 24 low-cost jobs, 2 full-cost jobs, 17 manufactured homes, and 22 multifamily units.						

3.2 Process Evaluation

This section summarizes the process evaluation of PPL Electric Utilities' PY8 portfolio.

The individual program process evaluations identify opportunities and offer recommendations to improve the overall effectiveness of the design, implementation, enrollment process, quality assurance, and other elements for all of PPL Electric Utilities' energy efficiency programs. These evaluations examine the portfolio's overall achievement and planned savings for each program. They also explore participant feedback, energy efficiency attitudes and behaviors, and challenges to energy efficiency improvements.

Process evaluation activities varied by program in PY8. Cadmus conducted these main activities:

- Program staff and ICSP interviews
- Participant surveys
- Treatment and control group surveys
- General residential population survey
- Surveys and interviews of vendors, contractors, manufacturers, and others
- Key performance indicators (KPIs) reviews
- Logic model reviews

Each program assessment is discussed in more detail in individual chapters of this report. The chapters discuss the findings from the program-specific evaluation activities. Any modifications to individual

program evaluation activities from Cadmus' approved evaluation plans are noted in each program chapter.

Table 25 lists the process evaluation activities conducted for each program in PY8 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 respective appendices.

Table 25. PY8 Process Evaluation Activities by Program

Program	Process Evaluation Activity							
	Completed Participant Survey ^[1]	Nonparticipant or Partial Participant Survey	KPI Review	Logic Model Review	Participant Satisfaction Analysis	Stakeholder Interview	Trade Ally Interview	Market Actor Interview
Appliance Recycling	549	9 ^[2]	✓	✓	✓	3	-	-
Custom	15	-	✓	✓	✓	2	6	-
Efficient Equipment	76 ^[3]	-	✓	✓	✓	2	9 ^[4]	22 ^[5]
Energy Efficient Home (EE Home)	292 ^[6]	-	✓	✓	✓	5	30 ^[7]	-
Energy Efficiency Kits and Education (EE Kits)	2,141 ^[8]	-	✓	✓	✓	3	5 ^[9]	-
Efficient Lighting	-	765 ^[10]	✓	✓	✓	2	16 ^[11]	-
Home Energy Education (HEE)	375	431 ^[12]	✓	✓	✓	3	-	-
Student Energy Efficiency Education (SEEE)	17,995 ^[13]	-	✓	✓	✓	3	-	-
WRAP	81 ^[14]	-	✓	✓	✓	3	4	4 ^[15]
Total	21,524	1,196 ^[16]	-	-	-	26	70	26

^[1] Includes all survey modes: online, telephone, and paper. For additional detail see program chapter and appendix.

^[2] Overall, 9 customers from the general population lighting survey had disposed of a working appliance and had not received an incentive.

^[3] Includes 7 equipment, 62 lighting, and 7 distributor surveys.

^[4] Includes 4 equipment contractors and 5 lighting contractors.

^[5] Includes 11 end-user purchasers, 7 contractor purchasers, and 4 end-user non-purchasers.

^[6] Includes 135 efficient equipment, 11 in-home audit, 121 online assessment, and 25 weatherization surveys.

^[7] Includes 10 HVAC contractors, 10 new home builders, 5 in-home energy auditors, and 5 heat pump water heater retailers.

^[8] Includes 1,910 paper surveys administered by the ICSP and 232 surveys administered by Cadmus.

^[9] Interviews with agencies.

^[10] Includes 300 residential customers and 465 small business customers.

^[11] Lighting manufacturer interviews.

^[12] Includes 56 low-propensity surveys.

^[13] Includes 158 teacher surveys administered by Cadmus, 238 teacher paper surveys administered by the ICSP, and 17,599 paper and online home energy worksheets administered by the ICSP.

^[14] Includes 75 baseload, low-cost, and full cost jobs, and 6 manufactured home jobs.

^[15] Includes 3 master-metered multifamily property managers and 1 manufactured home park property manager.

^[16] The Appliance Recycling Program nonparticipant surveys were completed as part of the Residential Efficient Lighting survey so they are counted in the Efficient Lighting Program total.

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4 Efficient Lighting Program

The Efficient Lighting Program encourages residential customers to purchase and install LED bulbs by providing upstream incentives to participating manufacturers to discount the prices of a variety of bulbs sold at local retail stores. The program targets residential customers but is available to all PPL Electric Utilities customers and anyone who purchases discounted bulbs from participating retailers.

The program is primarily delivered upstream, where the incentives are paid directly to manufacturers for bulbs sold at reduced prices at participating retailers. The ICSP, Ecova, managed program operations and provided support to participating retailers and manufacturers.

The objectives of the Efficient Lighting Program are these:²¹

- Encourage customers to purchase ENERGY STAR® LED bulbs in local retail stores by discounting prices
- Achieve widespread visibility of discounts through independent and regional retailers that carry program-eligible LED bulbs
- Develop and execute strategies aimed at transforming the market for LED bulbs
- Educate customers on new lighting technologies
- Engage retailers by educating and training retail sales associates about LED bulbs
- Obtain approximately 293,000 MWh/year gross verified savings

4.1 Progress Toward Phase III Projected Savings

The Efficient Lighting Program verified savings are within 152% of the estimated MWh/yr savings for PY8. It has achieved 50% of the estimated Phase III total planned savings and is making progress toward the Phase III projected savings.

Table 26 shows the program's verified gross program savings and progress toward its Phase III projected energy savings, as filed in the EE&C Plan.

Table 26. Efficient Lighting Program Estimated Savings

	PY8 Only			Phase III: PY8–PY12		
	Estimated ⁽¹⁾	Verified	Percentage of Estimated	Estimated ⁽¹⁾	Verified	Percentage of Estimated
MWh/yr	95,752	145,929	152%	292,853	145,929	50%
⁽¹⁾ Estimated savings are based on PPL Electric Utilities' revised EE&C plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.						

²¹ Program objectives are stipulated on PPL Electric Utilities Corporation. Energy Efficiency and Conservation Plan Act 129 Phase III. Docket No. M-2015-2515642 Compliance Filing before the Pennsylvania Public Utility Commission. December 5, 2016.

According to program staff, the program exceeded forecasted sales in PY8, requiring reduced incentives by the end of the year to preserve adequate budget and energy savings for subsequent years.

4.2 Participation and Reported Savings by Customer Segment

4.2.1 Definition of a Participant

A participant is a person or business purchasing discounted bulbs. Because of the upstream design of the Efficient Lighting Program, the identities of purchasers are not known. Cadmus estimated the number of participants by dividing the total number of bulbs discounted or given away by a bulb-per-participant count derived from residential and commercial customer telephone survey data collected in PY8, as described in section *D.1.4 Survey Findings in Appendix D*.

4.2.2 Program Participation and Reported Impacts

Table 27 presents the participation counts, reported energy and demand savings, and incentive payments for the Efficient Lighting Program in PY8 by customer segment.

Table 27. PY8 Efficient Lighting Program Participation and Reported Impacts

Parameter	Residential	Small C&I	Total ^[1]
PYTD # Participants ⁽²⁾	318,766	17,455	336,221
PYRTD MWh/yr	108,456	41,920	150,376
PYRTD MW/yr	12.50	9.65	22.15
PY8 Incentives (\$1,000)	\$10,131	\$1,381	\$11,513

^[1] Total does not equal sum because of rounding.
⁽²⁾The reported participant counts by sector use the PY8 cross-sector sales proportions, as described in *Appendix B.1.4*.

4.3 Gross Impact Evaluation

4.3.1 Census Quality Assurance/Quality Control

PPL Electric Utilities' energy efficiency management information system database records for the upstream lighting component of the Efficient Lighting Program contained input parameters from the ICSP, which PPL Electric Utilities used to compute energy and demand savings. Cadmus reviewed the data to ensure consistency and reasonability of these data inputs by, for example, checking wattage and lumens across multiple records for the same product for the census of records and comparing reported wattages to text descriptions of each bulb type.

Cadmus also looked up baselines in the current PA TRM tables (e.g., baseline wattages by lumen range and bulb type) and calculated savings based on delta watts (baseline minus LED watts),²² the ISR, hours

²² Pennsylvania Public Utility Commission. *2016 Technical Reference Manual*. Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards. June 2016. Available online: http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

of use (HOU), and coincidence factor assumptions specified in the PA TRM. The baseline adjustment Cadmus made is detailed in section *D.1.2 Database Review Findings* in *Appendix D*.

4.3.2 Lighting Manufacturer Invoice Audit

Cadmus audited copies of lighting manufacturer invoices, provided by the ICSP, to ensure that the reported quantities and bulb types were consistent with manufacturers' reports. Cadmus also used the invoices to verify the actual pack sizes of model numbers. For invoices that did not provide pack size information, Cadmus checked each model number online via manufacturer or retailer websites. The invoice audit found no errors.

4.3.3 Estimating Cross Sector Sales

Cadmus conducted general population surveys of PPL Electric Utilities' residential and small business populations and asked respondents the following about their LED purchase experience:

- If respondents purchased LEDs in the last six months
- How many LEDs they purchased
- From which retailer, they purchased the LEDs
- For small business owners, whether the respondent made the decisions about lighting purchases
- For small business owners, a description of the business type (which Cadmus used to map to the PA TRM building types)²³

Cadmus used this self-reported information to establish several of the assumptions used to estimate the proportion of this program's discounted bulbs purchased by small commercial businesses (cross-sector sales). Because bulbs installed in commercial buildings have higher HOU assumptions than those installed in residential settings, the per-bulb savings for commercial bulbs are higher.

The cross-sector sales analysis methodology and findings are detailed in *Upstream Lighting Cross-Sector Sales* in *Appendix A*.

4.3.4 Impact Evaluation Sampling

The impact evaluation sampling strategy is summarized in Table 28. Additional details about the evaluation methodology are in section *D.1.1* in *Appendix D*.

²³ Pennsylvania Public Utility Commission. *2016 Technical Reference Manual*. Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards. June 2016.

Table 28. PY8 Efficient Lighting Program Gross Impact Sample Design

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Tracking data	193,484	N/A	N/A	Census database review, QAQC and <i>ex post</i> adjustments
Manufacturer invoices	522	90/10	70	Manufacturer invoice audit; strategic sample
Residential general population	~1.2M	90/10	300	Survey data analysis
Small C&I general population	79,047	90/10	465 ^[1]	

^[1] 269 surveys were completed by respondents knowledgeable about lighting decisions and purchases. Of those, 70 surveys were completed by respondents who had purchased LEDs in the past six months.

In PY8, the Efficient Lighting Program reported energy savings of 150,376 MWh/yr, as shown in Table 29, and demand reduction of 22.15 MW, as shown in Table 30.

Table 29. Efficient Lighting Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Upstream Lighting	150,376	97%	0.32901	4.26%
Program Total	150,376	97%	N/A	4.26%

Table 30. Efficient Lighting Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Upstream Lighting	22.15	89%	0.32901	4.26%
Program Total	22.15	89%	N/A	4.26%

The following factors led to variation between the reported and verified savings and led to the observed realization rates:

- Baseline adjustments generally increased savings. For example, the ICSP used the “Post-EISA 2007” baseline assumptions (Column (d) in 2016 PA TRM Table 2-3) for candelabra-base bulbs, which are exempt from the Energy Independence and Security Act (EISA) of 2007; Cadmus used the higher baselines in Column (c) of this table.
- Cross-sector sales adjustments decreased savings. In PY6, Cadmus estimated that the small commercial sector purchased 12% of the program’s discounted bulbs, and PPL Electric Utilities used this estimate in the reported savings.²⁴ In PY8, Cadmus estimated the sector purchased 10% of the discounted bulbs.
- Commercial HOU assumption adjustments decreased savings. The HOU input used to compute *ex post* savings for PY8 is 16% lower than the PY6 input used to calculate reported savings.

4.4 Net Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,²⁵ which discusses the common methods to determine free ridership and spillover. Because the Efficient Lighting Program contributes substantial savings to PPL Electric Utilities’ portfolio, Cadmus will estimate net savings using an enhanced level of rigor. To provide estimates of free ridership for LEDs, Cadmus conducted demand elasticity modeling using information from PPL Electric Utilities’ tracking database supplemented with marketing event information provided by the ICSP. The demand elasticity model estimates the elasticity of demand with respect to price based on purchasing behavior changes observed in the sales data as prices and program-driven merchandising and promotional events change.

Free ridership is a measure of the savings that participants would have achieved on their own in the absence of the program – in this case the purchase and installation of LED light bulbs; these savings are subtracted from verified gross savings.

Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

Table 31 lists the methods and sampling strategy used to determine net savings for the Efficient Lighting Program in PY8. Additional details about methodology are in *Appendix B*.

²⁴ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

²⁵ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

Table 31. Efficient Lighting Program Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size	Achieved Sample Size	Response Rate	NTG Activity
Upstream Lighting	Upstream Lighting	All records	All records	N/A	Demand elasticity model

Table 32 shows the free ridership and NTG ratios by program component. Because the demand elasticity model relies solely on program tracking data the model estimates free ridership only and does not produce estimates of spillover.

Table 32. Efficient Lighting Program Net Impact Evaluation Results

Target Group or Stratum (if appropriate)	PYVTD	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 85% CL
Upstream Lighting	145,929	17%	0%	0.83	12%
Program Total	145,929	17%	0%	0.83	12%

Source: PPL Electric Utilities' tracking database

Free ridership estimates decreased in PY8 from those observed in PY7²⁶, from 39% to 17%. This decrease was driven by two factors:

- The program ICSP coordinated with retailers to feature multi-packs that lower the average per-bulb price, leading to prices of less than one dollar per-bulb in some cases, after program incentives.
- The program ICSP also coordinated with retailers to increase the promotion of program bulbs. These promotions included truckload sales, increased stock and promotion of key products, and special messaging to club members at some membership club stores highlighting special offers on certain products.

Table 33 compares the estimated free ridership for PY8 with estimates from recent evaluations. Most recent evaluations had estimated free ridership between 30% and 40%. PPL Electric Utilities' program in PY8 had the lowest estimated free ridership for LEDs at 17%.

²⁶ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Table 33. Benchmarking LED Free Ridership Results

Evaluation	Free Ridership
PPL Electric PY8	17%
Focus on Energy Wisconsin (2015) ^[1]	29%
Southwest Utility (2015-2016) ^[2]	37%
Focus on Energy Wisconsin (2016) ^[3]	38%
PPL Electric PY7 ^[4]	39%
Connecticut (2016) ^[5]	39%
Midwest Utility 1 (2016) ^[2]	40%
^[1] Focus on Energy Calendar Year 2015 Evaluation Report Volume II. Cadmus. May 20, 2016. Available online: https://www.focusonenergy.com/sites/default/files/WI%20FOE%20CY%202015%20Volume%20II.pdf ^[2] Report not publicly available. ^[3] Cadmus. <i>Focus on Energy Calendar Year 2016 Evaluation Report Volume II</i> . May 19, 2017. Available online: https://focusonenergy.com/sites/default/files/WI%20FOE%20CY%202016%20Volume%20II%20-%20%28Low%20Res%29.pdf ^[4] PPL Electric Utilities. <i>Annual Report Program Year 7: June 1, 2015–May 31, 2016</i> . Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016. ^[5] <i>R1615 Light Emitting Diode (LED) Net-to- Gross Evaluation</i> . Final Report for Connecticut EEB. Submitted by NMR Group, Inc., Cadmus, DNV GL. August 7, 2017. Available online: https://www.energizect.com/sites/default/files/R1615_CT%20LED%20Net-To-Gross%20Evaluation%20Report_Final_8.5.17.pdf	

4.5 Verified Savings Estimates

In Table 34, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Efficient Lighting Program in PY8. In PY9 and subsequent years, these totals will be added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 34. PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Total Demand (MW/yr) ^[1]
PYRTD Gross	150,376	22.15
PYVTD Gross	145,929	19.82
PYVTD Net ⁽²⁾	121,121	16.45
P3RTD Gross	150,376	22.15
P3VTD Gross	145,929	19.82
P3VTD Net ⁽²⁾	121,121	16.45
^[1] May not match due to rounding. ⁽²⁾ Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		

4.6 Process Evaluation

4.6.1 Research Objectives

The purpose of the process evaluation was to assess Efficient Lighting Program processes and provide recommendations for improving program operation. Cadmus assessed program delivery and market response, including the adoption of energy-efficient lighting. It also examined the program's effectiveness in generating awareness, driving participation to achieve desired savings goals, and disseminating information by evaluating these elements:

- Awareness of LED bulbs and of PPL Electric Utilities' discounts
- Purchases of energy-efficient lighting
- Customer satisfaction with LEDs and purchase-related decision making
- Barriers to purchasing LED bulbs
- Market progress indicators
- Possible program enhancements

4.6.2 Evaluation Activities

Table 35 lists the PY8 process evaluation activities for the Efficient Lighting Program.

Table 35. Process Evaluation Activities

Activity	Achieved Target
Program staff interviews	2 interviews, each with 2 program staff
Lighting manufacturer interviews	16 interviews
General residential population telephone surveys	300 complete responses
General small commercial population telephone surveys ^[1]	269 full-survey responses 196 short-survey responses
Program database review	Census of program records
Logic model review	N/A
^[1] Cadmus surveyed 269 small commercial customers who were responsible for the lighting in their facility; the 196 respondents who were not responsible for their facilities' lighting completed a very short survey.	

The research activities in PY8 were consistent with the evaluation plan except for the number of completed surveys with small commercial businesses, the use of the default PA TRM ISR for cross-sector bulbs, and the addition of manufacturer interviews, completed by the ICSP.

The general small business survey conducted to collect data for the cross-sector sales analysis required a minimum goal of 70 completed surveys with small businesses that purchased LEDs from a participating retailer. The small commercial survey data yielded an instantaneous ISR of 92%. Cadmus planned to use this as the first-year ISR and apply the three-year trajectory, according to the Uniform Methods Project

Residential Lighting Evaluation Protocol.²⁷ However, after adjustments to account for customers who installed some bulbs in their home or in apartments they build or manage, the sample size was small (n=26). As a result, Cadmus applied the TRM ISR default.

Table 36 lists the process evaluation sampling strategy. Additional details about sampling methodology are included in section *D.4.1* in *Appendix D*.

²⁷ National Renewable Energy Laboratory. *Uniform Methods Project*. Chapter 21: Residential Lighting Evaluation Protocol. Prepared by Apex Analytics, LLC. November 2014. Available online: <http://www.nrel.gov/extranet/ump/pdfs/ump-res-lighting-clean.pdf>

Table 36. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame ^[1]	Percent of Sample Frame Contacted to Achieve Sample ^[2]
PPL Electric Utilities and ICSP Program Staff	Staff	Telephone interview	2	N/A	2	2	N/A	100%
General Customer Population	Residential	Telephone survey	~1.2 million	90/5	300/70 LED purchasers	300	9,000	100%
	Small commercial	Telephone survey	160,000	90/5	300	465	11,000	100%
Lighting Manufacturers	ICSP contacts	Telephone & email surveys	17	N/A	17	16	N/A	N/A

^[1] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL database. After selecting all unique records, Cadmus removed any records from the population if the customers had participated in a survey in the last three months, were selected for another program survey, did not have valid contact information (email or telephone number), were on the do not call list, or opted out of the online survey.

^[2] Percent contacted means the percentage of the sample frame called to complete surveys.

4.6.3 Summary of Process Evaluation Findings

Based on interviews with PPL Electric Utilities and ICSP program staff, Cadmus found that the Efficient Lighting Program was delivered effectively. Additionally, because of the declining retail prices of LEDs, program incentives lowered price points such that sales exceeded planned PY8 sales within the incentive budget. In some cases, program bulb prices were lower than those assumed for baseline alternatives.

The quality of data received from the ICSP was very good in PY8; Cadmus found that data across multiple sources were sufficiently detailed and consistent and did not uncover any material errors during the audit of lighting manufacturer invoices.

Interviews with lighting manufacturers yielded the following key insights:

- One-third of manufacturers said their sales in Pennsylvania differed from their national sales:
 - Manufacturers who provided estimates reported that they sell 10% to 45% more LEDs in Pennsylvania than elsewhere.
 - In addition, two-thirds of manufacturers said their sales levels differed from national sales in areas targeted by utility-sponsored retailer or manufacturer LED buydown programs.
- Manufacturers anticipate that increased manufacturing of LEDs will mostly displace CFLs, with little to no change in the production of incandescent and halogen bulbs.
 - On average, manufacturers reported that LEDs comprise approximately 75% of all national bulb sales, while other bulb types occupy a substantially lower market share (less than 10% each).
 - Despite ENERGY STAR and EISA requirements, some manufacturers will continue to sell non-certified bulbs to meet existing demand.
- Better education of residential customers can further improve LED uptake.

Cadmus' analysis of general residential and small commercial population surveys indicates the following:

- More residential customers are purchasing and using LEDs than in previous years.
- Willingness to pay for LEDs at higher price points has declined over the past four years, for both residential and small-commercial customers.
- Willingness to pay for LEDs is similar for residential and small-commercial customers, in contrast with prior years, when commercial customers expressed a greater willingness to pay for LEDs.
- Residential customers who have used LEDs are more likely to live in single-family homes and have higher education and income levels than those who have not used LEDs.
- Both residential and commercial customers are satisfied with LEDs, and satisfaction with cost is increasing over prior years.
- Bulb traits such as longevity, brightness, and energy usage are more important to residential customers than cost.

Additional detail regarding findings from process evaluation activities and their methodology is in section *D.4 Process Evaluation* in *Appendix D*.

4.7 Cost-Effectiveness Reporting

A detailed breakdown of Efficient Lighting Program finances and cost-effectiveness is presented in Table 37. TRC benefits in Table 37 were calculated using gross verified impacts. NPV PYTD benefits and costs are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). NPV costs and benefits for P3TD financials are expressed in the PY8 dollars. Participant costs are equal to the total of differences between retail bulb prices and baseline bulb costs.²⁸

²⁸ Baseline bulb costs are from the Statewide Evaluator's Incremental Cost database, version 3.1.

Table 37. Summary of Efficient Lighting Program Finances – Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$11,513		\$11,513	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$1,625		\$1,625	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	\$13,138		\$13,138	
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$94	-	\$94	-
7	Marketing ^[4]	-	\$254	-	\$254
8	Program Delivery ^[5]	-	\$1,302	-	\$1,302
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$1,649		\$1,649	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-		-	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$14,787		\$14,787	
14	Total NPV Lifetime Electric Energy Benefits	\$43,921		\$43,921	
15	Total NPV Lifetime Electric Capacity Benefits	\$7,923		\$7,923	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$21,867		\$21,867	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8] ^[1]	\$73,711		\$73,711	
19	TRC Benefit-Cost Ratio ^[9]	4.98		4.98	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Table 38 presents program financials and cost-effectiveness on a net savings basis.

Table 38. Summary of Efficient Lighting Program Finances – Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$11,513		\$11,513	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	-		-	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1] ^[2]	\$10,904		\$10,904	
		EDC	CSP	EDC	EDC
5	Design & Development ^[3]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[4]	\$94	-	\$94	-
7	Marketing ^[5]	-	\$254	-	\$254
8	Program Delivery ^[6]	-	\$1,302	-	\$1,302
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11 ^[7]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$1,649		\$1,649	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-		-	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[8] ^[9]	\$13,162		\$13,162	
14	Total NPV Lifetime Electric Energy Benefits	\$36,454		\$36,454	
15	Total NPV Lifetime Electric Capacity Benefits	\$6,576		\$6,576	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$18,150		\$18,150	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[10] ^[1]	\$61,180		\$61,180	
19	TRC Benefit-Cost Ratio ^[11]	4.65		4.65	

^[1] May not sum to total due to rounding.

^[2] After adjusting incremental measure costs by the NTG ratio, costs are less than the total incentives, which are not adjusted and is why the sum does not match the total of rows 1-3.

^[3] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[4] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[5] Includes the marketing CSP and marketing costs by program CSPs

^[6] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[7] Rows 1-11 are presented in nominal dollars.

^[8] NPV TRC costs are greater than the sum of rows 4, 11 & 12 because incentives are greater than net incremental measure costs. Incentives in excess of incremental measure cost are included in the TRC cost.

^[9] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[10] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. 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.

^[11] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

4.8 Status of Recommendations

Overall, the program has exceeded planned sales of LEDs, as prices have continued to decline and adoption by customers has increased. Program data are complete, consistent, and accurate, and both PPL Electric Utilities and the ICSP are pleased with the implementation and performance of the program. Free ridership is 27%, a 12% decrease since PY7.²⁹ Differences in demographics and price sensitivity between customers who have used LEDs versus those who have not indicate some potential for targeted outreach efforts.

The impact and process evaluation activities in PY8 led to the following findings and recommendations from Cadmus to PPL Electric Utilities, along with a summary of how PPL Electric Utilities plans to address the recommendation in program delivery (Table 39).

Finding: In PY8, the program exceeded planned sales and savings within the estimated budget. Program incentives lowered price points such that sales exceeded estimated for PY8. In some cases, program bulb prices were lower than those assumed for baseline alternatives (see *Section 4.6.3 Summary of Process Evaluation Findings*). Promotional and merchandizing activities generated substantial sales lift and helped reduce estimated free ridership (see section *D.2.1 Net-to-gross Ratio Methodology* in *Appendix D*).

Finding: Manufacturers whom the ICSP interviewed (see *Manufacturer Interviews* in *Appendix B*) generally sell a larger percentage of LEDs in regions with utility-sponsored upstream lighting programs, including Pennsylvania. Manufacturers estimated LEDs represent approximately three quarters of national bulb sales. They also reported selling 10% to 45% more LEDs in Pennsylvania than national sales elsewhere (see section *4.6.3 Summary of Process Evaluation Findings*); they estimated LEDs represent approximately three quarters of national bulb sales. The interviewees projected that increased production of LEDs in the next few years would displace CFLs much more than incandescent or halogen bulbs. A small number of manufacturers also said, despite ENERGY STAR and EISA certifications, they would continue to sell uncertified LED bulbs (often less expensive than certified LED bulbs) to meet existing demand.

Finding: Survey data indicate LED purchases and use among general residential customers is steadily increasing, although there are still customers who have never used LEDs. Residential customers who have used LEDs are more willing to pay for LEDs than those who have not used LEDs. LED users are more likely to live in single-family homes and have higher education and income levels than those who have not used LEDs (see *Participant Profile* in *Appendix D*, section *D.4.2*).

Conclusion: The Efficient Lighting Program is exceeding objectives and operating well. It successfully augments Pennsylvania's lighting market to favor LED purchases. Because Cadmus found LED use steadily increasing, and manufacturers suggested LEDs represent the majority of bulb sales, Cadmus

²⁹ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

concluded that the market is in the process of transforming. Overall, free ridership is currently low, but may increase as LED adoption continues to increase. Additionally, there are still pockets of the general customer base who are not using LEDs and who present potential for increased adoption. Strategic research could identify these pockets of late adopters and targeted marketing might help to reach them. For example, research might identify pockets of late LED adopters among multifamily building owners or tenants, or among lower-income customers who may not be eligible for the programs offered specifically to income-qualified customers.

Recommendation #1: The program is currently exceeding its objectives to achieve savings by selling discounted LEDs through retail channels. In future years, PPL Electric Utilities could consider exploring ways to focus on increasing the LED use among late adopters, while scaling back broad-based incentives to maintain overall savings and cost objectives.

Recommendation #2: The program exceeded projected sales and savings for PY8, in part due to substantial sales lift from merchandising and promotional activities. Strategic planning of promotions, particularly those that coincide with the lowest prices, could help manage the pace of sales and keep the program close to annual savings targets.

4.8.1 Status of Recommendations for Program

Table 39 contains the status of each PY8 recommendation made to PPL Electric Utilities.

Table 39. Status of Recommendations

Efficient Lighting Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	In future years, consider exploring ways to focus on increasing the LED use among late adopters, while scaling back broad-based incentives to maintain overall savings and cost objectives.	Being considered. It may be challenging to target specific customer types due to the upstream nature of the Efficient Lighting Program.
2	Strategic planning of promotions, particularly those that coincide with the lowest prices, could help manage the pace of sales and keep the program close to annual savings targets.	Agree. PPL Electric Utilities currently takes this into consideration and is controlling the pace of this program using many methods (price, product placement, advertising, number of program bulbs, etc.)

5 Efficient Equipment Program

The Efficient 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 C&I, large C&I, GNE, and agricultural customers.

The program offers incentives for lighting, equipment (HVAC, refrigeration, motors, food service, and office), and agriculture equipment through three delivery channels—standard path, direct discount, and Distributor Discount.

Standard path prescriptive rebate channel. In the standard path, the customer installs the equipment, submits the rebate application, and receives the rebate. For all equipment offered through the Efficient Equipment Program, PPL Electric Utilities provides incentives in the range of \$0.03 to \$0.17 per annual kWh saved. Incentives may be capped at 50% to 100% of the total project costs (excluding internal labor).

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. Through this channel, 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 the customer's behalf to PPL Electric Utilities. As with the standard path, 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.

Distributor Discount delivery channel. The Distributor Discount delivery channel is a midstream option designed to make choosing and procuring high-efficiency lighting simpler and faster than through typical downstream methods. Contractors and end-use customers may purchase qualifying LED lamps, bulbs, and fixtures directly from a participating lighting distributor. The purchaser receives an instant discount through a discounted list price at the point of sale. The ICSP caps the rebate at \$1,800 per customer transaction. PPL Electric Utilities pays the distributor the discount that the distributor passed through to the buyer.

In Phase III, CLEAResult is the Efficient Equipment Program's ICSP.

The objectives of the Efficient Equipment Program are these:³⁰

- 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 and design engineers to provide high-efficiency technology options to customers and promote other PPL Electric Utilities energy efficiency programs
- Achieve high customer and contractor satisfaction with the program
- Obtain participation of approximately 12,700 small C&I customers through PY12, with a total reduction of approximately 249,720 MWh/yr
- Obtain participation of approximately 500 large commercial and industrial customers through PY12, with a total reduction of approximately 133,803 MWh/yr
- Obtain participation of approximately 7,500 GNE customers through PY12, with a total reduction of approximately 32,018 MWh/yr

5.1 Progress Toward Phase III Projected Savings

The Efficient Equipment Program verified savings are within 4% of the estimated MWh/yr savings for PY8. It has achieved 17% of the estimated Phase III total planned savings and is making progress toward the Phase III projected savings.

Table 40. Efficient Equipment Program Estimated Savings

	PY8 Only				Phase III: PY8–PY12			
	Estimated	Verified [1]	Percentage of Estimated	Unverified	Estimated [2]	Verified	Percentage of Planned	Unverified
MWh/yr	73,625	70,917	96%	2,601	415,541	70,917	17%	2,601
[1] Distributor Discount savings are unverified.								
[2] Estimated savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.								

Factors affecting the program's progress toward the estimated savings projected for PY8 include these:

- The direct discount program channel (lighting and equipment) started slowly in PY8.
- A new ICSP took over implementation of the program for Phase III, so there has been some ramp-up period for the ICSP and the program.

³⁰ Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

- Savings reported in PY8 for the Distributor Discount channel are unverified in this annual report. Verified savings will be reported in the January 15, 2018, interim report.

5.2 Participation and Reported Savings by Customer Segment

5.2.1 Definition of a Participant

A **lighting participant** in the standard path is defined as a unique job initiated by a customer. In PY8, the Efficient Equipment Program had 851 lighting jobs (10,166 individual database records) and 733 unique customers.

An **equipment participant** in the standard path is defined as a unique job initiated by a unique customer. A unique customer can submit multiple equipment jobs in different equipment categories (HVAC, motors, refrigeration, etc.). In PY8, the Efficient Equipment Program had 111 unique jobs and 103 unique equipment customers.³¹

A **direct discount participant** is defined as a unique job completed for a unique customer. In PY8, the Efficient Equipment Program had seven direct discount jobs and six unique customers. Cadmus grouped the seven direct discount delivery channel lighting jobs with the standard path lighting stratum in PY8 because the population in this delivery channel was so small.

A **Distributor Discount participant** is defined by a unique job, that is, a participating distributor's sale of qualified products. For purposes of the process evaluation, distributors are considered the participants because they receive the incentives. In PY8, 12 distributors reported 789 jobs (sales) to 437 unique PPL Electric Utilities customers (distinct account numbers). The jobs involved the sale of 35,973 lighting products; 81% of these were 4-foot linear LED lamps.

5.2.2 Program Participation and Reported Impacts

Table 41 presents the participation counts, reported energy and demand savings, and incentive payments for all the components of the Efficient Equipment Program in PY8, by customer segment.

Table 41. Efficient Equipment Participation and Reported Impacts

Parameter	GNE	Large C&I	Residential	Small C&I	Total ^[1]
PYTD # Participants	402	146	29	1,174	1,751
PYRTD MWh/yr	15,210	26,820	109	34,029	76,169
PYRTD MW/yr	1.77	3.64	0.02	4.74	10.16
PY8 Incentives (\$1000)	\$918	\$1,541	\$0	\$2,087	\$4,546

^[1] May not match due to rounding.

³¹ Includes one HVAC project that was incorrectly reported under the Custom Program.

5.3 Gross Impact Evaluation

For verification sampling, projects were stratified as standard path lighting, standard path equipment, and Distributor Discount. There were only seven direct discount lighting projects in PY8, so verification efforts and results for these projects were combined with the standard path lighting results.

Cadmus assigned equipment projects to one of four substrata—HVAC, motors, refrigeration, and other. The other substrata included agricultural equipment, food service equipment, and office equipment. Cadmus sampled equipment projects biannually to meet a level of 85% confidence with 15% precision (85/15). Cadmus conducted 21 unique site visits and reviewed project data for five additional projects (26 total projects). Cadmus evaluated all equipment projects with a basic level of rigor, according to the Phase III Evaluation Framework.³²

Lighting projects were assigned on a quarterly basis to one of four substrata—large, medium-large, small-medium, and small—based on *ex ante* reported savings. Because the lighting strata boundary definitions changed quarterly based on the population and project size, Cadmus selected the evaluation sample and analyzed the results by quarter. See *EM&V Sampling Approach* section in *Appendix E* for additional information. Cadmus sampled standard path lighting projects quarterly to meet 90/10 confidence and precision. Cadmus conducted 68 site visits and reviewed light logger data for 11 threshold lighting projects (as defined in the PA TRM, projects with reported energy savings >750,000 kWh). Cadmus evaluated all lighting projects under the threshold with a basic level of rigor and all threshold lighting projects with an enhanced level of rigor.³²

Cadmus sampled Distributor Discount lighting projects quarterly to meet 90/10 confidence and precision and conducted 51 site visits. Because a facility could be associated with multiple purchases, the site visits involved 81 jobs.

The evaluation sampling strategy is shown in Table 42. See *EM&V Sampling Approach* section in *Appendix E* for additional details about methodology.

Table 42. Efficient Equipment Gross Impact Sample Design for PY8

Stratum	Population Size (Jobs)	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Equipment	111 ^[1]	0.5	21	Site visits and desk audits
			5	Desk audits only
Lighting	851 ^[2]	0.5	68	Site visits and desk audits
Distributor Discount	789 ^[3]	0.5	81	Records review and site visits
Program Total	1,751		175	

^[1] Includes one HVAC project that was incorrectly reported under the Custom Program.
^[2] Includes seven direct discount participants.
^[3] There were 796 records corresponding to 789 unique jobs in the Distributor Discount channel.

³² Levels of rigor are described in the Evaluation Framework for Pennsylvania Act 129 EE&C Programs, section 3.3.2.2., October 21, 2016.

In PY8, the Efficient Equipment Program reported energy savings of 76,169 MWh/yr, as shown in Table 43, and demand reduction of 10.16 MW, as shown in Table 44.

Table 43. Efficient Equipment Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L. ^[1]
Equipment - HVAC	1,116	57%	1.17	55.58%
Equipment - Motors	965	88%	0.25	16.50%
Equipment - Other ^[2]	31	100%	0.00	0.00%
Equipment - Refrigeration	2,020	107%	0.40	22.86%
Equipment Total ^[3]	4,131	89%	N/A	15.46%
Lighting - Q1	3,065	95%	N/A ^[4]	4.52%
Lighting - Q2	25,262	98%	N/A ^[4]	2.28%
Lighting - Q3	16,203	96%	N/A ^[4]	3.78%
Lighting - Q4	24,907	97%	N/A ^[4]	5.12%
Lighting Total ^[3]	69,437	97%	N/A ^[4]	1.76%
Distributor Discount Large (unverified)	938	N/A	N/A	N/A
Distributor Discount Medium-Large (unverified)	680	N/A	N/A	N/A
Distributor Discount Medium-Small (unverified)	561	N/A	N/A	N/A
Distributor Discount Small (unverified)	423	N/A	N/A	N/A
Distributor Discount Total (unverified) ^[3]	2,601	N/A	N/A	N/A
Program Total ^[3]	76,169	96%	N/A	1.65%

^[1] The precision calculation in this evaluation assumes independence between projects in different strata that were implemented at a single customer site, which occurs for four customers in the population but was not observed in the sample.

^[2] The *Equipment – Other* substratum includes Agricultural projects.

^[3] May not match due to rounding.

^[4] The error ratios are not reported for the quarter strata of the lighting component of the program because additional stratification (according to project size) was used in the evaluation.

Table 44. Efficient Equipment Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L. ^[1]
Equipment - HVAC	0.14	53%	0.85	40.62%
Equipment - Motors	0.04	75%	0.38	24.97%
Equipment – Other ^[2]	0.00	100%	0.00	0.09%
Equipment - Refrigeration	0.17	111%	0.47	26.84%
Equipment Total ^[3]	0.35	83%	N/A	18.09%
Lighting - Q1	0.49	95%	N/A ^[4]	10.52%
Lighting - Q2	2.94	111%	N/A ^[4]	13.97%
Lighting - Q3	2.36	107%	N/A ^[4]	16.29%
Lighting - Q4	3.52	95%	N/A ^[4]	5.53%
Lighting Total ^[3]	9.31	103%	N/A ^[4]	6.33%
Distributor Discount Large (unverified)	0.16	N/A	N/A	N/A
Distributor Discount Medium-Large (unverified)	0.14	N/A	N/A	N/A
Distributor Discount Medium-Small (unverified)	0.11	N/A	N/A	N/A
Distributor Discount Small (unverified)	0.09	N/A	N/A	N/A
Distributor Discount Total (unverified) ^[3]	0.50	N/A	N/A	N/A
Program Total ^[3]	10.16	102%	N/A	5.17%
<p>^[1] The precision calculation in this evaluation assumes independence between projects in different strata that were implemented at a single customer site, which occurs for four customers in the population but was not observed in the sample.</p> <p>^[2] The <i>Equipment – Other</i> substratum includes Agricultural projects.</p> <p>^[3] May not match due to rounding.</p> <p>^[4] The error ratios are not reported for the quarter strata of the lighting component of the program because additional stratification (according to project size) was used in the evaluation.</p>				

5.3.1 Equipment

The following factors led to variation between the reported and verified savings and led to the observed realization rates. For some projects, these variations increased the verified savings, in others they decreased the verified savings. Additional information is in *EM&V Sampling Approach* section in *Appendix E*.

- In some of the sampled HVAC, refrigeration, and motors projects, the verified baseline equipment was different than the reported baseline.
- The verified hours of use and peak demand coincidence factor were different than the reported values based on project location and facility type for commercial central air conditioning equipment.
- The verified installed equipment quantities were different than the reported quantities, for a variety of equipment.
- Cadmus identified rounding issues in the PPL Electric Utilities' tracking database that resulted in realization rates that were different from 100%.

- For some equipment, incorrect values were reported in the PPL Electric Utilities' tracking database. For example, the installed unit quantity was reported in a different column and the quantity was reported as one unit. For some equipment, Cadmus also found that the tracking database equipment description did not match the equipment inputs.
- Cadmus identified issues with the PA TRM default value calculations for electronically commutated motors, where the PA TRM default value could not be replicated when using the PA TRM default inputs.

5.3.2 Lighting

The following factors led to variation between the reported and verified savings and to the observed realization rates. For some projects, these variations increased the verified savings; in others, they decreased the verified savings. Additional information is in the *EM&V Sampling Approach* section in *Appendix E*.

- In six of the sampled projects, the verified facility type was different than the reported facility type. This affected the *ex post* PA TRM hours of use and peak demand coincidence factors.
- In seven of the sampled projects, the verified baseline and/or installed lighting fixture controls were different than the reported controls.
- In 13 of the sampled projects, the verified baseline and/or installed lighting fixture quantities varied from the reported quantities.
- In seven of the sampled projects, the verified baseline and/or installed lighting fixture wattage varied from the reported wattage.
- In five of the sampled projects, the reported prescriptive PA TRM hours of use were incorrect for the fixture type (hours of use for screw-in bulb instead of general service lamp, or vice versa).
- In six of the sampled projects, the verified space conditioning type (air conditioned, no cooling) was different than the reported conditioning type.
- In eight of the sampled projects that used custom hours of use (reported energy savings >120,000 kWh), the reported custom hours of use were not calculated correctly.

5.3.3 Distributor Discount

Distributor Discount savings are unverified in this report. Investigation into locating incented lamps and fixtures for six projects continues; verified savings will be reported in the January 15, 2018, interim annual report. Based on the site visits and desk reviews conducted to date, Cadmus identified the following factors that lead to variation between the reported and verified savings for individual jobs. These factors will be updated and possibly expanded when reporting verified savings.

- Cadmus has been unable to locate lamps and fixtures for six projects included in the evaluation sample. Incented lamps and fixtures that are not installed and operating will have zero gross savings.
- Two records have zero verified savings because the baseline and Distributor Discount equipment were the same.

- The Interim Measure Protocol (IMP) for Lighting Improvements for Midstream Delivery Programs prescribes full lamp wattage for T8 replacements,³³ for example with LED tubes.³⁴ But a 32-watt T8 lamp in a 4-foot two-lamp fixture with standard ballast draws only 29.5 watts, or 92% of the IMP baseline watts. LED tubes replacing T8 lamps accounted for 55% of the impact evaluation sample records.

5.4 Net Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,³⁵ which discusses the common methods to determine free ridership and spillover. Cadmus used self-report surveys to assess free ridership for the Efficient Equipment Program and researched customer communication for additional context about free ridership.

Free ridership is a measure of the savings that participants would have achieved on their own in the absence of the program; these savings are subtracted from verified gross savings. Spillover, on the other hand, credits additional savings that participants achieved on their own, where their experience with the program was highly influential in their decision to install energy-efficient equipment without the incentive of rebates. Spillover increases net savings attributable to PPL Electric Utilities. Assessing spillover in commercial settings via phone surveys is difficult because respondents cannot provide the level of detail needed to quantify spillover. Therefore, for commercial programs, Cadmus collected self-reported survey data and qualitatively discussed spillover but did not quantify spillover.

Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

Table 45 lists the methods and sampling strategy used to determine net savings for each component of the Efficient Equipment Program in PY8. Additional details about methodology are in *Appendix E*.

³³ The IMP prescribes methods to calculate savings for midstream programs.

³⁴ The T8 lamp wattage and T8-lamp fixture wattage are prescribed in the PA TRM, Appendix C Fixture Identities worksheet.

³⁵ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

Table 45. Efficient Equipment Program Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size	Achieved Sample Size	NTG Activity
Equipment	Participants (online)	111 ^[1]	2	Self-report survey
	Participants (telephone)		5	
Lighting	Participants (online)	851	29	Self-report surveys
	Participants (telephone)		33	
Distributor Discount	End users (purchasers and non-purchasers)	437	15	
Program Total		1,399	84	

^[1] Includes one HVAC project that was incorrectly reported under the Custom Program.

Table 46 shows the free ridership, spillover, and NTG ratios by program stratum.

Table 46. Efficient Equipment Program Net Impact Evaluation Results

Stratum	Number of Surveys	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.	Ex Post kWh Gross Population Savings
Equipment	7	22%	0%	0.78	33%	3,670,721
Lighting	62	23%	0%	0.77	9%	67,246,382
Equipment and Lighting Total ^[3]	69	23% ^[2]	0%	0.77	24%	70,917,102
Distributor Discount ^[5]	15	14%	0%	N/A	N/A	N/A ^[5]
Program Total	84					

^[1] These estimates were weighted by the survey sample-verified program kWh/yr savings. This method ensures that respondents who achieved higher energy savings through the program products have a greater influence on the measure-level free ridership estimate than do the respondents who achieved lower energy savings.

^[2] The equipment and lighting stratum level free ridership were weighted by the measure's ex post kWh/yr program population savings to arrive at the final Efficient Equipment Program NTG estimate.

^[3] May not match due to rounding.

^[4] These estimates were weighted by the survey sample-unverified program kWh/yr savings.

^[5] Survey data indicate 14% free ridership. Savings are unverified in PY8. Ex Post gross population savings will be updated in PY9.

Standard path prescriptive rebate channel. In PY8, lighting stratum free ridership was 23%, spillover was 0%, and the NTG ratio was 0.77 (see *Appendix E, section E.2.3 Net-to-Gross Ratio Findings*). These are the same results estimated for the PY7 lighting stratum.³⁶

In PY8, equipment stratum free ridership was 22%. This estimate is heavily weighted toward one respondent who was estimated as a 0% free rider and represented 56% of the verified program energy savings in the analysis sample. If this respondent were removed from the equipment strata analysis, the

³⁶ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

free ridership estimate (weighted by verified program energy savings) would increase to 50% for the equipment stratum.

Distributor Discount delivery channel. Cadmus interviewed the end users (purchasers and non-purchasers) in the Distributor Discount delivery channel. End users are the businesses where the lighting was installed and are the ultimate beneficiary of the program discount. (Decision makers at these business determine when to make upgrades and how much to invest in lighting equipment and are termed end-use purchasers. Customers for whom contractors purchased lighting products are termed end-user non-purchasers.) Distributors are required to pass incentives to purchasers as instant discounts. Contractor purchasers are expected to pass these discounts along to end-use customers. End-use customers receive a postcard from the ICSP informing them of the discount courtesy of PPL Electric Utilities. Therefore, Cadmus determined that end users were the most appropriate program actors to answer the survey questions used to estimate free ridership (see *Self-Report Survey* section in *E.2.1 Net-to-Gross Ratio Methodology*). In PY8, the Distributor Discount delivery channel's free ridership was 14%, determined using participant end users' survey data (see *E.2.3 Net-to-Gross Ratio Findings*). One respondent estimated as a 0% free rider accounted for 50% of the unverified energy savings in the analysis sample.

5.4.1 High-Impact Measure Research

The Phase III Evaluation Framework requires the identification and oversampling of high-impact products and services to assess free ridership with greater certainty. In the Efficient Equipment Program, Cadmus determined commercial lighting projects contribute greater than 5% of the overall PY8 PPL Electric Utilities portfolio savings and classified it as a high impact measure. For net savings calculations, Cadmus exceeded the evaluation requirement for high-impact measure sampling by completing 62 self-report surveys with lighting participants. The relative precision of the high impact measure NTG estimate at 90% confidence is 11%.

For net savings calculations, Table 47 presents the free ridership, spillover, and NTG ratios for the Efficient Equipment Program's high impact lighting component (standard path prescriptive rebates).

Table 47. Efficient Equipment Program High Impact Measure NTG Results

High-Impact Measures	Population ^[1]	Number of Respondents	Free Ridership (%)	Spillover (%)	NTG Ratio
Lighting	851	62	23% ^[2]	0%	0.77 ^[3]
^[1] Unique accounts ^[2] Estimate was weighted by the survey sample-verified program kWh/yr savings. This method ensures that respondents who achieved higher energy savings through the program products have a greater influence on the measure-level free ridership estimate than do the respondents who achieved lower energy savings. ^[3] 11% relative precision at 90% confidence					

5.4.2 Spillover

Following methods defined in the Phase III Evaluation Framework, Cadmus asked survey respondents if they had installed any additional energy-efficient equipment since participating in the Efficient Equipment Program without receiving a PPL Electric Utilities rebate. The survey also asked if program

participation influenced their decision to install the additional equipment. The data collected through the surveys did not provide enough information to reliably quantify spillover in commercial settings; therefore, spillover is reported qualitatively.

Nine lighting stratum respondents purchased additional energy-efficient lighting and one purchased thermostats after participating in the Efficient Equipment Program, and all respondents credited factors related to PPL Electric Utilities as having some level of influence on their purchasing decisions.

One equipment stratum respondent reported purchasing window wraps after participating in the Efficient Equipment Program and rated information about saving energy received from PPL Electric Utilities as extremely influential on this purchasing decision.

No data collected through the Distributor Discount end-user surveys indicated spillover activity attributable to PPL Electric Utilities.

5.5 Verified Savings Estimates

In Table 48, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Efficient Equipment Program in PY8. In future years, these totals will be added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 48. Efficient Equipment PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Total Demand (MW/yr) ^[1]
PYRTD Gross	76,169	10.16
PYVTD Gross	70,917	9.87
PYVTD Net ⁽¹⁾	54,643	7.60
PY Unverified Savings ⁽²⁾	2,601	0.50
P3RTD Gross	76,169	10.16
P3VTD Gross	70,917	9.87
P3VTD Net ⁽¹⁾	54,643	7.60
P3 Unverified Savings ⁽²⁾	2,601	0.50

^[1] May not match due to rounding.
^[2] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.

5.6 Process Evaluation

5.6.1 Equipment and Lighting Process Evaluation

Research Objectives

The main research objectives focused on these areas:

- Program communications
- Administrative efficiency
- Administrative response
- Delivery infrastructure
- Technical support
- Customer response

Evaluation Activities

The PY8 process evaluation activities for the lighting and equipment standard path and direct discount components of the Efficient Equipment Program included these:

- Interviews with PPL Electric Utilities and ICSP program managers
- Online participant surveys
- Telephone participant surveys
- Telephone interviews with design engineers and contractors
- Logic model review

The research activities were consistent with the Efficient Equipment Program's evaluation plan with one exception. Participation was low in the direct discount delivery channel because it launched near the end of PY8 (April 2017). Six participants had seven projects, all of which were lighting, so these projects were included in the standard path lighting stratum. If participation rates are higher in PY9, Cadmus will evaluate the direct discount delivery channel separately.

Table 49 lists the process evaluation sampling strategy for the equipment and lighting prescriptive rebates. Additional details about sampling methodology are in *Appendix E, section E.6.3 Sample Cleaning and Attrition for Lighting and Equipment Participant Surveys*. The Distributor Discount delivery channel is discussed following the equipment and lighting sections below.

Table 49. Process Evaluation Sampling Strategy for Equipment and Lighting

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records Selected for Sample Frame ^[1]	Percent of Sample Frame Contacted to Achieve Sample ^[2]
Equipment and Lighting								
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone in-depth interview	2	N/A	2	2	N/A	100%
Participants	Equipment	Online survey	111 ^[3]	0.5	~69	2	81	100%
		Telephone survey		0.5		5		
	Lighting	Online survey	851	0.5		29	660	100%
		Telephone survey		0.5		33		
Contractors and Design Engineers	Equipment	Telephone in-depth interview	20	0.5	~5	4	All eligible	100%
	Lighting	Telephone in-depth interview	82	0.5	~5	5	All eligible	100%
Program Total								
^[1] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities database. After selecting all unique records, Cadmus removed any records from the population. See <i>Appendix E</i> for more details. ^[2] Percent contacted means the percentage of the sample frame contacted to complete surveys. ^[3] Includes one HVAC project that was incorrectly reported under the Custom Program.								

5.6.2 Summary of Process Evaluation Findings for Lighting and Equipment Components

In this section, Cadmus presents interview and survey data by giving the percentage or frequency of responses, then the sample size for the question. Sample size (denoted by “n”) refers to the number for respondents who were asked the question, not the number of respondents who answered. Note that sample sizes vary according to each question because of survey logic and skipped questions. Additional detail regarding findings from process evaluation activities and their methodology is in *Appendix E*.

Overall, the program has been successful. Participant and contractor satisfaction is high and the program is meeting its key performance indicators. A summary of findings is presented below and additional detail regarding findings from process evaluation activities and their methodology is in the *EM&V Sampling Approach* section in *Appendix E*.

Program Delivery

In PY8, the program was implemented by a different ICSP than in Phase II, and overall, the transition to a new ICSP has been smooth. The program is now administered entirely through an online portal making it easier for customers and contractors to submit paperwork and track the status of their projects. The focus of the program has been on customer satisfaction and encouraging a partnership between the ICSP and the customer.

Program Satisfaction

Program satisfaction among customers, contractors, and design engineers was high. Overall, 80% of participants (n=69) were *very satisfied* with the program, 17% were *somewhat satisfied*, and 1% were *neither satisfied nor dissatisfied*. This is a slight increase from PY7 where 76% of survey respondents ranked their satisfaction with the program as high (rated 8, 9, or 10 on a 10-point scale where 10 means *outstanding* and 1 means *unacceptable*).³⁷

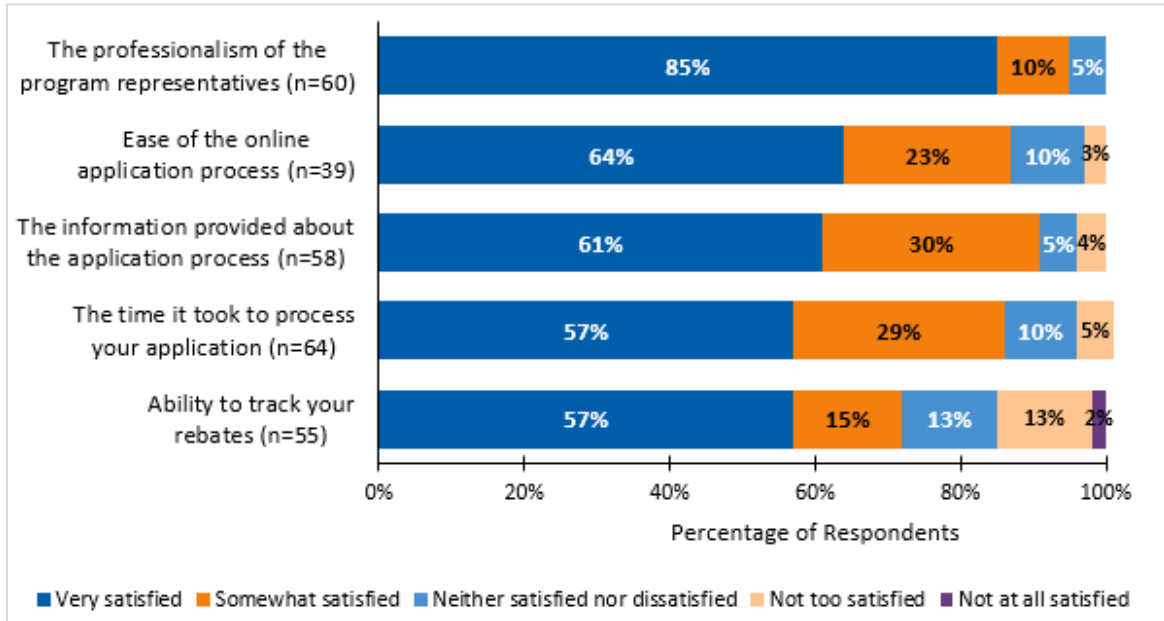
Figure 20 shows participant satisfaction with different components of the Efficient Equipment Program’s lighting and equipment components. Participants were most satisfied with the professionalism of the program representatives (85%) and least satisfied with the ability to track their rebates (57%) and the time it took to process their application (57%). Of the eight respondents who were *not too* or *not at all satisfied* with the ability to track their rebates, seven said this was *very* or *somewhat important*, and one said this was *neither important nor unimportant*. All three respondents who were *not too satisfied* with the time it took to process their application said this was *very important* (see the *Importance of Program Components* section in E.3.2).

When asked for recommendations to improve the program, seven participants, all of whom had received rebates for lighting upgrades, suggested simplifying or streamlining the application process. Of 57 respondents, five were *not too satisfied* or *not at all satisfied* with the information provided about the application process and four (one equipment and three lighting participants) suggested improving

³⁷ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

communications about the process. In particular, one equipment participant asked for clarity about what requires preapproval, one lighting participant had difficulty identifying which equipment was eligible, and two lighting participants asked for better communication during the application process.

Figure 20. Participant Satisfaction With Each Program Component



Source: Participant survey question “please indicate how satisfied you are with each one.”

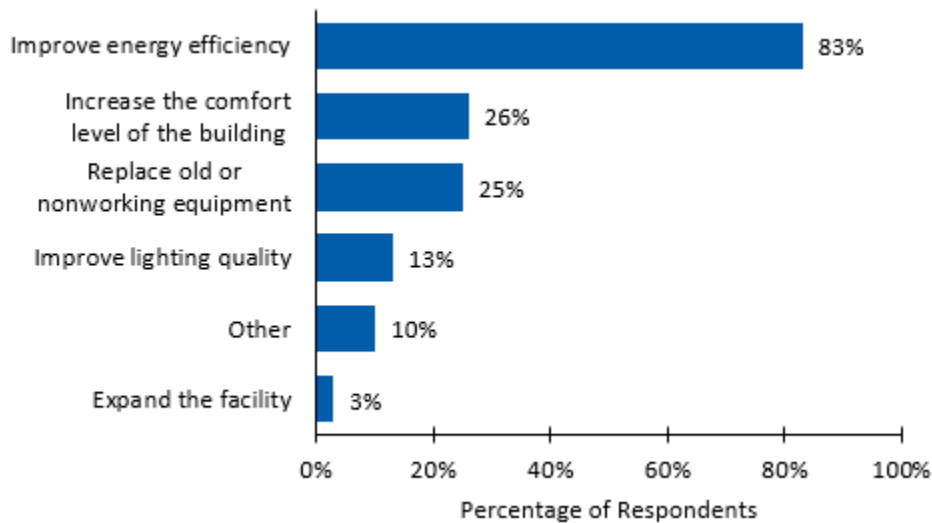
Cadmus interviewed nine lighting and equipment contractors. All were *very satisfied* with the program overall and *very satisfied* with their communications with program staff. Two equipment and five lighting contractors were *very or somewhat satisfied* with the rebate application process, one equipment contractor was *neither satisfied nor dissatisfied*, and one equipment contractor was *not too satisfied*, stating that the application process was difficult and kept changing.

Program Key Performance Indicators

The lighting and equipment components fulfilled the customer satisfaction KPI with 97% satisfaction among surveyed participants (n=69); the target was 80%. Additional details are in *E.3.2 Additional Findings for Lighting and Equipment Standard Path Delivery Channel* in Appendix E.

Decision Making

Figure 21 shows the reasons lighting and equipment respondents reported that they completed projects. The majority completed their project to improve energy efficiency (83%, n=69). Ten percent of respondents chose the “other” category, which included improving lighting, improving safety, reducing costs, and reducing maintenance. When asked why they chose the specific model, 54% chose the specific model because of its energy efficiency, 35% because of size or fit, 36% because of a recommendation, 30% because of price, and 9% because of lighting quality (multiple responses were allowed).

Figure 21. Reasons Respondents Completed the Lighting or Equipment Project

Source: Survey question "Please describe why your organization completed this project." (n=69); multiple responses allowed

PPL Electric Utilities' EE&C Plan identified three possible challenges that might hamper successful program implementation: customers not prioritizing energy efficiency, customers replacing equipment only when it failed, and customers not being aware of the benefits of installing and properly maintaining equipment.³⁸ To address these challenges, the ICSP is providing information to customers at various points during their project about how energy efficiency projects can offer benefits beyond energy savings. Information focuses on energy reliability, societal environmental impacts, increase in sales, and shorter payback.

Survey respondents were asked whether specific scenarios describing possible challenges with energy efficiency upgrades were true for them, and results are in Figure 22. The top two responses were that the respondent's organization had made all the energy efficiency improvements it could without a substantial investment (65%, n=55) and that making energy efficiency upgrades was cost-prohibitive (31%, n=55).

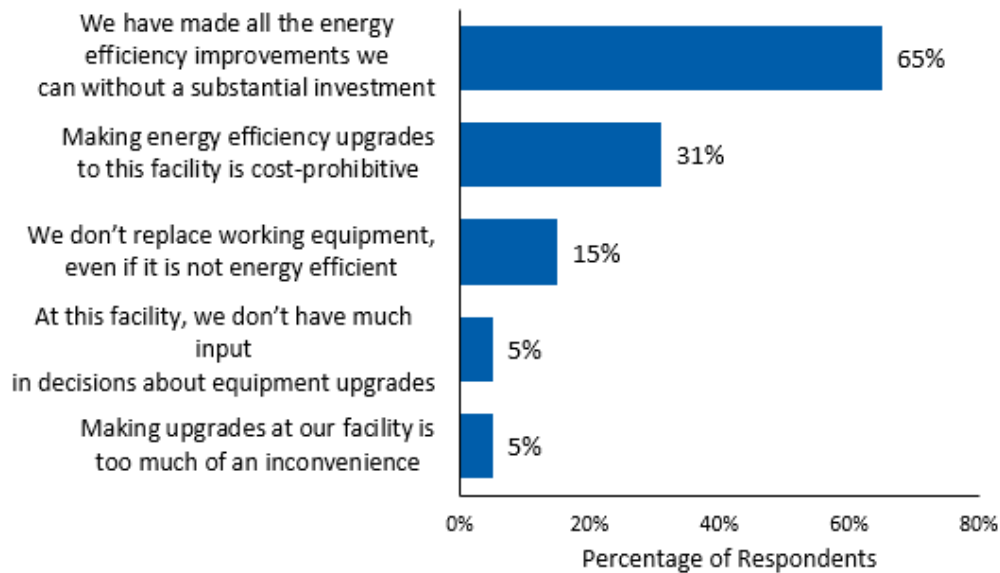
A challenge identified in the EE&C Plan was that customers do not replace working equipment with energy-efficient equipment.³⁹ Fifteen percent of respondents (n=55) said they did not replace working equipment even if the equipment was not energy-efficient. However, when asked if the rebated equipment replaced existing equipment, 96% of survey respondents said yes (n=51). Sixty-three percent said the replaced equipment was still in working condition with no problems, 35% said it had problems but was still working, and 2% said it had failed or was not working (n=49). Therefore, customers not

³⁸ PPL Electric Utilities Corporation. *Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642 Compliance Filing before the Pennsylvania Public Utility Commission. December 5, 2016. p. 93, 119, and 143.

³⁹ Ibid.

replacing working equipment with energy-efficient equipment does not appear to be a challenge for the Efficient Equipment Program’s standard path.

Figure 22. Participant Challenges to Energy Efficiency Upgrades



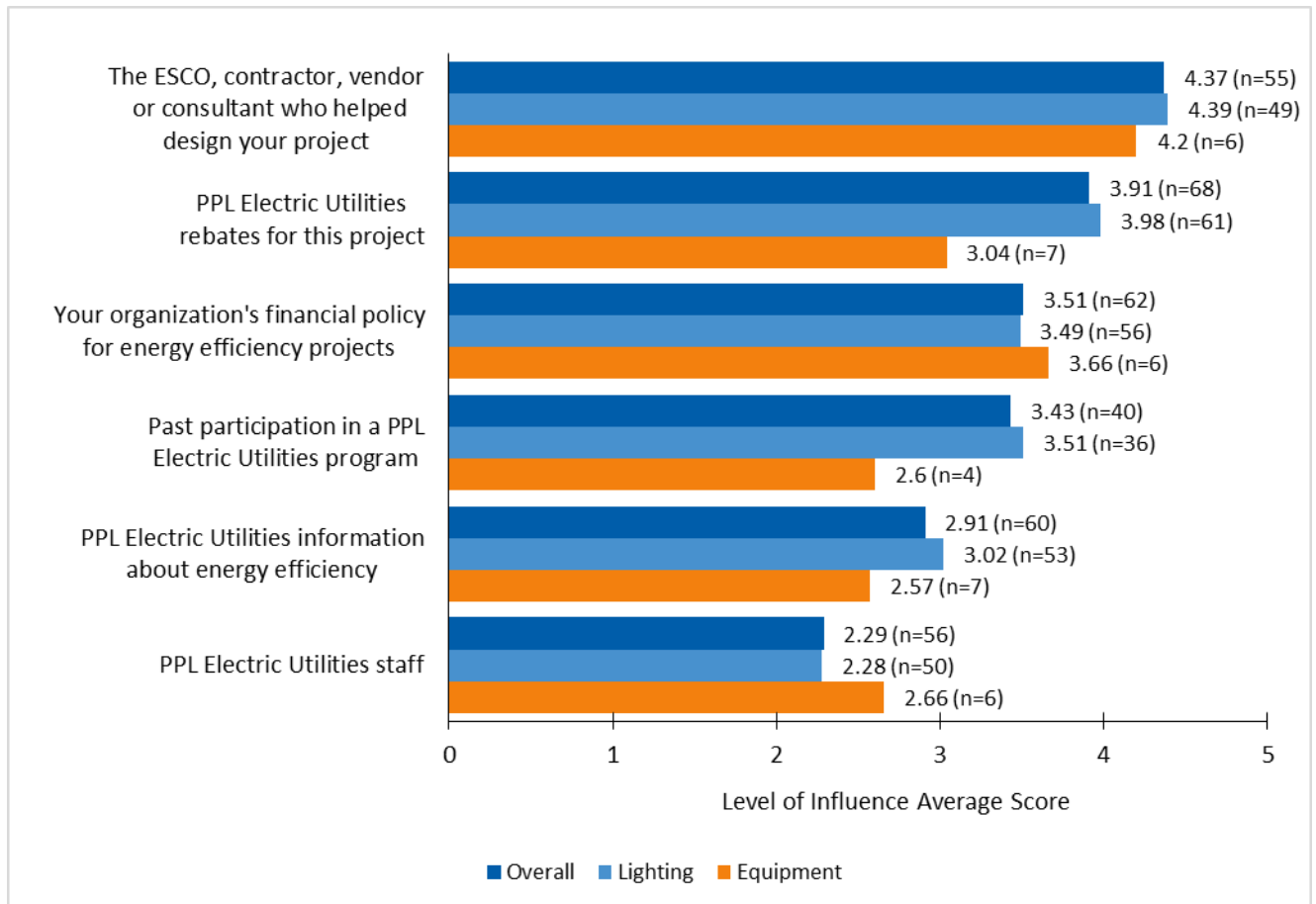
Source: Survey question: “Of the scenarios listed below that companies might face when purchasing new appliances or considering energy-efficient improvements, please indicate which are true for you.” (n=55)

Contractors also mentioned challenges they or their customers faced when participating in the program. Five contractors said upfront cost was a challenge, similar to the top participant responses. One contractor said customers sometimes had concerns about disruptions to operations. One contractor said that new construction projects could be challenging because the architect had often already decided the lighting type.

Program Influence

The survey asked questions about how much influence the program had on respondents’ decision to complete the project in the way they did. Figure 23 shows the average level of influence different items had on respondents’ projects, where 5 was *extremely influential* and 1 was *no influence*. The rebates from PPL Electric Utilities proved influential, with an overall average score of 3.91 (n=68), and rebates were more influential for lighting projects than for equipment projects. The energy services company (ESCO), contractor, vendor, or consultant who helped design the program was most influential (overall average score of 4.37, n=55).

Figure 23. Average Influence Score for Different Items



Source: Survey question "Please rate each item on how much influence it had on the decision to complete the project the way it was completed on a scale from 1 to 5 where 5 is *extremely influential* and 1 is *no influence*."

Contractors (n=9) were asked for their perception of the program's influence on the customer's decision to purchase more efficient equipment. Two equipment contractors said the program was *somewhat influential* and two said the program was *very influential*. Three lighting contractors said the program was *somewhat influential* and two said the program was *very influential*. This corroborates participant responses that PPL Electric Utility rebates were influential in their lighting or equipment projects (average influence score of 3.91, n=68).

5.6.3 Distributor Discount Process Evaluation

Research Objectives

The main research objectives of the process evaluation focused on these areas:

- Identify program successes and challenges
- Identify participating distributor, purchaser, and end-user motivations and barriers
- Make recommendations for program modification and improvement

Evaluation Activities

The PY8 process evaluation activities for the Distributor Discount channel of the Efficient Equipment Program included these:

- Interviews with PPL Electric Utilities and ICSP program managers
- Telephone interviews with participating distributors (those who received at least several incentives payments from the ICSP)
- Telephone interviews with end-user purchasers (commercial customers who purchased lighting directly from distributors)
- Telephone interviews with contractor purchasers (contractors who purchased lighting on behalf of PPL Electric Utilities' commercial customers)
- Telephone interviews with end-user non-purchasers (commercial customers for whom contractors purchased lighting)
- Customer segmentation analysis (end-user customers reported in PPL Electric Utilities' tracking database for both lighting components of the Efficient Equipment program)
- Develop program logic model and process map

Table 50 lists the planned and completed process evaluation activities for the Distributor Discount component.

Table 50. Process Evaluation Sampling Strategy for Distributor Discount

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Records Selected for Sample Frame ^[1]	Percent of Sample Frame Contacted to Achieve Sample ^[2]
Distributor Discount								
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone in-depth interview	5	N/A	5	5	N/A	100%
Participating Distributors	Distributors	Telephone in-depth interview	12	N/A	As many as possible	7	N/A	100%
End User Purchasers	End-use customers who purchase directly from distributors	Telephone in-depth interview	81 ^[3]	N/A	15	11	75	72%
Contractor Purchasers	Contractor purchaser for whom contact data were provided	Telephone in-depth interview	19 ^[3]	N/A	15	7	19	100%
End-User Non-Purchasers	End users for whom contractors purchased lighting	Telephone in-depth interview	36 ^[3]	N/A	15	4	36	100%
Program Total			145		98	31	139	

^[1] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL database. After selecting all unique records, Cadmus removed any records from the population.

^[2] Percent contacted means the percentage of the sample frame contacted to complete surveys.

^[3] There were 437 total end-use facilities (made up of end-user purchasers and non-purchasers) reported in PY8. However, purchaser data were not included in PPL Electric Utilities' PY8 tracking database, so Cadmus could not discern purchasers from non-purchasers (i.e., determine purchases made by contractors). Therefore, Cadmus used more detailed, but limited, invoice data files for a sample of sales to select the sample frames for these interviews.

The research activities were consistent with the evaluation plan with two exceptions—first, the number of interviews conducted with participating distributors was limited to the number of distributors the ICSP recruited and the number who agreed to an interview and, second, the number of completed interviews with purchaser and non-purchasers was lower than planned because Cadmus had limited contact information in the initial data collected by and received from the ICSP. Preliminary data received for PY9 are more complete; thus, Cadmus does not expect any challenges completing planned interviews in subsequent years.

Market Effects

Cadmus planned to analyze sales data to assess market effects related to the Distributor Discount channel. In PY8, however, the ICSP was unable to procure these data from distributors. In PY9, Cadmus will work with the ICSP and participating distributors to follow up on these efforts.

5.6.4 Summary of Process Evaluation Findings for Distributor Discount

The Efficient Equipment Program's Distributor Discount channel launched late in PY8, with no significant sales of discounted products until November 2016. According to the ICSP, by May 2017 only five participating distributors had submitted invoices for significant incentive payments. However, by the end of PY8, 12 distributors reported at least one program sale. During this time, the ICSP continued to develop its data tracking and invoicing procedures for this new program delivery channel.

Program Awareness

General customer and nonresidential program participant awareness of the Distributor Discount channel was low in PY8. Cadmus included questions in the participant surveys for the Custom and Efficient Equipment programs (lighting and equipment program components) and in a survey of the general small commercial population (used in the Efficient Lighting Program evaluation). Cadmus asked where these customers typically purchased lighting equipment and if they were aware of the Distributor Discount channel.

The results were these:

- Only 26% of Efficient Equipment Program's lighting participants surveyed (n=61) were aware of the Distributor Discount channel. Of these, 64% purchased lighting from distributors, 25% from an energy services company, and 20% from retail stores.
- Of the Efficient Equipment Program's equipment participants surveyed, seven were aware of the delivery channel.
- Of participants in the Custom Program (n=16), 38% reported they were aware of this new channel.
- Only 19% of the general small commercial population (n=268) were aware of the Distributor Discount channel. The majority of these (75%) said they purchased their lighting equipment at retailers, rather than through electrical distributors (22%).

Program Satisfaction

The Distributor Discount delivery channel was implemented relatively smoothly as it was introduced and began to ramp up during PY8. It received high satisfaction ratings from participating distributors, purchasers, and end users (see *E.6.2 Additional Findings for Distributor Discount* in *Appendix E*). Most distributors reported no major issues with the initial program launch, although one mentioned concern about a delay in the processing of incentive payments. The primary drawback from the distributors' perspective was the limited number of products on the qualified products list, which all distributors and some purchasers want to see expanded. To be included in the qualified products list, products must be certified by ENERGY STAR or the Design Lights Consortium (DLC).

Program Influence

The seven distributors interviewed said they expect the program to have some positive influence on efficient lighting sales, but that it is still too early to tell the magnitude of that impact. They estimated that 50% to 80% of their dollar sales before the program started came from lighting products that are now program-eligible; these sales have increased slightly since the program began. Distributors reported a major shift toward LEDs in the past three years, driven by technology improvements and price reductions; they think program incentives have had a positive influence on bringing in sales from smaller commercial customers.

Smaller customers clearly favor the Distributor Discount channel in Phase III. However, because the program launched late in PY8 and there are not enough data to make a comparison to Phase II, it is not clear whether this new channel is capturing more small customers, in terms of their annual electricity consumption, than the standard prescriptive rebate program component did in Phase II. There is a clear distinction between the Distributor Discount and standard prescriptive rebate channels and the two phases in the size of lighting jobs benefiting from program incentives (see the *End-User Segmentation Analysis* section in *Appendix E.6.2 Additional Findings for Distributor Discount*).

Contractors who purchased lighting from participating distributors agreed that incentives helped encourage the sale of efficient lighting and were *highly influential* to their clients' decisions. They also said the program changed the frequency with which they promote products certified by ENERGY STAR and the Design Lights Consortium.

Overall, the Distributor Discount channel is perceived by participants positive impacts on sales and installations of efficient lighting products, by reducing administrative and waiting time for both end users and contractors, making purchasing discounted lighting more attractive to a wider variety of customers. Additional details are in *Appendix E.6.2 Additional Findings for Distributor Discount*.

5.7 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 51. TRC benefits were calculated using gross verified impacts. NPV PYTD costs and benefits are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). NPV costs and benefits for P3TD financials are expressed in the PY8 dollars.

Table 51. Summary of Efficient Equipment Program Finances – Gross Verified – All Components

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$4,546		\$4,546	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$17,800		\$17,800	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	\$22,346		\$22,346	
		EDC	ICSP	EDC	ICSP
5	Design & Development ^[2]		-		-
6	Administration, Management, and Technical Assistance ^[3]	\$154	-	\$154	-
7	Marketing ^[4]	-	\$437	-	\$437
8	Program Delivery ^[5]	-	\$2,141	-	\$2,141
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$2,733		\$2,733	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$155		\$155	
13	Total NPV TRC Costs ^[7] (Net present value of sum of rows 4, 11, and 12)	\$25,234		\$25,234	
14	Total NPV Lifetime Electric Energy Benefits	\$35,814		\$35,814	
15	Total NPV Lifetime Electric Capacity Benefits	\$5,536		\$5,536	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$2,471		\$2,471	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits ^{[1] [9]} (Sum of rows 14 through 17)	\$43,822		\$43,822	
19	TRC Benefit-Cost Ratio ^[9]	1.74		1.74	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing ICSP and marketing costs by program ICSPs.

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Table 52 presents program financials and cost-effectiveness on a net savings basis.

Table 52. Summary of Efficient Equipment Program Finances – Net Verified – All Components

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$4,546		\$4,546	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$12,672		\$12,672	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	\$17,218		\$17,218	
		EDC	ICSP	EDC	ICSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$154	-	\$154	-
7	Marketing ^[4]	-	\$437	-	\$437
8	Program Delivery ^[5]	-	\$2,141	-	\$2,141
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$2,733		\$2,733	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$120		\$120	
13	Total NPV TRC Costs ^[7] (Net present value of sum of rows 4, 11, and 12)	\$20,071		\$20,071	
14	Total NPV Lifetime Electric Energy Benefits	\$27,594		\$27,594	
15	Total NPV Lifetime Electric Capacity Benefits	\$4,265		\$4,265	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$1,903		\$1,903	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits ^[8] (Sum of rows 14 through 17)	\$33,761		\$33,761	
19	TRC Benefit-Cost Ratio ^[9]	1.68		1.68	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing ICSP and marketing costs by program ICSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Incremental Cost Data

Cadmus used invoices and sales reports to review equipment cost data of rebated equipment for a sample of lighting jobs in the Efficient Equipment Program. Unit cost data for efficient equipment was compiled for these standard path and midstream projects by program and equipment type and compared with the SWE Incremental Cost Database updated in PY8. After comparing the findings and

reviewing the completeness and granularity of data, Cadmus recommended using the SWE incremental cost database to determine incremental measure cost in PY8.

5.8 Status of Recommendations

Overall, the Efficient Equipment Program was successfully launched in PY8. The verified savings are within 4% of the estimated MWh/yr savings projected for PY8, and the verified savings meet 17% of the projected Phase III savings in the EE&C Plan. Additionally, 80% of survey respondents were *very satisfied* with the program.

The impact and process evaluation activities in PY8 led to the following findings and recommendations from Cadmus to PPL Electric Utilities. Table 53 provides a summary of how PPL Electric Utilities plans to address the recommendation in program delivery.

5.8.1 Equipment and Lighting Standard Path Prescriptive Rebates

Finding: Eight equipment and lighting survey respondents suggested that PPL Electric Utilities provide more information about the program. Seven respondents requested information about available rebates, one had difficulty identifying which equipment was eligible, and another asked for clarity on preapproval requirements. Additionally, one contractor suggested promoting tax credits (see *Suggested Program Improvement* section in *Appendix E.3.2*).

Fifty-five percent of survey respondents (86% of equipment respondents and 52% of lighting respondents) had visited PPL Electric Utilities' website in the past six months (see *Online Engagement* section in *Appendix E.3.2*).

Conclusion: Many customers and contractors are not aware of the information PPL Electric Utilities provides on its website regarding program offerings and requirements and could visit PPL Electric Utilities' website more often. Most of their questions could be answered by visiting the website. The website lists the eligible equipment, explains the application process, and provides tax credit information.

Recommendation #1: PPL Electric Utilities and the ICSP could consider increasing promotion of PPL Electric Utilities' website to participating contractors through its current outreach activities. Contractors could pass information to participants to help answer questions about the program.

Finding: The EE&C Plan identified one potential program challenge may be that customers do not replace working equipment even if that equipment is not energy-efficient (see *Decision Making* section in 5.6.2).⁴⁰ However, 63% of respondents who replaced existing equipment said it was still in working condition with no problems, 35% said the replaced equipment had problems but was still working, and

⁴⁰ PPL Electric Utilities Corporation. *Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642 Compliance Filing before the Pennsylvania Public Utility Commission. December 5, 2016. p. 93, 119, and 143.

2% said the equipment had failed or was not working (n=49) (see *Decision Making* section in 5.6.2 Decision Making).

The top two challenges for respondents concerned not being able to make all of the energy efficiency improvements they could without a substantial investment (65%, n=55) and making energy efficiency upgrades to facilities was cost-prohibitive (31%, n=55). Additionally, five of nine contractors said the upfront cost was a challenge for customers (see *Decision Making* section in 5.6.2).

Conclusion: Efficient Equipment Program participants replace working equipment, and this does not appear to be a program challenge; nevertheless, projects costs are a challenge. The rebates offered through the program help customers purchase efficient lighting and equipment.

Recommendation #2: In addition to continuing to offer rebates to reduce first cost and assist customers, PPL Electric Utilities and ICSP could provide more information to contractors and customers about cost savings and the non-energy benefits of energy-efficient lighting and equipment to help customers rationalize project costs.

Finding: The most common way that participants learned about the program was from a contractor, vendor, or distributor (64%, n=69) (see section *E.3.2 Program Discovery*).

Finding: The energy services company, contractor, vendor, or consultant who helped design the project had the most influence on participant survey respondents' decisions about the project, with an average score of 4.37 out of 5 (n=55), followed by the rebates from PPL Electric Utilities with an average score of 3.91 (n=68). Lighting respondents gave their contractor an average influence score of 4.39 out of 5 (n=49), and equipment respondents gave their contractor an average influence score of 4.2 out of 5 (n=6). Lighting respondents gave PPL Electric Utility rebates an average influence score of 3.98 and equipment respondents gave rebates an average influence score of 3.04 out of 5 (see section 5.6.2 *Program Influence*).

Finding: Four contractors and design engineers said the program was *very influential* and five said the program was *somewhat influential* in a customer's decision to purchase more efficient equipment (see section 5.6.2 *Program Influence*).

Finding: Free ridership was 23% for the lighting components and 22% for the equipment components (see section 5.4 *Net Impact Evaluation*).

Conclusion: Free ridership is not a concern for this program. Design engineers and contractors are very influential in bringing customers to the program and in customers' decisions about their project. The program rebates are also influential in customers' decisions to purchase more efficient equipment.

Finding: The ICSP's documentation for some of the sampled equipment projects was missing inputs that were critical to the PA TRM calculations. Most of the missing inputs were related to the pre-retrofit or baseline equipment type and/or controls (see section *E.1.3 Site Visit Findings*).

Conclusion: Complete and accurate documentation of baseline and installed equipment is critical to the evaluated energy savings calculations.

Recommendation #3: The ICSP should verify that the project documentation includes all the inputs that are necessary for the PA TRM savings calculations.

5.8.2 Distributor Discount Delivery Channel

Finding: The program is operating as designed, with distributors stocking efficient products and reaching customers as intended. The program met or exceeded the participating distributors' expectations and its success is grounded in its simplicity and instant rebate, which made it easier to sell discounted products to customers. (Additional details can be found in *Appendix E.6.2.*) The ICSP expects a much larger participation in PY9 with additional distributors and the currently active contractors who are now familiar with the discounted product offerings.

Most purchasers heard about the program from their distributor. Satisfaction with the program among distributors, purchasers and end users is high. One suggestion from all distributors was to expand the qualified products list. (Additional details can be found in *Appendix E.6.2.*)

Conclusion: The program is ramping up and appears to be well received. Distributors and purchasers appreciate the simplicity of the Distributor Discount channel and would like to see more products added to the program.

Recommendation #4: The ISP could consider increasing product offerings; this will likely be well received by distributors and contractors.

Finding: The PPL Electric Utilities tracking database was inconsistent in recording the key contact people who could locate lighting purchased through the Distributor Discount channel. Information about this equipment was necessary to select the impact evaluation sample and to conduct verification site visits. The customer's invoices and other records confirming a purchase were not always sufficient to locate equipment at a facility. In a few cases, property management companies appeared to have made purchases for facilities in their portfolio but did not involve the local facility staff so they could not help locate the new lighting equipment installations. The inability to locate and verify equipment purchased through the Distributor Discount channel for six facilities resulted in zero verified savings. (See section 5.3.3 and *Appendix E.4.3 Realization Rate Findings* for details.)

Conclusion: The lighting products purchased through the program must be locatable to verify that the products are installed and operating as intended before savings can be verified. This is fundamental to determine energy savings. The In-Service rate is a major driver of the realization rate for this channel (see *Appendix E.4.3 Realization Rate Findings*). Cadmus believes the realization rate will improve if a facility representative can speak with evaluators, and authorize site visits.

Recommendation #5: As long as site visits are required, the process to notify and contact customers needs some modifications to improve access. To prepare customers for a possible evaluation site visit, the ICSP should flag all large projects with estimated savings of 15 MWh/year or more. The ICSP should

contact these customers ahead of evaluators, ask about lighting purchased through the Distributor Discount channel, advise of possible evaluation site visits, and obtain contact information for two people knowledgeable about the facility and the purchased equipment. It would be burdensome for the ICSP to contact all customers so the recommendation is only for those projects with larger savings, which are at risk of adjustment by Cadmus, and pose the greatest risk to the program's savings.

Recommendation #6: The ICSP could develop and maintain a database of repeat and large purchasers in the Distributor Discount channel (such as property managers or realty companies with interests in a number of facilities), with contact information of people knowledgeable about the purchases and about where equipment is shipped and installed, so Cadmus can verify product placement and determine savings for projects with the greatest risk of needing adjustment.

Finding: PPL Electric Utilities and Cadmus led development of a new IMP for the midstream delivery channel, with input from the electric distribution companies (EDCs), other evaluators, and the SWE team. The IMP pairs a baseline product with an efficient product to determine energy savings. Cadmus conducted site visits in part to determine whether the baseline and efficient product pairing in the IMP was accurate. Results from the site visit effort were found to be mostly consistent with the IMP, and the site specific findings did not reveal any systematic deviations from *ex ante* assumptions. Two areas where savings calculations were adjusted are described below (See *Appendix E.4.3 Realization Rate Findings* for details).

Finding: Savings calculations needed to be corrected for baseline wattage assumptions, where the IMP prescribed full baseline lamp wattage applied to equipment replaced by linear LED lamps, because the IMP method does not adjust for the normal light output ballast factor, to calculate the installed wattage. The anomaly for T8 lamp baselines has been addressed in a revised IMP, which was approved by the SWE in October 2017. The site visit effort did not reveal any substantial difference in the *in situ* and IMP baseline. (See *Appendix E.4.3 Realization Rate Findings* for details.)

Finding: Where Cadmus found the installed non-linear products, the baseline wattage did not match IMP assumptions for a majority of projects. The differences were random and included both positive and negative differences. Cadmus anticipates that the differences in baseline wattage will have a small effect on adjustments to the forthcoming verified savings for the distributor discount channel. (See *Appendix E.4.3 Realization Rate Findings* for details.)

Conclusion: Changes should be applied to baseline wattage assumptions for linear LED lamps, per the revised IMP.

The differences in baseline wattage found on-site and compared to the IMP assumptions were not consistent, and the sample sizes for individual non-linear equipment categories were not large enough to develop robust recommendations.

Recommendation #7: Continue to verify the accuracy of the baseline and efficient product pairs during the PY9 site visits. Site specific adjustments should be made to baseline wattage discrepancies with the

IMP, and systematic trends in deviations from IMP assumptions should be recorded so that they may be addressed.

Finding: Cadmus found that the building type and associated hours of use for the projects in the sample matched the findings of the on-site verification effort for all but six projects. (See *Appendix E.4.3 Realization Rate Findings*.)

Conclusion: The assignment of building types to indicate equipment hours of use, is critical to the accurate calculation of savings and has been performed satisfactorily. No changes are needed to the current process.

Recommendation #8: Continue to verify the accuracy of the building type assignments during the PY9 site visits.

5.8.3 Status of Recommendations for Program

Table 53 contains the status of each PY9 recommendation made to PPL Electric Utilities.

Table 53. Status of Recommendations for the Efficient Equipment Program

Efficient Equipment Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	PPL Electric Utilities and the ICSP could increase promotion of its' website through current outreach activities. Contractors could pass information to participants to help answer questions about the program.	Being considered. Need more information to better understand the objective of this "increased promotion." If it is to increase program participation? Improve customer satisfaction with the website? Help customers complete their applications faster?
2	PPL Electric Utilities and ICSP could provide more information to contractors and customers about cost savings and the non-energy benefits of energy-efficient lighting and equipment to help customers rationalize project costs.	Agree. PPL Electric Utilities is exploring EE&C "tips" with estimated energy savings and non energy benefits.
3	The ICSP should verify that the project documentation includes all the inputs that are necessary for the PA TRM savings calculations.	Agree
4	The ICSP could consider increasing product offerings in the Distributor Discount channel.	Being considered and depends on the pace of the program, the amount of documentation required, the cost per annual kWh saved, and the potential impact on the realization rate for this channel.
5	The ICSP should flag all large Distributor Discount projects with estimated savings of 15 MWh/yr or more and contact customers ahead of evaluators.	Being considered
6	The ICSP could develop and maintain a database of repeat and large purchasers in the Distributor Discount channel with contact information of people knowledgeable about the purchases and about where equipment is shipped and installed.	Being considered
7	Continue to verify the accuracy of the baseline and efficient product pairs during the PY9 site visits.	Agree
8	Continue to verify the accuracy of the building type assignments during the PY9 site visits.	Agree

6 Custom Program

The Commercial and Industrial (C&I) Custom Program offers financial incentives to customers who install equipment that is not offered in PPL Electric Utilities' other commercial programs, including products that are not addressed in the Pennsylvania Phase III technical reference manual (hereafter referenced as the PA TRM). These products may include new or replacement energy-efficient equipment, retrocommissioning, repairs, equipment optimization, new construction, operational and process improvements, combined heat and power (CHP), and behavioral changes that result in cost-effective energy savings. The program also includes a continuous energy improvement component, through which PPL Electric Utilities works closely with customers, primarily school districts, to identify ways to reduce their electricity usage through improved operations and maintenance and behavioral changes.

The program offers performance-based incentives for the avoided or reduced energy consumption—in kilowatt hours per year (kWh/yr)—that result from the project. Incentives are subject to an annual cap for each project (\$500,000) 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, C&I customers are required to submit documentation that their proposed efficiency upgrades pass the program's cost-effectiveness threshold, and the project must be approved before equipment is purchased. 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.

The implementation conservation service provider (ICSP), CLEAResult, manages the program and handles application intake, assesses eligibility, and calculates project energy savings and incentives.

The objectives of the Custom Program are these:⁴¹

- Encourage PPL Electric Utilities customers to take a comprehensive, whole-facility approach to energy efficiency by installing high-efficiency custom equipment or processes.
- Encourage qualifying equipment repairs, optimization, and operational or process changes that reduce electricity consumption.
- 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.

⁴¹ Program objectives and Phase III projected energy savings are listed in PPL Electric Utilities' revised EE&C plan (Docket No. 2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

- 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 (EPA) tax credits.
- Promote other PPL Electric Utilities energy efficiency programs.
- Achieve a total reduction of approximately 183,089 MWh/yr through Phase III (small C&I customers).
- Achieve a total reduction of approximately 163,197 MWh/yr through Phase III (large C&I customers).
- Achieve a total reduction of approximately 48,982 MWh/yr through Phase III (GNE customers).

6.1 Progress Toward Phase III Savings

The Custom Program verified savings are within 78% of the estimated MWh/yr savings projected for PY8. The program has achieved 12% of the estimated Phase III total planned savings. The program is on track to reach Phase III participation goal with 18% of participants reached in PY8 (the EE&C plan estimates 389 participants over five years).

Verified savings include all but three projects that were paid and claimed in PY8. Post-installation data are being collected for these three projects, and the measurement and verification will be completed in PY9 Q2. Savings for these projects are classified as unverified in PY8, and verified savings will be reported in PY9. Including the unverified savings, the program reached 119% of PY8 estimated savings.

Table 54 shows the program's verified gross program savings and progress toward its Phase III projected energy savings, as filed in the EE&C Plan.

Table 54. Custom Program Savings

	PY8 Only				Phase III: PY8-PY12			
	Estimated ⁽¹⁾	Verified	Percentage of Estimated ^[2]	Unverified Savings	Estimated ⁽¹⁾	Verified	Percentage of Estimated ^[2]	Unverified Savings
MWh/yr	59,712	46,368	78%	24,815	395,268	46,368	12%	24,815
⁽¹⁾ Planned savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. 2015-2515642) filed with the Pennsylvania PUC on December 5, 2016. ^[2] Including unverified savings, the percentage of estimated savings is 119% for PY8 and is 18% for Phase III.								

6.2 Participation and Reported Savings by Customer Segment

6.2.1 Definition of a Participant

A PY8 participant is defined as a project that was commercially operable and received an incentive payment between June 1, 2016, and May 31, 2017.⁴² Projects for which customers submitted an application during this period but did not receive an incentive are not counted as participants in PY8. It is possible for an individual customer to have multiple participating projects. Typical custom projects may take more than one quarter to complete.

6.2.2 Program Participation and Reported Impacts

Table 55 presents the participation counts, reported energy and demand savings, and incentive payments for the Custom Program in PY8 by customer segment.

Table 55. PY8 Custom Program Participation and Reported Impacts

Parameter	Residential	Small C&I	Large C&I	GNE	Total ^[1]
PYTD # Participants	1	27 ^[2]	29	14	71 ^[2]
PYRTD MWh/yr	121	4,773 ^[3]	36,920	29,518	71,332 ^[3]
PYRTD MW/yr	0.01	0.44	2.81	5.70	8.96
PY8 Incentives (\$1000)	\$0	\$672	\$2,011	\$1,642	\$4,325
^[1] May not match due to rounding.					
^[2] Distinct job numbers. Excludes one job moved to the Efficient Equipment Program.					
^[3] Excludes one job moved to the Efficient Equipment Program, reporting 233 MWh/yr.					

Table 56 lists the types of projects completed in PY8.

Table 56. PY8 Custom Program Project Types

Project Type	Number of Projects (n=71)	Percentage of Reported Savings Represented by Projects (n=71)
Motors	32	8%
HVAC	12	23%
Refrigeration	10	3%
Combined heating and power (CHP)	5	48%
Lighting	4	11%
Other	8	7%

⁴² As defined by the Phase III Evaluation Framework, EDC claimed savings are determined by the date the equipment is “installed and commercially operable.” Equipment that is installed and not commissioned, or operating as intended, is not considered “commercially operable.”

6.3 Gross Impact Evaluation

To evaluate Custom Program savings, Cadmus defined projects as large stratum and small stratum:

- **Large stratum.** During the application process, projects with an expected energy savings greater than 500,000 kWh/yr were assigned to the large stratum. Projects that were unusually complicated or had a high level of uncertainty in the expected energy savings could be added to the large stratum at the behest of the ICSP. Cadmus verified a census of 17 projects in the large stratum. There are three unverified projects for which savings are not included in this report.
- **Small stratum.** Projects with expected savings below 500,000 kWh/yr were assigned to the small stratum. Of the 52 small stratum projects reported in PY8, Cadmus verified savings for a sample of 10 projects selected into the evaluation sample.

Cadmus evaluates all projects in the evaluation sample, determining savings for an installed product with a high level of rigor, using approaches outlined in the International Performance Measurement and Verification Protocol (IPMVP).

The achieved precision for the program-level results are in compliance with the Evaluation Framework requirements to meet 85% confidence and 15% precision (85/15).⁴³ The overall evaluation sample, including large and small strata, exceeded the requirements of 85/15 at the program level, with 5.02% precision at the 85% confidence level.

- The verified large stratum savings made up 53% of the reported savings for PY8, and Cadmus verified a census of projects in that stratum (precision was not applicable).
- The small stratum savings were determined with less precision (32.53%) and in PY8 represented 12% of the reported savings.
- The remaining three unverified large projects (representing 35% of reported savings) will be verified in PY9 (precision is not applicable in PY8). These three, including the *ex ante* reported savings, are excluded from realization rate calculations.

Table 57 shows the evaluation sampling strategy. More details are in *Appendix F*, section *F.1.1 Methodology*.

⁴³ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC. October 21, 2016.

Table 57. Custom Program Gross Impact Sample Design for PY8

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Large	17	Census	17	Site visit, data collection, custom savings analysis, verification report
Small	51	CP= 85/20 Cv = 0.64 (assumed)	10	Site visit, data collection, custom savings analysis, verification report
Large Unverified	3	Census	3	Site visit, data collection, custom savings analysis, verification report
Program Total	71	85/15 Cv = 0.5	30	

Large stratum. The ICSP informed Cadmus about projects likely to fall into the large stratum. The ICSP calculates initial savings (called “reserved” savings) used to screen the project for TRC purposes. The reserved savings are based on early customer or contractor estimates of baseline and proposed equipment energy use and do not necessarily represent the reported or verified project savings.

Cadmus prepared the site-specific measurement and verification plan (SSMVP), typically in coordination with the ICSP, then evaluated these projects at a high level of rigor. In most cases, Cadmus conducted pre-installation inspections to gather baseline data for all large stratum projects except new construction projects, for which there was no existing condition, and projects that did not enter the large stratum until after the equipment was installed.

Cadmus conducted post-installation site visits and other customer outreach to verify installation and gather additional data to verify energy savings. For some large and small stratum projects, Cadmus installed logging equipment, collected data from a customer control system through trends or spot readings, or gathered equipment and operating information from customer interviews.

Unlike the small stratum, PPL Electric Utilities based the incentive payment for large stratum projects upon the verified savings, rather than the reported savings. This evaluation approach is called “real-time evaluation,” where savings are verified prior to incentive payment. The real-time approach is a cornerstone of PPL Electric Utilities’ Custom Program. Because project incentives are not paid until the savings are verified, the payments are based on an accurate estimate of the savings for a project. Conducting site visits and collecting site-specific data with the ICSP also improves customer experiences by limiting data requests, metering installations, and the number of customer touches. This approach relies on close coordination between Cadmus and the ICSP. Project coordination takes place on a weekly basis, and evaluation staff from Cadmus and the ICSP work with a shared goal of determining accurate savings for each project.

The realization rate is typically 100% for the large stratum projects. There were a few exceptions in PY8. The projects that were paid prior to verification in this stratum included advanced lighting controls projects. The ICSP identified this as a custom product for several projects just prior to the incentive

payment; therefore, Cadmus verified savings after payment. As a result, the realization rate for the large stratum is not 100%, although Cadmus verified all the large stratum projects and their savings.

Small stratum. At the close of Q3 in PY8, Cadmus selected a sample of 10 small stratum projects that participated from Q1 through Q3. Cadmus prepared the SSMVP for each project then conducted post-installation inspections and verified savings. (Pre-installation inspections are not possible because small stratum projects cannot be selected into the sample until after equipment is installed and an incentive is paid.)

Cadmus calculated the realization rate as the ratio of *ex post* verified gross savings to *ex ante* savings then applied this realization rate for the selected sample to the entire small stratum population.

In PY8, the Custom Program reported energy savings of 70,361 MWh/yr, as shown in Table 58, and demand reduction of 8.64 MW, as shown in Table 59. These values include reported savings from the verified large, unverified large, and small strata.

Table 58. Custom Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Large - verified	37,965	98%	0.06	0.00%
Large - unverified	24,815	--	--	--
Small	8,551	109%	0.63	28.18%
Program Total ^[1]	71,332	100%	N/A	5.33%

^[1] Program total may not match due to rounding.

Table 59. Custom Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Large - verified	5.45	81%	0.84	0.00%
Large - unverified	2.59	--	---	-
Small	0.92	94%	0.73	32.53%
Program Total ^[1]	8.96	83%	N/A	5.02%

^[1] Program total may not match due to rounding.

The following factors led to variation between the reported and verified savings and to the observed realization rates:

- The large stratum demand savings realization rate reflects an error in the reported savings for one project. This project was paid an initial and final incentive, and although the reported usage (kWh) savings were split between two records in the PPL Electric Utilities tracking database, the full project reported demand savings (kW) were duplicated and reported in each record. This effectively double-counted the kW savings for that project, leading to an adjustment, which is reflected in the realization rate.

- Operating hours used in the *ex ante* baseline and/or post-installation operation(s) did not include site-specific information. The ICSP relied on PA TRM defaults based on building type for several projects.
- Projects and equipment affected by production did not account for variations in manufacturing when comparing baseline and post-installation periods in the *ex ante* analysis. For production-dependent energy efficiency equipment and systems, an independent variable (e.g., production quantity, production volume, chilled water load) is used to compare energy use at various loads in the *ex post* analysis. A common annual load profile of the independent variable is also used in verified results to simulate the baseline and post-installation operations under similar conditions.
- In the small stratum sample, Cadmus found an incorrect baseline used in the *ex ante* analysis for several projects. For example, the ICSP used a code-compliant efficient equipment baseline to model energy use in a new construction project. Cadmus determined that the application of the product was for an industrial process, so the correct baseline would be industry standard equipment, not necessarily code-compliant equipment.

6.4 Net Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,⁴⁴ which discusses the common methods to determine free ridership and spillover. Cadmus used self-report surveys, administered online and by phone, to assess free ridership and spillover for the Custom Program and reviewed communication documents for surveyed participants to provide additional context about free ridership.

Free ridership is a measure of the savings that participants would have achieved on their own in the absence of the program; these savings are subtracted from verified gross savings. Spillover, on the other hand, credits additional savings that participants achieved on their own, where their experience with the program was highly influential in their decision to install energy-efficient equipment without the incentive of rebates. Spillover increases net savings attributable to PPL Electric Utilities.

Cadmus calculates net savings only to inform future program planning. Energy savings and demand reduction compliance targets are met using verified gross savings.

Table 60 lists the methods and sampling strategy used to determine net savings for the Custom Program in PY8. Cadmus conducted online and telephone self-report surveys with 15 of 71 Custom Program participants between November 2016 and August 2017. Five participants responded to the online survey and 10 to the telephone survey. Additional details about the methodology are in *Appendix F*, section *F.1.1*.

⁴⁴ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC. October 21, 2016.

Table 60. Custom Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size	Achieved Sample Size	Response Rate ^[1]	NTG Activity
Custom	Participants	71	15 ^[2]	23%	Self-report surveys
Program Total	N/A	71	15	23%	N/A

^[1] Response rate is calculated as the percentage of respondents who completed the survey (n=15) divided by the number of unique records in the population (n=64).

^[2] Email invitations were sent to all unique participants who had not completed a survey in the past three months and had not opted out. Following the online survey, Cadmus attempted to contact respondents who did not complete the online survey via telephone.

Table 61 shows the free ridership, spillover, and NTG ratio for the Custom Program.

Table 61. Custom Program Net Impact Evaluation Results

Stratum	Number of Surveys	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.
Custom (all projects)	15	21%	0%	0.79	11%
Program Total	15	21%	0%	0.79	11%

6.4.1 Free Ridership

Free ridership for the Custom Program was 21% in PY8, weighted by the size of the project completed by respondents. All customers were contacted to complete a survey, and 15 responded. These 15 respondents represented 10% of the program's verified population savings.

Table 62 shows PY8 Custom Program free ridership by stratum. The single large stratum project included in the free ridership analysis completed a motor project. Because a single project within the large stratum is represented in the survey, it is unlikely to represent free ridership for all the projects in the large stratum. Relative precision for the large stratum is not applicable because the sample size is one, so there is no variation to observe. Because of this, the program's total relative precision is listed as N/A in Table 62.

The small stratum free ridership includes seven motor projects and seven non-motor projects that represent 43% of the total small stratum program population verified savings. Five of the 14 small stratum respondents reported they would have canceled or postponed their project at least one year in the absence of the Custom Program. Four additional small stratum respondents would have reduced the size and scope of the project in the absence of the Custom Program. These nine small stratum respondents are the main contributors to the low small stratum free ridership estimate of 23%. The 14 surveyed small projects were not randomly selected but do represent 43% of total savings in this stratum (52 projects total), and so they are likely to be representative of the other projects in the small stratum with respect to both verified savings and free ridership.

Table 62. PY8 Custom Program Free Ridership Comparison by Stratum

Stratum	Number of Respondents	Weighted Free Ridership (%) ¹	Percentage of Analysis Sample Verified Savings	Percentage of Program Population Stratum Verified Savings	Relative Precision at 85% C.L.
Small	14	23%	81%	43%	15%
Large	1	13%	19%	2%	N/A
Program Total	15	21%	100%	N/A	N/A

⁽¹⁾Weighted by verified kWh/yr savings.

For the four largest projects represented by the survey respondents in PY8, the savings-weighted free ridership score was 8%. These four projects represented 54% of the analysis sample's verified savings,⁴⁵ and they accounted for four percentage points of the program-level free ridership estimate of 21%. Table 63 lists the sector for the four projects with the largest verified savings.

Table 63. PY8 Custom Program Free Ridership for Top Saving Projects

Sector/Stratum of Four Largest Projects included in Free Ridership Surveys	Verified kWh/yr Savings	Percentage of Analysis Sample Verified Savings	Percentage of Program Population Verified Savings	Free Ridership
Large C&I/Large	853,776	19%	2%	12.5%
Large C&I/Small	703,682	16%	2%	12.5%
Small C&I/Small	449,018	10%	1%	0%
Government, Nonprofit, Education/Small	430,457	9%	1%	0%
Total ^[1]	2,436,933	54%	5%	8% ^[2]

^[1] Total may not match due to rounding.
^[2] Weighted by verified kWh/yr savings. Relative Precision at 85% C.L. is 7%.

6.4.2 Customer Communication Research

PPL Electric Utilities and the ICSP increased awareness of the Custom Program by conducting outreach campaigns to explain how program incentives could help customers reduce energy use. They also relied on PPL Electric Utilities' key account managers (KAMs), designed presentations targeting specific industries to introduce customers to possible energy efficiency improvements, and shared information with trade allies, customers' contractors and design engineers at lunch and learn sessions and through newsletters and webinars. The ICSP is currently creating a system to more accurately track the customer experience and provide additional data about the influence of the Custom Program.

To explore if Cadmus could find supportive documentation showing that the Custom Program influenced customers' decisions to participate, Cadmus researched 198 communication documents between the

⁴⁵ The four largest projects in the analysis sample represented 5% of the Custom Program verified population savings.

ICSP and the participant for all participants who completed the self-report survey (n=15). These documents included email conversations, incentive reservation letters, and final savings notices. In this research, Cadmus did not find additional information to support making any adjustment to the free ridership score determined through the self-report surveys.

6.4.3 High-Impact Measure Research

Because Custom Program projects are unique, selecting high-impact measures was not appropriate. Cadmus did not identify any high interest projects or strata that were not already selected into the large strata.

6.4.4 Spillover

No data collected through the participant surveys indicated spillover activity attributable to PPL Electric Utilities.

6.5 Verified Savings Estimates

Table 64 shows the realization rates Cadmus applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the PY8 Custom Program. In the future, Cadmus will add these totals to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 64. Custom Program PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Demand (MW/yr) ^[1]
PYRTD Gross	71,332	8.96
PYVTD Gross	46,368	5.30
PYVTD Net ⁽²⁾	36,631	4.19
PY Unverified Savings	24,815	2.59
P3RTD Gross	71,332	8.96
P3VTD Gross	46,368	5.30
P3VTD Net ⁽²⁾	36,631	4.19
P3 Unverified Savings	24,815	2.59
^[1] May not match due to rounding.		
^[2] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		

6.6 Process Evaluation

6.6.1 Research Objectives

The main research objectives for the Custom Program focused on these areas:

- Program communications
- Administrative efficiency
- Administrative response
- Delivery infrastructure
- Technical support
- Customer response

6.6.2 Evaluation Activities

The PY8 process evaluation activities for the Custom Program were consistent with the evaluation plan and included these:

- Interviews with PPL Electric Utilities and ICSP program managers
- Telephone interviews with design engineers and contractors
- Online participant surveys
- Logic model review
- Telephone participant surveys

Table 65 lists the process evaluation sampling strategy. Additional details about sampling methodology are included in *Participant Surveys* in *Appendix F*.

Table 65. PY8 Custom Program Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame ^[1]	Percent of Sample Frame Contacted to Achieve Sample ^[2]
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone In-depth Interview	2	N/A ^[3]	2	2	N/A	100%
Participants	Custom	Online	71	N/A ^[3]	All participants	5	All eligible (64)	100%
		Telephone				10	All eligible (38)	100%
Design Engineers and Contractors	All participating	Telephone In-depth Interview	17	N/A ^[3]	5-10	6	17	71%
Program Total			90			23		

^[1] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities tracking database. After selecting all unique records, Cadmus removed any records from the population if the customers had participated in a survey in the last three months, were selected for another program survey, did not have valid contact information (email or telephone number), were on the do not call list, or opted out of the online survey.

^[2] Percent contacted means the percentage of the sample frame contacted to complete surveys.

^[3] Because this program's evaluation did not include sampling, Cv and target precision are not meaningful.

6.6.3 Summary of Process Evaluation Findings

In this section, Cadmus presents interview and survey data as follows: the report contains the percentage or frequency of responses, followed by the sample size for the particular question. Sample size (denoted by "n") refers to the number for respondents who were asked the question, not the number of respondents who answered. Note that sample sizes vary according to each question, due to survey logic and skipped questions. Additional detail regarding findings from process evaluation activities and their methodology is in *Appendix F*, section *F.3.1 Process Evaluation Methodology*.

Overall, the program has been successful. All participant survey respondents (n=15), and all customers' contractors and design engineers (n=6) were *very satisfied* with the program.

Program Delivery

In PY8, the Custom Program was implemented by a different ICSP than in previous program years. Overall, this transition has been smooth and seamless. The program is now administered entirely through an online portal, which allows customers, contractors, and design engineers to more easily submit paperwork and track the status of their projects. The focus of the program has been on customer satisfaction and encouraging a partnership between the ICSP and the customer. PPL Electric Utilities and the ICSP increased awareness by conducting outreach campaigns to explain how Custom Program incentives could help customers reduce energy use. The majority (60%) of survey respondents first learned about the program from their contractor, vendor, or distributor or through PPL Electric Utilities' website.

6.6.4 Program Satisfaction

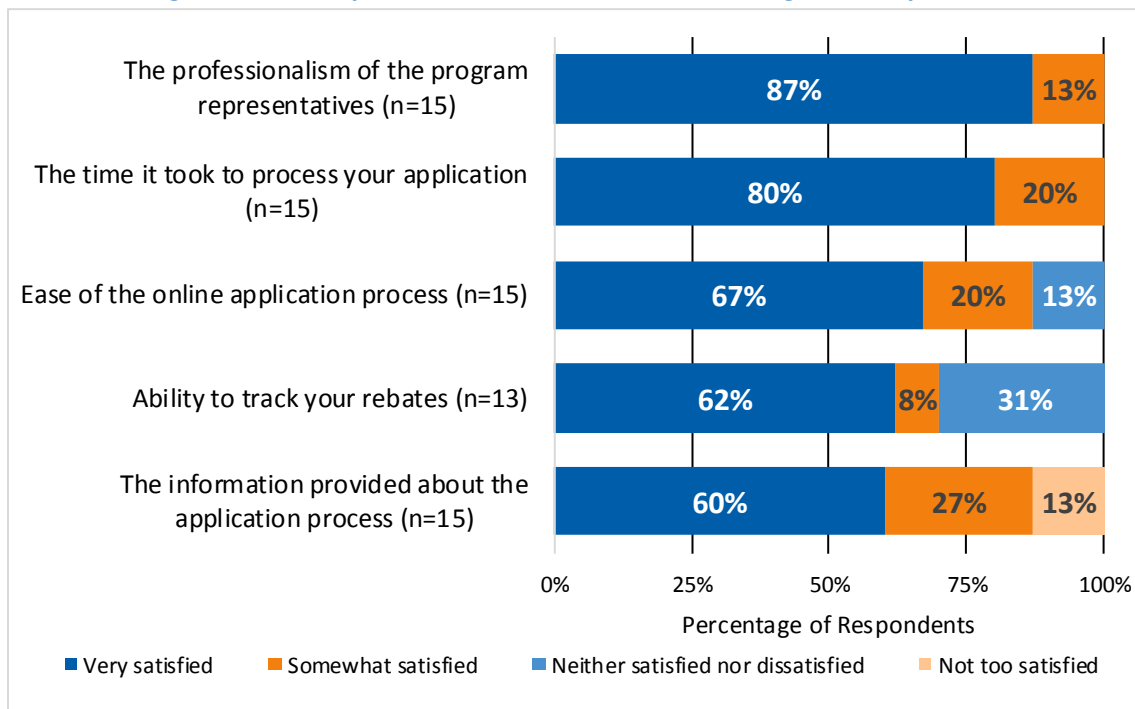
Program satisfaction among customers, contractors, and design engineers was high. All participant survey respondents (n=15) and all contractors and design engineers (n=6) were *very satisfied* with the program. This was an increase from PY7, where 87% of participant survey respondents (n=23) rated their satisfaction as high (8, 9, or 10 on a 10-point scale).^{46,47}

Participants were most satisfied with the professionalism of program representatives and the time it took to process their application (Figure 24). Participants were least satisfied with the ability to track their rebates and the information provided about the application process. Sixty-seven percent of respondents said the information about the application process was very important (n=15). Respondents said the ability to track their rebates was less important, with 20% (n=15) responding that this was *neither important nor unimportant or not too important* (see the *Importance of Program Components* section in *Appendix F.3.2. Additional Findings*).

When asked for recommendations to improve the program, two respondents recommended providing more information about the application process. Sixty-seven percent of respondents were *very satisfied*, and 20% were *somewhat satisfied* with the ease of the application process. Two respondents recommended simplifying the application.

⁴⁶ Using a 1- to 10-scale where 10 means *outstanding* and 1 means *unacceptable*.

⁴⁷ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Figure 24. Participant Satisfaction with Different Program Components

Source: Survey Question "Please indicate how satisfied you are with each one."

Contractors and design engineers said that working with program staff was a positive experience and they often took advantage of the program staff's technical capabilities to provide input for the projects. They appreciated the responsiveness of staff; as one contractor said: "If they don't know right away, they will make sure to get you an answer." Contractors and design engineers also said the rebate processing times for the program have improved over the past year, which helped keep their customers satisfied.

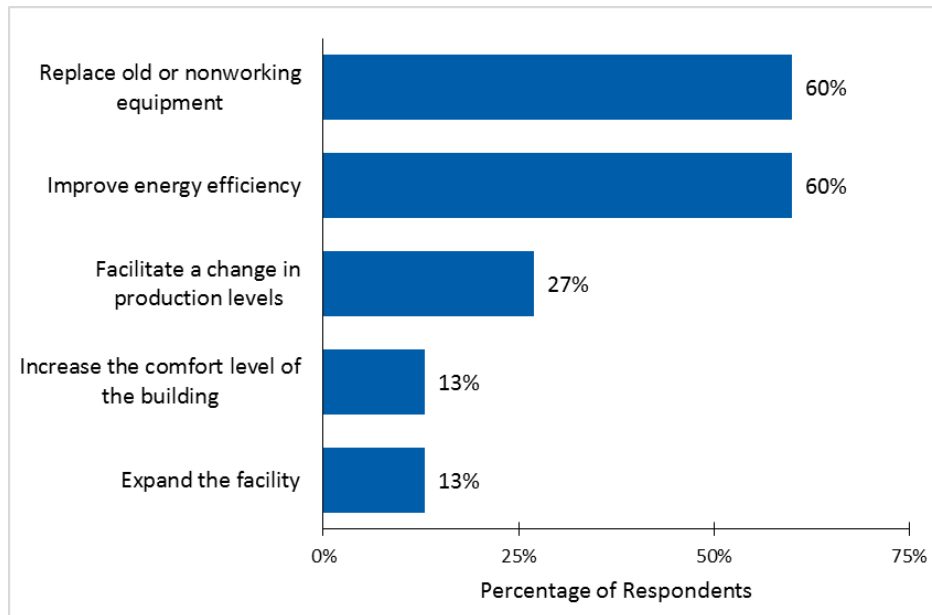
6.6.5 Program Key Performance Indicators

The Custom Program fulfilled its satisfaction key performance indicator (KPI) and is on track to fulfilling its Phase III energy savings targets, as discussed in the *Key Performance Indicators* section in *Appendix F*.

- Recorded 100% satisfaction (n=15) among surveyed participants (target: 80%)

6.6.6 Decision-Making

Over half of the surveyed participants said their organization completed the project to replace old or nonworking equipment (60%, n=15) and to improve energy efficiency (60%, n=15). About a quarter of respondents (27%, n=15) completed the project to facilitate a change in production levels. Figure 25 shows these results.

Figure 25. Reasons Participants Completed the Energy Efficiency Project

Source: Survey question "Please describe why your organization completed this project." (n=15); multiple responses allowed

One of the potential challenges to program participation that PPL Electric Utilities noted in the EE&C Plan was that customers may not replace working equipment even if it is not energy-efficient. This does seem to be a challenge for the Custom Program, as only five of the 15 respondents reported replacing working equipment; two reported their replaced equipment had no problems and three said the replaced equipment had problems but was still working.

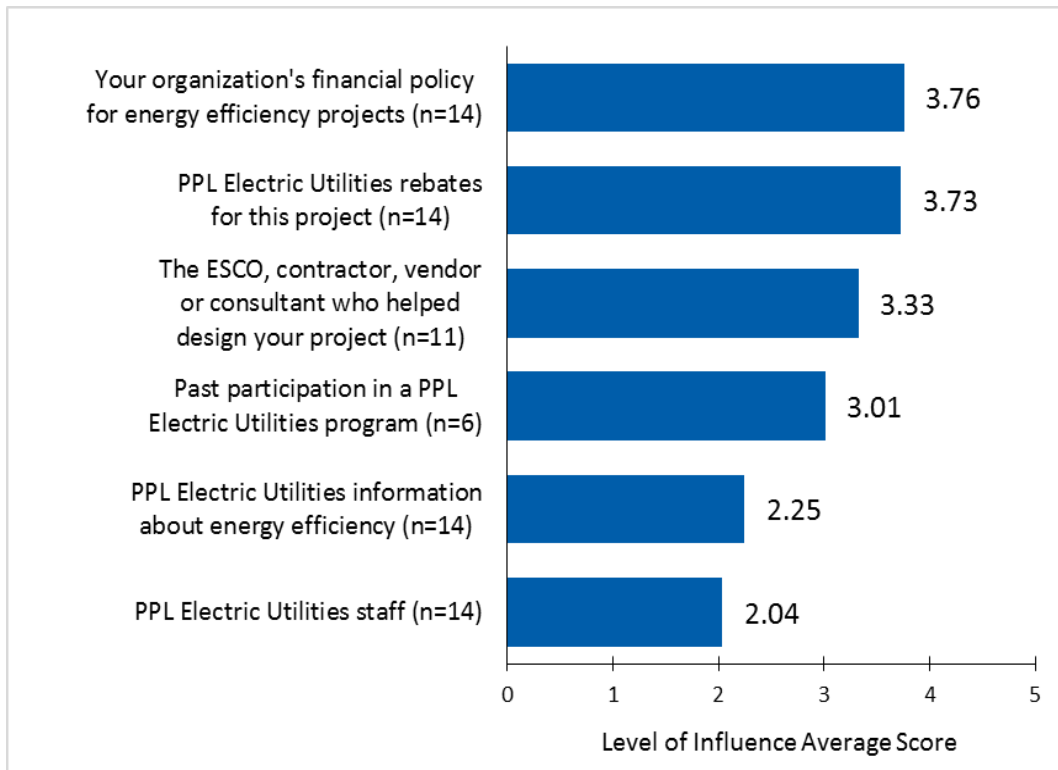
6.6.7 Program Influence

The evaluation survey asked questions about how much influence the program had on the participants' decision to complete the project the way they did. Figure 26 shows the average level of influence different items had on respondents' projects, where 5 was *extremely influential* and 1 was *no influence*. The rebates from PPL Electric Utilities proved influential, with an average score of 3.73 (n=14).

The most influential factor was the customer's organization's financial policy (average score of 3.76, n=15). The components with the least influence were PPL Electric Utilities' information about energy efficiency (average score of 2.25, n=14) and PPL Electric Utilities' staff (average score of 2.04, n=14); however, these components were influential to some respondents.

All six contractors and design engineers said the program was influential in a customer's decision to purchase more efficient equipment. Four contractors said the program was *somewhat influential* and two said the program was *very influential*.

Figure 26. Average Influence Score for Different Items



Source: Survey question "Please rate each item on how much influence it had on the decision to complete the project the way it was completed on a scale from 1 to 5 where 5 is *extremely influential* and 1 is *no influence*."

6.7 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 66. The total resource cost (TRC) benefits in Table 66 were calculated using gross verified impacts. Net present value (NPV) PYTD costs and benefits are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). NPV costs and benefits for P3TD financials are expressed in the PY8 dollars. The TRC costs and benefits in this table do not include benefits and costs from unverified projects.

Table 66. Summary of Custom Program Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$4,325		\$4,325	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$18,894		\$18,894	
4	Incremental Measure Costs (Sum of rows 1 through 3) [1]	\$23,218		\$23,218	
		EDC	CSP	EDC	CSP
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	\$113	-	\$113	-
7	Marketing [4]	-	\$475	-	\$475
8	Program Delivery [5]	-	\$2,438	-	\$2,438
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11*	Program Overhead Costs (Sum of rows 5 through 10) [1]	\$3,027		\$3,027	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-		-	
13	Total NPV TRC Costs [6] (Net present value of sum of rows 4, 11, and 12)	\$26,245		\$26,245	
14	Total NPV Lifetime Electric Energy Benefits	\$22,902		\$22,902	
15	Total NPV Lifetime Electric Capacity Benefits	\$3,002		\$3,002	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	-		-	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits [7] (Sum of rows 14 through 17)	\$25,904		\$25,904	
19	TRC Benefit-Cost Ratio [8]	0.99		0.99	

[1] May not sum to total due to rounding.
[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.
[4] Includes the marketing CSP and marketing costs by program CSPs
[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.
[6] Total TRC Costs includes Total EDC Costs and Participant Costs.
[7] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. 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.
[8] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.
* Rows 1-11 are presented in nominal dollars

Table 67 presents program financials and cost-effectiveness on a net savings basis.

Table 67. Summary of Custom Program Finances—Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants ^[1]	\$4,325		\$4,325	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$14,018		\$14,018	
4	Incremental Measure Costs (Sum of rows 1 through 3)	\$18,342		\$18,342	
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$113	-	\$113	-
7	Marketing ^[4]	-	\$475	-	\$475
8	Program Delivery ^[5]	-	\$2,438	-	\$2,438
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11^[6]	Program Overhead Costs (Sum of rows 5 through 10)	\$3,027		\$3,027	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-		-	
13	Total NPV TRC Costs ^[7] (Net present value of sum of rows 4, 11, and 12)	\$21,369		\$21,369	
14	Total NPV Lifetime Electric Energy Benefits	\$18,093		\$18,093	
15	Total NPV Lifetime Electric Capacity Benefits	\$2,371		\$2,371	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	-		-	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits ^[8] (Sum of rows 14 through 17)	\$20,464		\$20,464	
19	TRC Benefit-Cost Ratio ^[9]	0.96		0.96	
<p>^[1] Includes direct install equipment costs and costs for EE&C kits.</p> <p>^[2] Includes direct costs attributable to plan and advance the programs. Note: The design of the HERs program should be included here, while the actual development and mailing of HERs would be attributable to Program Delivery.</p> <p>^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance. Any common portfolio costs that are allocated across programs should be shown in this row.</p> <p>^[4] Includes the marketing CSP and marketing costs by program CSPs.</p> <p>^[5] Direct program implementation costs. Labor, fuel, and vehicle operation costs for appliance recycling and direct install programs. For behavioral programs, this includes the printing and postage of HERs.</p> <p>^[6] Rows 1-11 are presented in nominal dollars</p> <p>^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.</p> <p>^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. 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.</p> <p>^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.</p>					

6.8 Status of Recommendations

Overall, the program has been highly successful, with the reported savings, including the three large unverified projects, exceeding the estimated savings projected for PY8, (projections shown in the EE&C Plan). All 15 participants who completed a survey said they are *very satisfied* with the program.

The impact and process evaluation activities in PY8 led Cadmus to make the following findings and recommendations to PPL Electric Utilities. This section also provides a summary of how PPL Electric Utilities plans to address the recommendation (Table 68).

Finding: For several projects that had equipment and processes whose energy use was dependent on production, the ICSP did not account for differences in production between the baseline and post-installation metering periods when reporting savings. This led to a realization rate discrepancy for several individual projects in the small stratum sample. On an individual project basis, this can be significant; however, the effect on the sample overall was minor because some projects had increased savings realized through the verification and other projects had reduced savings (in *Appendix F.1.4 Realization Rate Findings*).

Conclusion: An analysis approach used to calculate reported savings may not have accounted for production differences between the baseline and post-installation metering periods. If a difference in production existed between the periods (e.g., higher production in summer, lower in winter) the savings may have been skewed. By normalizing baseline and post-installation project energy use, the effect of having different production in the baseline and post-installation period is removed, as the savings are then based on a common production metric, or load profile. Using a more accurate method for determining savings for these types of projects would lead to more accurate reported savings, and reduce realization rate uncertainty in small stratum projects.

Recommendation #1: The reported savings should account for production dependence, especially in manufacturing facilities, when comparing baseline and post-installation equipment energy use. For example, the ICSP could develop a regression model of the baseline and post-installation energy use versus an independent variable (e.g., production of manufactured goods, compressed air, tons of cooling). The model for the baseline and post-installation periods, used to simulate the energy use from each period, is applied to a common load profile for the independent variable. Customers can typically provide a metric to annualize energy use.

Finding: PPL Electric Utilities and the ICSP increased awareness by conducting outreach campaigns to explain how the Custom Program incentives could help customers reduce energy use. They relied on KAMs, designed presentations targeted to specific industries to introduce customers to possible energy efficiency improvements, and shared information with contractors and design engineers at lunch and learn sessions and through newsletters (in section 6.6.3 *Summary of Process Evaluation Findings*).

The majority (60%) of survey respondents first learned about the program from their contractor, vendor, or distributor or through PPL Electric Utilities' website (20%) (in section 6.6.3 *Summary of Process Evaluation Findings*).

Survey respondents said PPL Electric Utilities' rebate was influential on their decision to complete the project, giving an average score of 3.73 out of 5, where 5 is *extremely influential* (in section 6.6.7 *Program Influence*).

Contractors and design engineers said the program was influential in a customer's decision to purchase more efficient equipment. Four contractors and design engineers said the program was *somewhat influential* and one said the program is *very influential* (in section 6.6.7 *Program Influence*).

Program free ridership was 21% in PY8, a decrease from 39% in PY7 (in section 6.4 *Net Impact Evaluation*).

Conclusion: PPL Electric Utilities and the ICSP increased program influence through outreach campaigns to contractors and design engineers. This approach was successful because the majority of respondents learn about the program from a contractor or from the PPL Electric Utilities' website.

Finding: One contractor and two of 15 participant survey respondents were *not too satisfied* with the rebate application process (in *Appendix F.3.2 Additional Findings* and *F.3.1 Process Evaluation Methodology, Design Engineer and Contractor Satisfaction*). Two participant survey respondents and one contractor recommended that PPL Electric Utilities and the ICSP provide more information at the beginning about the application process and its requirements (in *Appendix F.3.2 Additional Findings*).

One contractor recommended providing customers with a recommended contractor list and 50% (n=16) of survey respondents had visited PPL Electric Utilities' website within the past six months.

Conclusion: Many customers and contractors are not aware of the information PPL Electric Utilities provides on its website regarding program offerings and requirements. Most of their questions could be answered by visiting the website. The website lists the eligible equipment, explains the application process, and provides tax credit information.

Recommendation #2: PPL Electric Utilities and the ICSP could consider increasing promotion of PPL Electric Utilities' website through the outreach activities.

6.8.1 Status of Recommendations for Program

Table 68 contains the status of each PY9 recommendation made to PPL Electric Utilities.

Table 68. Status of Recommendations

Custom Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	If equipment energy use is production dependent, the ICSP needs to correct the baseline and post-installation equipment energy use to account for variations in production between the baseline and post-installation periods.	Being considered
2	PPL Electric Utilities and the ICSP could consider increasing promotion of PPL Electric Utilities' website.	Being considered. Need more information to better understand the objective of this "increased promotion." If it is to increase program participation? Improve customer satisfaction with the website? Help customers complete their applications faster?

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7 Home Energy Education Program

Beginning in PY8, PPL Electric replaced its Residential and Low-Income Energy-Efficiency Behavior and Education Programs from Phase II with the Home Energy Education Program for Phase III. The Home Energy Education Program encourages customers to save energy by providing energy use feedback, a social normative comparison, and educational offerings aimed at nudging customers to save energy. These “nudges” are offered in the form of home energy reports sent through the mail and email and an energy management portal called “Ways to Save,” on which customers can take an online home energy assessment and enter detailed information about their home in exchange for a kit that includes energy-saving products.⁴⁸

The feedback and educational offerings convey the following:

- A comparison of customer’s household energy use to that of similar customers in the same geographical area
- Personalized energy efficiency tips (such as turning off lights and taking shorter showers) and product recommendations (such as LEDs, smart strips, and appliances)
- Messaging that encourages customers to visit PPL Electric Utilities’ Customer Engagement Hub and the program-affiliated energy management portal and complete an online home energy assessment⁴⁹

PPL Electric Utilities contracted with Ecova as the program’s implementation conservation services provider (ICSP). The ICSP administered the Home Energy Education Program and also oversaw all of PPL Electric Utilities’ residential programs. The ICSP subcontracted with Tendril (the home energy reports vendor) to develop and distribute the program’s educational offerings—the home energy reports, the energy management web portal, and online home energy assessments.

In PY8, the program distributed six print home energy reports to customers.⁵⁰ Customers with valid email addresses also received these six reports in electronic format via email and could opt into only receiving electronic reports. Customers also had access to the program’s energy management web portal where they could set energy-saving goals, receive recommendations toward reaching these goals,

⁴⁸ Customers may opt in to receive a home energy kit after completing the online assessment. The savings for those kits are reported in the Energy Efficient Home Program.

⁴⁹ The PPL Electric Utilities’ Customer Engagement Hub is a website with information about all available rebates. All PPL Electric Utilities’ customers have access to the Customer Engagement Hub and to the energy management portal; however, treatment group customers received encouragement through the home energy reports to visit the energy management portal.

⁵⁰ Legacy low-income customers who received reports in Phase II received only one print home energy report in PY8, in April 2017. The decision to include low-income customers in the Home Energy Education Program occurred late in the program year. PPL Electric Utilities and the ICSP originally planned not to include the low-income customers from Phase II in Phase III.

and check off any actions they had completed. Customers could also contact the ICSP's program's call center with any questions or comments pertaining to the usage feedback and educational offerings.

The objectives of the Home Energy Education Program were these:⁵¹

- Encourage customers to adopt energy-efficient behaviors and install high-efficiency products
- Help customers become more aware of how their behavior and practices affect energy use
- Educate customers about no- and 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 123,000 customers through 2021 with a total of approximately 228,000 MWh/year gross verified savings⁵²
- Achieve high customer satisfaction with the program

The program operated as a randomized controlled trial where eligible customers were randomly assigned to a treatment group or to the control group. Customers in the treatment group received the home energy reports. Treatment group customers who did not wish to receive the reports could opt out of the program at any time. Customers in the control group did not receive the reports nor told they were part of the control group.

The treatment and control group assignments from Phase II carried over into Phase III. The home energy reports vendor (the ICSP's subcontractor) identified new treatment and control group customers to expand the program for Phase III, and Cadmus conducted the random assignments of these customer additions in early PY8.

New in Phase III, the home energy reports vendor identified and removed from treatment "low-propensity" customers early on in PY8. Low-propensity customers are those customers in the treatment group who were predicted to have low program engagement and energy savings. To identify these customers, the vendor reviewed pre- and post-treatment usage data and conducted a common traits analysis and identified the 10% of treatment group customers with the lowest propensity to save. These low-propensity customers received a letter notifying them that they would be automatically opted out of receiving the home energy reports unless they opted back in by replying to a survey linked in the letter. Customers had up to three months to opt back in.

⁵¹ Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

⁵² Ibid. Note that the EE&C plan states that the participation target is 128,000; however, the correct number is 123,000.

7.1 Progress Toward Phase III Projected Savings

The Home Energy Education Program verified savings are 86% of the estimated MWh/yr savings for PY8. It has achieved 15% of the estimated Phase III total savings and is making progress toward the Phase III projected savings, but is behind the pace estimated in the EE&C Plan.

The program did not meet its projected estimates of MWh/yr savings for PY8 because of two factors. The program excluded the Phase II low-income treatment customers for the majority of PY8 then reinstated these customers in the final month of PY8, which was not early enough to generate substantial savings for PY8.⁵³ In addition, the new Phase III treatment customers underperformed by generating lower-than-expected savings.

Table 69 shows the program’s verified gross energy savings and progress toward its Phase III project energy savings, as filed in the EE&C plan.

Table 69. Home Energy Education Program Estimated Savings

	PY8 Only			Phase III: PY8–PY12		
	Estimated	Verified	Percentage of Estimated	Estimated ^[1]	Verified	Percentage of Estimated
MWh/yr	40,144	34,326 ^[2]	86%	227,938	34,326	15%
^[1] Estimated savings are based on PPL Electric Utilities’ revised EE&C plan (Docket No. 2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.						
^[2] Verified savings in this table reflect an average percentage reduction in usage per participant. Details about savings achieved by treatment wave are provided in Appendix G.						

7.2 Participation and Reported Savings

7.2.1 Definition of a Participant

A participant in the Home Energy Education Program is defined as a residential customer assigned to the treatment group who received home energy reports. A participant receiving a minimum of one report is retained in the treatment group for analysis, even if the participant opts out. Low-propensity participants, even if they did not opt back into the program, are also retained in the treatment group for analysis.⁵⁴

⁵³ Cadmus observed that low-income treatment customers continued to save from June 2016 through April 2017. However, because the PA TRM assumes a one-year measure life, PPL Electric Utilities could claim savings only for May 2017. Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016.

⁵⁴ Cadmus followed a “once randomized, always analyzed” approach to maintaining the randomized controlled trial, as dictated by best practices for this type of analysis. Details are provided in *Appendix G*. Stewart, J., and A. Todd. *Chapter 17: Residential Behavior Protocol, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures*. 2017. National Renewable Energy Laboratory. NREL/SR-7A40-68573. Available online: <http://www.nrel.gov/docs/fy17osti/68573.pdf>.

The customer population is divided into six cohorts of customers known as “waves” that are based on when customers began receiving the home energy reports:

- Phase I Legacy Wave 1 received first report in PY2, April or May 2010
- Phase I Legacy Wave 2 received first report in PY3, June 2011
- Phase II Expansion Wave received first report in PY6, October or December 2014
- Phase II Low-Income Wave 1 received their first report in PY6, October or December 2014
- Phase II Low-Income Wave 2 received their first report in PY7, June 2015
- Phase III Expansion Wave received their first report in PY8, June 2016

Cadmus evaluated the energy savings of all six waves.

7.2.2 Program Participation and Reported Impacts

Table 70 presents the participation counts, reported energy and demand savings, and incentive payments for the Home Energy Education Program in PY8 by customer segment.

Table 70. PY8 Home Energy Education Program Participation and Reported Impacts

Parameter	Residential	Total
PYTD # Participants	184,257	184,257
PYRTD MWh/yr	40,467	40,467
PYRTD MW/yr	54.39	54.39
PY8 Incentives (\$1000)	\$0	\$0

7.3 Gross Impact Evaluation

The impact evaluation estimated the Home Energy Education Program’s energy savings. The program’s experimental design and the large number of customers in the randomized treatment and control groups made it possible for Cadmus to obtain accurate and precise estimates of the program’s causal impacts. For each wave, Cadmus conducted a regression analysis of monthly billing consumption of customers in the treatment and control groups. Because the home energy reports encouraged customers to participate in PPL Electric Utilities’ other energy efficiency programs, Cadmus also estimated energy savings from participation in these programs (see *Appendix C.1.4 Uplift Analysis Methodology* for details).

The EM&V sampling strategy is summarized in Table 71. Cadmus included customers in the regression analysis regardless of whether they received treatment (a home energy report) from the ICSP’s subcontractor. Specifically, Cadmus included customers the ICSP’s subcontractor identified as low-propensity to save and for whom the subcontractor discontinued treatment. Additional details about methodology and attrition are in *Appendix G*.

In PY8, the Home Energy Education Program reported energy savings of 40,467 MWh/yr, as shown in Table 72, and demand reduction of 54 MW, as shown in Table 73.

Table 71. Home Energy Education Program Gross Impact Sample Design for PY8

Stratum	Population Size ^[1]		Assumed Proportion or Cv in Sample Design ^[2]	Achieved Sample Size ^[3]		Impact Evaluation Activity
	Treatment	Control		Treatment	Control	
Legacy Wave 1	50,000	50,000	N/A	48,295	48,292	Regression analysis on monthly billing data to estimate treatment effect (by stratum)
Legacy Wave 2	55,040	25,003	N/A	50,792	23,027	
Expansion Wave 1	48,722	12,654	N/A	47,557	12,356	
Low-Income Wave 1	73,500	18,560	N/A	72,184	18,239	
Low-Income Wave 2	21,401	10,046	N/A	20,718	9,676	
Phase III Expansion Wave 1	27,697	11,096	N/A	27,035	10,833	
Program Total ^[4]	276,360	127,359	N/A	266,581	122,423	

^[1] Population size is based on the number of customers originally randomized prior to the start of the program.

^[2] Cadmus did not sample customers for inclusion in the analysis, and therefore did not assume a proportion or Cv.

^[3] Cadmus included all customers in analysis with at least 11 months of pre-treatment and at least one month of post-treatment billing data (details on attrition can be found in *Appendix C.1 Methodology*).

^[4] Total may not sum to all rows due to rounding.

Table 72. Home Energy Education Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Legacy Wave 1	10,514	92%	0.10	14.67%
Legacy Wave 2	12,406	109%	0.14	19.75%
Expansion Wave 1	9,620	99%	0.16	23.65%
Low-Income Wave 1	5,687	8%	0.21	30.95%
Low-Income Wave 2	945	5%	0.67	96.55%
Phase III Expansion Wave 1	1,295	88%	0.65	93.55%
Program Total ^[1]	40,467	85%	N/A	11.40%

^[1] Total may not sum to all rows due to rounding.

Table 73. Home Energy Education Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Legacy Wave 1	14.13	12%	0.34	49.60%
Legacy Wave 2	16.68	14%	0.36	51.51%
Expansion Wave 1	12.93	12%	0.37	53.30%
Low-Income Wave 1	7.65	12%	0.40	57.29%
Low-Income Wave 2	1.27	7%	0.78	112.00%
Phase III Expansion Wave 1	1.74	11%	0.76	109.14%
Program Total ^[1]	54.39	12%	N/A	48.48%

^[1] Total may not sum to all rows due to rounding.

The following factors led to variation between the reported and verified savings and to the observed realization rates:

- The differences between the reported and verified savings are greatest in low-income wave savings and are the largest drivers in the variation between the reported and verified savings. Upon investigation, the ICSP and its subcontractor found the low-income waves' savings unintentionally included 12 months of savings rather than one month.
- As in PY7, Cadmus did not evaluate demand reductions using hourly data in PY8. Instead, it converted each wave's PY8 average energy savings into demand reductions using the evaluated PY4 ratio of peak demand reduction values to average the per-customer per-hour energy savings. This allowed the PY4 demand reductions to be scaled by the magnitude of the current program year's energy savings. (The *Ex Post Verified Savings Methodology* section provides additional details on the demand reduction methodology.) Using this method, Cadmus evaluated average demand reductions of 0.037 kW per customer, compared to the average reported demand reductions 0.30 kW per customer, resulting in a 12% realization rate.⁵⁵

7.4 Net Impact Evaluation

The Home Energy Education Program evaluation results in an estimate of net savings. The estimate included any spillover that may have occurred within treated customer homes. No free ridership was anticipated, because customers did not choose to receive the home energy reports and no incentives were provided. The evaluation did not estimate Home Energy Education Program gross savings; therefore, the NTG ratio is irrelevant in this analysis.

7.5 Uplift Analysis

Cadmus estimated Home Energy Education Program uplift (the effect of the program on participation in other PPL Electric Utilities efficiency programs) and the energy savings resulting from uplift in PY8. Participation uplift savings appeared in the regression-based estimate of Home Energy Education Program savings and the savings of other PPL Electric Utilities efficiency programs that experienced uplift. Therefore, the Home Energy Education Program savings that were counted in other programs were subtracted from PPL Electric Utilities' residential portfolio savings to avoid counting the savings twice.

The Phase III Evaluation Framework requires the estimation of home energy report savings attributable to current and past efficiency program participation.⁵⁶ For example, installation of a high-efficiency air conditioner in PY4 is expected to yield savings in PY8 and through the expected life of the product. To estimate the home energy report savings in PY8 that are attributable to the prior adoption of high-

⁵⁵ The definition of peak demand changed between PY4 and PY8. In PY4, peak demand was calculated for the top 100 hours of PPL Electric Utilities' system demand. In PY8, peak hours are defined as hours with day-ahead forecasts for the PJM market that are 95% or more of the PJM peak summer forecast.

⁵⁶ Pennsylvania Public Utility Commission. *Phase III Evaluation Framework*. August 25, 2016. See Behavior Section 6.1.1.8.

efficiency air conditioners and other products, Cadmus collected historical energy efficiency program data from PPL Electric Utilities' tracking database. See *Appendix C.1.4 Uplift Analysis Methodology* for details on participation uplift and uplift savings estimation methodology.

7.5.1 Participation Uplift

Participation uplift is the effect of the Home Energy Education Program on participation in PPL Electric Utilities' other efficiency programs. To estimate this effect, Cadmus compared the rates of participation in at least one other Act 129 program in PY8 between treatment and control group customers. The home energy report had a positive effect on participation in other programs where rates of cross-program participation were greater for treatment group customers.

Table 74 shows participation uplift results for PY8. On average, across all waves, treatment customers participated in other PY8 programs at a 6% greater rate than did control customers. Phase III Expansion Wave 1 customers had the greatest participation uplift compared to the other waves; on average, treatment customers in this wave participated in other PPL Electric Utilities programs at a 15% greater rate than control customers. Participation uplift was positive for all waves except the low-income waves. However, Cadmus estimated participation uplift for low-income waves based on cross-participation that began after they had received their first home energy report (treatment) in May 2017. It is likely that many of PPL Electric Utilities' other programs had slowed recruitment for PY8 by this time, since it was the last month of the program year.

Table 74. PY8 Participation Uplift Summary

Wave	Control Group Participation Rate (per 1,000 Customers)	Participation Uplift (Treatment Effect on Participation Rate)	Percentage Participation Uplift
Legacy Wave 1	29	1.26	5%
Legacy Wave 2	35	2.18	7%
Expansion Wave 1	28	1.5	6%
Low-Income Wave 1	0.4	-0.43	-52% ^[1]
Low-Income Wave 2	0.3	-0.61	-69% ^[1]
Phase III Expansion Group 1	34	4.4	15%
Program Total ^[2]	23	1.47	6%

^[1] Percentage participation uplift looks large for the low-income waves because of the small magnitude of cross-participation for these customers. Cross-participation for low-income waves includes only rates of cross-participation that occurred in May 2017, after customers received the first treatment report in PY8.

^[2] May not match due to rounding.

7.5.2 Savings Uplift

Cadmus estimated savings uplift to determine whether treatment group customers *saved* more than control group customers from cross-participation in other programs. Cadmus calculated savings uplift as the difference in treatment and control groups' average cross-program savings per customer, multiplied by the number of treatment group customers. Savings uplift is positive if the per-customer savings accrued in PY8 from current or previous participation in other Act 129 programs was greater for the

treatment group than for the control group. Cadmus accounted for the timing of product installations in other programs and annualized their net savings using a weather-effects weight based on the product's end use.

Table 75 shows participation uplift results for PY8 resulting from PPL Electric Utilities' downstream programs. Across all waves, uplift accounted for just over 7% of Home Energy Education Program savings. Note that cross-program savings are greatest in Legacy Wave 1 and Legacy Wave 2, suggesting that cross-program savings persisted over time. Similar to participation uplift, Low-Income Wave 2 achieved negative uplift savings; control customers in this wave save more, on average, than treatment customers when participating in other PPL Electric Utilities programs.

Table 75. PY8 Downstream Uplift Savings Summary

Wave	Average Cross-Program Savings per Customer (kWh/yr)			Total Uplift Savings (MWh/yr)	Percent of Program Total Savings
	Treatment Group	Control Group	Difference		
Legacy Wave 1	331.32	296.66	34.66	1,024.81	10.56%
Legacy Wave 2	307.9	279.55	28.35	951.65	7.06%
Expansion Wave 1	75.31	66.51	8.8	300.83	3.17%
Low-Income Wave 1	10.26	9.34	0.92	42.32	8.88%
Low-Income Wave 2	7.10	7.24	-0.13	-1.66	-3.54%
Phase III Expansion Wave 1	19.69	16.19	3.51	97.13	8.50%
Program Total ^[1]	136.09	175.98	13.76	2,415.09	7.04%

^[1] May not match due to rounding.

Cadmus estimated the Home Energy Education Program's impact on upstream lighting (LED) purchases by applying the default upstream lighting reduction factors from the Phase III Evaluation Framework. Cadmus applied defaults when results from the customer survey did not find expected statistical differences in LED purchases between the treatment and control group. See the *Uplift Analysis Methodology* section further details on the uplift analysis for upstream lighting.

Table 76. PY8 Upstream Lighting Uplift Savings Summary

Stratum	Population Verified Savings (MWh/yr)	Years in Program	Reduction Factor	Upstream Lighting Uplift (MWh/yr)
Legacy Wave 1	9,705	7	3.00%	260.41
Legacy Wave 2	13,476	6	3.00%	375.73
Expansion Wave 1	9,480	2.5	1.50%	137.69
Low-Income Wave 1	476	2.5	1.50%	6.51
Low-Income Wave 2	47	2	1.50%	0.71
Phase III Expansion Wave 1	1,142	1	0.75%	7.84
Program Total ^[1]	34,326	N/A	N/A	788.87

^[1] Total may not sum to all rows due to rounding.

Additionally, Cadmus deducted 1,191 MWh/yr from the residential sector to account for the 45,000 LED bulbs that PPL Electric Utilities mailed to high-energy use customers in the low-income waves' treatment groups, distributed through the Phase II Residential Retail Program. PPL Electric Utilities claimed savings from these bulbs in PY7. Cadmus deducted these savings from the residential sector because the savings were counted in the residential Home Energy Education program in PY8 (there is no separate low-income program that claimed these savings in PY8).

In total, Cadmus deducted Home Energy Education Program uplift savings of 4,395 MWh/yr from the residential portfolio savings.

7.6 Verified Savings Estimates

In Table 77 the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Home Energy Education Program in PY8. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts. Because the NTG ratio is irrelevant in this analysis, net savings are the same as verified gross savings.

Table 77. PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Demand (MW/yr) ^[1]
PYRTD Gross	40,467	54.39
PYVTD Gross	34,326	6.75
PYVTD Net ^{[2] [3]}	-	-
P3RTD Gross	40,467	54.39
P3VTD Gross ^[4]	34,326	6.75
P3VTD Net ^{[2] [3]}	-	-
^[1] May not match due to rounding. ^[2] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target. ^[3] The NTG ratio is irrelevant; net savings are the same as verified gross savings. ^[4] Note that values in this table are rounded; multiplying PYRTD by PYVTD Gross from this table may not equal PY3VTD, but differences are due to rounding.		

7.7 Process Evaluation

7.7.1 Research Objectives

The evaluation of the Home Energy Education Program involved these research objectives:

- Assess the effectiveness of the program's energy efficiency and behavior program model
- Assess the level of influence the program has on customers' decisions
- Identify adoption of specific energy-saving products and behaviors by customers
- Determine the level of engagement with and reception of the home energy reports and other educational offerings
- Evaluate customer satisfaction with the program

7.7.2 Evaluation Activities

Table 78 lists the PY8 process evaluation activities for the program.

Table 78. Process Evaluation Activities

Activity	Number Completed
PPL Electric Utilities and ICSP program manager interview	3
Logic model development and review	1
Treatment group customer surveys (telephone)	375
Control group customer surveys (telephone)	375
Low-Propensity surveys (telephone)	56

The research activities were consistent with the evaluation plan except for the number of completed surveys for the low-propensity surveys. The evaluation plan stated a target of 70 completed surveys with low-propensity customers, and 56 were completed.

Cadmus did not reach the target number of completes because a higher-than-expected number of customers did not pass a screener question. The screener question asked whether the customer remembered seeing the notice letter that explained the process for continuing to receive the home energy reports. To be included in the survey sample, the customer needed to respond “yes” to having seen the notice letter. This screener question terminated more customers than anticipated and decreased the incidence rate.

Table 79 lists the process evaluation sampling strategy. Additional details about sampling methodology are included in *Appendix G.2.1*.

Table 79. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size ^[1]	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame ^[2]	Percent of Sample Frame Contacted to Achieve Sample ^[3]
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone In-depth Interview	3	N/A	3	3	3	100%
Treatment Group Customer Surveys	Phase I Legacy Waves	Telephone Survey	74,563	0.5	125	125	2,500	99%
	Phase II Expansion Wave	Telephone Survey	39,569	0.5	125	125	2,500	
	Phase III Expansion Wave	Telephone Survey	28,228	0.5	125	125	2,500	
Control Group Customer Surveys	Phase I Legacy Waves	Telephone Survey	52,495	0.5	125	125	2,500	98%
	Phase II Expansion Wave	Telephone Survey	10,320	0.5	125	125	2,500	
	Phase III Expansion Wave	Telephone Survey	11,309	0.5	125	125	2,500	
Low-Propensity Surveys	Treatment group customers who did not opt back in after receiving notice letter	Telephone Survey	17,540	0.5	70	56	10,214	32%
Program Total			234,027	N/A	823	809	25,217	N/A
<p>^[1] The total number of customers in the treatment and control groups at the time of the survey activity. These numbers may not match those reported in the impact analysis sections of this report due to different time periods.</p> <p>^[2] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities tracking database. After selecting all unique records, Cadmus removed any records from the population if the customer had participated in a survey in the last three months, was selected for another program survey, did not have valid contact information (email or telephone number), was on the do not call list, or opted out of the online survey.</p> <p>^[3] Percent contacted means the percentage of the sample frame called to complete surveys.</p>								

7.7.3 Summary of Process Evaluation Findings

The following section highlights program delivery and participant satisfaction findings. Additional findings from process evaluation activities and their methodology are in *Appendix G*.

Program Delivery and Performance

Several program delivery changes occurred in Phase III PY8. They included a new home energy report vendor and product, the low-propensity removal process, new online services, and the late decision to send reports to the low-income waves. The Home Energy Education Program quickly and successfully made the transition to a new ICSP and home energy report vendor.

Table 80 provides a summary of the key program delivery and performance differences between the Phase II and Phase III home energy reports. Overall, the Phase III PY8 program performed like Phase II in report readership. The Phase III PY8 program performed better on the perception of the neighbor comparison accuracy. However, the Phase III expansion wave had a lower average daily percentage savings (0.3%) compared to the Phase II expansion wave (0.8%) in its first-year run.

Table 80. Key Program Delivery and Performance Differences between Phase II and Phase III

Program Delivery or Performance Category	Phase II Delivery Description or Performance Outcome (PY6)	Phase III Delivery Description or Performance Outcome (PY8)
Home Energy Report Cadence and Format	Treatment group customers received four print reports and seven electronic reports in PY6.	Treatment group customers received six print reports and/or six electronic reports in PY8.
Average Daily Percentage Savings During Phase's First-Year Run	0.8% in PY6 for Phase II expansion wave.	0.3% in PY8 for Phase III expansion wave.
Report Readership	95% (n=358) read or skimmed the report.	91% (n _w =492) read or skimmed the report.
Low-Propensity Removal Process	No comparable process existed with the Phase II report vendor.	An involuntary opt-out process where the Phase III report vendor identified, notified, and removed treatment group customers who were predicted to have low engagement with the program. Removed approximately 17,300 customers from the program and stopped sending them home energy reports.
Neighbor Comparison Component	Used the term "neighbor" and based the comparison on proximity (average distance in miles).	Uses the term "nearby households" and bases the comparison on proximity and building characteristics (type of heating, square footage, year built, etc.).
Perception of Neighbor Comparison Accuracy	Mean agreement rating of 4.8 (n=292) out of a 10-point scale for the statement "I believe the neighbor comparison is accurate."	Mean agreement rating of 6.1 (n _w =481) out of a 10-point scale for the statement "I believe the like household comparison is accurate."
Program Web Portal	No program-affiliated web portal available.	Integrates the energy management portal within PPL Electric Utilities' Customer Engagement Hub (a website with all of the information on available rebates). All PPL Electric Utilities' customers have access to the Customer Engagement Hub and the energy management portal, but treatment group customers receive encouragement through the home energy reports to visit the portal.
Visits to Program Web Portal	No program-affiliated web portal available.	56% (n _w =165) of treatment group respondents and 55% (n _w =85) of control group respondents reported visiting the portal.

Weighted survey data are indicated by the notation n_w.

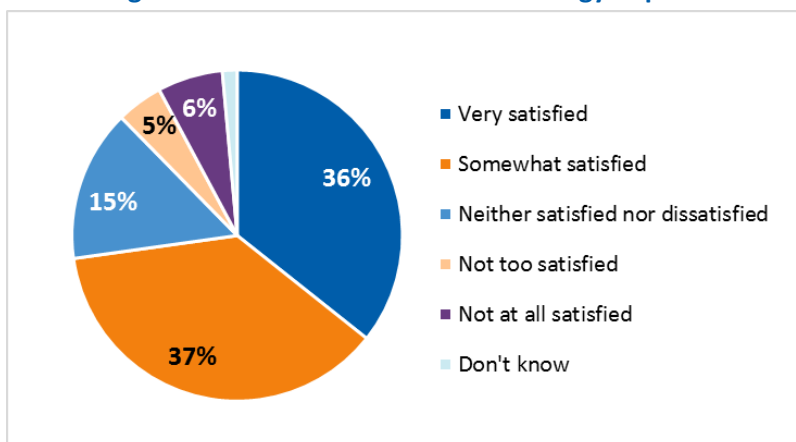
Satisfaction with Home Energy Reports

In PY8, the majority of treatment group respondents said they were satisfied with the home energy reports. As shown in Figure 27, 73% of respondents said they were satisfied. Specifically, 36% were *very satisfied* and 37% were *somewhat satisfied*. In PY6, when the customer surveys were last conducted, 80% of respondents (n=355) were satisfied. The lower percentage of satisfied respondents in PY8 may be because of differences in the satisfaction scale; the PY8 survey introduced a neutral answer choice on the satisfaction scale, which was absent in the PY6 survey.

Nonetheless, home energy report types of programs typically see some of the lowest satisfaction scores because they lack incentives that traditional rebate programs offer and use an opt-out participation format. Among PPL Electric Utilities' PY8 residential and low-income programs, the Home Energy Education Program had the lowest satisfaction scores.⁵⁷

Phase III treatment wave respondents—the wave that has been exposed only to the new home energy reports—were the most satisfied. A significantly higher proportion of Phase III respondents (46%, n_w=97) said they were *very satisfied* with the report compared to Phase I (33%, n_w=252) and Phase II (34%, n_w=137) wave respondents.⁵⁸

Figure 27. Satisfaction with Home Energy Reports



Note: Weighted survey data are indicated by the notation n_w.

Source: Customer survey question, "How would you rate your overall satisfaction with the Home Energy Reports? Would you say you are ...?" (n_w=485). Number includes all responses to the satisfaction question.

Cadmus reviewed historical survey results on satisfaction with the home energy reports among first-year waves (i.e., the first wave to launch in each phase). The historical survey results showed similar report satisfaction (*very* and *somewhat* combined) among first-year waves. Of the Phase I first-year wave in

⁵⁷ See Section 2.12 for all PPL Electric Utilities' PY8 program satisfaction results.

⁵⁸ Difference is statistically significant, p≤0.05.

PY2, 78% (n=314) of respondents were satisfied,⁵⁹ of the Phase II first-year wave in PY6, 82% (n=175) were satisfied,⁶⁰ and of the Phase III first-year wave in PY8, 83% (n_w=97) were satisfied. A significant difference did emerge when comparing the proportion of *very satisfied*; 46% of Phase III first-year wave respondents were *very satisfied* compared to 29% of Phase II first-year wave respondents.⁶¹

Treatment group respondents most frequently suggested improving the accuracy of the home energy reports for the neighbor/like household comparison and the personal usage data. The word “accurate” or “accuracy” appeared in 17% of the 126 suggestions collected from the customer surveys.

Influence of Home Energy Reports

Unlike the impact evaluation, the customer surveys found little to no differences between the responses of treatment and control group. Such results commonly occur because these surveys have low statistical power or are not designed to detect differences in the frequency or intensity of behaviors. Cadmus found no group differences between the treatment and control groups on the awareness of energy efficiency programs and whether the customer had visited the energy management portal. The lack of differences in these two areas can be explained by PPL Electric Utilities’ mass marketing efforts and both groups’ access to the portal. Even though the surveys did not find a difference between treatment and control group on the awareness of energy efficiency programs, the uplift analysis showed that treatment group customers participated in energy efficiency programs at a higher rate than control group customers.

No significant differences emerged between groups on the adoption of energy-saving products except for the installation of LED light bulbs; more treatment group respondents (84%, n_w=491) than control group respondents (73%, n_w=254) reported installing LED light bulbs.⁶² Significant differences did emerge for energy-saving behavioral practices, but results were the opposite expectation where the control group’s adoption was higher.

For comparisons at the wave level, there were significant differences in survey responses between waves, but Cadmus could not identify any clear patterns. The customer surveys did show one influence of the home energy reports specifically on the Phase III treatment wave customers, the wave that had been exposed only to the new home energy reports. A significantly higher proportion of Phase III

⁵⁹ PPL Electric Utilities. *Implementation of Act 129 Energy Efficiency & Conservation Plan Program Year 2 Process Evaluation Report*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 2011.

⁶⁰ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

⁶¹ Difference is statistically significant, $p \leq 0.05$.

⁶² Difference is statistically significant, $p \leq 0.05$.

treatment wave respondents (69%, $n_w=35$) reported visiting the energy management portal than Phase III control wave respondents (51%, $n_w=14$).⁶³

7.8 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 81. The TRC benefits were calculated using gross verified impacts. The NPV PYTD benefits and costs are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). Net present value costs and benefits for P3TD financials are expressed in the PY8 dollars. Because the NTG ratio is irrelevant in this analysis, net savings are the same as verified gross savings. Cadmus did not include a summary of program finances for net verified savings.

⁶³ Difference is statistically significant, $p \leq 0.10$.

Table 81. Summary of Home Energy Education Program Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	-	-	-	-
2	EDC Incentives to Trade Allies	-	-	-	-
3	Participant Costs (net of incentives/rebates paid by utilities)	-	-	-	-
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	-	-	-	-
		EDC	ICSP	EDC	ICSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$38	-	\$38	-
7	Marketing ^[4]		\$143	-	\$143
8	Program Delivery ^[5]		\$663		\$663
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$845		\$845	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-	-	-	-
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$845		\$845	
14	Total NPV Lifetime Electric Energy Benefits	\$1,303		\$1,303	
15	Total NPV Lifetime Electric Capacity Benefits	\$308		\$308	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	-		-	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$1,611		\$1,611	
19	TRC Benefit-Cost Ratio ^[9]	1.91		1.91	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio-level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing ICSP and marketing costs by program ICSPs.

^[5] Includes ICSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

7.9 Status of Recommendations

The Home Energy Education Program achieved 86% of its projected estimates of savings for PY8. The program did not meet its 80% customer satisfaction KPI with the home energy reports. The impact and process evaluation activities in PY8 led to the following findings and recommendations from Cadmus to PPL Electric Utilities, along with a summary of how PPL Electric Utilities plans to address the recommendation in program delivery (Table 82.)

Finding: The Phase III Expansion Wave 1 did not achieve average daily savings that were significantly different from 0.0 kWh/day. This is a result of the low average daily savings estimated for this wave (0.1 kWh/day, or 0.3% compared to baseline savings) as well as the large precision surrounding the treatment effect (94% relative precision at 85% confidence). Savings from this wave contributed 3% of verified program savings. (See the *Ex Post Verified Savings Methodology* section.)

Finding: The Phase III Expansion Wave 1 average pre-treatment consumption (41.6 kWh/day) is lower than average pre-treatment consumption of Legacy Wave 1, Legacy Wave 2, and Expansion Wave 1 (50.6 kWh/day, 63.7 kWh/day, and 74.4 kWh/day, respectively). (See the *Ex Post Verified Savings Methodology* section.)

Finding: Legacy Wave 1, Legacy Wave 2, and Expansion Wave 1 contributed 95% of verified program savings. (See the *Ex Post Verified Savings Methodology* section.)

Conclusion: The older waves drove the savings in PY8, with few overall savings from the new Phase III wave. A contributor of the small estimated treatment effect could be that baseline consumption for the new wave is less than Legacy Wave baseline consumption, limiting the potential of this wave to save.

Recommendation #1: Resume treating customers who were previously identified as having a low-propensity to save. These customers are part of the strongest savings waves (Legacy Wave 1, Legacy Wave 2, and Expansion Wave 1), but were not treated in PY8. As a result, the program could not claim savings for these customers even though they were included in the analysis (details in *Appendix C.1 Methodology*). Had low-propensity customers been treated throughout PY8, the program could have achieved an additional estimated 24% of verified program savings,⁶⁴ allowing the program to meet its estimated savings with Legacy Wave 1, Legacy Wave 2, and Expansion Wave 1 alone.

Finding: Low-Income Wave 1 achieved statistically significant average daily savings in PY8, despite not receiving treatment until May 2017. This was also the wave with the largest number of treatment customers active at the beginning of PY8, accounting for 25% of all treatment customers. Assuming savings across the program year would have been at least as strong as they were in the first month of treatment (May 2017), this wave could have contributed an additional 16% of overall program savings

⁶⁴ Based on the number of customers active in PY8 but not treated (6,723 customers in Legacy Wave 1, 8,519 customers in Legacy Wave 2, and 9,108 customers in Expansion Wave 1) and the average number of days customers remained active in PY8 (~364.72 days). Since low-propensity customers were included in the analysis, the average daily savings per customer would not have changed.

had the wave been treated for the full program year (based on the savings achieved across 31 days by treatment customers still active beginning in May 2017). (See the *Ex Post Verified Savings Methodology* section.)

Conclusion: A much earlier inclusion of the low-income waves would have helped the program to meet its PY8 projected savings.

Recommendation #2: Continue to treat low-income waves in PY9 and beyond so they can contribute savings to the Home Energy Education Program.

Finding: The new home energy reports vendor used the low-propensity removal process to identify high-propensity customers who could contribute toward filling the Phase III expansion wave. (See the *Program Delivery* section in *Appendix G.2.2.*)

Finding: Phase III treatment wave respondents saved the lowest per customer, on average, than the other waves (0.3% compared to between 0.9% and 1.9% across the other waves) (See the *Ex Post Verified Savings Methodology* section.)

Finding: Phase III treatment wave respondents—the wave that has only been exposed to the new home energy reports—were the most satisfied. A significantly higher proportion of Phase III respondents (46%) said they were *very satisfied* with the report compared to Phase I (33%) and Phase II (34%) wave respondents. (See the *Satisfaction with Home Energy Reports* section in 7.7.3.)

Finding: Phase III treatment wave respondents had a significantly lower proportion of program detractors (34%) than did Phase I (50%) and Phase II (57%) treatment wave respondents (See the *Net Promoter Score* section in *Appendix G.2.2.*)

Finding: Phase III treatment wave respondents gave a significantly higher mean agreement rating (7.2) compared to Phase I (5.3) and Phase II (5.8) treatment wave respondents for the statement “I believe the like household comparison is accurate.” (See the *Reception to the Home Energy Reports* section in *Appendix G.2.2.*)

Finding: A significantly higher proportion of Phase III treatment wave respondents (69%) reported visiting the portal than did Phase III control wave respondents (51%). (See the *Online Engagement* section in *Appendix G.2.2.*)

Conclusion: The new Phase III treatment wave customers differ from customers in the older waves, possibly because of the way these customers were selected (via the low-propensity removal process).

Recommendation #3: Consider working with the home energy reports vendor to conduct A/B message testing among the new Phase III treatment wave customers to identify the messaging that increases energy savings. Consider testing words or graphics that have been shown to specifically nudge low-energy users to save.

Finding: PPL Electric Utilities said that after the new home energy reports vendor revised the reports and no longer used the term “neighbor,” the number of customer complaints to the program call center nearly ceased. In previous program years, the program call center received dozens of complaints, mostly about the neighbor comparison. (See the *Program Delivery and Performance* section in 7.7.3.)

Finding: In the PY6 customer surveys, which assessed the home energy reports sent by the previous vendor, treatment group respondents gave a mean agreement rating of 4.8 on a 10-point scale for the statement “I believe the neighbor comparison is accurate.” In the PY8 customer surveys, which assessed the home energy reports from the new vendor, treatment group respondents gave a significantly higher mean agreement rating of 6.1 for the statement “I believe the like household comparison is accurate.” (See the *Reception to the Home Energy Reports* section in Appendix G.2.2.)

Finding: Treatment group respondents most frequently suggested improving the accuracy of the home energy reports for the neighbor/like comparison and the personal usage data. The word “accurate” or “accuracy” appeared in 17% of the 126 suggestions collected from the customer surveys. (See the *Satisfaction with Home Energy Reports* section in 7.7.3.)

Finding: The PY8 home energy reports slightly increased the rate of completing the online home energy assessment, even though the reports were designed to encourage treatment group customers to take the assessment to improve the data accuracy of the reports. The online home energy assessment saw minimal positive participation uplift; on average, treatment group customers participated in the online assessment at a rate of 0.75% or 0.04 customers (per 1,000 customers) more than customers in the control group. (See the *Online Engagement* section in Appendix G.2.2.)

Conclusion: Customer perception of the neighbor comparison improved from Phase II; however, customers still want data accuracy improvements in the home energy reports.

Recommendation #4: Consider using the term “accurate” or “accuracy” in the home energy reports and associating the term with completing the online home energy assessments. In the electronic home energy reports, an embedded hyperlink within the term “accurate” or “accuracy” could get customers to click and easily redirect them to the home energy assessment. Make it clear to customers that completing the online energy assessment will improve the accuracy of the data and information shown in the home energy reports. Add enough detail about the neighbor comparison and data accuracy to help customers understand the importance of updating their home information.

7.9.1 Status of Recommendations for Program

Table 82 contains the status of each PY8 recommendation made to PPL Electric Utilities.

Table 82. Status of Recommendations

Home Energy Education Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	Resume treating customers previously identified as having a low-propensity to save. These customers are part of the strongest savings waves (Legacy Wave 1, Legacy Wave 2, and Expansion Wave 1) but were not treated in PY8.	Being considered
2	Continue to treat low-income waves in PY9.	Being considered
3	Work with the home energy reports vendor to conduct A/B message testing among the new Phase III treatment wave customers by testing words or graphics shown to specifically nudge low-energy users to save.	Being considered
4	Consider using the term “accurate” or “accuracy” in the home energy reports by embedding a hyperlink within the term to direct customers to the home energy assessment, making it clear that completing the online energy assessment will improve the accuracy of the data and information shown in the home energy reports, and adding enough detail about the neighbor comparison and data accuracy connection.	Being considered

8 Energy Efficiency Kits and Education Program

Through the Energy Efficiency Kits and Education Program, PPL Electric Utilities delivers energy education and kits with energy-saving products to income-qualified customers at or below 150% of the federal poverty income guidelines. The program is available to customers in single-family housing and in multifamily housing where each unit is metered (not master-metered).⁶⁵

The program uses two channels to recruit participants and deliver the program:

- **Direct mail kits.** CMC Energy, the low-income implementation conservation service provider (ICSP), conducted targeted mail outreach to invite qualified customers to participate in the Energy Efficiency Kits and Education Program. To receive a kit in the mail, recipients had to return the business reply card attached to the mailing. To generate the list of targeted outreach recipients, PPL Electric Utilities identified customers who had received Low Income Home Energy Assistance Program (LIHEAP) benefits, were enrolled in PPL Electric Utilities' OnTrack Program, or were low-income-qualified and had been identified by the ICSP through market research, data mining, or other means.
- **Agency delivery.** Through their day-to-day interactions with clients, agencies (community-based organizations, or CBOs) assisted the ICSP's subcontractor (Resource Action Programs, or RAP) in recruiting qualified customers to participate in a one-hour energy-education workshop or a one-on-one session with agency staff at the agency's office. RAP conducted train-the-trainer webinar sessions to help agency staff understand key elements of the workshops and provide them with the tools they needed to introduce energy education and low-cost/no-cost energy efficiency products to their low-income clients. To maximize attendance, the agencies offered the workshops at various times during the day, evening, and weekend. During the workshops and one-to-one sessions, agency staff introduced customers to the energy-saving products and educational materials in the kits.

In PY8, the program began distributing two kits, depending on the customer's fuel source for water heating, since PPL Electric Utilities can only claim savings for water measures installed in homes with an electric water heater. Both kits contained self-installed products (Table 83), energy education literature, and surveys to gather participation information for the program. Kits for customers with electric water heaters also included faucet aerators and low-flow showerheads. Kits for customers with a water heater fuel type other than electricity did not contain aerators or showerheads.

Each kit included a paper survey, along with a self-addressed, stamped envelope. The ICSP encouraged survey return by offering a drawing for a \$100 gift card for returned surveys. Cadmus used the survey-collected data to determine installation rates and satisfaction with the program. Table 83 lists the items included in each kit.

⁶⁵ Before PY8, the Energy Efficiency Kit and Education Program was called the E-Power Wise Program.

Table 83. Products Included in PY8 Energy Efficiency Kits

Energy-Efficiency Product	Non-Electric Water Heater Kit	Electric Water Heater Kit
Six 9W LED Bulbs	✓	✓
One LED Night Light	✓	✓
One Tier 2 Advanced Power Strips	✓	✓
One Furnace Whistle	✓	✓
One Low-Flow Showerhead		✓
One Kitchen Aerator		✓
Tips on Energy-Efficiency Behavior	✓	✓
Paper Survey	✓	✓

The objectives of the Energy Efficiency Kits and Education Program are these:⁶⁶

- Provide low-income customers with a no-cost energy efficiency kit and education to help them conserve energy and reduce their energy costs
- Maintain partnerships with local agencies so customers receive maximum and timely customer assistance
- Achieve high satisfaction with customers and participating agencies, through quality service and an impactful program offering
- Promote other PPL Electric Utilities energy efficiency programs, specifically other low-income assistance programs
- Achieve a total approximate reduction in energy use of 38,000 MWh/year gross verified savings

8.1 Progress Toward Phase III Projected Savings

The Energy Efficiency Kits and Education Program verified savings are within 130% of the estimated MWh/yr savings for PY8. It has achieved 25% of the estimated Phase III total planned savings and is making progress toward the Phase III projected savings.

Table 84 shows the program's verified gross program savings and progress toward its Phase III projected energy savings, as filed in the EE&C Plan.

⁶⁶ Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

Table 84. Energy Efficiency Kits and Education Program Estimated Savings

PY8 Only				Phase III: PY8–PY12			
	Estimated ⁽¹⁾	Verified	Percentage of Estimated		Estimated ⁽¹⁾	Verified	Percentage of Estimated
MWh/yr	7,074	9,219	130%	MWh/yr	37,601	9,219	25%
⁽¹⁾ Estimated savings are based on PPL Electric Utilities' revised EE&C plan (Docket No. 2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.							

Factors affecting the program's progress toward the estimated savings projected for PY8 include this:

- The ICSP distributed 4,058 more kits than the 8,000 kits estimated in the EE&C Plan for PY8. PPL Electric Utilities and the ICSP made the decision to send more kits to offset the slow uptake of the Low-Income Winter Relief Assistance Program (WRAP) at the beginning of PY8.

8.2 Participation and Reported Savings by Customer Segment

8.2.1 Definition of a Participant

A participant in the program is defined as income-eligible customers who received an energy-savings kit through the agency or the direct-mail delivery channel. For recordkeeping purposes, each kit is assigned a unique job number. Customers who received more than one kit had multiple job numbers, one per unique kit. In the event that kits were returned to the ICSP, the kit had two unique job numbers: one to indicate the distributed kit, and one to indicate the returned kit. Returned kits appear as separate records in PPL Electric Utilities' tracking database, for record keeping purposes.

8.2.2 Program Participation and Reported Impacts

Table 85 presents the number of records in the tracking database, the participation counts (distributed kits that were not returned), and reported energy and demand savings for the Energy Efficiency Kits and Education Program in PY8 by customer segment. There are no incentive payments for this program. Income qualified customers receive the kit for free.

Table 85. Energy Efficiency Kits and Education Program Participation and Reported Impacts

Parameter	Low-Income	Total ^[1]
PYTD Number of Records ^[2]	12,117	12,117
PYTD Number of Participants Receiving Kits ^[3]	12,058	12,058
PYRTD MWh/yr	10,420	10,420
PYRTD MW/yr	0.75	0.75
PY8 Incentives (\$1000)	\$0	\$0
^[1] May not match due to rounding.		
^[2] The number of records is determined by the unique job numbers. Returned kits are assigned two unique job numbers: one for the distributed kit, and one for the returned kit. Note that this is just for record keeping purposes.		
^[3] The number of unique kits distributed by the ICSP in PY8 that were not returned is 12,058.		

8.3 Gross Impact Evaluation

8.3.1 Data Collection

Cadmus collected data to verify energy savings through the ICSP-administered participant surveys (paper surveys included in each kit). It also conducted a phone survey with a sample of program participants who did not return a paper kit survey. Cadmus also collected enrollment information from the ICSP's subcontractor to confirm the records in PPL Electric Utilities' tracking database.

8.3.2 Sample Design

Each energy-savings kit included a paper survey for participants to complete and return to the ICSP. The survey asked questions about installing the products and about the participant's experiences with the products and program. Participants returned the surveys to the ICSP throughout the year. When the program year ended in May 2017, the ICSP sent the survey data to Cadmus. Cadmus used the data to estimate the program's energy savings in PY8.

Cadmus also conducted a follow-up phone survey with a sample of program participants who did not return the surveys enclosed in the kits (these participants are referred to as non-responders). Cadmus used these phone survey responses to estimate the program's energy savings in PY8 and to investigate any bias in in-service rates (ISRs) between responders and non-responders. Cadmus did not include customers who returned kits in its sample frame for the phone surveys.

The impact evaluation sampling strategy is listed in Table 86. Additional details about methodology are in *Appendix H.1.1 Methodology*.

Table 86. Energy Efficiency Kits and Education Gross Impact Sample Design for PY8

Stratum	Population Size ^[1]	Assumed Proportion or Cv in Sample Design	Achieved Sample Size ^[2]	Impact Evaluation Activity
Agency	2,409	N/A ^[3]	241	ICSP-collected paper kit survey
		0.5	104 ^[4]	Non-responder phone survey
Direct Mail	9,649	N/A ^[3]	1,668	ICSP-collected paper kit survey
		0.5	128 ^[4]	Non-responder phone survey
Program Total	12,058	N/A	2,141	

^[1] Number of unique kits not returned to the ICSP, not number of unique records in PPL Electric Utilities' tracking database, which includes returned kits.

^[2] Number includes partially completed surveys. Respondents could skip questions.

^[3] Cadmus used survey responses collected by the ICSP from participants who returned their surveys. Therefore, Cadmus did not have an assumed proportion of Cv.

^[4] Cadmus completed a greater number of phone surveys than planned because of multiple waves of data collection. As a result, 34 phone surveys contributed to the agency savings estimate, and 62 phone surveys contributed to the direct mail savings estimate. Cadmus used additional phone surveys to test for significant difference in ISRs between those who returned paper surveys and those who did not.

8.3.3 Gross Impact Evaluation Activities

Cadmus performed the activities described below to evaluate the Energy Efficiency Kits and Education Program gross impacts. Refer to *Appendix H.1 Gross Impact Evaluation* for detail on these activities.

- **Records review.** Cadmus reviewed the records in PPL Electric Utilities' tracking database and compared these to the records in the enrollment data provided by the ICSP, verifying discrepancies with the ICSP prior to conducting any analyses.
- **Participant kit survey.** Cadmus collected the kit surveys returned by mail to the ICSP and used the collected data in the *ex post* savings analysis. Cadmus also reviewed the records in the survey data and verified all discrepancies between the survey records and PPL Electric Utilities' tracking database with the ICSP.
- **Participant phone survey.** Cadmus conducted phone surveys of a sample of participants who did not return a kit survey and used the collected data in the *ex post* savings analysis to investigate any impact-related bias of participants who returned the kit survey.

8.3.4 Gross Impact Evaluation Results

In PY8, the Energy Efficiency Kits and Education Program reported energy savings of 10,420 MWh/yr, as shown in Table 87, and demand reduction of 0.75 MW, as shown in Table 88.

Table 87. Energy Efficiency Kits and Education Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Agency	1,995	93%	0.45	3.90%
Direct Mail	8,425	87%	0.42	1.47%
Program Total ^[1]	10,420	88%	N/A	1.41%

^[1] Rows may not sum to program total due to rounding.

Table 88. Energy Efficiency Kits and Education Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Agency	0.14	123%	0.55	4.80%
Direct Mail	0.61	116%	0.54	1.88%
Program Total	0.75	118%	N/A	1.78%

^[1] Rows may not sum to program total due to rounding.

The following factors led to variation between the reported and verified savings and to the observed realization rates.

- Furnace whistles achieved an ISR of 30%, compared to the planned ISR of 17%, with a product-level energy realization rate of 175% for the agency stratum and 186% for the direct mail stratum.
- LEDs achieved an ISR of 84% for the agency stratum and 81% for the direct mail stratum; these percentages are lower than the planned ISR of 96% in the agency stratum and 98% in the direct mail stratum. The ISR for LEDs may have been lower than anticipated because the kit included a

total of six LED bulbs, four more than in previous program years, although this does not entirely explain the lower ISRs for LED bulbs. The first and second LED bulbs achieved an ISR of 97% and 95% (respectively) in the agency stratum, and 98% and 95% (respectively) in the direct mail stratum. After the third bulb, which achieved an ISR of 92% in the agency stratum and 91% in the direct mail stratum, the ISRs drop rapidly, achieving between 65% and 85% in the agency stratum and between 59% and 80% in the direct mail stratum.

- Program participants achieved lower energy education savings per kit than planned. On average, participants achieved 170.36 kWh/yr in the agency stratum and 172.65 kWh/yr in the direct mail stratum. The ICSP applied a per-participant average of 253 kWh/yr for planning, resulting in an energy realization rate of 67% for the agency stratum and 68% for the direct mail stratum.
- The ICSP reported 0 MW/yr for energy education, and Cadmus found 0.0117 kW/yr in the agency stratum and 0.0136 kW/yr in the direct mail stratum, which increased the overall demand realization rates to 123% for the agency stratum and 116% for the direct mail stratum.

8.3.5 In-Service Rates

Cadmus conducted a test of equivalency between participants who did and did not return a paper survey to investigate the possibility that these two groups have significantly different ISRs. Table 89 provides the results of these tests. Note that for products that rely on certain home characteristics, such as an electric water heater, Cadmus estimated the ISR out of the total number of participants who were *eligible* to receive savings for that particular product *given* these home characteristics.

Table 89. Test of Equivalency between Responder and Non-responder ISRs

Product	Agency		Direct Mail		P-value ^[1]	
	Paper Survey	Phone Survey	Paper Survey	Phone Survey	Agency	Direct Mail
Kitchen Aerator	65%	53%	68%	38%	0.1123	< 0.0001
Energy Education ^[2]	43%	40%	51%	36%	0.5863	0.0013
Furnace Whistle	31%	34%	39%	20%	0.5537	0.0001
LED	86%	80%	82%	72%	0.0529	0.0010
LED Nightlight	90%	85%	91%	80%	0.1753	0.0001
Showerhead	66%	53%	66%	42%	0.1045	0.0001
Smart Strip	65%	76%	70%	60%	0.0486	0.0257

^[1] A p-value less than 0.10 indicates a significant difference in ISRs at the 10% significance level.
^[2] Cadmus determined the ISR for energy education by looking at those who were eligible to achieve one of the four energy education pieces against those who actually achieved those savings.

The tests concluded that LED bulbs and smart strips in the agency stratum achieved significantly different ISRs between paper survey responses and phone survey responses at the 10% significance level. Kitchen aerators and showerheads were almost significantly different at the 10% significance level with p-values of 0.1123 and 0.1045, respectively.

In the direct mail stratum, all products showed significantly different ISRs between paper and phone survey responses at the 10% significance level. Furthermore, direct mail participants who did not return

a paper survey achieved lower ISRs across all products than did participants who returned surveys, according to the differences between ISRs of paper and phone survey respondents. This suggests that those returning the paper survey may be more engaged and install more LEDs. However, Cadmus is not able to isolate the cause of the difference in the ISRs reported. It may be that the two groups install products differently and the ISRs are different, or the difference in survey modes triggered different responses.

8.4 Net Impact Evaluation

This program is offered to income-eligible customers in the low-income community, and no free riders are anticipated among the population receiving the energy-savings kits. That is, income-constrained customers are not likely to purchase the items in these kits on their own. The program assumes a NTG ratio of 1.0.

8.5 Verified Savings Estimates

In Table 90, Cadmus applied the realization rates to the reported energy and demand savings estimates to calculate the verified savings estimates for the Energy Efficiency Kits and Education Program in PY8. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 90. PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Total Demand (MW/yr) ^[1]
PYRTD Gross	10,420	0.75
PYVTD Gross	9,219	0.88
PYVTD Net ^{[2] [3]}	-	-
P3RTD Gross	10,420	0.75
P3VTD Gross	9,219	0.88
P3VTD Net ^{[2] [3]}	-	-

^[1] Total may not match due to rounding.
^[2] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.
^[3] Net savings are not computed because program is assumed to have a NTG ratio of 1.0.

8.6 Process Evaluation

8.6.1 Research Objectives

Cadmus conducted the PY8 process evaluation with a focus on program delivery and participation and addressed the following research objectives:

- Identify areas of program success
- Identify areas that may benefit from program improvements
- Assess agency satisfaction with program
- Assess satisfaction of customers receiving the kits

8.6.2 Evaluation Activities

Table 91 lists the PY8 process evaluation activities for the Energy Efficiency Kits and Education Program.

Table 91. Energy Efficiency Kits and Education Program Process Evaluation Activities

Activity	Number Completed
PPL Electric Utilities and ICSP Program Manager Interviews	3
Postcard Participant Surveys	1,909
Telephone Participant Surveys	232
Telephone Agency Interviews	5
Logic Model Review	-

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

- Cadmus conducted three stakeholder interviews instead of the two originally planned. It interviewed staff from both ICSPs, CMC Energy and its subcontractor RAP.
- Cadmus conducted more phone surveys than initially planned. The contracted survey firm did not complete required quotas after sending surveys intended for customers with non-electric water heaters to those who received kits with water products. However, Cadmus used responses for non-water products, increasing the final sample of phone surveys to more than planned.

Table 92 lists the process evaluation sampling strategy. Additional details about sampling methodology are included in *Appendix H.2 Process Evaluation Methodology*.

Table 92. PY8 Energy Efficiency Kits and Education Program Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame ^[1]	Percent of Sample Frame Contacted to Achieve Sample ^[2]
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone in-depth interview	3	N/A	3	3	N/A	100%
Participants	Direct mail, agency	Paper kit survey	12,058 ^[3]	N/A	As many as possible	1,909	All eligible	N/A
		Telephone survey		90/10	140	232 ^[4]	All non-respondents to paper kit survey	46% ^[5]
Agencies	Participating	Telephone In-depth Interview	22	N/A	5	5	N/A	23%
Program Total			N/A	N/A	N/A	N/A	N/A	100%

^[1] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities database. After selecting all unique records, Cadmus removed any records from the population of customers who had participated in a survey in the last three months, had been selected for another program survey, did not have valid contact information (email or telephone number), were on the do not call list, or opted out of the online survey.

^[2] Percent contacted means the percentage of the sample frame called to complete surveys.

^[3] Number of unique kits not returned to the ICSP, not unique jobs.

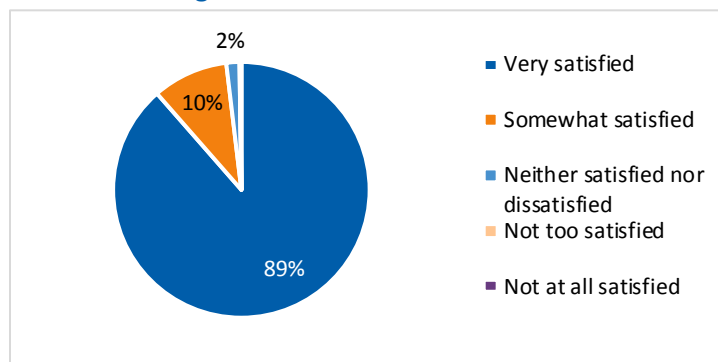
^[4] The contracted survey firm did not complete required quotas after sending surveys intended for customers with non-electric water heaters to those who received kits with water products. However, Cadmus used responses for non-water products, increasing the final sample of phone surveys to more than planned.

^[5] Cadmus provided the survey firm with 8,888 records, but only 4,110 records were needed to reach the survey target.

8.6.3 Summary of Process Evaluation Findings

Overall, Cadmus found that the ICSP had continued to deliver and manage the program very well in its transition between the E-Power Wise Program in Phase II and the current Phase III program. All involved—PPL Electric Utilities, the ICSP, and the agencies—reported that communication among all parties was strong and led to program success. This is consistent with PY7 findings and has contributed to high overall satisfaction ratings across delivery channels.⁶⁷ Ninety-nine percent of program participants were satisfied with the program (top two categories). Eighty-nine percent of customers (n=2,117) said they were *very satisfied* with the program. An additional 10% were *somewhat satisfied*. Figure 28 shows full participant results. Detailed results on participant satisfaction can be found in *Appendix H.2.2 Participant Satisfaction*.

Figure 28. Customer Satisfaction



Source: Survey question, "Thinking about your overall experience with the Energy Efficiency Kit, how would you rate your satisfaction?"

Would you say you are..." (n=2,117) Does not total 100% because of rounding.

Agencies were also asked about their satisfaction with the program. Four out of five agencies were *very satisfied* and one was *somewhat satisfied*. All agencies said the launch of the program this year met their expectations. Specifically, the agencies found the training at the beginning of the program year very comprehensive, with one stating that because the ICSP sent trial kits to the agency, the staff could better understand the kit and educate their customers about it. Two agencies said the one-on-one attention that the ICSP gave the agency representatives was very helpful. When enrolling customers, two agencies said the online data entry/customer qualification process was very smooth.

PPL Electric Utilities and the ICSP defined plans for energy savings for the Energy Efficiency Kits and Education Program and set levels for two other metrics they monitor—participation and customer satisfaction. PPL Electric Utilities exceeded planned participation by over 4,000 kits and satisfaction targets by 19%.

PPL Electric Utilities, as well as the ICSP and the agencies, also wanted to expand the reach of the program to more rural areas by recruiting additional agencies. This also is not a specific key performance

⁶⁷ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

indicator (KPI) for PY8. PPL Electric Utilities and the ICSP sent more kits than planned because they want to phase out this program in PY12 while still hitting their planned Phase III participation and savings.

PPL Electric Utilities made a few program changes from PY7 to PY8. First, it added Tier 2 advanced power strips and four more bulbs and created distinct kits for homes with electric or non-electric water heaters. It also updated the look of the kit to better emphasize awareness of energy efficiency and added the PPL Electric Utilities logo to ensure that the kit was appropriately attributed. PPL Electric Utilities also updated its website to reflect these changes.

Beginning in PY8, the Energy Efficiency Kits and Education Program offered two types of kits, one for customers with electric water heaters and one for customers with non-electric water heaters, because PPL Electric Utilities cannot claim savings for water measures installed in homes with non-electric water heaters. The change to two different kits caused issues with how agencies and the ICSP tracked kit distributions, with one agency reporting issues with tracking how many kits they gave out and where the kits went. Problems with tracking kits led to giving some customers with non-electric water heaters kits intended for homes with electric water; this mistake meant wasted costs on products for which PPL Electric Utilities could not claim savings, but it also led to customer confusion about the additional water products included in the kits. One agency said some customers were confused about the two types of kits, and another said some customers did not understand why there was a difference. These issues and confusion did not, however, impact agency or customer satisfaction.

Some agencies faced confusion from their clients about how to install the products contained in the kits. Two agencies said energy education training for them, and the materials provided to customers in the kits, could be improved. Specifically, they asked for better ways to educate clients about more complex products such as the filter alarm (furnace whistle) and Tier 2 advanced power strips. Additionally, many agencies expressed concern over the confusion faced by their elderly clients. Two agencies said they were more likely to serve elderly clients who have trouble understanding the products in the kit. One agency also said it received a lot of phone calls and repeat visits from elderly clients who did not understand how to install the products.

Many agencies said the size of the kit had become a problem for storage at the agency and for clients to transport home. One agency said that many of its clients take public transportation, walk, or bike to its office and struggle to bring the kit home. The agency has seen clients place the kit products in their personal bags and leave the box behind, and it suggested adding a handle to the box or providing a bag to help clients carry the products home. One agency is also looking for other ways to deliver energy savings kits to its customers; many of its clients seem interested when they call the agency for information about other programs or learn about the kits at an event, but they never come into the agency to enroll in the program and pick up a kit. Additional details can be found in *Appendix H.2.2 Suggested Program Improvements*.

Additional details regarding findings from process evaluation activities and their methodologies are in *Appendix H.2.1 Process Evaluation Methodology*.

8.7 Cost-Effectiveness Reporting

Details of program finances and cost-effectiveness are presented in Table 93. The TRC benefits in Table 93 were calculated using gross verified impacts. The NPV PYTD benefits and costs are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). NPV costs and benefits for P3TD financials are expressed in the PY8 dollars.

Table 93. Summary of Energy Efficiency Kits and Education Program Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	-	-	-	-
2	EDC Incentives to Trade Allies	-	-	-	-
3	Participant Costs (net of incentives/rebates paid by utilities)	-	-	-	-
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	-	-	-	-
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$63	-	\$63	-
7	Marketing ^[4]		\$111		\$111
8	Program Delivery ^[5]		\$1,721		\$1,721
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$1,894	-	\$1,894	-
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-	-	-	-
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$1,894	-	\$1,894	-
14	Total NPV Lifetime Electric Energy Benefits	\$1,668	-	\$1,668	-
15	Total NPV Lifetime Electric Capacity Benefits	\$334	-	\$334	-
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$378	-	\$378	-
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-	-	-	-
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$2,380	-	\$2,380	-
19	TRC Benefit-Cost Ratio ^[9]	1.26	-	1.26	-

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Table 94 presents program financials and cost-effectiveness on a net savings basis. Net verified savings are equal to gross verified savings because the program is assumed to have a NTG ratio of 1.0

Table 94. Summary of Energy Efficiency Kits and Education Program Finances—Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	-	-	-	-
2	EDC Incentives to Trade Allies	-	-	-	-
3	Participant Costs (net of incentives/rebates paid by utilities)	-	-	-	-
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	-	-	-	-
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$63	-	\$63	-
7	Marketing ^[4]		\$111		\$111
8	Program Delivery ^[5]		\$1,721		\$1,721
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$1,894		\$1,894	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-	-	-	-
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$1,894		\$1,894	
14	Total NPV Lifetime Electric Energy Benefits	\$1,668		\$1,668	
15	Total NPV Lifetime Electric Capacity Benefits	\$334		\$334	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$378		\$378	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$2,380		\$2,380	
19	TRC Benefit-Cost Ratio ^[9]	1.26		1.26	
<p>^[1] May not sum to total due to rounding.</p> <p>^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.</p> <p>^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.</p> <p>^[4] Includes the marketing CSP and marketing costs by program CSPs</p> <p>^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.</p> <p>^[6] Rows 1-11 are presented in nominal dollars.</p> <p>^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.</p> <p>^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. 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.</p> <p>^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.</p>					

8.8 Status of Recommendations

Overall, the program has performed as expected and exceeded both its planned participation and planned savings. After conducting impact and process evaluation activities in PY8, Cadmus made the following findings and recommendations to PPL Electric Utilities. A summary of how PPL Electric Utilities plans to address the recommendation in program delivery is presented in Table 95.

Finding: The Energy Efficiency Kits and Education Program achieved 88% of its reported savings. The ICSP used planned ISRs that were higher than the survey verified ISRs, especially in the direct mail stratum, which was the primary reason Cadmus verified fewer than 100% of energy *ex ante* savings (see *Section 8.3.4 Gross Impact Evaluation Results*)

Conclusion: Updates to ISRs used in planning calculations could increase accuracy of reported savings and improve realization rates.

Recommendation #1: Consider using the survey verified ISRs from the PY8 impact evaluation to estimate PY9 *ex ante* energy and demand savings. Additionally, consider using the average per-participant energy education savings estimated from the PY8 impact evaluation to report PY9 *ex ante* energy and demand savings.

Finding: Cadmus found significantly different ISRs between paper and phone survey responses in the direct mail stratum for all products at the 90% confidence level. In the agency stratum, differences in ISRs between paper and phone survey responses were significant for LED bulbs and Tier 2 advanced power strips and nearly significant for showerheads and kitchen aerators (see *Section 8.3.5 In-Service Rates*).

Conclusion: Across all products in the direct mail stratum, participants who returned the paper survey achieved significantly different ISRs than did participants who did not return the paper survey and completed the phone survey. In fact, participants who returned a paper survey achieved higher ISRs for all of their products. In the agency stratum, participants who returned a paper survey achieved significantly different ISRs for only certain products. However, Cadmus was not able to isolate the cause of the difference in the ISRs reported. It may be that the groups install products differently and the ISRs are actually different, or, the difference in survey modes triggered different responses.

Recommendation #2: Consider ways to increase program engagement and ISRs, especially in the direct mail stratum, by adding or improving energy education materials, providing clearer installation instructions, or suggesting activities that promote attention to energy efficiency. Continue the survey modes and analysis conducted in PY8 and administer phone surveys in PY9 to a sample of participants who do not return the paper survey.

Finding: Agencies face confusion about the energy savings kits and how to install the included products (see *Section 8.6.3 Summary of Process Evaluation Findings*). One of the five agencies interviewed said some customers were confused by the two types of kits, and two of the five agencies wanted better explanations for using Tier 2 advanced power strips and filter alarms. Two agencies also said they were more likely to serve elderly clients who have trouble understanding the products in the kit; one agency

said it received a lot of phone calls and repeat visits from elderly clients who asked how to install the products.

Conclusion: The energy education that agencies provided as part of the program was not meeting the needs of their clients. Clients were especially confused about Tier 2 advanced power strips and filter alarms, why there were two types of kits, and how to use the installation instructions. This confusion required agencies to spend additional time and resources to assist clients with the program.

Recommendation #3: Improve and continue to direct the way agencies promote the kits. Consider ways to better equip agencies to help customers understand the products, such as ensuring that written directions are clear and concise, with diagrams for all installations, and providing multiple resources so customers can get additional help. Consider ways to reduce customer confusion around two kits. The agencies should not need to discuss two kits, but, if it occurs and customers ask why there are two kits, consider talking about a customized kit designed to meet the specific customer's energy needs.

Finding: One of five agencies interviewed reported that many of its clients take public transportation, walk, or bike to its office and have difficulty carrying the kit home. These customers sometimes leave the box and take the products home in a bag. Two agencies said they lose some customers who initially show interest at an event but do not come to the office to enroll and pick up the kit. See *Section 8.6.3 Summary of Process Evaluation Findings* for details.

Conclusion: Some customers who initially express interest never pick up a kit, so PPL Electric Utilities loses potential savings and the agency is unable to offer additional services. Many customers who do come to the agency cannot easily transport the kit home and sometimes remove the items and leave the box.

Recommendation #4: Continue agency recruitment efforts to improve customer outreach. To help agencies provide kits to their clients, consider adding a handle to the kit box or provide agencies bags in which clients can carry kit contents. Examine other methods of delivery for agencies, such as allowing them to add customers to the ICSP's subcontractor's mailing list, to send kits to customers who cannot carry the kit contents or who express interest in a kit but cannot come into the agency to pick it up.

Finding: Issues with the kit tracking system led to confusion throughout the program year. The ICSP and one agency said the current kit distribution tracking system made it difficult to know to whom the kit was delivered or the type of kit the customer should receive. One high-distributing agency took the initiative to track its own kit distributions. Cadmus' review of program records in PPL Electric Utilities' tracking database also revealed several issues with the ICSP data tracking and transfer system. Cadmus found that some customers received incorrect kit types and found errors in water heater configurations, laundry locations, home types, home cooling configurations, home heating fuel types, and survey responses between the two kit types. Specific findings from Cadmus' database review can be found in *Appendix H.1.2 Database Review Findings*.

Conclusion: The tracking system was not working as intended after the program began offering two types of kits based on the customer's water heating fuel type. The data tracking and transfer system

broke down when transferring data between the ICSP and its subcontractor, causing them to distribute incorrect kit types to several customers. The switch to two types of kits has caused a burden to a system intended to help agencies and the ICSP work together better.

Recommendation #5: Consider increasing the level of inventory and quality control in the kit distribution tracking system, including internal crosschecks between the ICSP and its subcontractor when transferring data and preparing kits for shipment. Improve the kit tracking system so that the ICSP and agencies can easily tell what kits are shipped to the agency, when they are received, when they are distributed, and to whom. These additional checkpoints may require extra steps in the kit distribution process but should cause less waste of program funds by ensuring the program does not provide water-savings products to customers with non-electric water heaters.

8.8.1 Status of Recommendations for Program

Table 95 contains the status of each PY8 recommendation made to PPL Electric Utilities.

Table 95. Status of Recommendations

Energy Efficiency Kits and Education Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	Consider using the survey verified ISRs from the PY8 impact evaluation to estimate PY9 <i>ex ante</i> energy and demand savings. Additionally, consider using the average per-participant energy education savings estimated from the PY8 impact evaluation to report PY9 <i>ex ante</i> energy and demand savings.	Will be implemented
2	Consider ways to increase program engagement and ISRs, especially in the direct mail stratum, by adding or improving energy education materials, providing clearer installation instructions, or suggesting activities that promote attention to energy efficiency. Continue survey modes and analysis conducted in PY8 and administer phone surveys in PY9 to a sample of participants who do not return the paper survey.	Will be implemented
3	Improve and continue to direct the way agencies promote the kits. Consider ways to better equip agencies to help customers understand the products, such as ensuring that written directions are clear and concise, with diagrams for all installations, and providing multiple resources so customers can get additional help. Consider ways to reduce customer confusion around two kits. The agencies should not need to discuss two kits, but, if it occurs and customers ask why there are two kits, consider talking about a customized kit designed to meet the specific customer's energy needs.	Will be implemented
4	Continue agency recruitment efforts to improve customer outreach. To help agencies provide kits to their clients, consider adding a handle to the kit box or providing agencies bags in which clients can carry kit contents. Examine other methods of delivery for agencies, such as allowing them to add customers to the ICSP's subcontractor's mailing list so kits can be sent to customers who cannot carry the kit contents or who express interest in a kit but cannot come into the agency to pick it up	Will be implemented

Energy Efficiency Kits and Education Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
5	Consider increasing the level of inventory and quality control in the kit distribution tracking system, including internal crosschecks between the ICSP and its subcontractor when transferring data and preparing kits for shipment. Improve the kit tracking system so that the ICSP and agencies can easily tell what kits are shipped to the agency, when they are received, when they are distributed, and to whom. These additional checkpoints may require extra steps in the kit distribution process but should cause less waste of program funds by ensuring the program does not provide water-savings products to customers with non-electric water heaters.	Being considered

9 Appliance Recycling Program

In this downstream program, the Appliance Recycling Program, PPL Electric Utilities pays a rebate to customers who turn in eligible appliances and provides free pick-up and environmentally sound recycling services. Refrigerators must measure between 10 and 30 cubic feet to qualify for the program, and both primary and secondary refrigerators and freezers are eligible. Eligible appliances must be plugged in and functioning when picked up. If customers recycle an inefficient refrigerator or freezer, they can also turn in room air conditioners; however, these are not picked up as a stand-alone service.

Table 96 shows the appliance eligibility parameters and rebates.

Table 96. Eligible Equipment and Rebates

Equipment	Eligibility Rating	Rebate Range
Refrigerator	Working unit; > 10 cubic feet and ≤ 30 cubic feet	Between \$20 and \$75
Freezer	Working unit; > 10 cubic feet and ≤ 30 cubic feet	Between \$20 and \$75
Room Air Conditioner	Working unit removed from mounting	Between \$10 and \$25

PPL Electric Utilities' energy efficiency programs' staff provides overall strategic direction and program management. Its EM&V staff oversees evaluation activities and coordinates with PPL Electric Utilities' programs' staff. In PY8, Ecova, the ICSP, delivered the Appliance Recycling Program to customers, including marketing and managing the call center services; online and telephone scheduling of appliance pick-ups, processing applications and rebates; tracking program data; and providing customer and transaction information to PPL Electric Utilities. Recleim, the ICSP's subcontractor, managed the pick-up, decommissioning, and recycling of appliances.

The objectives of the Appliance Recycling Program are these:⁶⁸

- Encourage customers to dispose of their existing, inefficient refrigerators, freezers, and air-conditioning units, in an environmentally responsible manner
- Reduce the use of secondary, inefficient refrigerators, freezers, and air-conditioning units
- Decommission appliances on-site to prevent resale in a secondary market
- Promote other PPL Electric Utilities' energy efficiency programs
- Achieve a total energy reduction of approximately 65,000 MWh/year gross verified savings
- Achieve high customer satisfaction with the program

⁶⁸ Program objectives are stipulated on PPL Electric Utilities Corporation. *Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642 Compliance Filing before the Pennsylvania Public Utility Commission. December 5, 2016.

9.1 Progress Toward Phase III Projected Savings

The Appliance Recycling Program's verified savings are within 90% of the estimated MWh/yr savings projected for PY8. It has achieved 18% of the estimated Phase III total planned savings and is making progress toward the Phase III projected savings.

Table 97 shows the program's verified gross program savings and progress toward its Phase III projected energy savings, as filed in the EE&C plan.

Table 97. Appliance Recycling Program Savings

	PY8 Only			Phase III: PY8–PY12		
	Estimated	Verified	Percentage of Estimated	Estimated ^[1]	Verified	Percentage of Estimated
MWh/yr	13,120	11,844	90%	65,522	11,844	18%
^[1] Savings are based on PPL Electric Utilities' revised EE&C plan (Docket No. 2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.						

The program achieved 90% of the projected PY8 savings estimates. It did not meet projections for two reasons. First, overall participation was 5% lower than estimated, with 11,368 appliances recycled in PY8, because of the ramp-up period after relaunching the program. The program had stopped offering services midway through the previous program year. The program is not underperforming but lacked momentum, and participation was lower than expected only for the first couple of months.

Second, more air conditioners were recycled with the refrigerators than anticipated (1,227 air conditioners were recycled compared to 917 estimated). The energy savings from the additional air conditioners did not make up for unrealized refrigerator savings because these units have lower per-unit savings than do refrigerators and freezers.

9.2 Participation and Reported Savings by Customer Segment

9.2.1 Definition of a Participant

Cadmus defined participants as each unique job number, which also corresponds with each unique appliance decommissioned through the Appliance Recycling Program during the program year. The program is targeted primarily to residential customers but is available to all PPL Electric Utilities customers with a working, residential-grade refrigerator, freezer, or room air conditioner.

Table 98 presents the participation counts, reported energy and demand savings, and incentive payments for the Appliance Recycling Program in PY8 by customer segment.

Table 98. PY8 Appliance Recycling Participation and Reported Impacts

Parameter	Residential	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total ^[1]
PYTD Number of Participants	11,139	124	3	102	11,368
PYRTD MWh/yr	11,797	127	3	109	12,035
PYRTD MW/yr	1.61	0.02	0.00	0.01	1.65
PY8 Incentives (\$1000)	\$337	\$2	\$0	\$2	\$341
^[1] May not match due to rounding.					

9.3 Gross Impact Evaluation

Cadmus calculated gross verified savings through a records review and an update of one input to the savings algorithm specified in the PA TRM. Cadmus reviewed the tracking data after the second quarter of PY8 and again at the end of the program year. This review consisted of reconciling the records and appliances reported in PPL Electric Utilities' tracking database with the ICSP program tracking data.

Savings are partially deemed in the PA TRM for recycled appliances. The ICSP reports the quantity of each recycled appliance (refrigerators, freezers, and window air conditioners) through information it uploads to its tracking database. In its tracking database, PPL Electric Utilities reports gross savings per refrigerator and per freezer using the default inputs for the regression equation provided in the PA TRM,⁶⁹ with the exception of the proportion of units manufactured prior to 1990, which were forecasted based on previous year program tracking data. Cadmus updated the pre-1990 inputs to reflect the actual proportion reported in PPL Electric Utilities' tracking database.

The impact evaluation sampling strategy is listed in Table 99. Since the year of manufacture is reported in PPL Electric Utilities tracking database for all units, Cadmus reviewed a census of records.

Table 99. Appliance Recycling Gross Impact Evaluation Sample Design for PY8

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Appliance Recycling	11,368	N/A ^[1]	11,368	Records Review
Program Total	11,368	N/A	11,368	
^[1] Because this program's evaluation did not include sampling, Cv and target precision are not meaningful.				

As shown in Table 100, in PY8, the Appliance Recycling Program reported energy savings of 12,035 MWh/yr.

⁶⁹ Pennsylvania Public Utility Commission. *2016 Technical Reference Manual*. Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards. February 2017.

Table 100. Appliance Recycling Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Appliance Recycling	12,035	98%	N/A	N/A
Program Total	12,035	98%	N/A	N/A

Table 101 shows the verified product counts of units recycled in PY8 and the verified energy savings by product.

Table 101. Gross Energy Results by Product

Product	PYVTD MWh/yr	Product Count
Refrigerator	9,475	8,056
Freezer	2,207	2,085
Room air conditioner	162	1,227
Program Total ^[1]	11,844	11,368
^[1] May not match due to rounding.		

Table 102 shows a demand reduction of 1.65 MW in PY8.

Table 102. Appliance Recycling Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Appliance Recycling	1.65	99%	N/A	N/A
Program Total	1.65	99%	N/A	N/A

The following factors led to variation between the reported and verified savings and to the observed realization rates:

- The actual proportion of appliances that were manufactured prior to 1990 was slightly lower than the assumed proportion used to generate the reported savings in PPL Electric Utilities' tracking database.
- The actual proportion for refrigerators was 29% rather than the assumed 35%.
- The actual proportion for freezers was 57% rather than the assumed 60%.

9.4 Net Impact Evaluation

Calculating the net savings for appliance recycling programs is more complex than for most types of energy efficiency programs. Cadmus followed the methodology described in the Common Methods for Appliance Recycling programs specified by the SWE (Phase III Evaluation Framework, Appendix B).⁷⁰ This

⁷⁰ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by the Statewide Evaluation Team (NMR Group Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC). Contracted under the Pennsylvania Public Utility Commission's RFP 2015-3 for the Statewide Evaluator. Final version August 25, 2016.

is consistent with the Uniform Methods Project (UMP) appliance recycling protocol to determine program net savings.⁷¹

The approach has three major factors for determining net savings:

- Free ridership is a measure of the savings that participants would have achieved on their own in the absence of the program. Secondary market impacts account for the fact that recycling units through the program does not lead to a one-for-one reduction in the number of appliances operating on the grid. Induced replacement accounts for the portion of households that replace the appliance they recycled, when the appliance would not have been replaced absent the program. These impacts are subtracted from verified gross savings.
- Spillover, on the other hand, credits additional savings that participants achieved on their own, where their experience with the program was highly influential in their decision to install energy-efficient equipment without the incentive of rebates. Spillover adds to gross savings.
- Net savings are determined only for future program planning purposes. Energy savings and demand reduction compliance targets are met using verified gross savings.

Table 103 lists the methods and sampling strategy used to determine net savings for the Appliance Recycling program in PY8. Additional details about methodology are in *Appendix I Section 1.2 Net Impact Evaluation*.

Table 103. Appliance Recycling Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size ^[1]	Final Sample Population	Achieved Sample Size	NTG Activity
Appliance Recycling	Freezers	1,719	777	82	Online self-report surveys
Appliance Recycling	Refrigerators	6,562	3,133	327	Online self-report surveys
Appliance Recycling	Freezers	1,719	1,316	70	Telephone self-report surveys
Appliance Recycling	Refrigerators	6,562	4,760	70	Telephone self-report surveys
Appliance Recycling	Nonparticipating customers	1,202,758 ^[3]	9,000	9 ^[2]	Telephone self-report surveys
Program Total				558	

^[1] Population Refers to number of freezers and refrigerators recycled. The sample frame after cleaning is contained in Table I-267.

^[2] Only nine respondents in the general population survey said they had recycled a working appliance outside of the program and provided their chosen method of disposal. Given the small sample size, nonparticipant responses were not included in the NTG analysis.

^[3] Cadmus selected a random sample from the full population of PPL Electric Utilities' residential customers.

⁷¹ National Renewable Energy Laboratory. *Uniform Methods Project (Chapter 7)*. Available online: <http://energy.gov/sites/prod/files/2013/11/f5/53827-7.pdf>

Table 104 shows the free ridership, spillover, and NTG ratios by program component. The precision for the NTG ratio did not meet the 15% target at 85% confidence because of a large variance in the spillover estimates. Most survey respondents had zero spillover savings and, of those who did, a small handful reported very large spillover savings (nearly 100 times the average) from equipment such as heat pump water heaters. Absent spillover, precision was 9% for refrigerators and 15% for freezers. Individual spillover equipment and quantities are included in *Appendix I.2.3 Net-to-Gross Ratio Findings*.

Table 104. Appliance Recycling Net Impact Evaluation Results

Target Group or Stratum (if appropriate)	PYVTD (MWh/yr)	Free Ridership and SMI (%)	Induced Replacement (%)	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.
Refrigerator	9,475	38%	1%	3%	0.65	88%
Freezer	2,207	37%	0%	5%	0.68	115%
Air Conditioner	162	0% ^[1]	0%	0%	1.0	NA
Program Total ^[2]	11,844				0.66	73%

^[1] Free ridership is assumed to be zero because their pick up is a convenience only if a household recycles a refrigerator or freezer.
^[2] May not match due to rounding.

Table 105 shows historical and current NTG ratios, which have remained stable over the life of the program, between 0.60 and 0.70, with the exception of a temporary uptick in PY5.⁷² PY7 is not included in the table because no surveys were fielded in PY7,⁷³ and the PY6 NTG ratio was applied that year.⁷⁴

Table 105. Current and Historical Net-to-Gross Ratios

Program Year	Net-to-Gross Ratio
PY8	0.66
PY6	0.60
PY5	0.74
PY4	0.68
PY3	0.63
PY2	0.61

Table 106 compares the NTG ratio for PPL Electric Utilities' program with results from recent evaluations from other utilities. The most recent results are 2015 and, similar to PPL Electric Utilities' program, these

⁷² PPL Electric Utilities. *Annual Report Program Year 5: June 1, 2013–May 31, 2014*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2014.

⁷³ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

⁷⁴ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

programs were suspended and relaunched. The NTG ratio for PPL Electric Utilities' program is higher than average, which is particularly notable given that the incentives are lower than other programs.

Table 106. Net-to-Gross Ratio Benchmarking

Evaluation	Evaluation Year	Refrigerator	Freezer	Incentive per-Unit
PPL Electric Utilities	2016-2017	0.65	0.68	\$35
Mid-Atlantic	2014-2015	0.42	0.42	\$50
Midwest Utility 1	2015	0.36	0.48	\$40
Midwest Utility 2	2014-2015	0.51	0.59	\$50
Midwest Utility 3	2016	0.70	0.73	\$50

9.5 Verified Savings Estimates

In Table 107, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Appliance Recycling Program in PY8. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 107. PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Demand (MW/yr) ^[1]
PYRTD Gross	12,035	1.65
PYVTD Gross	11,844	1.63
PYVTD Net ^[2]	7,770	1.07
P3RTD Gross	12,035	1.65
P3VTD Gross	11,844	1.63
P3VTD Net ^[2]	7,770	1.07
^[1] May not match due to rounding.		
^[2] Net savings are not used to meet PPL Electric Utilities' energy savings compliance target.		

9.6 Process Evaluation

9.6.1 Research Objectives

The purpose of the process evaluation was to assess and provide recommendations for improving the Appliance Recycling Program's effectiveness in achieving its objectives. The main research objectives focused on these areas:

- Document program goals and design
- Document program administration, program delivery and implementation
- Evaluate customer satisfaction with the program
- Determine possible program enhancements

- Determine whether PPL Electric Utilities, ICSP, and the ICSP's subcontractor are meeting key performance indicators

9.6.2 Evaluation Activities

Table 108 lists the PY8 process evaluation activities for the Appliance Recycling Program.

Table 108. Process Evaluation Activities

Activity	Planned Target	Number Completed
PPL Electric Utilities Program and ICSP Staff program manager interviews	3	3
Online participant survey	All eligible	409
Telephone participant survey	140 ^[1]	140
Telephone nonparticipant survey	Up to 70 ^[2]	9 ^[3]
Program database review	-	-
Logic model review	-	-

^[1] The 140 surveys targeted 70 participants who recycled a refrigerator and 70 who recycled a freezer.
^[2] Nonparticipant surveys were fielded in PY8 as part of the general population residential lighting survey.
^[3] The number of completed surveys depended on the number of eligible respondents in this survey. Only nine respondents told Cadmus how they disposed of a working refrigerator or freezer and how they disposed of the appliance outside of the program.

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

- Appliance Recycling Program nonparticipant surveys were fielded in PY8 as part of the general population residential lighting survey. Cadmus did not have enough eligible nonparticipant respondents to the general population residential lighting survey to include the responses in the net savings analysis. Only nine survey respondents told Cadmus how they disposed of a working refrigerator or freezer and how they disposed of the appliance outside of the program. Cadmus relied solely on participant survey respondents to determine the NTG ratio.

Table 109 lists the process evaluation sampling strategy. Additional details about sampling methodology are included in *Appendix I.3.1*.

Table 109. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size ^[1]	Number of Records Selected for Sample Frame ^[2]	Percent of Sample Frame Contacted to Achieve Sample ^[3]
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone In-depth Interview	3	-	3	3	N/A	100%
Participants	Appliance Recycling	Online survey	8,281 ^[4]	-	As many as possible	409	3,910	100%
		Telephone survey	8,281 ^[4]	90/10 stratified random sample	140 ^[5]	140	6,076	46%
Nonparticipants	General Population Residential Lighting Survey	Telephone survey	1,202,758 ^[6]	N/A	Up to 70 ^[7]	9 ^[8]	9,000 ^[9]	99%
Program Total	N/A	N/A	N/A	N/A	N/A	561	N/A	N/A

^[1] Number includes only completed surveys. Respondents could skip questions.

^[2] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities' database. After selecting all unique records, Cadmus removed any records from the population if the customers had participated in a survey in the last three months, were selected for another program survey, did not have valid contact information (email or telephone number), were on the do not call list or opted out of the online survey.

^[3] Percent contacted means the percentage of the sample frame called or emailed to complete surveys.

^[4] Number of records available at time of final survey (Q1-Q3).

^[5] The 140 surveys targeted 70 participants who recycled a refrigerator and 70 who recycled a freezer.

^[6] Cadmus selected a random sample from the full population of PPL Electric Utilities' residential customers.

^[7] Nonparticipant surveys were fielded in PY8 as part of the general population residential lighting survey. The survey asked if the respondent recycled a refrigerator or freezer. If so, the survey went on to ask additional questions about the recycled appliance.

^[8] The number of completed surveys depended on the number of eligible respondents in this survey.

^[9] Cadmus selected 9,000 records but only dialed 8,998.

9.6.3 Summary of Process Evaluation Findings

Program Delivery

The Appliance Recycling Program was delivered well, despite not meeting its estimated savings and participation in PY8. PPL Electric Utilities said it was pleased with the transition to the new Phase III ICSP and the ICSP's subcontractor after the previous ICSP (JACO Environmental) unexpectedly discontinued its program midway through PY7. Participant satisfaction was high in PY8. The program started on time and ran smoothly from the beginning. Throughout the participant survey, Cadmus found that very few customers reported complaints or suggestions about how to change the program. However, the participation trends in PY8 show that, despite the successful transition, the previous ICSP's unexpected closure caused some loss of momentum.

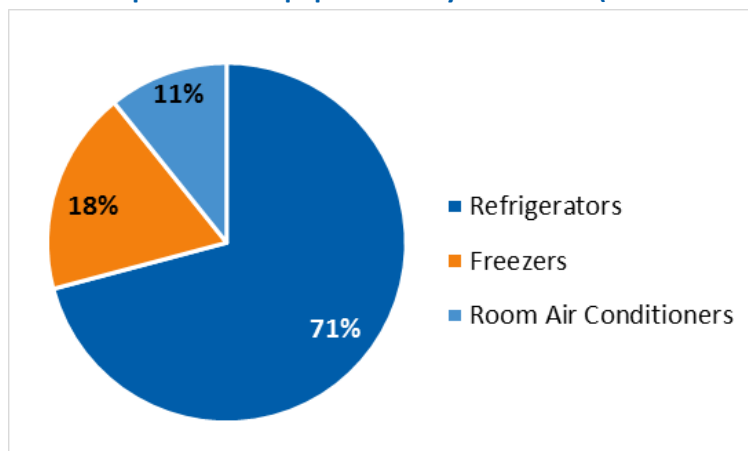
Program Changes

The primary delivery changes in the program from Phase II to Phase III were intended to make it easier for customers to engage with the program. These changes were to add Saturday pick-up times and, in higher volume areas, make sure the ICSP always offered at least two possible pick-up dates within a two-week window. In addition, the ICSP asked its subcontractor to add a procedure to allow appliance pick-ups without the customer being present. This procedure involved requiring that the unit be shut tightly with duct tape with a note authorizing pick-up. This procedure was never used in PY8, but was made available.

Appliance Recycling Program Savings and Participation

The program did not meet its estimated savings for two reasons. First, overall participation was 5% lower than estimated with 11,368 appliances recycled in PY8. Second, more air conditioners were recycled with the refrigerators than anticipated—1,227 were recycled compared to 917 estimated, 11% of the total units recycled, as shown in Figure 29, instead of the estimated 8%. (Room air conditioners can be recycled only with a recycled refrigerator or freezer.) The energy savings from the additional air conditioners did not make up for unrealized refrigerator savings because room air conditioners have lower per-unit savings than refrigerators and freezers.

Figure 29. Proportion of Equipment Recycled in PY8 (% of Total Units)



Source: PPL Electric Utilities Tracking Database

The PY8 program participation trends show a steady ramp-up in the spring, which is different than in PY5 and PY6 when the program started with higher participation because of retained momentum from the previous program year (Figure 30).^{75,76,77} Because the previous ICSP unexpectedly discontinued its program during PY7,⁷⁸ the PY8 Appliance Recycling Program spent the spring and summer ramping up—these are seasons when program participation is traditionally high. Unlike prior years, participation in PY8 peaked later in the winter; however, this did not make up for the initial slow ramp-up period. All program years show the seasonal nature of participation in the Appliance Recycling Program.⁷⁹

According to PPL Electric Utilities, the launch of the Appliance Recycling Program in Phase III was consistent with its expectations. It also said the initial discontinuation of the program in PY7 was helpful in some ways, because it was more like starting a new program from the beginning (with a waitlist) instead of trying to create a transition plan.⁸⁰

⁷⁵ PPL Electric Utilities. *Annual Report Program Year 5: June 1, 2013–May 31, 2014*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2014.

⁷⁶ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

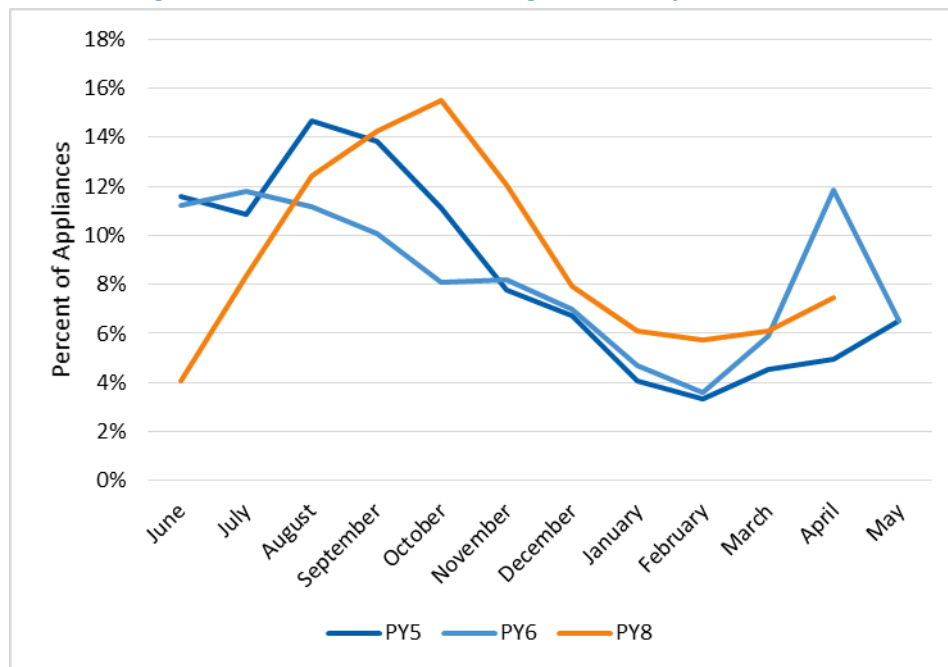
⁷⁷ Cadmus did not conduct a process evaluation in PY7.

⁷⁸ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

⁷⁹ PPL Electric Utilities' tracking database did not include data for pick-ups in May 2017.

⁸⁰ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Figure 30. PY5, PY6, and PY8 Program Participation Trends



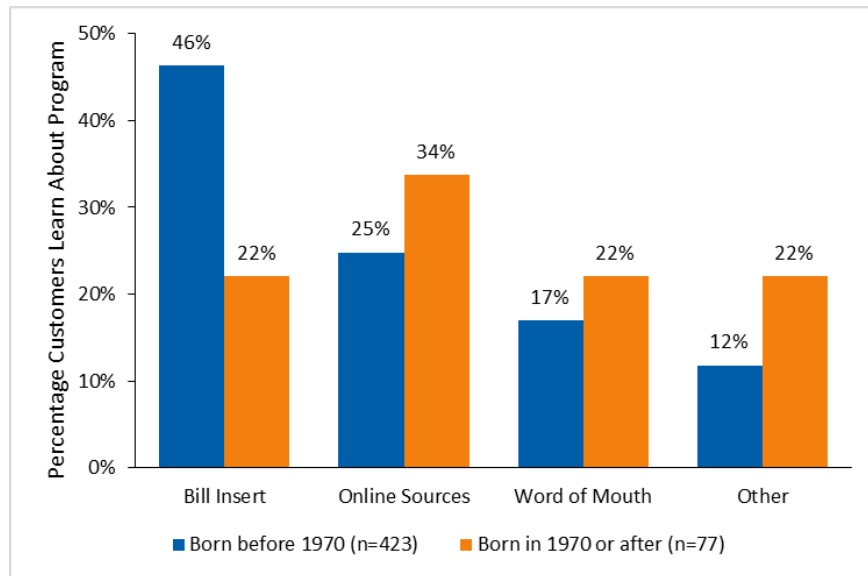
Source: PPL Electric Utilities Tracking Database. Note that Cadmus did not conduct a process evaluation in PY7.

Program Marketing and Program Demographics

Traditionally, the Appliance Recycling Program has been well communicated to customers through bill inserts, and this has remained an important marketing channel in PY8. In PY8, survey data confirmed that the most common way that customers learned about the program was through bill inserts from PPL Electric Utilities. Although PPL Electric Utilities is not required to reach all age groups within its customer base, demographic data from the participant surveys suggest that the program is reaching older generations and not younger. As a comparison, 40% (n=287) of Energy Efficient Home Program participants were born in 1970 or after while only 17% (n=507) of Appliance Recycling Program participants were in this age group.

Cadmus compared respondents born before 1970 with younger respondents. As shown in Figure 31, older respondents heard about the program mostly through bill inserts (46%, n=423), and younger respondents (n=77) heard about the program through a variety of channels including online sources (34%), bill inserts (22%), and word of mouth (22%) (Figure 31). This shows that older respondents are twice as likely to have heard of the program through a bill insert as younger respondents. A marketing strategy that emphasizes multiple channels of communication appears to reach all ages.

Figure 31. Ways Participants Learn about the Program vs. Participant Age

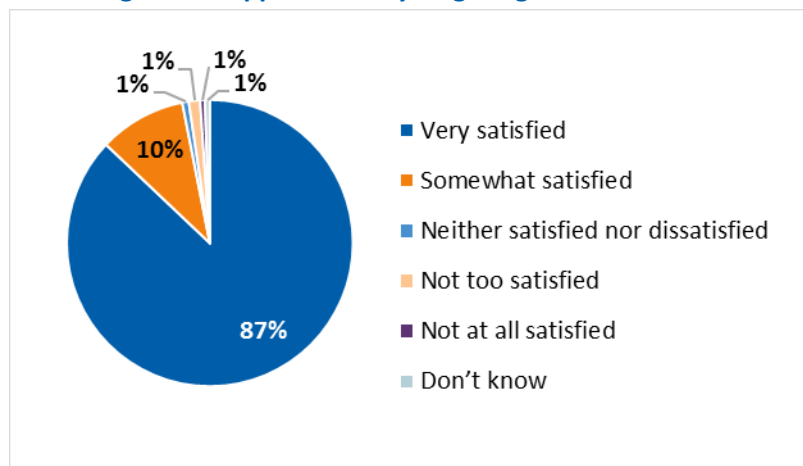


Source: ICSP tracking data and participant survey question, “What year were you born?”

Program Satisfaction

Program satisfaction remains very high and did not change much from PY6. Nearly all participant survey respondents (97%, n=549) said they were satisfied with the program overall compared to 99% in PY6 (n=226).⁸¹ In PY8, 87% of participant respondents said they were *very satisfied* and 10% said they were *somewhat satisfied*. Figure 32 shows the breakdown of program satisfaction.

Figure 32. Appliance Recycling Program Satisfaction



Source: Participant survey question, “Now, thinking about your overall experience with the PPL Electric Utilities residential rebate program, how would you rate your satisfaction?” (n=559) Includes responses from completed surveys and partially completed surveys. Total may exceed 100% due to rounding.

⁸¹ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

Program Key Progress Indicators

The Appliance Recycling Program fulfilled its satisfaction KPI, as discussed in *Appendix I.3.2 Key Performance Indicators*:

- 97% satisfaction (n=559) among surveyed participants (target: 80%)⁸²

Additional detail regarding findings from process evaluation activities and methodology is in *Appendix I.3.1*.

9.7 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 110. Cadmus calculated TRC benefits using gross verified impacts. The NPV PYTD costs and benefits are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). NPV costs and benefits for P3TD financials are expressed in PY8 dollars.

⁸² Includes responses from completed surveys and partially completed surveys.

Table 110. Summary of Appliance Recycling Program Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$341		\$341	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	-		-	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	\$341		\$341	
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$38	-	\$38	-
7	Marketing ^[4]	-	\$162	-	\$162
8	Program Delivery ^[5]	-	\$1,405	-	\$1,405
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$1,604		\$1,604	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-		-	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$1,945		\$1,945	
14	Total NPV Lifetime Electric Energy Benefits	\$3,409		\$3,409	
15	Total NPV Lifetime Electric Capacity Benefits	\$623		\$623	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	-		-	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$4,032		\$4,032	
19	TRC Benefit-Cost Ratio ^[9]	2.07		2.07	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Table 111 presents program financials and cost-effectiveness on a net savings basis.

Table 111. Summary of Appliance Recycling Program Finances—Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$341		\$341	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	-		-	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	\$341		\$341	
		EDC	CSP	EDC	EDC
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$38	-	\$38	-
7	Marketing ^[4]	-	\$162	-	\$162
8	Program Delivery ^[5]	-	\$1,405	-	\$1,405
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$1,604		\$1,604	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-		-	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$1,945		\$1,945	
14	Total NPV Lifetime Electric Energy Benefits	\$2,237		\$2,237	
15	Total NPV Lifetime Electric Capacity Benefits	\$409		\$409	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	-		-	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$2,645		\$2,645	
19	TRC Benefit-Cost Ratio ^[9]	1.36		1.36	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

9.8 Status of Recommendations

After a slow start from the initial loss of momentum caused by the unexpected program closure in PY7, the program delivery went smoothly, with effective coordination between the ICSP and the ICSP's subcontractor. Through the participant survey, Cadmus found that participants were highly satisfied with the program; 97% of respondents reporting they were *very* or *somewhat satisfied* and they had very few complaints or suggestions for changing the program. In addition, the NTG ratio for PPL Electric Utilities' program is higher than average, which is particularly notable given that the incentives paid are lower than programs in other jurisdictions benchmarked in this report.

Overall the program is running well and there is no reason to make delivery changes at this time. The impact and process evaluation activities in PY8 led to the following findings, and Cadmus made one recommendation to PPL Electric Utilities. A summary of how PPL Electric Utilities plans to address the recommendation in program delivery is presented in Table 112.

Finding: Demographic data from the participant surveys suggest that the program is reaching older generations, and not as many younger customers. As a comparison, 40% (n=287) of Energy Efficient Home Program participants were born in 1970 or after, while only 17% (n=507) of Appliance Recycling program participants were in this age group. Both programs are more likely to reach homeowners than renters (see 9.6.3 *Program Marketing and Program Demographics*).

Comparisons of respondents born earlier than 1970 with respondents born in 1970 or later found that older respondents were twice as likely to have heard of the program through a bill insert (46%) than younger respondents (22%). Younger respondents heard about the program through a greater variety of channels, most commonly through online sources (34%, n=77) (see 9.6.3 *Program Marketing and Program Demographics*).

Conclusion: Although reaching all age groups is not an objective of the program, it may be useful to compare the demographics of the program to the demographics of other rebate programs because there may be a variety of reasons why the Appliance Recycling Program is reaching older customers and not younger. For example, older customers are more likely to have aging or secondary appliances that need recycling. Some research may help determine if there is a sizeable number of appliances reaching the "recycling age" in the younger demographic. It also might be worth considering a marketing strategy in future years that emphasizes multiple channels of communication involving savvy online tactics. This would reach all ages of participants, which is important, because younger participants could be future participants and the source of future energy savings for this program.

Recommendation #1: If program participation dips, consider opportunities to tailor marketing strategies to younger customers (those born in 1970 or later) who are not reached as effectively as other demographic groups by mailed bill inserts. For example, explore outreach entry points such as paid online media advertisements and social media influencers. One possibility is to target younger customer segments by purchasing advertisements on social media sites such as Instagram, Facebook, and Twitter.

9.8.1 Status of Recommendations for Program

Table 112 contains the status of each PY8 recommendation made to PPL Electric Utilities.

Table 112. Status of Recommendations

Appliance Recycling Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	Demographic data from the participant surveys suggest that the program is not reaching younger participants. If program participation dips, consider opportunities to tailor marketing strategies to younger participants, who are not reached as effectively as are other demographics by bill inserts sent through the mail. For example, explore outreach entry points such as paid media advertisements and influencers. One possibility is to target younger customer segments by purchasing advertisements on social media sites such as Instagram, Facebook, and Twitter.	Being considered. PPL Electric Utilities needs more information to determine the reason the program collects fewer refrigerators from younger customers. They could be renters who do not control the appliance, they could own newer refrigerators that do not benefit from recycling, they may need different marketing information to encourage participation, etc.

10 Energy Efficient Home Program

The Energy Efficient Home Program is designed for new construction and retrofitted existing homes. The program offers a wide range of energy-efficient products, rebates, education, and services that give customers a variety of customizable solutions to increase their home's energy efficiency. The program has these five components: new home construction incentives, in-home energy audits (including energy-savings kits), online home energy assessments (including energy-savings kits), weatherization, and energy efficiency equipment.

In PY8, the new homes component offers up to \$2,500 in incentives for the construction of energy-efficient new homes through either \$0.30 per annual kWh saved for homes at least 15% above the residential building code (2009 IECC) or \$0.35 per annual kWh saved for ENERGY STAR®-rated homes at least 15% above code.

The in-home energy audit and the online energy assessment components provide tools and information that help residential customers make decisions about actions they can take to improve the energy efficiency of their homes. Energy savings for the two types of audits, comprehensive in-home audits and online assessments, accrue from low-cost energy-efficient products mailed to the customers in an energy-savings kit. The kits currently include LEDs, faucet aerators, energy-efficient showerheads, pipe insulation, and weatherstripping.⁸³ (Faucet aerators, showerheads, and pipe insulation are distributed only to homes with electric water heating.)

The weatherization component provides customers with rebates when they make any of these three eligible home improvements: attic insulation, wall insulation, or air sealing.

Lastly, the equipment component offers downstream rebates for eligible products, including air source heat pumps (SEER 16+), ductless heat pumps (< 5.4 tons, ≥ SEER 15, ≥ HSPF 8.6), central air conditioners (SEER 16+), heat pump water heaters (≥ 2.3 EF), efficient pool pumps (variable speed drive), ENERGY STAR refrigerators, advanced smart thermostats, and fuel-switching to non-electric high-efficiency central heating equipment (natural gas or propane furnace, oil furnace, or fossil fuel boiler).

PPL Electric Utilities' energy efficiency program staff provides overall strategic direction and program management. Its EM&V staff oversees evaluation activities and coordinates with programs staff.

Ecova manages the program and serves as the ICSP. The ICSP delivers the audit, weatherization, and efficient equipment portions of the program to customers. This involves maintaining a call and rebate processing center, conducting in-home audits, recruiting and educating trade allies (HVAC contractors, heat pump water heater retailers, in-home energy auditors, new home builders), and marketing the

⁸³ Customers participating in the Energy Efficient Home Program through February 2017 received electroluminescent nightlights in the kits. These were later recalled, and customers received replacement LED nightlights. No new kits contain LED nightlights.

program to achieve sufficient participation. Performance Systems Development (PSD) is a subcontractor to the ICSP and is responsible for the program's new home component by processing applications and assisting builders and Home Energy Rating System (HERS) raters.

The objectives of the Energy Efficient Home Program were these:⁸⁴

- Encourage customers to view energy efficiency in a holistic manner
- Provide customers with education, audits, surveys, and energy-saving solutions
- Promote the construction of energy-efficient new homes
- Educate construction industry professionals and other trade allies about the benefits of energy-efficient homes
- Reduce energy consumption by approximately 73,000 MWh/year in gross verified savings
- Achieve high customer and trade ally satisfaction with the program

10.1 Progress Toward Phase III Projected Savings

The Energy Efficient Home Program verified savings are 135% of the estimated MWh/yr savings for PY8. The program plans an annual increase in projected energy savings. It has achieved 13% of the estimated Phase III total planned savings and is making very good progress toward meeting the Phase III projected savings, as planned.

Table 113 shows the program's verified gross program savings and progress toward its Phase III projected energy savings, as filed in the EE&C Plan.

Table 113. Energy Efficient Home Program Estimated Savings

	PY8 Only			Phase III: PY8–PY12		
	Estimated ^[1]	Verified	Percentage of Estimate	Estimated ^[1]	Verified	Percentage of Estimate
MWh/yr	7,357	9,943	135%	73,721	9,943	13%
^[1] Estimated savings are based on PPL Electric Utilities' revised EE&C plan (Docket No. 2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.						

10.2 Participation and Reported Savings by Customer Segment

10.2.1 Definition of a Participant

For all components of the Energy Efficient Home Program, a participant is defined as a rebated project, and each project is assigned a unique job number. For the new homes component, a participant is defined as the single-family home or a tenant unit within a newly constructed multifamily building.⁸⁵

⁸⁴ Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

⁸⁵ In PY8, the new homes participation comprised 60% single-family homes and 40% multifamily units.

10.2.2 Program Participation and Reported Impacts

Table 114 presents the participation counts, reported energy and demand savings, and incentive payments for the Energy Efficient Home Program in PY8 by customer segment.

Table 114. Energy Efficient Home Program Participation and Reported Impacts

Parameter	Residential	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total ^[1]
PYTD # Participants	11,303	65	4	29	11,401
PYRTD MWh/yr	10,424	117	6	74	10,621
PYRTD MW/yr	1.92	0.02	0.00	0.01	1.95
PY8 Incentives (\$1000)	\$1,712	\$17	\$3	\$1	\$1,734
^[1] May not match due to rounding.					

10.3 Gross Impact Evaluation

Cadmus conducted these research activities to inform the gross impact evaluation:

- Program database review
- Records reviews of participant rebates
- Site visits for new homes
- REM/Rate modeling review for new homes⁸⁶
- Participant surveys

Cadmus conducted a database review of each component to ensure that appropriate data were collected and to confirm that *ex ante* savings were properly calculated using the appropriate PA TRM algorithms.

Cadmus conducted reviews for a sample of records to evaluate the savings impacts of the audit, weatherization, and efficient equipment program components. The records reviews accomplished these:

- Verified that product types were correctly categorized based on the verified installed products
- Verified reported equipment data used for PA TRM energy-savings calculations via rebate applications, Air Conditioning, Heating, and Refrigeration Institute (AHRI) certificates, invoices, and other supporting documentation
- Calculated *ex post* savings using the PA TRM algorithms and verified equipment data

Cadmus conducted two verification activities for the new homes component: REM/Rate modeling and site visits. Cadmus used the results from the 40 REM/Rate modeling reviews and data collected during site visits to determine the *ex post* savings. Additionally, Cadmus adjusted the reported product quantities to reflect conditions found during site visits. Cadmus conducted site visits at 20 homes to

⁸⁶ More information about REM/Rate software and applications is available online: <http://www.remrate.com/>

verify installation of lighting, appliance, and ceiling shell products and used these data to verify the building information input in REM/Rate and to collect data on lighting and appliances to determine *ex post* savings.

Lastly, Cadmus used the results of telephone and online surveys to calculate the ISR for the online assessment and in-home audit components and confirmed installation of insulation and efficient equipment.

The evaluation sampling strategy is summarized in Table 115. Additional details about methodology are in *Appendix J*.

Table 115. PY8 Energy Efficient Home Program Gross Impact Sample Design

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
New Homes	339	0.5	20	Site visits
		0.5	40	REM/Rate modeling review
Audit and Kit ^[1]	3,550	0.5	54	Verification online survey
		0.5	78	Verification phone survey
		0.5	80	Records review
Weatherization	482	0.5	25	Verification phone survey
		0.5	40	Records review
Efficient Equipment	7,030	0.5	135	Verification phone survey
		0.5	350	Records review
Program Total	11,401			

^[1] Includes online assessment and in-home audit components. Both channels delivered energy efficiency kits to customers.

In PY8, the Energy Efficient Home Program reported energy savings of 10,621 MWh/yr, as shown in Table 116 and demand reduction of 1.95 MW, as shown in Table 117.

Table 116. Energy Efficient Home Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
New Homes	966	92%	0.18	5.78%
Audit and Kit ^[1]	1,494	69%	N/A	7.21%
Weatherization	664	80%	0.99	18.49%
Efficient Equipment	7,496	100%	0.42	3.13%
Program Total	10,621 ^[2]	94%	N/A	2.70%

^[1] Includes online assessment and in-home audit components. Both channels delivered energy efficiency kits to customers.
^[2] Program total does not match sum of rows due to rounding.

Table 117. Energy Efficient Home Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
New Homes	0.31	89%	0.33	10.82%
Audit and Kit ^[1]	0.14	71%	N/A	6.88%
Weatherization	0.06	83%	0.67	12.53%
Efficient Equipment	1.44	95%	0.41	3.05%
Program Total ^[2]	1.95	92%	N/A	2.85%

^[1]Includes online assessment and in-home audit components. Both channels delivered energy efficiency kits to customers.
^[2] Program total may not match sum of rows due to rounding.

The following factors led to variation between the reported and verified savings and to the observed realization rates of less than 100%:

- New homes.** Cadmus found that most of the variability between the reported *ex ante* and *ex post* savings was caused by lighting and appliance assumptions used by the ICSP to calculate energy and demand savings. Cadmus evaluated REM/Rate models provided by the ICSP's subcontractor by comparing reported data against the data Cadmus obtained during site visits. Cadmus determined that the ICSP used REM/Rate assumptions to calculate savings, which is inconsistent with the PA TRM. Cadmus found fewer high-efficiency lamps than reported. These factors led to a realization rate of 92% for energy savings and 89% for demand savings. Additional information can be found in *Appendix J*.
- Audit and kit.** Cadmus conducted a records review for the in-home audit and kits component and found only a few small errors. It found no inconsistencies between databases for the online assessment component. Using participant surveys, Cadmus calculated ISRs for the online assessment component's energy-savings products included in the kit and found ISRs ranged from 42% to 89%, by product. Cadmus then applied these ISRs to calculate *ex post* savings for the kits delivered through the in-home audit.⁸⁷ The audit stratum had a 69% energy realization rate because of data entry errors as well as lower than expected ISRs for the products included in the kits. Additional information can be found in *Appendix J*.
- Weatherization.** Cadmus' records review found 24 data entry errors across 48 insulation and air sealing participants and that the baseline R-value was incorrectly calculated for 11 insulation participants. Both sets of errors led to an 80% energy realization rate for the weatherization component. Additional information can be found in *Appendix J*.
- Efficient equipment.** Cadmus' records review found 141 errors across air source heat pump, central air conditioner, ductless heat pump, fuel switching, heat pump water heater, and smart

⁸⁷ In-home audit kits arrived after the auditor was in the home, and therefore could not be installed by the auditor. Because the items were not installed by the auditor, the ISR for directly installed items was not applied. Additionally, due to the small sample size for in-home audit survey (n=11), a separate ISR for this component was not justifiable. Cadmus applied the ISR from the online assessment because the two were operationally similar, with customers installing them in their home without assistance from a contractor.

thermostat participants. No errors were found in the review of pool pumps and ENERGY STAR refrigerators. Errors generated verified savings both above and below 100% of the *ex ante* savings, so overall, the errors offset each other to produce a 100% energy realization rate for the efficient equipment component. Additional information can be found in *Appendix J*.

10.4 Net Impact Evaluation

Free ridership, spillover, and the methods Cadmus used to determine net savings for downstream, upstream, and midstream programs are provided in the Phase III Evaluation Framework.⁸⁸ Cadmus used self-report surveys to assess free ridership and spillover for the Energy Efficient Home Program.

Free ridership is a measure of the savings that participants would have achieved on their own in the absence of the program; these savings are subtracted from verified gross savings. Spillover credits additional savings that participants achieved on their own. This refers to participants whose experience with the program was highly influential in their decision to install energy-efficient equipment without the incentive of rebates. Spillover increases gross savings.

Cadmus calculates net savings only to inform future program planning. Energy savings and demand reduction compliance targets are met using verified gross savings.

Table 118 lists the methods and sampling strategy used to determine net savings for the Energy Efficient Home Program in PY8. Additional details about methodology are in *Appendix J*.

⁸⁸ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

Table 118. Energy Efficient Home Program Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size ^[1]	Achieved Sample Size	Respondents' % of Reported Savings	NTG Activity
Builders	New Homes	17	10	76%	Builder self-report interviews
Participants (Customers)	Audit and Kit ^[2]	3,550	54	4%	Participant self-report online survey
			78		Participant self-report phone survey
	Weatherization	482	25	4%	Participant self-report phone survey
	Efficient Equipment	7,030	135	5%	Participant self-report phone survey ^[3]
Program Total		11,078	302	13%	

^[1] Population refers to unique projects, with exception of New Homes, which refers to the population of builders (builders receive the program incentive). The sample frame after cleaning and removing duplicate customer accounts is contained in Table J-288 in *Appendix J*.

^[2] Includes online assessment and in-home audit components. Both channels delivered energy efficiency kits to customers.

^[3] Cadmus selected a sample of 75 participant surveys for these high-impact measures: ductless heat pumps, central air conditioners, and air-source heat pumps. Heat pump water heaters were included in the HVAC group. For the following measures, the sample size was 60: pool pumps, refrigerators, smart thermostats, and fuel switching.

Table 119 shows the free ridership, spillover, and NTG ratios by program component.

Table 119. Energy Efficient Home Program Net Impact Evaluation Results

Stratum	PYVTD	Free Ridership (%) ^[1]	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.	Verified Gross Population kWh/yr Savings
New Homes	10	51%	0%	0.49	35%	893,210
Online Assessment Kit	114 ^[2]	7%	9%	1.02	8%	997,284
Audit – In-Home	11	4%	1%	0.97	5%	30,313
Weatherization	25	49%	7%	0.58	14%	534,699
Efficient Equipment	135	41%	7%	0.66	25%	7,487,966
Program Total ^{[3] [4]}	295	39%	7%	0.68	40%	9,943,472

^[1] These estimates were weighted by the survey sample-verified program kWh/yr savings. This method ensures that respondents who achieved higher energy savings through the program products have a greater influence on the measure-level free ridership estimate than do the respondents who achieved lower energy savings.

^[2] Seven respondents reported not installing any of the kit products and were not included in the NTG analysis.

^[3] The stratum level free ridership, spillover, and NTG estimates were weighted by the product's verified kWh/yr program population savings to arrive at the final Energy Efficient Home Program NTG ratio of 0.68.

^[4] May not match due to rounding.

10.4.1 High-Impact Measure Research

The Phase III Evaluation Framework requires the identification and oversampling of high-impact products and services to assess free ridership with greater certainty. In the Energy Efficient Home Program, Cadmus expected HVAC equipment (i.e., air source heat pumps, ductless heat pumps, and

central air conditioners) to contribute the largest proportion of program energy savings. For net savings calculations, Cadmus exceeded the Evaluation Framework's requirement for high-impact measure sampling at 85/15 by completing 45 self-report surveys. The relative precision of the high impact HVAC measures free ridership estimate at 85/15 confidence and precision is 13%.

Table 120 presents the product-level free ridership estimate for the Energy Efficient Home Program's high impact HVAC equipment.

Table 120. Energy Efficient Home Program High-Impact Measure Free Ridership Results

High-Impact Measures	Population ^[1]	Number of Respondents	Free Ridership (%)
Air Source Heat Pump	1,177	19	46% ^[2]
Central Air Conditioning	818	12	57% ^[2]
Ductless Heat Pump	907	14	43% ^[2]
Overall	2,902	45	44% ^[3]

^[1] Unique accounts.

^[2] These estimates were weighted by the survey sample-verified program kWh/yr savings. This method ensures that respondents who achieved higher energy savings through the program products have a greater influence on the measure-level free ridership estimate than do the respondents who achieved lower energy savings.

^[3] The overall free ridership estimate of 44% was weighted by the verified kWh/yr program savings across all high-impact measure respondents; 13% relative precision at 85/15 confidence and precision.

In PY8, free ridership was lower than was estimated in PY7 for all high-impact HVAC equipment except air source heat pumps (46% in PY8 and 39% in PY7). A possible reason for the increase in free ridership for air source heat pumps was that participants received larger rebates in PY7 compared to PY8.

In PY7, 80% of air source heat pump survey respondents received a program rebate of \$1,200. In PY8, 100% of the air source heat pump survey respondents received a program rebate of \$200. Holding all else equal, Cadmus would expect PY8 respondents who received a \$200 incentive to exhibit higher indications of free ridership than PY7 respondents who received a \$1,200 incentive.

Cadmus also interviewed 10 HVAC contractors about their standard practices and the importance of the program's rebates. Eight HVAC contractors said the PPL Electric Utilities rebates did not have much impact on their revenue and sales. Two contractors said the rebates provided some credibility to their standard business practices. Only two said they saw an increase (of about 30%) in sales because of the rebates. Nevertheless, half of the HVAC contractors interviewed said the rebate program was important in their decision to stock, promote, or install high-efficiency HVAC equipment.

10.5 Verified Savings Estimates

In Table 121, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Energy Efficient Home Program in PY8. These totals are added to the verified savings achieved in previous program years to calculate the P3TD program impacts.

Table 121. PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Demand (MW/yr) ^[1]
PYRTD Gross	10,621	1.95
PYVTD Gross	9,943	1.78
PYVTD Net ^[2]	6,736	1.16
P3RTD Gross	10,621	1.95
P3VTD Gross	9,943	1.78
P3VTD Net ^[2]	6,736	1.16
^[1] May not match due to rounding.		
^[2] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		

10.6 Process Evaluation

10.6.1 Research Objectives

The purpose of the process evaluation was to assess program effectiveness and provide recommendations to help the program achieve its objectives. The main research objectives focused on these areas:

- Customer and trade ally satisfaction with the program
- Customers' motivation to participate in the program and their barriers to adopting energy-efficient practices
- Effect of PPL Electric Utilities' programs on customers' decisions and trade ally business practices
- Whether PPL Electric Utilities and ICSPs met performance objectives and key metrics

10.6.2 Evaluation Activities

PY8 process evaluation activities for the Energy Efficient Home Program are listed in Table 122 and further described in *Appendix J*.

Table 122. Process Evaluation Activities

Activity	Number Completed
PPL Electric Utilities and ICSP program manager interviews	5
Online participant survey	54
Telephone participant survey	238
In-home energy auditor interview	5
Heat pump water heater retailer interview	5
HVAC contractor interview	10
New home builder interview	10
Program database review	All records
Logic model review	N/A
Key performance indicators (KPIs) progress assessment	N/A

There were four deviations from the evaluation plans. First, Cadmus did not field telephone surveys with manufactured homes participants or interviews with manufactured homes dealers because PPL Electric Utilities temporarily discontinued this offer at the beginning of PY8.

Second, Cadmus did not field online participant surveys for weatherization and efficient equipment participants because customer contact information was not received with sufficient time to complete the survey and analysis for this annual report. Instead, Cadmus fielded telephone surveys for equipment and weatherization participants. In PY9, Cadmus will field online surveys for efficient equipment and weatherization participants.

Third, Cadmus did not reach the target number of completed surveys for the in-home audit and kit component. Although the plan specified 70 participant surveys, the population of this component was 88 participants, rendering that target unachievable. Cadmus completed eight telephone surveys and three online surveys.

Finally, Cadmus evaluated lighting savings from the new homes component. Cadmus used interviews with builders to verify LED lightbulbs installed in program homes were not purchased from retailers to ensure savings were not already counted in PPL Electric Utilities' residential Efficient Lighting Program. Based on those responses, Cadmus calculated an LED adjustment coefficient. This methodology is discussed further in *Appendix J.1.1*.

Table 123 lists the process evaluation sampling strategy. Additional details about sampling methodology are included in the *New Homes* section in *Appendix J.2.1* and the *Trade Ally Interviews* section in *Appendix J.3.1*.

Table 123. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame ^[2]	Percent of Sample Frame Contacted to Achieve Sample ^[3]
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone in-depth interview	5	N/A	5	5	N/A	100%
Participants ^[1]	In-Home Audit and Kit	Online survey	88	90/10	All records	3	73	100%
		Telephone survey		90/10	70	8	56	100%
	Online Assessment	Online survey	3,462	90/10	All records	51	3137	100%
		Telephone survey		90/10	70	70	2702	65%
	Equipment	Telephone survey	7,030	90/10	135	135	2,331	99%
	Weatherization	Telephone survey	482	85/15	25	25	295	90%
Contractors or Retailers	In-Home Audit and Kit	Telephone in-depth interview	8	N/A	5	5	8	100%
	Equipment	Telephone in-depth interview	380 HVAC, 267 HPWH	N/A	10 HVAC, 5 HPWH	10 HVAC, 5 HPWH	380 HVAC, 267 HPWH	5% HVAC, 6% HPWH
Builders	New Homes	Telephone in-depth interview	17	N/A	10	10	17	100%
Program Total			11,358			327		
<p>^[1] For participants, population refers to unique projects at the time of the survey.</p> <p>^[2] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL database. After selecting all unique records, Cadmus removed any records from the population if the customers had participated in a survey in the last three months, were selected for another program survey, did not have valid contact information (email or telephone number), were on the national Do Not Call list, or opted out of the online survey.</p> <p>^[3] Percent contacted means the percentage of the sample frame called to complete surveys.</p>								

10.6.3 Summary of Process Evaluation Findings

The following sections highlight the major program delivery and satisfaction findings. Additional detail regarding findings from process evaluation activities and their methodology are in *Appendix J*.

Program Delivery Summary

The Energy Efficient Home Program is PPL Electric Utilities' most comprehensive residential program, with rebates for new construction, equipment and weatherization retrofits, no-cost kit products, and educational components. The program achieved high satisfaction among its participants and trade allies during PY8, the first year of Phase III, exceeding expectations for savings and participation and surpassing goals for rebate-processing times to enhance customer experience. The program was delivered smoothly by the ICSP and its subcontractor, particularly considering the complexity and size of the program. The program experienced few challenges with delivery.

Cadmus' combined process and impact evaluation activities and found minor opportunities for improvement that, if resolved, could enhance the program's success for the remainder of the phase. These were the challenges:

- The in-home audit component experienced some difficulties with the ordering system for kits. Many auditors said kits were not delivered in time for the audit, so they could not help customers install the kit products.
- A large percentage of participants purchased air-source heat pumps and central air conditioners that were on the low end of the rebate eligibility requirements. This was in contrast to ductless mini-split heat pumps, for which PPL Electric Utilities offered a tiered system that rebated higher seasonal energy efficiency rating (SEER) units at greater incentive levels.
- In the new homes component, builders installed fewer high-efficacy lamps than expected. Because lighting efficiency has a low-cost and high impact on energy efficiency, Cadmus anticipated high-efficacy light installation rates to be near 100%. Cadmus found that 45% of installed lamps were CFLs and 23% were LEDs. In general, builders said the low installation rate for high-efficacy lights was because of concerns with CFL performance, lifespan, and poor color spectrum (i.e., the cold light emitted by efficient bulbs was perceived to be less aesthetically pleasing).

Standard Market Practice

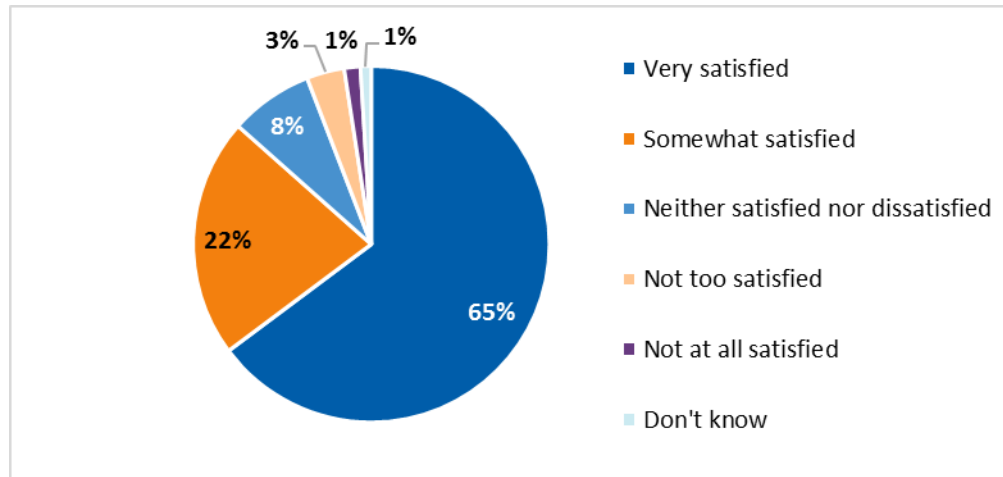
The new home builder interviews found that most builders were likely to include the same features and equipment in their homes without the PPL Electric Utilities rebates, which was in line with the high free ridership of 60% for this component. When asked which factors influenced their decision to build homes to the program's eligibility standards, builders often said that the PPL Electric Utilities program rebates had little influence on their building practice (only three out of 10 said *extremely influential*). Data from

these interviews suggest that the market is already moving toward efficient building practices, particularly compared to the 2009 IECC,⁸⁹ which is the program’s baseline.

Satisfaction Summary

In PY8, the majority of participants (n=409) Cadmus interviewed or surveyed were satisfied with their experience in the Energy Efficient Home Program (Figure 33). In addition, over half (57%) said that their opinion of PPL Electric Utilities had at least improved somewhat after participating in the program.

Figure 33. Participant Overall Satisfaction with Program



Participant Survey Questions J1 (Equipment; Weatherization) and I1 (In-Home Audit): “Now, thinking about your overall experience with the PPL Electric Utilities [program] rebate program, how would you rate your satisfaction?” (Equipment n=146, Weatherization n=28, In-Home Audit n=13, Online Assessment n=222).

Cadmus also interviewed trade allies and builders involved with the program. They also said they were satisfied with the program; 27 out of 30 were either *very satisfied* or *somewhat satisfied*.

10.7 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 124. TRC benefits in Table 124 were calculated using gross verified impacts. The NPV PYTD costs and benefits are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). Net present value costs and benefits for P3TD financials are expressed in the PY8 dollars.

⁸⁹ International Code Council. *International Energy Conservation Code 2009*. 2011.

Table 124. Summary of Energy Efficient Home Program Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$1,734		\$1,734	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$6,944		\$6,944	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	\$8,678		\$8,678	
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$73	-	\$73	-
7	Marketing ^[4]	-	\$191	-	\$191
8	Program Delivery ^[5]	-	\$2,939	-	\$2,939
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$3,203		\$3,203	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$434		\$434	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$12,315		\$12,315	
14	Total NPV Lifetime Electric Energy Benefits	\$5,027		\$5,027	
15	Total NPV Lifetime Electric Capacity Benefits	\$1,092		\$1,092	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$57		\$57	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$6,176		\$6,176	
19	TRC Benefit-Cost Ratio ^[9]	0.50		0.50	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Table 125 presents program financials and cost-effectiveness on a net savings basis.

Table 125. Summary of Energy Efficient Home Program Finances–Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	\$1,734		\$1,734	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$3,754		\$3,754	
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	\$5,488		\$5,488	
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$73	-	\$73	-
7	Marketing ^[4]	-	\$191	-	\$191
8	Program Delivery ^[5]	-	\$2,939	-	\$2,939
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$3,203		\$3,203	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$434		\$434	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$9,126		\$9,126	
14	Total NPV Lifetime Electric Energy Benefits	\$3,314		\$3,314	
15	Total NPV Lifetime Electric Capacity Benefits	\$704		\$704	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$55		\$55	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$4,073		\$4,073	
19	TRC Benefit-Cost Ratio ^[9]	0.45		0.45	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

10.8 Status of Recommendations

Overall, the Energy Efficient Home Program was successfully delivered and administered in PY8. This is no small feat, considering the program offers retrofit weatherization and new construction rebates, in-home and online energy assessments and energy-savings kits, and rebates for HVAC and other efficient equipment. Additionally, the program exceeded its estimated MWh/yr savings for PY8, achieving 9,943 MWh/yr in savings (135% of the PY8 estimated projected savings).

The impact and process evaluation activities in PY8 led to the following findings and recommendations from Cadmus to PPL Electric Utilities. These addressable concerns include the in-home audit kit delivery system, home builder free ridership, and customers' choice of the lowest efficiency HVAC equipment eligible for rebates. At the end of this section, Table 126 summarizes how PPL Electric Utilities plans to address the recommendations in program delivery.

10.8.1 New Home Builder Component

Finding: Builders currently have two tiers for incentives; either they can build 15% more efficient than the 2009 IECC residential building code or they can additionally meet the ENERGY STAR 3.1 standards for an increased incentive. However, only 2% of builders chose to build to ENERGY STAR 3.1 (see *Participant Profile* in *Appendix J.3.2 Additional Findings*).

Finding: The new home builder NTG ratio was 0.49 because of a large overlap between current industry practices and program requirements (Table 119), including ENERGY STAR appliances and high-efficiency HVAC systems.

Interviews with new home builders revealed that more than half (six out of 10 interviewed) were very likely to include the same features and equipment without the PPL Electric Utilities rebates; three would have reduced the efficiency of the homes they built, and one would have cancelled or postponed building. Only three builders reported that the PPL Electric Utilities program rebates were very influential in their decision to complete each building project (see *Appendix J.2.2*).

Conclusion: It appears that free ridership is largely from the increased prevalence of high-efficiency construction in current industry standards.

Recommendation #1: Consider restructuring the new homes rebate component to increase energy efficiency requirements. For example, PPL Electric Utilities and the ICSP could consider streamlining the program offering to simply require the ENERGY STAR 3.1 performance path, which few builders are currently pursuing. Alternatively, the program could increase the minimum percentage above code required for participation in the program (currently, the program requires builders to construct homes that are 15% more efficient than the 2009 IECC). These approaches are designed to push the building practice toward higher levels of efficiency (which is the intent behind offering incentives).

Finding: For the new homes component, Cadmus found that most of the variability in the *ex ante* savings and *ex post* savings was caused by differences in lighting and appliance assumptions used by the ICSP to calculate energy and demand savings. Lighting in the homes Cadmus visited comprised fewer

high-efficacy lamps than documented by the ICSP (see *New Homes* section in *Appendix J.1.1 Methodology*).

In addition, builders reported they had some dissatisfaction with high-efficacy lights. Respondents stated that the cold light emitted by high-efficacy bulbs was not aesthetically pleasing for prospective homebuyers (see *Standard Market Practice* section in *Appendix J.3.2*) and that high-efficacy CFLs had poor performance and a short lifespan. Furthermore, builders were less likely to install LEDs compared to CFLs because of the increased overhead costs. Of all lamps installed in the homes Cadmus visited, 45% were CFLs and 23% were LEDs. Nevertheless, on average, 76% of the bulbs installed in program homes were high-efficacy bulbs, which is 16% above the minimum code requirement (minimum code is 50% high-efficacy bulbs). Despite being above the minimum code requirements, installation rates could be much closer to 100% (see *Appendix J.1.4*).

Conclusion: Lighting efficiency is not a high priority for program builders in meeting the program requirement that new homes be constructed 15% better than code, nor is it a high priority for HERS raters when rating the home to accurately capture bulb counts. However, higher energy savings can be accrued by installing more LEDs in new homes constructed through the program. Because code requires the installation of at least 50% high-efficacy bulbs, the energy savings of the remaining 50% is available for PPL Electric Utilities to capture if builders install more high-efficiency bulbs.

Recommendation #2: Consider encouraging HERS raters to spend more time verifying installation of high-efficacy lamps to improve the accuracy of *ex ante* savings from lighting, thus improving the realization rate. Further, PPL Electric Utilities and the ICSP could consider educating builders about the potential savings (both energy and monetary) of LEDs, with a focus on the variety of LED options (e.g., different color temperatures and dimmability) to increase the installation of LEDs in new homes. Also consider revising eligibility to encourage builders to use LEDs to meet the high-efficacy lighting requirements or meet a certain percentage of high-efficacy lighting beyond that required by code. These changes should ensure a higher rate of high-efficacy lamp installations and higher savings.

10.8.2 Equipment Component

Finding: HVAC contractors reported that the PPL Electric Utilities rebates had little influence on customer demand for energy-efficient heat pumps and central air conditioners (see *Consumer Demand and Market Outlook* in *Appendix J.3.2*). Additionally, of the 10 HVAC contractors interviewed, nine said the primary challenge of selling and promoting energy-efficient HVAC equipment was the upfront cost of that equipment, particularly for higher efficiency models (18 SEER and above) because the rebate did not encourage customers to go above 16 SEER (see *Drivers and Barriers to Saving Energy* section in *Appendix J.3.2*).

Most of the rebates for air source heat pumps and central air conditioners were for units 16 SEER to 18 SEER, the lowest equipment eligibility requirement, with a single rebate level. However, for ductless mini-split heat pumps, the program offered tiered rebates, and purchases were more evenly distributed across the higher efficiencies (see *Participant Profile* in *Appendix J.3.2*).

Conclusion: A large percentage of participants purchased air source heat pumps and central air conditioners that just met the eligibility requirements and cost less than higher efficiency models. These equipment types also had moderate levels of free ridership. Free ridership was lower for ductless mini-split heat pumps for which participation was more distributed across higher efficiency tiers. Participants appeared not to purchase higher efficiency air source heat pumps and central air conditioners (above 18 SEER) because the single-level rebate gave them no reason to. In contrast, participants appeared to have more motivation to purchase higher efficiency equipment with a tiered rebate system, such as for ductless mini-split heat pumps.

Recommendation #3: Consider redesigning the rebates for air source heat pumps and central air conditioners to a tiered system similar to that used for the ductless heat pumps. The incentives should be commensurate with savings and consider the cost of the units.

10.8.3 In-Home Audit Component

Finding: Of the five in-home energy auditors interviewed, four said the energy efficiency kits did not arrive before their in-home visits so they could not help customers install the products included in the kit. They suggested PPL Electric Utilities change the kit ordering and delivery system to ensure timely arrival at the participant's home (see *Program Delivery* and *Suggested Program Improvements* in *Appendix J.3.2*). One contractor said kits were difficult to order.

Conclusion: Although the intent of the program is to mail kits when the customer signs up for an in-home audit, often kits do not arrive before the audit. In-home energy auditors cannot help customers install the products, so installation rates and savings may have been affected.

Recommendation #4: Consider options to change the channel through which customers receive the kits, such as sending kits in bulk directly to in-home energy auditors rather than waiting for customers to sign up for an in-home audit. In that way, the auditor has kits on hand and can take them to the customer's home and install products during the audit. Consider designing the system so that in-home energy auditors or contractors can track all kits delivered during in-home audits.

10.8.4 Status of Recommendations for Program

Table 126 contains the status of each PY8 recommendation made to PPL Electric Utilities.

Table 126. Status of Recommendations

Energy Efficient Home Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	Consider restructuring the new homes rebate component to increase energy efficiency requirements. For example, PPL Electric Utilities and the ICSP could consider streamlining the program offering to simply require the ENERGY STAR 3.1 performance path, which few builders are currently pursuing.	Being considered
2	Consider encouraging HERS raters to spend more time verifying installation of high-efficacy lamps to improve the realization rate for lighting for this component. This will ensure that builders meet the minimum requirements for the program and consequently full savings can be claimed. Further, PPL Electric Utilities and the ICSP could consider educating builders on the potential savings (both energy and monetary) of LEDs, with a focus on variety of LED options (e.g., different color temperatures and dimmability) to increase the installation of LEDs in new homes. Also consider revising eligibility to encourage builders to use LEDs to meet the high-efficacy lighting requirements or meet a certain percentage of high-efficacy lighting beyond code. These changes should ensure a higher rate of high-efficacy lamp installations and higher savings.	Being considered
3	Consider redesigning the rebates for air source heat pumps and central air conditioners to a tiered system similar to that used for the ductless heat pumps.	Being considered
4	Consider options to changing the channel through which customers receive the kits, such as sending kits in bulk directly to in-home energy auditors rather than waiting for customers to sign up for an in-home audit. Design the system so that in-home energy auditors or contractors track all kits delivered during in home audits.	Being considered

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11 Student Energy Efficient Education Program

The Student Energy Efficient Education (SEEE) Program provides THINK! ENERGY school-based energy efficiency education through classroom presentations to students and classroom materials for teachers. The curriculum is offered once during the school year, typically in the fall. Students receive educational materials and a take-home energy-savings kit of low-cost products to install at home. Each kit delivered to a student is counted as a program participant. The energy-savings kits are tailored to each grade level participating in the program and contain items such as LED bulbs, low-flow showerheads, faucet aerators, smart power strips, and electroluminescent nightlights. Each kit includes a Home Energy Worksheet (HEW) that asks questions to track kit product installation rates as well as participant demographics and program satisfaction.

PPL Electric Utilities' residential implementation conservation service provider (ICSP), Ecova, identified National Energy Foundation (NEF) as the subcontractor to the ICSP. The ICSP undertakes a broad spectrum of responsibilities that includes marketing to and recruiting potential schools and teachers, creating curricula correlated with Pennsylvania academic standards, securing support of the program components by the Pennsylvania Department of Education, and assembling and shipping the energy-savings kits. PPL Electric Utilities collaborates with the ICSP on the program's strategic direction while maintaining the overarching Act 129 administrative, program support, evaluation, and data management systems. The ICSP provides oversight and direction to its subcontractor.

The objectives of the SEEE Program are these:⁹⁰

- Expand and promote energy efficiency literacy through education outreach programs
- Provide energy efficiency education to students offered through school assemblies and classroom curriculum
- Confirm energy efficiency education correlates to Pennsylvania Department of Education Academic Standards
- Provide students and teachers with a take-home kit of energy efficiency products that can be installed at home
- Provide teachers with energy efficiency information, lesson plans, activities, training, materials, and support for classroom use
- Obtain participation by approximately 115,000 students and teachers through 2021 and approximately 24,000 MWh/yr gross verified savings
- Achieve high customer (students and teachers) satisfaction with the program

⁹⁰ Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) approved by the Pennsylvania PUC on December 5, 2016.

11.1 Progress Toward Phase III Projected Savings

The SEEE Program verified savings are within 88% of the estimated MWh/yr savings projected for PY8. It has achieved 19% of the estimated Phase III total planned savings and is making progress toward the Phase III projected savings.

Table 127 shows the program's verified gross program savings and progress toward Phase III projected energy savings, as filed in the EE&C Plan.

Table 127. SEEE Program Estimated Savings

PY8 Only				Phase III: PY8-PY12			
	Estimated ⁽¹⁾	Verified	Percentage of Estimated		Estimated ⁽¹⁾	Verified	Percentage of Estimated
MWh/yr	5,180	4,539	88%	MWh/yr	23,993	4,539	19%
⁽¹⁾ Estimated savings are based on PPL Electric Utilities' revised EE&C plan (Docket No. 2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.							

Factors affecting the program's progress toward the estimated savings projected for PY8 include:

- A manufacturer recall of electroluminescent nightlights due to safety concerns.
- Differences between the ISRs and other PA TRM algorithm inputs used by the ICSP and found by Cadmus through the survey analysis.

The model of the nightlights included in the SEEE Program kit was not part of the manufacturer recall. However, at the time the recall was announced PPL Electric Utilities did not know which nightlight models were affected and it therefore instructed all kit recipients across all of its programs to stop using electroluminescent nightlights. The ICSP contacted all participating schools twice via telephone and instructed teachers to tell parents and students to remove them. Replacement nightlights were not issued; however, a formal website was set up for recipients to request a replacement LED nightlight. Accordingly, Cadmus assigned *ex post* savings of 0 MWh/yr for nightlights in the kits offered to the Bright Kids and Take Action cohorts (as described in *11.2.1 Definition of a Participant*).

11.2 Participation and Reported Savings by Customer Segment

11.2.1 Definition of a Participant

The SEEE Program provides energy-savings kits to students in three cohorts:

- Bright Kids (2nd – 3rd grades)
- Take Action (5th – 7th grades)
- Innovation (9th – 12th grades)

Each energy-savings kit distributed is counted as a participant. PPL Electric Utilities did not collect or record utility account numbers of classroom students who received a kit. Participants (energy-savings kits) are recorded in the ICSP's database and PPL Electric Utilities' tracking database with a school, classroom, and teacher identifier. This identifier represents one classroom and is recorded with the number of kits distributed in that specific classroom. The number of kits distributed per classroom is

collected on the teacher evaluation form and recorded in the ICSP and PPL Electric Utilities' tracking databases.

11.2.2 Program Participation and Reported Impacts

Table 128 presents the participation counts, reported energy and demand savings for the SEEE Program in PY8 by customer segment. The program does not offer incentives; the kits are offered free of charge.

Table 128. SEEE Participation and Reported Impacts

Parameter	Residential	Total ^[1]
PYTD Participants	24,145	24,145
PYRTD MWh/yr	5,118	5,118
PYRTD MW/yr	0.46	0.46
PY8 Incentives (\$1,000)	\$0	\$0
^[1] Total may not match due to rounding.		

11.3 Gross Impact Evaluation

Cadmus conducted the following activities to evaluate the SEEE Program's gross impacts. Refer to *Appendix K* for details on these activities:

- **Database review.** A review of PPL Electric Utilities' tracking database to ensure the accuracy of the database records compared to the ICSP's records.
- **HEW survey analysis.** An analysis of all online and paper HEWs returned by students who received a kit. The HEWs provided inputs, such as ISRs, for calculating energy savings. Students were not required to complete a HEW as part of the program. Cadmus analyzed all returned HEWs to provide data for the process and impact evaluations.

The impact evaluation's sampling strategy is summarized in Table 129.

Table 129. SEEE Gross Impact Sample Design for PY8

Stratum	Population Size	Assumed Proportion or Cv in Sample Design ^[1]	Achieved Sample Size	Impact Evaluation Activity
Bright Kids 2 nd – 3 rd grades	5,065	N/A	3,517	Paper and online HEWs
Take Action 5 th – 7 th grades	14,049	N/A	10,556	Paper and online HEWs
Innovation 9 th – 12 th grades	5,031	N/A	3,526	Paper and online HEWs
Program Total	24,145	N/A ^[1]	17,599	
^[1] Because this program's evaluation did not include sampling, Cv and target precision are not meaningful.				

In PY8, the SEEE Program reported energy savings of 5,118 MWh/yr, as shown in Table 130, and demand reduction of 0.46 MW, as shown in Table 131.

Table 130. SEEE Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Bright Kids	525	83%	0.09	0.99%
Take Action	3,404	90%	0.21	1.34%
Innovation	1,189	87%	0.22	3.36%
Program Total ^[1]	5,118	89%	N/A	1.18%

^[1] Total may not match due to rounding.

Table 131. SEEE Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Bright Kids	0.05	120%	0.09	0.98%
Take Action	0.30	110%	0.20	1.25%
Innovation	0.12	93%	0.17	2.67%
Program Total ^[1]	0.46	106%	N/A	1.03%

^[1] Total may not match due to rounding.

The following factors led to variation between the reported and verified savings and led to the observed realization rates:

- The ICSP reported nightlight savings; however, because PPL Electric Utilities instructed all kit recipients across its programs to stop using nightlights because of a manufacturer recall, Cadmus assigned *ex post* savings of 0 MWh/yr for this kit product. This resulted in a lower realization rate for the Bright Kids and Take Action cohorts.
- ISRs were lower for showerheads, faucet aerators, and smart strips than the ICSP used in its planning calculations, resulting in lower realization rates for the Take Action and Innovation cohorts.
- There were differences between the PA TRM algorithm inputs the ICSP used for its planned savings calculations and the inputs Cadmus used for its evaluated savings calculations. Specifically, the ICSP used the default values for number of showers in the home (lower than the value Cadmus identified through data gathering) and number of people in the home (for faucet aerators only; higher than the value Cadmus identified through data gathering), which caused the ICSP to overestimate savings for those products.

11.3.1 In-Service Rates

Table 132 shows the verified ISR for each of the items in the energy-savings kit from PY5 through PY8. Consistent with prior years, ISRs were lower for showerheads and faucet aerators than the plugged-in products (LED bulbs and smart strips). Reported ISRs for all kit products have decreased steadily since PY5.

Table 132. Verified SEEE ISRs for Kit Products by Year

Kit Product	Stratum	PY5 ^[1]	PY6 ^[2]	PY7 ^[3]	PY8
LED (3 bulbs) ^{[4][5]}	Bright Kids	73%	77%	90%	82% ^[7]
	Take Action	60%	67%	89%	79% ^[8]
	Innovation	67%	65%	89%	80% ^[9]
Kitchen Aerator ^[6]	Take Action	35%	34%	32%	29%
Showerhead ^[6]	Take Action	31%	30%	25%	25%
	Innovation	34%	32%	31%	27%
Smart Strip	Innovation	80%	74%	74%	72%
Electroluminescent Night Light	Bright Kids	88%	87%	86%	--
	Take Action	80%	79%	73%	--

^[1] PPL Electric Utilities. Annual Report Program Year 5: June 1, 2013–May 31, 2014. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2014.

^[2] PPL Electric Utilities. Annual Report Program Year 6: June 1, 2014–May 31, 2015. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

^[3] PPL Electric Utilities. Annual Report Program Year 7: June 1, 2015–May 31, 2016. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

^[4] ISR reflects average of all three bulbs per kit.

^[5] For LED bulbs in PY7 and PY8, Cadmus based the ISR on the ISRs reported on the survey and an installation rate “trajectory” to include savings for all program bulbs assumed to be installed over time. For these, it incorporated the recommendations of the Uniform Methods Project (UMP) Residential Lighting Evaluation Protocol.⁹¹

^[6] Cadmus calculated the water products’ installation rates by dividing those who installed the product in an electric water heat home by the respondents who answered the question and have electric water heat.

^[7] Individual Trajectory PY8 LED ISR for Bright Kids – LED1 84%, LED2 82%, LED3- 80% (ISRs calculated from surveys without “trajectory” calculation were LED1 59%, LED2 43%, LED3- 35%)

^[8] Individual Trajectory PY8 LED ISR for Take Action – LED1 81%, LED2 80%, LED3- 77% (ISRs calculated from surveys without “trajectory” calculation were LED1 50%, LED2 35%, LED3- 27%)

^[9] Individual Trajectory PY8 LED ISR for Innovation – LED1 81%, LED2 80%, LED3- 78% (ISRs calculated from surveys without “trajectory” calculation were LED1 49%, LED2 36%, LED3- 29%)

11.4 Net Impact Evaluation

The SEEE Program is a select offering to schools, and kits are provided free of charge to teachers, who in turn provide the kits to their students. No free riders are anticipated among the population receiving the energy-savings kit. That is, Cadmus does not expect teachers to voluntarily purchase and provide kits to students in the absence of the program. Likewise, because the kits are sent home with children as part of the school’s curriculum and households do not choose to participate in the program and do not

⁹¹ National Renewable Energy Laboratory. *Uniform Methods Project*. Chapter 21: Residential Lighting Evaluation Protocol. Prepared by Apex Analytics, LLC. November 2014. Available online: <http://www.nrel.gov/extranet/ump/pdfs/ump-res-lighting-clean.pdf>

The UMP uses the findings from the 2014 California Upstream and Residential Lighting Impact Evaluation, which suggested that bulb installation rates could be as high as 97% within four years of purchase. Discounting the future savings back to the current program year reduces the ISR from 97%. This evaluation used a weighted average nominal discount rate of 8.14% for all electric distribution companies (EDCs).

choose to purchase the kit, Cadmus assumes there is no free ridership. Additionally, no spillover is measured.

The program is assumed to have a NTG ratio of 1.0.

11.5 Verified Savings Estimates

In Table 133, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the SEEE Program in PY8. These totals are added to the verified savings achieved in previous program years to calculate the Phase III to date (P3TD) program impacts.

Table 133. PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Demand (MW/yr) ^[1]
PYRTD Gross	5,118	0.46
PYVTD Gross	4,539	0.49
PYVTD Net ^[2] ^[3]	-	-
P3RTD Gross	5,118	0.46
P3VTD Gross	4,539	0.49
P3VTD Net ^[2] ^[3]	-	-
^[1] May not match due to rounding.		
^[2] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		
^[3] Net savings are not computed because program is assumed to have a NTG ratio of 1.0.		

11.6 Process Evaluation

11.6.1 Research Objectives

The evaluation of the SEEE Program involves these research objectives:

- Identify program design and delivery successes and challenges
- Identify areas that may benefit from program improvements
- Assess participating student and teacher satisfaction with the program
- Collect demographic data to determine characteristics of participating households

11.6.2 Evaluation Activities

Table 134 lists the PY8 process evaluation activities for the SEEE Program. The research activities were consistent with the evaluation plan with the exception of the number of completed online teacher surveys. Cadmus offered the online survey to all teachers and the number who responded exceeded the planned target.

Table 134. Process Evaluation Activities

Activity	Number Completed
Analysis of student-returned HEWs	17,599
Program staff interviews with PPL Electric Utilities, the ICSP, and the ICSP's subcontractor	3
Analysis of the ICSP's subcontractor-administered teacher evaluation survey	238
Online teacher surveys administered by Cadmus	158
Review logic model	N/A

Table 135 lists the process evaluation sampling strategy. Additional details about sampling methodology are included in *Appendix K*.

Table 135. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame ^[1]	Percent of Sample Frame Contacted to Achieve Sample ^[2]
PPL Electric Utilities, ICSP, and ICSP subcontractor program stakeholders	N/A	Telephone In-depth Interview	3	N/A ^[3]	3	3	N/A	100%
Teachers	All participating teachers	Online survey	886	90/10 Probability Sample	70	158	All eligible (852) ^[4]	100%
		ICSP subcontractor-administered paper survey	886	N/A ^[3]	All returned surveys	238	All eligible (886)	100%
Students	Bright Kids, Take Action, Innovation	ICSP subcontractor-administered paper and online HEWs	24,145	N/A ^[3]	All returned surveys	17,599	All eligible (24,145)	100%
Program Total								

^[1] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL database. After selecting all unique records, Cadmus removed any records from the population if the customers did not have valid contact information (email or telephone number), were on the do not call list, or opted out of the online survey.

^[2] Percent contacted means the percentage of the sample frame called or sent an email survey to complete surveys.

^[3] Because this program's evaluation did not include sampling, Cv and target precision are not meaningful.

^[4] **Table K-297** shows sample frame attrition. Eight-hundred and fifty-two email addresses were available to contact.

11.6.3 Summary of Process Evaluation Findings

Additional detail regarding the process evaluation methodology and findings can be found in *Appendix K.2.1 Process Evaluation Methodology*.

Program Delivery

The SEEE Program provides energy efficiency education through classroom presentations to students and training and classroom materials for teachers. The program offers the curriculum once per school year, typically in the fall. Students receive educational materials and a free energy-savings kit of low-cost products to install at home. The kits contained LED bulbs, low-flow showerheads, faucet aerators, smart power strips, and/or electroluminescent nightlight, depending on the student cohort. Each kit included a HEW that asked questions to track kit product installation rates as well as participant demographics and program satisfaction.

The SEEE Program did not meet its planned savings, achieving 4,539 kWh/yr of energy savings. However, it did fulfill its KPIs, as discussed in *Key Performance Indicators* in *Appendix K*. The program achieved the following:

- Delivered 24,145 kits to students (target: 24,000)
- Recorded 87% satisfaction among surveyed participants (target: 80%)

The program achieved its participation goal (and filled the program's waitlist) almost exclusively by relying on teachers' prior knowledge of and participation in the program. The ICSP's subcontractor (National Education Foundation, or NEF), which administered the program in Phases I and II, also administered the program in PY8. From PY7 to PY8, the ICSP's subcontractor changed the target number of kits per cohort (although the overall number of kits planned for delivery remained the same) and the products included in the kits. It also reduced the dollar amount of the classroom mini-grants offered as financial incentives for teachers to encourage high HEW return rates from students. PPL Electric Utilities also experimented with new delivery methods to engage students. For example, it introduced the first Innovation Challenge for high school students, which involved a competition for best-in-class videos or websites promoting energy efficiency, with prizes for the winning teams.

Although the program largely operated as expected in PY8, it did encounter an unexpected challenge when the manufacturer of electroluminescent nightlights, which PPL Electric Utilities offers to this and other programs, recalled the nightlights due to safety concerns. The model of the nightlights included in the SEEE Program kit was not part of the manufacturer recall. However, at the time the recall was announced PPL Electric Utilities did not which nightlight models were affected and it therefore instructed all kit recipients across all of its programs to stop using electroluminescent nightlights. The ICSP contacted all participating schools twice via telephone and instructed teachers to tell parents and students to remove the nightlights. Replacement nightlights were not issued. This issue, along with low showerhead installation rates, impacted the program's ability to achieve its PY8 planned savings.

The ICSP's subcontractor is developing an "augmented reality" application (app) for smartphones and tablets, which it is considering piloting in PY9 to the Take Action cohort. The intent of the app is to further engage students and their parents with the kit products at home.

Student Satisfaction

Seventy-three percent of participants completed HEWs, down from 81% in PY7. Eighty-seven percent of survey respondents (n=17,264) said they were *very satisfied* (68%) or *somewhat satisfied* (19%) with the program overall. The cohort most frequently *very satisfied* was Bright Kids (85%) and least frequently *very satisfied* was Innovation (51%).⁹²

Teacher Satisfaction

Cadmus analyzed two teacher surveys: paper surveys administered by the ICSP's subcontractor and online surveys administered by Cadmus. The results were consistent, with teachers generally reporting high satisfaction rates, favorable impressions of various program elements, and improvements to their opinions of PPL Electric Utilities from previous program years.

Results from Cadmus' online survey indicated that 96% of participating teacher respondents (n=151) were *very satisfied* (79%) or *somewhat satisfied* (17%) with the SEEE Program overall. Eighty-nine percent of respondents said they had participated in a previous program year, about one quarter of whom reported their experiences had improved since previously participating (most said it stayed the same).

Eighty-nine percent of all respondents said they would be *very likely* (58%) or *somewhat likely* (31%) to incorporate energy efficiency into their future curricula. Results from the ICSP subcontractor's paper survey indicated that 99% of teacher respondents characterized their overall impressions of the SEEE Program as *excellent* (87%) or *good* (12%). Also, nearly all teacher respondents said they had *excellent* or *good* impressions of the program's materials (100%), content (100%), presenters (99%), and student engagement (98%).

Ninety-seven percent of respondents to Cadmus' online survey said they attended the THINK! ENERGY presentations offered by the ICSP's subcontractor, which taught students about energy and conservation topics using hands-on and interactive activities, and 83% used their teacher's packet in some manner.

Teachers who responded to the ICSP's paper surveys most frequently recommended incorporating more interactive, group, and hands-on activities to the THINK! ENERGY curriculum and presentations. They made additional suggestions to improve the THINK! ENERGY presentations. Several respondents thought the presenters rushed through presentations and were not as well-trained as in past years. Other recommendations included creating and delivering content such as a follow-up presentation later in the school year, reinstating the poster contest offered in prior years, increasing the dollar amounts of mini-grants, and increasing the number of or changing the contents of kit products.

⁹² 17,264 of the 17,599 students who returned a HEW responded to the satisfaction question. Of the 17,264 who responded, 87% (or 15,020) said they were *satisfied*.

The program achieved a teacher NPS of +69. The NPS is a brand loyalty metric that measures how likely customers are to recommend the program to others. The theory and calculations that underpin the NPS are described in *Teacher Satisfaction* section in *Appendix K.2.1 Process Evaluation Methodology*.

11.7 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 136. The TRC benefits were calculated using gross verified impacts. NPV PYTD benefits and costs are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). NPV benefits and costs for P3TD financials are expressed in PY8 dollars.

Table 136. Summary of Student Energy Efficiency Education Program Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	-	-	-	-
2	EDC Incentives to Trade Allies	-	-	-	-
3	Participant Costs (net of incentives/rebates paid by utilities)	-	-	-	-
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	-	-	-	-
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$95	-	\$95	-
7	Marketing ^[4]		\$136		\$136
8	Program Delivery ^[5]		\$674		\$674
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$905		\$905	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-	-	-	-
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$905		\$905	
14	Total NPV Lifetime Electric Energy Benefits	\$1,188		\$1,188	
15	Total NPV Lifetime Electric Capacity Benefits	\$197		\$197	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$380		\$380	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$1,765		\$1,765	
19	TRC Benefit-Cost Ratio ^[9]	1.95		1.95	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as “Program Delivery” costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Table 137 presents program financials and cost-effectiveness on a net savings basis. In this program, the NTG ratio is equal to 1.0; therefore, the net verified savings are equal to the gross verified savings.

Table 137. Summary of Student Energy Efficient Education Program Finances—Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	-	-	-	-
2	EDC Incentives to Trade Allies	-	-	-	-
3	Participant Costs (net of incentives/rebates paid by utilities)	-	-	-	-
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	-	-	-	-
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$95	-	\$95	-
7	Marketing ^[4]		\$136		\$136
8	Program Delivery ^[5]		\$674		\$674
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$905		\$905	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-	-	-	-
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$905		\$905	
14	Total NPV Lifetime Electric Energy Benefits	\$1,188		\$1,188	
15	Total NPV Lifetime Electric Capacity Benefits	\$197		\$197	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$380		\$380	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$1,765		\$1,765	
19	TRC Benefit-Cost Ratio ^[9]	1.95		1.95	

^[1] May not sum to total due to rounding.
^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.
^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.
^[4] Includes the marketing CSP and marketing costs by program CSPs
^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.
^[6] Rows 1-11 are presented in nominal dollars.
^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.
^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.
^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

11.8 Status of Recommendations

Overall, the SEEE Program performed well in PY8, distributing more kits than projected, and exceeding the program's satisfaction target, with 96% of surveyed teachers and 87% of students reporting they were *very* or *somewhat satisfied* with the program. The program realized 89% of reported savings, with the difference largely due to the electroluminescent nightlights that were recalled.

The impact and process evaluation activities in PY8 led to the following findings and recommendations by Cadmus to PPL Electric Utilities along with a summary of how PPL Electric Utilities plans to address the recommendation in program delivery (Table 138).

Findings: Despite exceeding its planned participation in PY8, the SEEE Program did not meet its planned savings for PY8 (see *11.1 Progress Toward Phase III Projected Savings*). The recall of electroluminescent nightlights, and the associated assignment of 0 MWh/yr *ex post* savings, was the primary reason the program did not meet its planned savings for PY8. However, lower-than-anticipated ISRs for water products and differences between Cadmus' and the ICSP's assumptions also impacted the program's realization rate and ability to achieve its PY8 planned savings (see *11.3 Gross Impact Evaluation*). Specifically, the ICSP used the default values for number of showers in home (lower than the value Cadmus identified through data gathering) and number of people in the home (for faucet aerators only; higher than the value Cadmus identified through data gathering), which caused the ICSP to overestimate savings for those kit products.

Conclusion: Updates to ISRs used in planning calculations, and coordination between Cadmus and the ICSP regarding PA TRM assumptions and inputs, could increase accuracy of reported savings and improve realization rates.

Recommendation #1: The ICSP should use PY8 survey verified results for ISRs and home characteristics (i.e., number of persons in the home and number of showers in home) to estimate PY9 *ex ante* energy savings.

Findings: Consistent with PY5 through PY7, in PY8 participants continued to use the plugged-in products (e.g., LED bulbs, smart power strips, and night lights) more than the water-saving products (see *11.2. In-Service Rates*); however, ISRs for all kit products have decreased steadily since PY5. For showerheads, ISRs have decreased from a high in PY5 of 31% and 34% (Take Action and Innovation cohorts, respectively) to 25% and 27% in PY8. For faucet aerators, ISRs have decreased from 35% in PY5 to 29% in PY8. Despite low ISRs, and savings eligibility for electric water heat customers only, showerheads still generate a substantial portion of program savings (36% of the Innovations cohort *ex post* savings and 22% of the Take Action cohort *ex post* savings). (Percentages are slightly different due to rounding.)

Program stakeholders are looking for new ways to capture savings to combat product saturation. In PY9, the ICSP is developing an augmented reality application which it may pilot with the Take Action cohort to further engage students and their parents with the kit products at home (see the *Program Delivery* section and *Suggested Program Improvements* in Appendix K).

Conclusion: New kit products and innovative methods for student engagement are likely needed to combat program saturation and maintain or increase product ISRs.

Recommendation #2: Continue exploring innovative methods for generating increased kit product engagement, installation rates, and savings. The ICSP's subcontractor could encourage showerhead installations through its augmented reality application planned for PY9, for example, by assigning additional points for showerhead installation through its gamification system.

11.8.1 Status of Recommendations for Program

Table 138 contains the status of each PY9 recommendation made to PPL Electric Utilities.

Table 138. Status of Recommendations

SEEE Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	The ICSP should use PY8 survey verified results for ISRs and home characteristics (i.e., number of persons in the home and number of showers in home) to estimate PY9 <i>ex ante</i> energy savings.	Agree
2	Continue exploring innovative methods for generating increased kit product engagement, installation rates, and savings.	Agree. As an alternative, PPL may consider eliminating measures with low installation rates but that likely cannot be implemented until PY10, due to kit inventory.

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12 Weatherization Relief Assistance Program

The Act 129 Winter Relief Assistance Program (WRAP), also known as Low-Income WRAP, operates in parallel with PPL Electric Utilities' Universal Services Programs' Low-Income Usage Reduction Program (USP LIURP) WRAP. Both programs are designed to reduce electric consumption for low-income customers.

PPL Electric Utilities offers services to income-qualified customers residing in single-family homes, master-metered multifamily units, individually metered multifamily units, and manufactured homes.⁹³ Act 129 WRAP is delivered by CMC, the implementation conservation service provider (ICSP), which is responsible for outreach, customer recruitment, audits, education, and the direct installation of equipment in customers' homes. It also supports these functions: operating a customer call center, marketing, and tracking activities. The ICSP used qualified community-based organizations (CBOs) and contractors for tasks including the installation of energy-savings products and services and replacement of outdated and inefficient equipment with program-qualifying energy-efficient equipment. Franklin Energy, a subcontractor to the ICSP, is responsible for targeted outreach and recruitment for the program component that targets manufactured homes located in manufactured or mobile home parks.

All qualifying customers receive a free energy audit that evaluates their home for eligible energy-saving products. The home energy auditor refers to a preapproved list of products and services along with criteria to determine if appliances and other large equipment can be replaced cost-effectively, within the program's budget (program acquisition cost and total funding). For all qualifying customers, PPL Electric Utilities offers direct installation of a range of energy efficiency products and services, including HVAC, lighting, weatherization, water saving/heating, appliances, appliance recycling, and home health and safety. WRAP also offers energy education delivered by auditors who make recommendations to encourage customers to conserve energy.

Through WRAP, PPL Electric Utilities provides four types of service (also known as job types) at no cost to the income qualified customer. These include baseload (offered to customers without electric heat and without an electric water heater), low-cost (offered to customers without electric heat but with electrically heated water), full-cost (offered to customers with electric heat), and an initiative offering services to targeted manufactured home park customers.

In PY8, the majority of jobs implemented through Act 129 WRAP were baseload and low-cost jobs.⁹⁴ Under these categories of jobs, PPL Electric Utilities offers WRAP services to individually metered customers in single-family and multifamily buildings, and master-metered buildings for homes occupied

⁹³ Individually metered low-income multifamily residences are eligible for the same measures as individually metered single-family low-income residences under Low-Income WRAP. Further, individually metered manufactured homes are eligible for the same measures as any other type of individually metered home receiving services from Low-Income WRAP.

⁹⁴ Most full-cost jobs will be implemented through PPL Electric Utilities' Universal Services Low-Income Usage Program (USP LIURP) and not through the Act 129 WRAP program.

by low-income residents. New construction projects are also eligible to receive WRAP items, but they are at a cost to the property owner or builder; only LEDs are offered at no cost.

Baseload jobs may include these measures:

- Energy education
- Replacement of lighting with LEDs
- Refrigerator replacement
- Air conditioner replacement
- Dehumidifier replacement
- Tier 2 smart strips

Low-cost jobs include all baseload products as well as products for electrically heated water such as these:

- Water heater replacement with a heat pump water heater
- Water heater pipe insulation
- Faucet aerators
- Efficient showerheads

Full-cost jobs include all baseload and low-cost products (if water heat is present) and may include shell and HVAC products such as these:

- Insulation (e.g., attic, floor, wall)
- Infiltration (e.g., caulking, weather-stripping, blower door testing)
- HVAC repair or replacement
- Duct insulation

PPL Electric Utilities' program component that targets manufactured homes located in manufactured or mobile home parks offers all baseload and low-cost job products, with the addition of targeted air sealing that is installed without blower door testing.

The objectives of the Low-Income WRAP are these:⁹⁵

- Provide low-income customers with an array of no-cost energy-saving equipment and education to help reduce their energy costs
- Increase the health and safety of low-income customers' homes by installing no-cost items such as smoke and carbon monoxide detectors, which may be coordinated with or implemented by the Low-Income Usage Reduction Program (LIURP) WRAP (operating outside of Act 129 WRAP)
- Achieve high customer and trade ally satisfaction through high-quality service and an impactful program offering
- Promote other PPL Electric Utilities energy efficiency programs, specifically other low-income assistance programs such as On-Track and LIHEAP.
- Achieve a total approximate reduction in energy use of 55,546 MWh/year gross verified savings

⁹⁵ Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

12.1 Progress Toward Phase III Projected Savings

The WRAP verified savings are within 24% of the estimated MWh/yr savings for PY8. The program has achieved 5% of the estimated Phase III total planned savings and is making progress toward the Phase III project savings.

Table 139 shows the program's verified and unverified gross savings and progress toward its Phase III projected energy savings, as filed in the EE&C plan.⁹⁶ In PY8, savings for full-cost jobs were not verified and will be verified along with PY9 full-cost jobs in PY10 Q2 as explained in 12.3.3 *Gross Impact Evaluation Activities*.

Table 139. Low Income WRAP Estimated Savings

	PY8 Only				Phase III: PY8-PY12			
	Estimated [1]	Verified	Percentage of Estimated	Unverified Savings	Estimated [1]	Verified	Percentage of Estimated	Unverified Savings
MWh/yr	11,060	2,652	24%	16	55,546	2,652	5%	16
[1] Estimated savings are based on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.								

The main factor that affected the program's progress toward achieving the estimated savings projected for PY8 was program participation. PPL Electric Utilities anticipated delivering services to about 7,000 low-income WRAP participants per year to achieve a total of approximately 35,000 participants during Phase III. However, in PY8, the WRAP had 2,718 participants as the program had a slow start. Low program participation was mentioned as a possible risk in the EE&C plan,⁹⁷ and PY8 ended with 2,718 completed jobs. Although PY8 participation was not substantially lower than PY7 participation (3,585 completed jobs),⁹⁸ the plan estimated 7,000 low-income WRAP participants were needed each year to achieve approximately 35,000 participants during Phase III. However, 1,502 projects were completed in PY8, which contributed approximately 1,800 MWh/yr but were not entered into the PPL Electric tracking database in PY8. These will be reported in PY9. See 12.3.4 *Gross Impact Evaluation Results* and the *Program Delivery* section in *Appendix L* for details about other minor factors that affected the program's progress.

12.2 Participation and Reported Savings by Customer Segment

12.2.1 Definition of a Participant

An Act 129 WRAP participant is defined as a PPL Electric Utilities customer who is an income-eligible household that receives a WRAP audit. At a minimum, the audit includes energy education and may lead to the installation of other WRAP products and services. Each household treated (single-family or

⁹⁶ PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

⁹⁷ Ibid.

⁹⁸ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

multifamily) is identified in the PPL Electric Utilities' tracking database with a unique customer job number.

12.2.2 Program Participation and Reported Impacts

Table 140 presents the participation counts, reported energy and demand savings, and incentive payments for WRAP in PY8 by customer segment.

Table 140. Low Income WRAP Participation and Reported Impacts

Parameter	Government/ Nonprofit/ Education (GNE) ^[1]	Low-Income	Total ^[2]
PYTD # Participants	235	2,483	2,718
PYRTD MWh/yr	238	3,253	3,491
PYRTD MW/yr	0.02	0.32	0.34
PY8 Incentives (\$1000)	\$0	\$0	\$0
^[1] Master-metered multifamily jobs are allocated to the GNE category.			
^[2] May not match due to rounding.			

12.3 Gross Impact Evaluation

12.3.1 Data Collection

In PY8, Cadmus collaborated with PPL Electric Utilities and the ICSP to collect the required data to verify energy savings and demand reduction for WRAP. Cadmus obtained the ICSP's Energy Reduction Management System (ERMS) database extract for verification and assessment of participant records. The ICSP also provided audit records and site inspection records for a random sample of sites.

Cadmus conducted a records review for a sample of homes and site visits to a random sample to verify that products were installed as reported. Cadmus also conducted a phone survey with a sample of program participants and collected supporting data to analyze the impact of energy education for WRAP participants.

12.3.2 Sample Design

To verify savings, Cadmus used a double sampling approach using records review in the first sample and site visits in the second sample.⁹⁹ The sample design consisted of five strata: one for each job type (baseload, low-cost, and full-cost), one for master-metered multifamily units, and one for manufactured home participants. This strategy allowed for an examination of savings by stratum. Within each stratum,

⁹⁹ Cadmus used ratio estimation for double sampling, as described in Thompson (2012), to calculate the realization rates and precision for the records review, site visits, and combined overall total gross savings. Additional details are provided in Appendix D.

Thompson, Steven K. (2012) *Sampling Third Edition*. Joh Wiley & Sons, Inc., Hoboken, New Jersey.

Cadmus applied a simple random sampling method to select a sample of homes for records review verification and sample for site visit verification. The sampling strategy is summarized in Table 141.

Table 141. WRAP Gross Impact Sample Design for PY8

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Baseload	1,451	0.5	89	Records review
		0.5	24	Site visit
Low-Cost	968	0.5	92	Records review
		0.5	24	Site visit
Full-Cost	7	0.5	7	Records review
		0.5	2	Site visit
Manufactured Home Initiative (all job types)	57	0.5	39	Records review
		0.5	17	Site visit
Master-Metered Multifamily (all job types)	235	0.5	76	Records review
		0.5	22	Site visit
Program Total	2,718		303	Records review
			89	Site visit ⁽¹⁾

⁽¹⁾ Cadmus did not visit participants' dwellings that were already inspected by the ICSP.

Cadmus achieved the desired sample size across all strata for all evaluation activities except for the site visits of the full-cost stratum. The full-cost jobs require one year of post-treatment data to conduct a billing analysis. Therefore, Cadmus reported full-cost jobs as unverified in PY8. The PY8 and PY9 full-cost jobs will be verified by conducting a billing analysis in PY10.

12.3.3 Gross Impact Evaluation Activities

Cadmus conducted the activities described here to evaluate the WRAP gross impacts for PY8. Refer to *L.1 Gross Impact Evaluation* section in *Appendix L* for details on these activities.

- Database review.** Cadmus reviewed the census of records in PPL Electric Utilities' tracking database and compared these to the records in the participant data provided by the ICSP. Cadmus verified discrepancies with the ICSP prior to conducting any analyses. See the *Database Review Findings* section in *Appendix L* for details of Cadmus' review findings.
- Audit records review.** Cadmus reviewed a random sample of audit records from four of the five strata listed in Table 141.¹⁰⁰ Records reviews involved verifying reported quantities and other relevant inputs for savings calculations from the records obtained by WRAP contractors' auditors at each job site. Cadmus verified all data fields in PPL Electric Utilities' tracking database, including, but not limited to, home address, water heater fuel type, heating fuel type,

¹⁰⁰ For the full-cost stratum, Cadmus will conduct a billing analysis and records reviews in PY10.

reported quantities, and baseline conditions for each item in the audit records. See the *Records Review Findings* section in *Appendix L* for details of Cadmus' review findings.

- **Site visits.** Cadmus conducted site visits for a random sample to ensure that customers were receiving quality installations and that the quantity of items installed aligned with items reported in PPL Electric Utilities' tracking database. Cadmus verified item quantities and inputs for savings calculations found in the PPL Electric Utilities' tracking database and the audit records. Cadmus also collected additional baseline information not found in the audit records. See the *Site Visit Findings* section for details of Cadmus' site visit findings. Cadmus calculated an ISR for each item based on data collected from the site visits. See *12.3.4 Gross Impact Evaluation Results* section for details of calculated ISRs.
- **Engineering analysis.** Cadmus conducted an engineering analysis and used the findings from the audit records review and site visits as inputs to the engineering algorithms from the PA TRM.¹⁰¹ See section *L.1.2 Ex Post Verified Savings Methodology* in *Appendix L* for details of the analysis.
- **Inspection records review.** Cadmus reviewed a sample of the ICSP's inspection records to confirm installation against products reported in the PPL Electric Utilities' tracking database. The data were not used to calculate verified savings. The review findings are summarized in the *Records Review Findings* section in *Appendix L*.
- **Billing analysis.** A billing analysis requires one year of post-treatment consumption data. In PY8, Cadmus did not conduct a billing analysis for full-cost jobs and manufactured home park initiative jobs that included limited air sealing for the following reasons:
 - **Full-cost jobs.** There were not enough post-treatment data to conduct a billing analysis in PY8. In PY10 Q2, Cadmus will conduct a single billing analysis for PY8 and PY9 full-cost jobs.
 - **Manufactured home park initiative jobs.** Only 21 manufactured home park initiative jobs received limited air sealing products. Nine of these jobs received only door corner pads as the limited air sealing products; door corner pads have almost no savings. In addition, Cadmus found low ISRs for the limited air sealing products during the site visits of manufactured home park initiative jobs. Therefore, Cadmus did not conduct a billing analysis for participants who received limited air sealing products. Instead, Cadmus used an engineering approach to estimate energy savings for limited air sealing products based on the actual products installed for each home.

12.3.4 Gross Impact Evaluation Results

In PY8, WRAP reported energy savings of 3,491 MWh/yr. The realization rate is 76%, weighted by stratum. Since the full-cost stratum remains unverified in PY8, the full-cost stratum's reported savings were excluded from realization rate calculations. Table 142 shows the reported energy savings by program stratum. Likewise Table 143 shows reported demand reduction but excludes unverified demand reduction from realization rate calculations.

¹⁰¹ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016.

Table 142. Low-Income WRAP Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Manufactured Home Initiative	49	76%	0.57	8.01%
Master Metered Multifamily	238	91%	0.43	4.56%
Baseload	1,700	73%	1.16	11.33%
Low-Cost	1,488	78%	0.89	8.62%
Full-Cost (Unverified)	16	N/A	N/A	N/A
Program Total ^[1]	3,491	76% ^[2]	N/A	6.34%

^[1] May not match due to rounding.
^[2] Realization rates exclude unverified energy savings. The program-level realization rate is weighted by stratum.

Table 143. Low-Income WRAP Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Manufactured Home Initiative	0.00	89%	0.58	8.04%
Master Metered Multifamily	0.02	103%	0.47	4.88%
Baseload	0.17	87%	1.06	10.35%
Low-cost	0.15	81%	0.86	8.32%
Full-cost (unverified)	0.00	N/A	N/A	N/A
Program Total ^[1]	0.34	86% ^[2]	N/A	6.13%

^[1] May not match due to rounding.
^[2] Realization rates exclude unverified demand savings. The program-level realization rate is weighted by stratum.

The following factors led to the variation between the reported and verified savings and to the observed realization rates, reducing reported savings by 822,978 kWh. These are factors the ICSP and their contractors can address. Once addressed, the realization rates will increase.

- Tier 2 smart strips, the limited air sealing products, LED nightlights, and thermostatic restriction valves all had relatively low ISRs (see Table L-309 and Table L-307 in *Site Visit Findings* section in *Appendix L* for more details).
- Cadmus verified energy education savings through a participant survey and found that 39% of respondents practiced at least one recommendation following the energy education they received. (See the *Ex Post Savings Calculation Methodology for Energy Education* section in *Appendix L* for details and Table L-302.)
- Contractors sometimes installed 1.5 GPM low-flow kitchen faucet aerators and showerheads when the existing aerator or showerhead was already 1.5 GPM, resulting in no energy savings. Similarly, contractors installed many LED nightlights where there had previously been no nightlights, resulting in negative energy savings equal to the consumption of an LED nightlight. (See Table L-305 and the sections *Records Review Findings* and *Site Visit Findings* in *Appendix L* for details.)
- Cadmus found that savings for Tier 2 smart strips were underreported by 20% (the location of some Tier 2 smart strips was incorrect). The correction increased savings. (See Table L-305 in the *Records Review Findings* section in *Appendix L* for details.)

12.4 Net Impact Evaluation

This program is offered to income-eligible customers in the low-income community, and no free riders are anticipated among the population participating in the program. That is, income-constrained customers are not likely to purchase the energy efficiency measures on their own. Cadmus discussed this with SWE and PPL Electric Utilities early in PY8 and all agree that a NTG ratio of 1.0 was appropriate.

12.5 Verified Savings Estimates

In Table 144, the realization rates determined by Cadmus were applied to the reported energy and demand savings estimates to calculate the verified savings estimates for WRAP in PY8. In future years, these totals will be added to the verified savings achieved in previous program years to calculate the Phase III to date (P3TD) program impacts.

This is an income-verified program and no net savings analyses are conducted. Therefore, Table 144 does not include entries for net savings.

Table 144. Low Income WRAP PYTD and P3TD Savings Summary

Savings Type	Energy (MWh/yr) ^[1]	Total Demand (MW/yr) ^[1]
PYRTD Gross	3,491	0.34
PYVTD Gross	2,652	0.29
PYVTD Net ^{[2] [3]}	-	-
PY Unverified Savings	16	0.00
P3RTD Gross	3,491	0.34
P3VTD Gross	2,652	0.29
P3VTD Net ^{[2] [3]}	-	-
P3 Unverified Savings	16	0.00

^[1] Total may not match due to rounding.
^[2] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.
^[3] Cadmus assumed there is no free ridership in this low-income program. Therefore, no net savings analyses were conducted.

12.6 Process Evaluation

12.6.1 Research Objectives

Cadmus conducted the PY8 process evaluation with a focus on program delivery and participation and addressed the following research objectives:

- Identify areas of program success
- Identify areas that may benefit from program improvements
- Assess satisfaction with program contractors
- Assess satisfaction with market actors including multifamily building property managers and manufactured home park property managers
- Assess satisfaction with overall customer experience and installed products

- Assess the potential effect on participation in other PPL Electric Utilities programs (specifically low-income assistance programs) as a stated objective of the program.

12.6.2 Evaluation Activities

Table 145 lists the PY8 process evaluation activities for the WRAP.

Table 145. WRAP Process Evaluation Activities

Activity	Number Completed
Program Staff Interviews: PPL Electric Utilities, ICSP, and ICSP Subcontractor	3
Market Actor Interviews: Master-Metered Multifamily Building Property Managers	3
Market Actor Interviews: Manufactured Home Park Property Managers	1
Trade Ally Interviews: Contractors	4
Telephone Participant Surveys	81
Logic Model Review	-
Process Flow Map Review	-

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

- Cadmus conducted phone surveys instead of online surveys. It did not complete online surveys in PY8 for these reasons:
 - The number of email addresses was limited
 - The email addresses provided mostly belonged to the uncommon email providers
 - Considering the demographics of WRAP participants (senior living communities in master-metered multifamily building stratum, manufactured home park residents, and other regular low-income participants), achieving satisfactory response rates through online surveys was unlikely.
- Cadmus did not complete phone surveys with tenants in the master-metered multifamily building apartments because contact information was not available. Cadmus did contact the master-metered multifamily building property managers and used their feedback to assess satisfaction with the program.
- Cadmus planned to interview three contractors and interviewed four. The ICSP provided contacts for all four WRAP contractors who were active in PY8, including those who conducted WRAP audits in prior program years and one contractor affiliated with a CBO.

Table 146 lists the process evaluation sampling strategy.

Table 146. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame ^[1]	Percent of Sample Frame Contacted to Achieve Sample ^[2]
PPL Electric Utilities Program and ICSP Staff	Key Individuals from PPL and ICSP	Telephone In-depth Interview	3	N/A	3	3	N/A	100%
Market Actor Interviews	Master-metered Multifamily Property Managers	Telephone In-depth Interview	3	N/A	3	3	N/A	100%
	Manufactured Home Park Property Manager		1	N/A	1	1	N/A	100%
Participants	Program Participant	Telephone survey	2,426 jobs	0.5	75	75	75	100%
	Manufactured Home Park Initiative	Telephone survey	57 jobs		Based on Actual	6	6	100%
	Master-metered Multifamily	Telephone survey	235 tenant units treated		Based on Actual	0	0	0%
Contractors	Participating ^[3]	Telephone In-depth Interview	4	N/A	3	4	N/A	100%
Program Total			2,729	N/A	N/A	92	N/A	100%

^[1] Sample frame is a list of participants with contact information who have a chance to complete the survey. The final sample frame includes unique records in the PPL database. After selecting all unique records, Cadmus removed any records from the population if the customers had participated in a survey in the last three months, were selected for another program survey, did not have valid contact information (email or telephone number), were on the do not call list, or opted out of the online survey.

^[2] Percent contacted means the percentage of the sample frame called to complete surveys.

^[3] Contact information was provided by the ICSP.

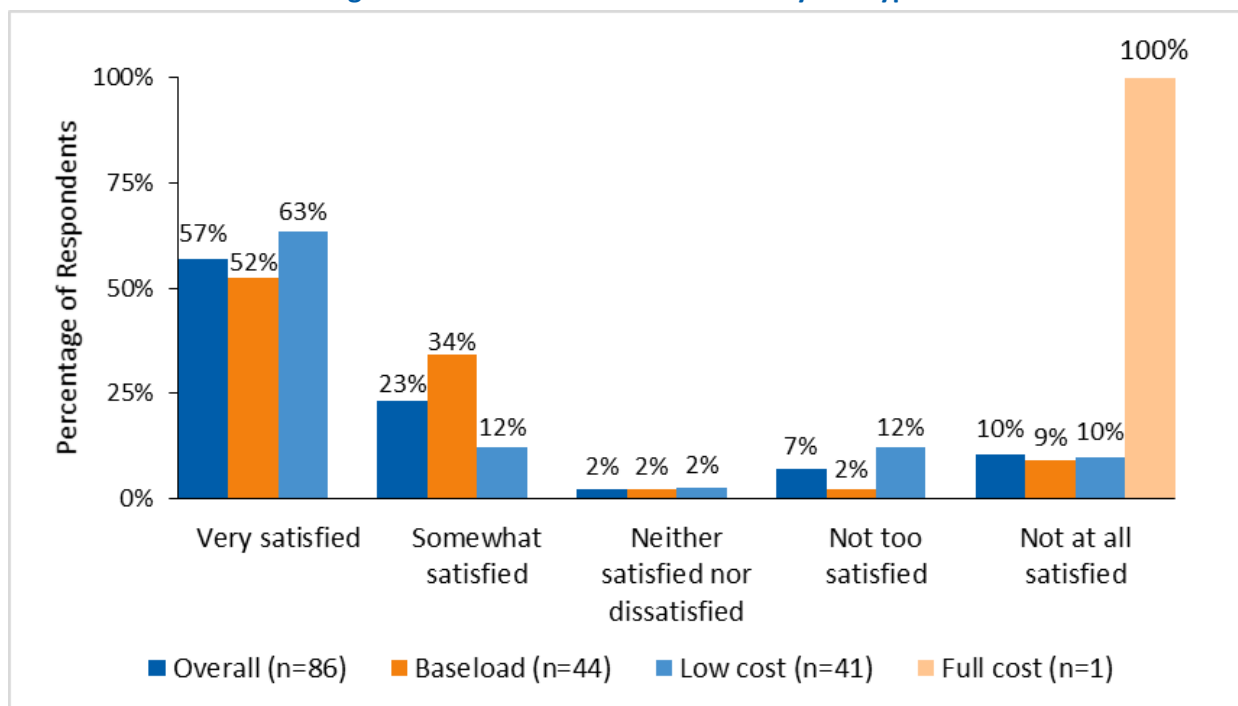
12.6.3 Summary of Process Evaluation Findings

Overall, Cadmus found that the program participants were satisfied with WRAP and that the ICSP performed well in PY8, its first year of involvement with WRAP. Cadmus also identified areas for improvement in operation and program implementation, as briefly discussed below.

When asked about their satisfaction with the WRAP, 57% of all survey respondents who replied to the overall satisfaction question (n=86) said they were *very satisfied* with the WRAP. An additional 23% rated their satisfaction as *satisfied*.

Full results of customer satisfaction by job type for PY8 are shown in Figure 34. Detailed results on participant satisfaction can be found in the *Participant Satisfaction* section in *Appendix L*. Only one of the seven who received a full-cost job responded.

Figure 34. PY8 Customer Satisfaction by Job Type



Source: Survey Question "Now, thinking about your overall experience with the PPL Electric Utilities WRAP program, how would you rate your satisfaction?"

Participants were also asked about how participating in the WRAP affected their opinion of PPL Electric Utilities. Of the 79 respondents who replied to this question, 33% said their opinion *improved significantly*, 13% said it *improved somewhat*, and 39% said it *has not changed* after participating in the WRAP.

Contractors and property managers were asked about their satisfaction with the WRAP overall and with specific elements of the program. Of four contractors Cadmus interviewed, one was *very satisfied*, one was *somewhat satisfied*, and two were *neither satisfied nor dissatisfied*. Of the four property managers, two were *very satisfied* with the WRAP, and two were *somewhat satisfied*. Any lack of satisfaction was

primarily because of issues of program administration and data collection and is discussed further below and in the *Program Delivery* section in *Appendix L*.

In PY8, the WRAP underwent a few changes. The largest change was that PPL Electric Utilities transferred program management to a new ICSP. All four contractors Cadmus interviewed said this caused some logistical issues during program launch, specifically a delay of almost two months in program launch.

Another major change was to the data collection process. In PY8, data collection in the field for all Act 129 WRAP jobs was completed through a tablet-based application. Contractors said the application was well-suited to baseload jobs, specifically that it gave good directions to contractors and was easy to use. However, all four contractors emphasized that the application had some issues, such as the lack of detail on some products and the inability to view data and conduct quality control once the form was filled out and submitted by the auditor through the application. Two contractors said they kept detailed records of site audits because the application lacked these important features. This is discussed in greater detail in the *Program Delivery* section in *Appendix L*.

All parties involved in the WRAP—property manager, contractors, and participants—said they had issues with communication, particularly with scheduling. The four property managers reported communication issues when scheduling work. All four contractors said the ICSP schedulers were not very familiar with the service area and scheduled jobs in an inefficient order. This also affected 10 customers who said they did not receive notices of schedule changes or follow-up calls. Seven customers and two contractors reported a lack of detail in communications, specifically what work would be completed through WRAP. Lastly, two contractors reported difficulty finding the right person to speak with at the ICSP when issues arose.

Additional detail regarding findings from process evaluation activities and their methodology is in *Appendix L.2 Process Evaluation*.

12.7 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 147. TRC benefits were calculated using gross verified impacts. NPV PYTD costs and benefits are expressed in PY8 dollars (PY8 includes months in both 2016 and 2017). NPV costs and benefits for P3TD financials are expressed in PY8 dollars.

Table 147. Summary of WRAP Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	-	-	-	-
2	EDC Incentives to Trade Allies	-	-	-	-
3	Participant Costs (net of incentives/rebates paid by utilities)	-	-	-	-
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	-	-	-	-
		EDC	CSP	EDC	CSP
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$287	-	\$287	-
7	Marketing ^[4]		\$287		\$287
8	Program Delivery ^[5]		\$3,438		\$3,438
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$4,012		\$4,012	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-	-	-	-
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$4,012		\$4,012	
14	Total NPV Lifetime Electric Energy Benefits	\$512		\$512	
15	Total NPV Lifetime Electric Capacity Benefits	\$103		\$103	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$284		\$284	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$899		\$899	
19	TRC Benefit-Cost Ratio ^[9]	0.22		0.22	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

Table 148 presents program financials and cost-effectiveness on a net savings basis. In this program, there is no free ridership; therefore, net verified savings are equal to gross verified savings.

Table 148. Summary of WRAP Finances—Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000)	
1	EDC Incentives to Participants	-	-	-	-
2	EDC Incentives to Trade Allies	-	-	-	-
3	Participant Costs (net of incentives/rebates paid by utilities)	-	-	-	-
4	Incremental Measure Costs (Sum of rows 1 through 3) ^[1]	-	-	-	-
		EDC	EDC	CSP	EDC
5	Design & Development ^[2]	-	-	-	-
6	Administration, Management, and Technical Assistance ^[3]	\$287	-	\$287	-
7	Marketing ^[4]		\$287		\$287
8	Program Delivery ^[5]		\$3,438		\$3,438
9	EDC Evaluation Costs	-	-	-	-
10	SWE Audit Costs	-	-	-	-
11 ^[6]	Program Overhead Costs (Sum of rows 5 through 10) ^[1]	\$4,012		\$4,012	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-	-	-	-
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^[7]	\$4,012		\$4,012	
14	Total NPV Lifetime Electric Energy Benefits	\$512		\$512	
15	Total NPV Lifetime Electric Capacity Benefits	\$103		\$103	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$284		\$284	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	-		-	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^[8]	\$899		\$899	
19	TRC Benefit-Cost Ratio ^[9]	0.22		0.22	

^[1] May not sum to total due to rounding.

^[2] All costs for Plan Design and Development are portfolio level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.

^[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.

^[4] Includes the marketing CSP and marketing costs by program CSPs

^[5] Includes CSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, QA/QC documentation. These costs cannot be quantified separately and are included as "Program Delivery" costs.

^[6] Rows 1-11 are presented in nominal dollars.

^[7] Total TRC Costs includes Total EDC Costs and Participant Costs.

^[8] Total TRC Benefits equals the sum of Total Lifetime Electric and Non-Electric Benefits. Benefits include: avoided supply costs, including the reduction in costs of electric energy, generation, transmission, and distribution capacity, and natural gas valued at marginal cost for periods when there is a load reduction.

^[9] TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

12.8 Status of Recommendations

Overall, the program has performed well in terms of participant satisfaction in PY8. At the beginning of the program year, WRAP made the transition from internal administration in Phase I and Phase II to an ICSP and took some time to launch and ramp up. The ICSP is taking steps to increase participation to meet its Phase III estimates of projected savings. Additionally, 1,501 projects were completed in PY8, which contributed 1,800 MWh/yr that will be reported in PY9. All parties expect the program to be on track by the end of PY9.

Cadmus identified a few recommendations that would optimize operational efficiency increase program satisfaction and increase savings. Table 149, which follows the recommendations, summarizes how PPL Electric Utilities plans to address the recommendations.

Finding: Cadmus found that some WRAP participants and contractors had issues with various aspects of program communications. Some participants were confused about program benefits, eligibility requirements, energy education, and overall program implementation process. Some native Spanish-speaking customers had difficulty communicating with program representatives. The ICSP subcontractor resolved this barrier at the manufactured home park by sending staff members who speak Spanish fluently. However, the language barrier remained for a few participants with other WRAP job types at some sites. WRAP contractors had some communication issues with the ICSP, stating that job scheduling was not implemented optimally and created additional travel time. WRAP contractors also said they were not provided with a communication protocol to reach the ICSP, which caused confusion about who to call. After scheduling, some customers cancelled or failed to keep their appointment, inevitably leading to site visit schedules that were less than optimal. (See the *Program Delivery* section in *Appendix L* for details.)

Conclusion: Improvements in program communication could smooth the program's operational performance and increase satisfaction, an important element as the ICSP continues to ramp up participation to meet the Phase III performance targets. Customer relations could benefit from clearer procedures to manage customer expectations about WRAP's advantages and requirements, especially about the number and type of products that will be installed. The ICSP is currently working to improve job scheduling procedures, another important element in increasing participation and satisfaction.

Recommendation #1: Consider improving program communication by revising the language in program marketing materials to better explain benefits and eligibility requirements for Act 129 WRAP, by job type, and by simplifying and providing greater context in the energy education provided to WRAP participants. Additionally, consider providing more training for PPL Electric Utilities' call center staff, the ICSP staff, and the installation contractors, to clarify information and language to use in interactions with WRAP participants. Consider developing a comprehensive communication protocol for all stakeholders (the ICSP, ICSP's subcontractor, WRAP contractors, and participants).

Finding: Cadmus found that all contractors had problems with the current tablet-based data management system because its setup does not allow contractors to review the data collected on site once entered into the tablet. This limits contractor's ability to run quality control checks of technical

field staff's work and forces contractors to keep separate records, which adds time to the job. (See the *Program Delivery* section in *Appendix L* for details.)

Conclusion: Improvements on the data view and submission features of the current tablet-based application could improve quality control of technical field staff work, minimize discrepancies in data collection, and increase the overall data quality.

Recommendation #2: Consider an in-depth discussion with the ICSP and WRAP contractors to learn how certain features of the tablet-based application could be improved to help contractors manage data and simplify their quality control process, and improve the accuracy of data entry.

Finding: Cadmus found that contractors often installed 1.5 GPM low-flow kitchen faucet aerators and showerheads when the existing aerator or showerhead was already 1.5 GPM, resulting in no energy savings. (According to field technicians, the GPM should be stamped on the showerhead or aerator.) Similarly, contractors often installed LED nightlights where there were no baseline nightlights, resulting in negative energy savings equal to the consumption of an LED nightlight. (See *Site Visit Findings* section in *Appendix L* for details.)

Conclusion: Significant instances of installations that did not save energy, where the baseline condition was the same or more efficient than the efficient equipment, were contributing factors to the relatively low realization rates for low-flow kitchen faucet aerators and showerheads and LED nightlights.

Recommendation #3: Consider instructing contractors to install low-flow faucet aerators and showerheads only if the existing aerator or showerhead has a flow rate higher than 1.5 GPM or provide some other procedure to determine when the installation is appropriate. Consider providing instructions to determine when the installation of LED nightlights is appropriate.

Finding: Cadmus calculated a 44% ISR (weighted by stratum) for Tier 2 smart strips. During site visits, participants said they removed the smart strips because they did not like them or did not understand how to operate them. (See *Site Visit Findings* section in *Appendix L* for details.)

Conclusion: Across all strata, WRAP participants were not very satisfied with the Tier 2 smart strips installed, and a large portion did not seem to understand how to use them. The low ISR contributed to a sizeable reduction in potential savings.

Recommendation #4: Consider offering Tier 1 smart strips instead of, or in addition to, Tier 2 smart strips. Although Tier 1 smart strips have lower potential savings (about 20% of the savings of Tier 2 smart strips), they are less complicated to set up and would be easier for most WRAP participants to operate. Participants could opt in to using a Tier 2 smart strip if they desired.

Finding: Only 39% of WRAP participants in PY8 reported acting on at least one energy-savings recommendation following the energy education they were provided (see *Appendix L.1 Gross Impact*

Evaluation Results). In PY7, 94% of WRAP participants reported acting on at least one energy-saving recommendation following the energy education they received.¹⁰²

Conclusion: There is a large potential for savings from the energy education component; however, low participation among WRAP customers drove down the energy savings realized for several possible reasons. Customers may be overwhelmed with the number of options they are given. Also, unlike the Energy Efficiency Kits and Education Program, customers receive no prompts, such as magnets or stickers, as reminders of the recommendations. Because participants receive one education session and no reminder prompts, persistence in energy savings recommendations may be limited.

Recommendation #5: Consider asking contractors to focus on explaining a few major energy-saving suggestions in detail.

Recommendation #6: Also, consider providing reminders to help participants more consistently implement the recommendations. For example, auditors could put magnets on participants' clothes washers suggesting they wash in cold water to save energy, give participants a five-minute timer for their shower, and place a sticker on thermostats to remind residents to turn up their thermostat in the summer and down in the winter.

12.8.1 Status of Recommendations for Program

Table 149 contains the status of each PY8 recommendation made to PPL Electric Utilities.

¹⁰² PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Table 149. Status of Recommendations

Winter Relief Assistance Program		
Recommendation Number	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
1	Consider improving program communication by revising language in program marketing materials to better explain benefits and eligibility requirements for Act 129 WRAP, by job type, and by simplifying and providing greater context in the energy education provided to WRAP participants. Additionally, consider providing more training for PPL Electric Utilities' call center staff, ICSP staff, and installation contractors to clarify information and language to use in interactions with WRAP participants. Consider developing a comprehensive communication protocol for all stakeholders (ICSP, ICSP's subcontractor, WRAP contractors, and participants).	Will be implemented
2	Consider an in-depth discussion with the ICSP and WRAP contractors to learn which features of the tablet-based application can be improved to help contractors manage data and streamline their quality control process.	Will be implemented
3	Consider instructing contractors to install low-flow faucet aerators and showerheads only if the existing aerator or showerhead has a flow rate higher than 1.5 GPM. Consider instructions for LED nightlight installations.	Agree
4	Consider offering Tier 1 smart strips instead of Tier 2 smart strips unless customers wish to opt in and take advantage of a Tier 2 smart strip.	Being considered. PPL Electric Utilities considered this previously but determined that it would result in lower verified savings because the savings per Tier 2 smart strip is so much greater than Tier 1, even with a much lower installation rate.
5	Consider asking contractors to focus on explaining a few major energy-saving suggestions in detail.	Being considered
6	Provide reminders (such as stickers or magnets) as a part of the energy education component to help participants remember and more consistently implement the recommendations.	Being considered

13 Cost Recovery

Act 129 allows Pennsylvania EDCs to recover EE&C plan costs through a cost-recovery mechanism. PPL Electric Utilities' cost-recovery charges are organized separately by customer sectors to ensure that the electric rate classes that finance the programs are the rate classes that receive the direct energy and conservation benefits. Cost-recovery is governed by tariffed rate class, so it is necessarily tied to the way customers are metered and charged for electric service.

Table 150. EE&C Plan Expenditures by Cost-Recovery Category^[1] (\$1,000)

Cost Recovery Sector	Rate Classes Included	PYTD Spending	P3TD Spending
Residential & Low-Income	Residential (primarily RS)	\$27,597	\$27,597
Small C&I	Small C&I (primarily GS1 & GS3)	\$6,460	\$6,460
Large C&I	Large C&I (primarily LP4 & LP5)	\$6,511	\$6,511
GNE	Residential, Small C&I, and Large C&I	\$4,430	\$4,430
Common ^[2]		\$5,601	\$5,601
Portfolio Total		\$50,599	\$50,599

^[1] Includes SWE costs.
^[2] Includes costs not collected at the sector level. These costs are allocated to the sectors at the end of the phase.

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Appendix A. Upstream Lighting Cross-Sector Sales

A.1 Introduction

The Efficient Lighting program is intended for residential customers but, because incentives are paid directly to manufacturers, the actual participants are not known. 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 PA TRM, Cadmus conducted a study to estimate the proportion of program bulbs that are purchased by commercial customers, referred to as cross-sector sales.

Prior to PY8, Cadmus most recently conducted this study in PY6. Therefore, PPL Electric Utilities used the cross-sector sales analysis conducted in PY6 to calculate the ratio between commercial and residential bulb sales reported in PPL Electric Utilities' tracking database and the sector-level incentive expenditures for PY8. Cadmus then made *ex post* adjustments to reported energy and demand savings in PY8 to adjust bulb quantities and savings based on the PY8 study. PPL Electric Utilities will adjust its expenditure accounting going forward in Phase III.

A.2 Surveys

Cadmus used data from general population customer surveys and from PPL Electric Utilities' customer records to estimate the proportion of cross-sector sales. Details regarding survey sampling and methodology can be found in *Appendix D, Section D.1.1 EM&V Sampling Approach* and *Section D.4.3 Sample Cleaning and Attrition for General Population Surveys*.

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.¹ Both surveys were conducted in the spring of 2017 to avoid any potential bias due to seasonality, pricing changes, or other time-based factors that could contribute to changes in bulb-purchasing behavior.

In its residential and small business general population surveys, Cadmus asked respondents to report various details about their LED purchase experience:

- If they purchased LEDs recently (in the last six months)
- How many LEDs they purchased
- From which retailer, they purchased the LEDs
- For small business owners, whether they are knowledgeable about their organizations' lighting purchases

¹ Cadmus excluded customers with a GS3 rate code because these larger businesses are not expected to purchase bulbs from retailers, and any customers with SIC code 4841 (Cable and Other Pay Television Services) because these were determined to be fixed-usage accounts, not applicable to the assumed population.

- For small business owners, a description of their business type
- For small business owners, whether they installed any of the LEDs in their homes or facilities that they build or manage vs. their business facilities

Cadmus used this self-reported information to establish several assumptions used to estimate the proportion of bulbs being purchased by each sector.

For both residential and small business customers, 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 highly accurate—mainly because of 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.

In PY8, Cadmus made an additional adjustment to the small commercial base to account for the proportion of surveyed respondents who indicated their business was not responsible for purchasing lighting for their facility. This adjustment amounts to a default assumption that the landlords or other parties who purchase lighting for those commercial customers' facilities do not purchase equipment from retailers that participate in the Efficient Lighting Program. Therefore, Cadmus considers this adjustment, which reduced the assumed small business customer base by 42%, to be very conservative.

Lastly, 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 and annual kWh usage in the survey respondent group to those in the assumed population and found,² given the variety seen in both, that the distributions were reasonably similar. In addition, Cadmus compared these same metrics for the subset of commercial survey respondents who said they were not responsible for lighting in their facility (these respondents completed an abbreviated survey) to those who completed the full survey; Cadmus did not identify any material differences between these two groups.

The computed metrics and resulting proportions are shown in Table A-1.

² These metrics are included in PPL Electric Utilities' customer information system, an extract from which is provided to Cadmus quarterly.

Table A-1. Metrics and Calculated Proportions, by Population

Population	Percentage of Respondents Purchasing LEDs from Participating Retailers		LEDs per Customer			PPL Electric Utilities Customer Base	LEDs Purchased from Participating Retailers ^[1]	Percentage of Total (Cross-Sector Proportion)
	Estimate	N	Estimate	N	Std. Dev			
Small Commercial	19%	269	20.21	52	41.4	79,047	308,840	10%
Residential	24%	300	9.96	73	10.84	1,200,000	2,908,000	90%
Total		569		125		1,279,047	3,216,840	100%

^[1] Calculation for LEDs purchased from participating retailers is (% x avg. # x customer base).

To compute a statistical confidence interval on the proportions shown in Table A-1, 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.³ The true cross-sector proportion lies between 5.6% and 14.2%, or about 4.5% precision at 85% confidence.

A.3 Savings Inputs and Impact

The 2016 PA TRM gives the following general equations for computing lighting energy and demand savings:

$$\Delta kWh/yr = \frac{Watts_{base} - Watts_{EE}}{1000 \frac{W}{kW}} \times HOU \times (1 + IE_{kWh}) \times 365.25 \frac{days}{yr} \times ISR$$

$$\Delta kW_{peak} = \frac{Watts_{base} - Watts_{EE}}{1000 \frac{W}{kW}} \times CF \times (1 + IE_{kW}) \times ISR$$

The assumptions regarding hours of use, coincidence factor, and ISR vary by sector. These assumptions are deemed (in the 2016 PA TRM) for the residential sector. For the bulbs assumed to be purchased by the small commercial sector, Cadmus used the hours of use and coincident factor assumptions by building type from Table 3-5 in the 2016 PA TRM. Using these data, Cadmus computed a weighted average for each business type by first mapping the business types of respondents who purchased LEDs from participating retailers to the PA TRM building type then 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 A-2.

³ The normal distribution was truncated at zero to ensure that the number of bulbs was positive.

Table A-2. PY8 Survey Respondent Bulbs Purchased Distribution, by Building Type

PY8 Small Commercial Survey Respondents Who Purchase LEDs from Participating Retailers			PA TRM Assumption	
Mapped Building Type	Number of Respondents	Percentage of Total Bulbs Purchased	HOU/Yr	Coincidence Factor
Agriculture	6	42%	2,956	0.475
Retail	10	20%	2,383	0.56
Office	19	18%	1,420	0.26
Warehouse	2	7%	2,815	0.5
Lodging	1	3%	2,925	0.38
Grocery	1	3%	7,798	0.99
Health	2	2%	2,476	0.47
Institutional/Public Service	3	2%	1,456	0.23
Industrial Manufacturing – 1 Shift	2	1%	2,857	0.57
Industrial Manufacturing – 2 Shift	3	1%	4,730	0.57
Restaurant	2	1%	3,054	0.55
Miscellaneous/Other	1	1%	2,001	0.33
Grand Total	52	100%^[1]	2,682^[2]	0.47^[2]

^[1] May exceed 100% due to rounding.
^[2] Weighted averages.

The effect of the proportional split, and the different assumptions for the residential vs. commercial sector, are illustrated in Table A-3.

Table A-3. PY8 Assumptions Used and Savings Example (60W Equivalent Bulb)

Savings Example: 60W Equivalent A-Line LED											
	Delta W	HOU/Day	Coincidence Factor	HOU & Coincidence Factor Source	ISR	IE _{kWh/yr} Factor	IE _{kw}	Per-Bulb kWh/yr Savings	% of Bulbs	Savings per Program Bulb (kWh/yr)	Proportion of kWh/yr Savings
Residential	34	3.00	0.106	2016 PA TRM	92%	-6%	12%	32.20	90%	28.98	78%
Small Commercial	34	7.35	0.465	Building type mapping of survey respondents ^[1]	92%	0% ^[1]	19.2% ^[1]	83.90	10%	8.39	22%
Total									100%	37.37	100%

^[1] Interactive factors from PA TRM Table 3-9 for unknown heating fuel

A.3.1 Calculating Uncertainty for Program Savings

In this study of discounted LEDs, the estimate included a cross-sector sales adjustment where population sizes, proportion of respondents who purchased bulbs (survey estimate), and the average number of bulbs respondents 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 cross-sector sales adjustment were estimated with uncertainty, the variance of the ratio has no closed form solution and commonly used methods were not applicable.

Therefore, Cadmus 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. Cadmus calculated the cross-sector sales adjustment and energy savings for each realization then estimated the uncertainty of the savings estimate based on variation in the realizations.

Precision for energy savings was estimated by calculating the 7.5 and 92.5 percentiles of the distribution that Cadmus had used to determine the confidence interval around the total savings and to report precision. The precision of the demand savings was set 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 PA TRM used. Based on the variance in the realizations, Cadmus estimated precision for energy and demand savings at 4.5% with 85% confidence.

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Appendix B. Site Inspection Summary

Table B-4 summarizes programs receiving verification site visits by Cadmus or the ICSP (listed in column “Inspection Firm”). The table includes the numbers of inspections, and resolution of discrepancies.

Table B-4. Site Inspection Summary

Program	Inspection Firm	Inspections Conducted	Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
Distributor Discount Lighting	Warren Energy Engineering (for Cadmus)	52	52	Adjustment to IMP baseline watts or counts; unable to find equipment
Distributor Discount Lighting	CLEAResult (the ICSP)	7	1	Product not found ship to location and move to another facility
Custom	CLEAResult (the ICSP)	69	66	<ul style="list-style-type: none"> Mismatch of quantities of fixtures on rebate form vs. what was installed in the field Wrong fixture types selected in baseline fixtures (i.e. Lamps were counted instead of fixtures, mistaken fixture types, etc.) Wrong HOU given on rebate form vs. what was found from customer interviews on site Project savings may have increased or decreased as a result of site visits which made the projects switch from prescriptive to customer submitted HOU Post fixture wattages or quantities did not match what was submitted on the rebate form Project scope deviation and possibly not understanding systems installed for Custom
Efficient Equipment Lighting	CLEAResult (the ICSP)	153	142	
Efficient Equipment HVAC	CLEAResult (the ICSP)	6	4	
Efficient Equipment Motors	CLEAResult (the ICSP)	1	1	
Efficient Equipment Refrigeration	CLEAResult (the ICSP)	8	6	
Custom	Warren Energy Engineering (for Cadmus)	44	14	Discrepancies only found on small sample sites (10 visits) and large sample visits that were reported prior to verification (4 visits). Corrections made to verified reports
Efficient Equipment Lighting	Warren Energy Engineering (for Cadmus)	68	41	Implementer reported incorrect building type (and associated TRM HOU and CF), pre- and post-install fixture quantities, pre- and post-install fixture types, pre- and post-install fixture controls, lamp type (and associated TRM HOU and CF).
Efficient Equipment HVAC	Cadmus	9	2	Guest room occupancy sensor: Baseline setback control was incorrectly reported
			1	Guest room occupancy sensor: Verified quantity of operational sensors was less than reported
			1	Guest room occupancy sensor: Verified HVAC unit capacity was less than reported

Program	Inspection Firm	Inspections Conducted	Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
			1	Commercial ASHP > 5.4 Tons IEERL: Verified installed unit quantity and capacity varied from reported
Efficient Equipment Motors	Cadmus	5	1	Variable Frequency Drive Improvements: Double-counted kitchen exhaust fan VFDs as VFD improvements
			1	Variable Frequency Drive Improvements: Verified motor quantity and horsepower varied from reported
			1	Kitchen Exhaust Fan VFDs: Double-counted kitchen exhaust fan VFDs as VFD improvements
Efficient Equipment Refrigeration	Cadmus	7	1	Anti-Sweat Heater Controls: Verified quantity less than reported
			1	High-Efficiency Evaporator Fans-Walk-In Freezer, PSC 16W-23W: verified unit type was a cooler, not freezer
			1	High Efficiency Evaporator Fans-Reach in Cooler, SP <16W: Verified quantity higher than reported
			1	High Efficiency Evaporator Fans-Reach in Freezer, SP <16W: Verified quantity higher than reported
			1	Add Door to Existing Ref Display Cases: Verified quantity less than reported
			1	Night Covers for Display Cases: Verified quantity less than reported
Energy Efficient Homes – New Homes Component	Cadmus	20	4	Cadmus found that four of the sites overestimated savings because of inaccurate ICSP assumptions. The quantity of high-efficiency lighting in homes was lower than reported in one out of 20 homes. In nine of 20 homes, refrigerators were replaced by the homeowner, resulting in zero verified savings for refrigerators.
Energy Efficient Homes – New Homes Component	Performance Systems Development (PSD) (for the ICSP)	27	56	<ul style="list-style-type: none"> Domestic Hot Water (21) – Domestic Hot Water discrepancies were most often caused by misreported efficiency ratings. Windows (11) – Window discrepancies were most often caused by misreported total window square footage or misreported window orientation. This is often caused by raters taking orientation and window square footage from plans and failing to reconfirm conditions on site. Cooling Equipment (9) – Cooling Equipment discrepancies were most often caused by misreported efficiency ratings. Lighting (7) – All lighting discrepancies involved an incorrectly reported percentage of energy-efficient bulbs. Raters often miscount or fail to identify all the existing fixtures in the home, causing inconsistencies in reporting. Heating (8) – Heating Equipment discrepancies were most often caused by misreported efficiency ratings.

Program	Inspection Firm	Inspections Conducted	Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
WRAP	Cadmus	90	90	Overall, Cadmus found minor discrepancies in measure counts or inputs in every home visited; measures with low ISRs were Tier 2 smart strips and LED nightlights.
WRAP Manufactured Homes	CMC (the ICSP)	1	0	CMC found no discrepancies.
WRAP Baseload	CMC (the ICSP)	32	11	CMC found additional opportunities in 11 units. The CMC inspector installed the additional measures including a CO detector, bulbs, and Tier 2 smart Strips.
WRAP Low Cost	CMC (the ICSP)	20	5	CMC found additional opportunities in 5 units. The CMC inspector installed the additional measures including bulbs and Tier 2 smart Strips.

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Appendix C. Home Energy Report Impact Evaluation Detail

C.1 Methodology

C.1.1 Data Preparation

Cadmus worked with PPL Electric Utilities and the ICSP to acquire the data necessary for the Home Energy Education Program evaluation in PY8. Major data preparation steps included cleaning and compiling the program tracking data, billing consumption, and weather data and testing for significant differences in annual pre-treatment consumption between treatment and control customers, by wave.

Cleaning and Compiling Final Data

Cadmus received program tracking data from the ICSP and billing consumption from PPL Electric Utilities. This section describes the steps Cadmus took to process the data and verify customers in the tracking and billing data.

Program Tracking Data

Cadmus received Home Energy Education Program tracking data from the ICSP at the close of PY8. These data included treatment group customers to whom the ICSP had sent home energy reports and control group customers the ICSP had tracked through the program year. Because of the randomized control trial design of the Home Energy Education Program, Cadmus included all of the possible customers in its evaluation, adopting a “once in, always in policy,” which refers to the customers originally randomized into either the treatment or control group prior to the launch of the home energy reports. Cadmus supplemented the customer program data from the ICSP with the program tracking data it collected in PY7 to account for any customers not included in the ICSP’s tracking data.

Table C-5 shows customer attrition through PY8, by treatment and control groups, by wave, and as originally randomized, active at the beginning of treatment, and treated. The attrition process captures customers whose accounts closed (became inactive) since the launch of the program. The counts in the “Active at the Beginning of Treatment in PY8” column include customers in Cadmus’ full tracking dataset who were active when PY8 treatment began. For low-income waves, PY8 treatment began in May 2017. For the other waves, PY8 treatment began at the start of the program year, June 2016. The counts in the “Treated in PY8” column include customers in the ICSP’s tracking data, that is, the treatment customers for whom Cadmus can verify that the ICSP provided home energy reports during PY8.

Table C-5. PY8 Customer Attrition

Wave	Originally Randomized		Active at the Beginning of Treatment in PY8 ^[1]		Treated in PY8 ^[2]	
	Treatment	Control	Treatment	Control	Treatment	Control
Legacy Wave 1	50,000	50,000	36,291	36,333	29,568	29,499
Legacy Wave 2	55,040	25,003	42,082	19,032	33,563	15,122
Expansion Wave 1	48,722	12,654	43,303	11,209	34,195	8,866
Low-Income Wave 1 ^[3]	73,500	18,560	58,568	14,865	46,001	11,597
Low-Income Wave 2 ^[3]	21,401	10,046	16,845	7,929	12,581	5,896
Phase III Expansion Wave 1	27,697	11,096	27,697	11,096	27,697	11,096
Total ^[4]	276,360	127,359	224,786	100,464	183,605	82,076

^[1] Customers in Cadmus' full tracking dataset who were active when PY8 treatment began.
^[2] Customers in the ICSP's tracking data for whom Cadmus verified that the ICSP provided home energy reports and were active when PY8 treatment began.
^[3] Treatment for low-income customers began in May 2017.
^[4] May not match due to rounding

Billing Data

Cadmus collected customer billing data for each wave from PPL Electric Utilities to supplement the billing data it had collected and cleaned in PY7. To clean the billing data, Cadmus followed these steps:

1. Dropped customers who went inactive before the delivery of the first energy reports
2. Cleaned and calendarized bills, including dropping bills that covered more than 65 days, dropping bills with negative consumption, dropping bills earlier than one year prior to the delivery of the first energy reports, and truing up bills with estimated reads
3. Dropped customers with less than 11 months of pre-treatment bills

Table C-6 provides the PY8 modeling attrition. The final modeling sample included customers in Cadmus' final tracking data who were not dropped during the billing data cleaning process and were included in the billing analysis. These customers were not necessarily active at the beginning of treatment in PY8.

Table C-6. PY8 Modeling Attrition

Step in Attrition	Legacy Wave 1		Legacy Wave 2		Expansion Wave 1	
	Treatment	Control	Treatment	Control	Treatment	Control
Originally Randomized Customers	50,000 (100%)	50,000 (100%)	55,040 (100%)	25,003 (100%)	48,722 (100%)	12,654 (100%)
Active at Program Launch	48,959 (98%)	48,955 (98%)	53,541 (97%)	24,325 (97%)	47,867 (98%)	12,435 (98%)
Calendarization	48,775 (98%)	48,771 (98%)	53,288 (97%)	24,191 (97%)	47,866 (98%)	12,435 (98%)
Less than 11 Months of Pre-Treatment Data	48,295 (97%)	48,292 (97%)	50,792 (92%)	23,027 (92%)	47,557 (98%)	12,356 (98%)
Final Modeling Sample	48,295 (97%)	48,292 (97%)	50,792 (92%)	23,027 (92%)	47,557 (98%)	12,356 (98%)
Step in Attrition	Low-Income Wave 1		Low-Income Wave 2		Phase III Expansion Wave 1	
	Treatment	Control	Treatment	Control	Treatment	Control
Originally Randomized Customers	73,500 (100%)	18,560 (100%)	21,401 (100%)	10,046 (100%)	27,697 (100%)	11,096 (100%)
Active at Program Launch	72,630 (99%)	18,344 (99%)	20,875 (98%)	9,765 (97%)	27,697 (100%)	11,096 (100%)
Calendarization	72,626 (99%)	18,344 (99%)	20,875 (98%)	9,765 (97%)	27,697 (100%)	11,096 (100%)
Less than 11 Months of Pre-Treatment Data	72,184 (98%)	18,239 (98%)	20,718 (97%)	9,676 (96%)	27,035 (98%)	10,833 (98%)
Final Modeling Sample	72,184 (98%)	18,239 (98%)	20,718 (97%)	9,676 (96%)	27,035 (98%)	10,833 (98%)

Weather Data

Cadmus collected weather data from the weather station closest to each home and estimated the heating degree days (HDDs) and cooling degree days (CDDs) 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.

C.1.2 Verification of Balanced Treatment and Control Groups

Cadmus verified that subjects in the randomized treatment and control groups were equivalent in pre-treatment energy use. Cadmus conducted the random assignment of eligible customers to treatment or control groups for Legacy Wave 2 in Phase I, Expansion Wave 1 and both low-income waves in Phase II, and the Phase III Expansion Wave 1 in Phase III. The ICSP performed the randomization for Legacy Wave 1. Cadmus verified the equivalence of these waves using the cleaned billing data from *Section Billing Data*, comparing pre-program average annual consumption from before the launch of the program.

Table C-7 provides the results of the tests for significant differences in treatment and control group pre-treatment consumption. Cadmus found that all waves were well balanced. No significant difference existed between the pre-treatment consumption of treatment and control groups in any wave.

Table C-7. Tests for Significant Differences in Annual Pre-Treatment Consumption

Wave	Customers		Average Annual Electricity Use per Customer (kWh/yr)			p-value ^[1]
	Treatment Group	Control Group	Treatment Group	Control Group	Difference	
Legacy Wave 1	48,295	48,292	18,526	18,459	67	0.1369
Legacy Wave 2	50,792	23,027	27,640	27,746	-107	0.1370
Expansion Wave 1	47,557	12,356	23,195	23,196	-1	0.9900
Low-Income Wave 1	72,184	18,239	11,859	11,815	45	0.4280
Low-Income Wave 2	20,718	9,676	8,076	8,143	-67	0.5033
Phase III Expansion Wave 1	27,035	10,833	15,179	15,176	2	0.9648

^[1] A p-value >0.05 indicates an insignificant difference at the 5% significance level.

C.1.3 Ex Post Verified Savings Methodology

Energy Savings Model Specification

For Phase III, Cadmus used regression analyses of monthly billing data from customers in the treatment and control groups to estimate the Home Energy Education Program's energy savings. The billing analysis conformed to IPMVP Option C, whole facility,⁴ and the approach described in the Uniform Methods Project.^{5,6} Methods also followed those described in the Phase III Evaluation Framework for behavioral programs.⁷

⁴ 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/>.

⁵ Agnew, K., and M. Goldberg. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol*. U.S. Department of Energy, National Renewable Energy Laboratory. April 2013. (NREL/SR-7A30-53827) Available online: http://www1.eere.energy.gov/office_eere/de_ump_protocols.html.

⁶ Stewart, J., and A. Todd. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 17: Residential Behavior Protocol*. U.S. Department of Energy, National Renewable Energy Laboratory. August 2014. (NREL/SR-7A40-62497) Available online: http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

⁷ Pennsylvania Public Utility Commission. *Phase III Evaluation Framework*. August 25, 2016. See Behavior Section 6.1.1.

More specifically, Cadmus used a multivariate regression to analyze the energy use of customers who had been randomly assigned to treatment and control groups. Cadmus tested and compared two general model specifications to check the robustness of savings results:

- The **post-only** model regresses customer average daily consumption on a treatment indicator variable and includes as regressors customers' pretreatment energy use, month-by-year fixed effects, and weather.⁸ The model is only estimated with post-treatment customer bills.
- The **difference-in-differences (D-in-D) fixed effects** model regresses average daily consumption on a treatment indicator variable, month-by-year fixed effects, customer fixed effects, and weather. The model is estimated with pre-treatment and post-treatment customer bills.

Both models yielded savings estimates that were within each other's confidence intervals, meaning that their results were not statistically different (see this graphically in Figure C-1 through Figure C-6, presented later in this section). In PY8, Cadmus reported the results of the post-treatment only model, consistent with PY7.

The error term ε_{it} should be uncorrelated with program participation ($PART_i$) and other observable variables because of the random assignment of homes to treatment and control groups, and therefore ordinary least squares should result in an unbiased estimate of the average daily savings per customer. Cadmus clustered the standard errors on customers to account for arbitrary correlation in customer consumption over the analysis period.

The following sections provide additional details about each modeling approach.

Post-Only Model

The post-only model was specified assuming the average daily consumption (ADC_{it}) of electricity of home 'i' in month 't' as given by Equation 1.

Equation 1

$$ADC_{it} = \beta_1 PART_i \times PY_t + \beta_2 Pre-Usage_i + \beta_3 Pre-Summer_i + \beta_4 Pre-Winter_i + \beta_5 Pre-Usage_i \times \tau_t + \beta_6 Pre-Summer_i \times \tau_t + \beta_7 Pre-Winter_i \times \tau_t + W'\gamma + \tau_t + \varepsilon_{it}$$

Where:

- β_1 = Coefficient representing the conditional average treatment effect of the program on electricity use (kWh per customer per day).
- $PART_i$ = Indicator variable for program participation (which equals 1 if customer 'i' was in the treatment group and 0 otherwise).
- PY_t = Indicator variable for each program year (which equals 1 if the month 't' was in the program year and 0 otherwise).

⁸ Allcott, H., and T. Rogers. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review* 104 (10), 3003-3037. 2014.

β_2	=	Coefficient representing the conditional average effect of pre-treatment electricity use on post-treatment average daily consumption (kWh per customer per day).
$Pre-Usage_i$	=	Mean household energy consumption of customer 'i' across all pre-treatment months.
β_3	=	Coefficient representing the conditional average effect of pre-treatment summer electricity use on post-treatment average daily consumption (kWh per customer per day).
$Pre-Summer_i$	=	Mean household energy consumption of customer 'i' during June, July, August, and September of the pre-treatment period.
β_4	=	Coefficient representing the conditional average effect of pre-treatment winter electricity use on post-treatment average daily consumption (kWh per customer per day).
$Pre-Winter_i$	=	Mean household energy consumption of home 'i' during December, January, February, and March of the pre-treatment period.
W	=	Vector using both HDD and CDD variables to control for the impacts of weather on energy use.
γ	=	Vector of coefficients representing the average impact of weather variables on energy use.
τ_t	=	Average energy use in month 't' reflecting unobservable factors specific to the month. The analysis controls for these effects with month-by-year fixed effects.
β_5	=	Coefficient representing the conditional average effect of pre-treatment electricity use, given month 't', on post-treatment average daily consumption (kWh per customer per day).
β_6	=	Coefficient representing the conditional average effect of pre-treatment summer electricity use, given month 't', on post-treatment average daily consumption (kWh per customer per day).
β_7	=	Coefficient representing the conditional average effect of pre-treatment winter electricity use, given month 't', on post-treatment average daily consumption (kWh per customer per day).
ϵ_{it}	=	Error term for customer 'i' in month 't.'

Difference-in-Differences Fixed Effects Model

The D-in-D fixed effects model was specified assuming the average daily consumption (ADC_{it}) of electricity of customer 'i' in month 't' as given by Equation 2:

Equation 2

$$ADC_{it} = \alpha_i + \tau_t + W'\gamma + \beta_1 PART_i \times POST_t + \epsilon_{it}$$

Where:

β_1	=	Coefficient representing the conditional average treatment effect of the program on electricity use (kWh per customer per day).
$PART_i$	=	Indicator variable for program participation (which equals 1 if customer 'i' was in the treatment group and 0 otherwise).
$POST_t$	=	Indicator variable for whether month 't' is pre- or post-treatment (which equals 1 if month 't' was in the treatment period and 0 otherwise).
W	=	Vector using both HDD and CDD variables to control for the impacts of weather on energy use.
γ	=	Vector of coefficients representing the average impact of weather variables on energy use.
α_i	=	Average energy use in customer 'i' reflecting unobservable, non-weather-sensitive, and time-invariant factors specific to the customer. The analysis controlled for these effects with customer fixed effects.
τ_t	=	Average energy use in month 't' reflecting unobservable factors specific to the month. The analysis controlled for these effects with month-by-year fixed effects.
ϵ_{it}	=	Error term for customer 'i' in month 't'

Regression Analysis Estimates

Cadmus estimated separate average treatment effects for each wave and program year. Table C-8 shows both the D-in-D fixed effects model and post-only model estimates of average daily savings per customer, by wave and program year. All of the models were estimated by ordinary least squares, and Huber-White robust standard errors were adjusted for correlation over time in a customer's consumption.

Note that the ICSP's subcontractor did not send home energy reports to low-income waves until April 20, 2017. To measure the savings occurring after customers received their first home energy reports, Cadmus included two program-year indicators for PY8:

- PY8a covers the period in PY8 in which low-income waves did not receive any home energy reports (June 2016 through April 2017)
- PY8b covers the period in PY8 in which these waves received a home energy report (May 2017). The treatment effect for low-income waves included only May 2017.

Table C-8. Treatment Effects for the Home Energy Education Program by Model Specifications

Treatment Year	Legacy Wave 1		Legacy Wave 2		Expansion Wave	
	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only
PY1	0.2 (0.06) ***	0.2 (0.04) ***	-	-	-	-
PY2	0.7 (0.05) ***	0.7 (0.05) ***	-	-	-	-
PY3	0.9 (0.07) ***	0.9 (0.06) ***	0.9 (0.09)	1.0 (0.08)	-	-
PY4	1.0 (0.07) ***	1.0 (0.07) ***	1.2 (0.11) ***	1.3 (0.10) ***	-	-
PY5	0.9 (0.08) ***	0.9 (0.08) ***	1.2 (0.13) ***	1.3 (0.12) ***	-	-
PY6	0.9 (0.09) ***	0.9 (0.09) ***	1.2 (0.14) ***	1.3 (0.14) ***	0.6 (0.14) ***	0.6 (0.12) ***
PY7	0.9 (0.09) ***	0.8 (0.08) ***	1.1 (0.14) ***	1.1 (0.14) ***	0.8 (0.12) ***	0.7 (0.10) ***
PY8	0.9 (0.09) ***	0.9 (0.09) ***	1.0 (0.15) ***	1.1 (0.15) ***	0.8 (0.14) ***	0.8 (0.12) ***
Treatment Year	Low-Income Wave 1		Low-Income Wave 2		Phase III Expansion Wave 1	
	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only
PY6	0.1 (0.09)	0.1 (0.08)	-	-	-	-
PY7	0.4 (0.08) ***	0.4 (0.06) ***	0.1 (0.09) *	0.2 (0.07) **	-	-
PY8a ^[2]	0.4 (0.09) ***	0.4 (0.08) ***	0.2 (0.10) *	0.2 (0.09) *	0.1 (0.07)	0.1 (0.07)
PY8b ^[3]	0.3 (0.12) ***	0.3 (0.07) ***	0.0 (0.16)	0.1 (0.08)		

^[1] Standard errors are presented below the estimated treatment effect in parenthesis (*** Significant at 1%; ** Significant at 5%; * Significant at 10%).

^[2] PY8a covers months June 2016 through April 2017 of PY8.

^[3] PY8b covers May 2017 of PY8.

Both the D-in-D fixed effects and post-only models yielded savings estimates that were statistically indistinguishable, suggesting that the estimated treatment effects do not depend on the modeling approach. Cadmus reported savings based on the post-only models for all waves because of the increased precision achieved with these models; this is seen in the smaller standard errors of post-only estimates compared to D-in-D fixed effects estimates.

Treatment effects were significant across all waves and program years with two exceptions. Cadmus evaluated average daily savings per customer of 0.123 kWh with a p-value of 0.1361 for Low-Income Wave 1. A p-value less than 0.10 suggests that the estimate is not statistically different from 0.0 kWh/day. This results from two factors: the true but unknown average daily savings may be small and close to zero, and there were a relatively small number of observations used in estimation (since the estimate only covered May 2017).

Cadmus also evaluated statistically insignificant average daily savings per customer of 0.113 kWh (p-value of 0.1240) for the Phase III Expansion Wave 1.

Table C-9 shows the estimated average daily savings as a percentage of control group consumption, by program year and wave. Savings remain consistent with PY7 for Legacy Wave 1, Legacy Wave 2, Expansion Wave 1, and Low-Income Wave 1, ranging between 1.4% in Expansion Wave 1 and 1.9% in Legacy Wave 1. Note that the percentage average daily savings persisted throughout PY8 for

Low-Income Wave 1; savings appear unaffected by the months in the beginning of PY8 when these customers did not receive any home energy reports.

The Phase III Expansion Wave 1 achieved the lowest percentage average daily savings of all waves (0.3%). However, the majority of waves began with low percentage average daily savings, most notably Legacy Wave 1 and Low-Income Wave 1. These waves both achieved a ramp up in savings the longer the program continued; the same may apply to the Phase III Expansion Wave 1 as well.

Table C-9. Percentage Treatment Effects for the Home Energy Education Program by Model Specifications

Treatment Year	Legacy Wave 1		Legacy Wave 2		Expansion Wave 1	
	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only
PY1	0.5% (0.1%) ^{***}	0.3% (0.1%) ^{***}	-	-	-	-
PY2	1.3% (0.1%) ^{***}	1.3% (0.1%) ^{***}	-	-	-	-
PY3	1.9% (0.1%) ^{***}	1.9% (0.1%) ^{***}	1.4% (0.1%)	1.5% (0.1%)	-	-
PY4	2.0% (0.1%) ^{***}	2.0% (0.1%) ^{***}	1.7% (0.2%) ^{***}	1.8% (0.1%) ^{***}	-	-
PY5	1.7% (0.2%) ^{***}	1.7% (0.2%) ^{***}	1.6% (0.2%) ^{***}	1.7% (0.2%) ^{***}	-	-
PY6	1.7% (0.2%) ^{***}	1.7% (0.2%) ^{***}	1.7% (0.2%) ^{***}	1.8% (0.2%) ^{***}	1.0% (0.2%) ^{***}	1.0% (0.2%) ^{***}
PY7	1.9% (0.2%) ^{***}	1.8% (0.2%) ^{***}	1.7% (0.2%) ^{***}	1.8% (0.2%) ^{***}	1.4% (0.2%) ^{***}	1.3% (0.2%) ^{***}
PY8	1.9% (0.2%) ^{***}	1.9% (0.2%) ^{***}	1.5% (0.2%) ^{***}	1.7% (0.2%) ^{***}	1.5% (0.2%) ^{***}	1.4% (0.2%) ^{***}
Treatment Year	Low-Income Wave 1		Low-Income Wave 2		Phase III Expansion Wave 1	
	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only	D-in-D Fixed Effects	Post-Only
PY6	0.2% (0.3%)	0.3% (0.2%)	-	-	-	-
PY7	1.4% (0.3%) ^{***}	1.4% (0.2%) ^{***}	0.7% (0.4%)*	0.8% (0.3%)**	-	-
PY8a ^[2]	1.2% (0.3%) ^{***}	1.3% (0.3%) ^{***}	0.9% (0.5%)*	0.8% (0.5%)*	0.3% (0.2%)	0.3% (0.2%)
PY8b ^[3]	1.5% (0.6%) ^{***}	1.6% (0.3%) ^{***}	-0.1% (1.1%)	0.9% (0.6%)		

^[1] Standard errors are presented below the estimated treatment effect in parenthesis (^{***} Significant at 1%; ^{**} Significant at 5%; ^{*} Significant at 10%).

^[2] PY8a covers months June through April of PY8.

^[3] PY8b covers May of PY8.

Annual Program Energy Savings

Cadmus estimated program savings in PY8 for each wave's population of treated customers as the product of average daily savings per participant and the number days these customers were treated in PY8, shown in Equation 3. Because home energy reports in Pennsylvania have only a one-year measure life, PPL Electric Utilities can claim only the savings in PY8 that occurred after the first reports were sent. Therefore, Cadmus included only May 2017 in the number of treated days for treatment customers in the low-income waves.

Equation 3

$$Savings_h = -\hat{\beta}_{1,h} * \sum_{i=1}^N Treatment\ Days_{i,h}$$

Where:

$\hat{\beta}_{1,h}$ = Average daily savings (kWh) per treatment group customer in wave 'h', estimated from Equation 1.

$Treatment\ Days_{i,h}$ = The number of days customer 'i' in wave 'h' was treated in PY8.

Cadmus estimated realization rates for each wave as the ratio of verified program savings to reported program savings (estimated by the ICSP).

Table C-10 shows the estimate of PY8 total savings and average annual savings per customer with 85% confidence intervals for each wave. Except for the low-income waves, the reported savings fall within the 85% confidence intervals around *ex post* verified savings. However, the 85% confidence intervals do not contain the reported program total savings, suggesting the two estimates are significantly different.

Table C-10. PY8 Home Energy Education Program Savings Estimate

Wave	Point Estimate (MWh/yr)	85% Confidence Interval (Lower Bound)	85% Confidence Interval (Upper Bound)
Legacy Wave 1	9,705	8,281	11,128
Legacy Wave 2	13,476	10,815	16,137
Expansion Wave	9,480	7,238	11,722
Low-Income Wave 1	476	329	624
Low-Income Wave 2	47	2	92
Phase III Expansion Wave	1,142	74	2,211
Total Program ^[1]	34,326	30,414	38,238

^[1] May not match due to rounding.

Ex Post Verified Savings across Time

Figure C-1 through Figure C-7 provide the percentage daily savings across time for each pre- and post-treatment month through PY8. Cadmus calculated percentage daily savings for each wave as the ratio of average daily savings to monthly average control group consumption. Because Cadmus reported the post-only results for each wave, it plotted the monthly percent savings and confidence intervals (gray) resulting from the D-in-D fixed effects model (blue) to show pre-treatment consumption trends.

The orange line in the figures shows the monthly savings resulting from the reported post-only model specifications. The post-only monthly savings trend closely to the D-in-D fixed effects monthly savings, and they remain within the D-in-D fixed effects confidence interval across months and waves; this suggests that the savings estimated by each model specification are not significantly different. It also suggests that savings are robust and not dependent on the model specification (pre-post versus D-in-D fixed effects). For every wave, the confidence interval in the pre-treatment period contains zero. This suggests that treatment and control groups had equivalent consumption prior to treatment.

Cadmus specified both the D-in-D fixed effects and post-only models with month and year fixed effects. To avoid linear dependency in the regressors, Cadmus dropped one month and year from each model specification. In the D-in-D fixed effects model specifications, Cadmus dropped the last month prior to treatment, which explains the gap in monthly savings in each figure for this month. Similarly, Cadmus dropped the first month of treatment in the post-only model specifications (since they did not include pre-treatment bills).

Figure C-1 and Figure C-2 show steady savings across months in PY8 for Legacy Wave 1 and Legacy Wave 2. A slight upward trend is observed for Legacy Wave 1 that began after the Phase II ICSP resumed treatment in October 2014 and that persisted throughout Phase II and now into Phase III. Legacy Wave 2 appears to have the opposite trend after resuming treatment in Phase II, with savings slightly decreasing throughout Phase II and Phase III. Monthly savings reflect actual weather, so small changes in savings from year to year may not be program-related.

Figure C-1. Percentage Daily Savings across Time: Legacy Wave 1

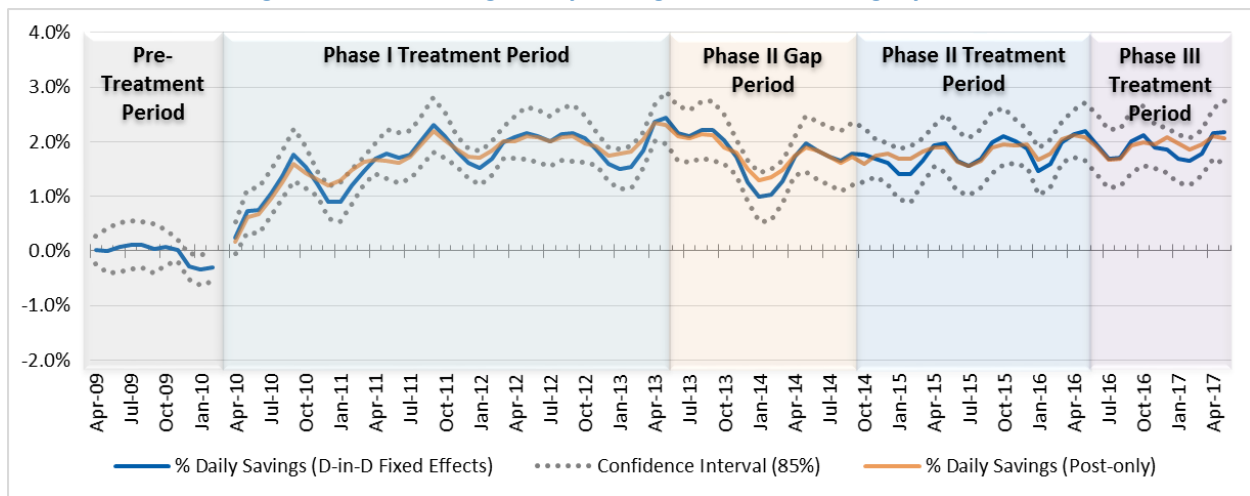


Figure C-2. Percentage Daily Savings across Time: Legacy Wave 2

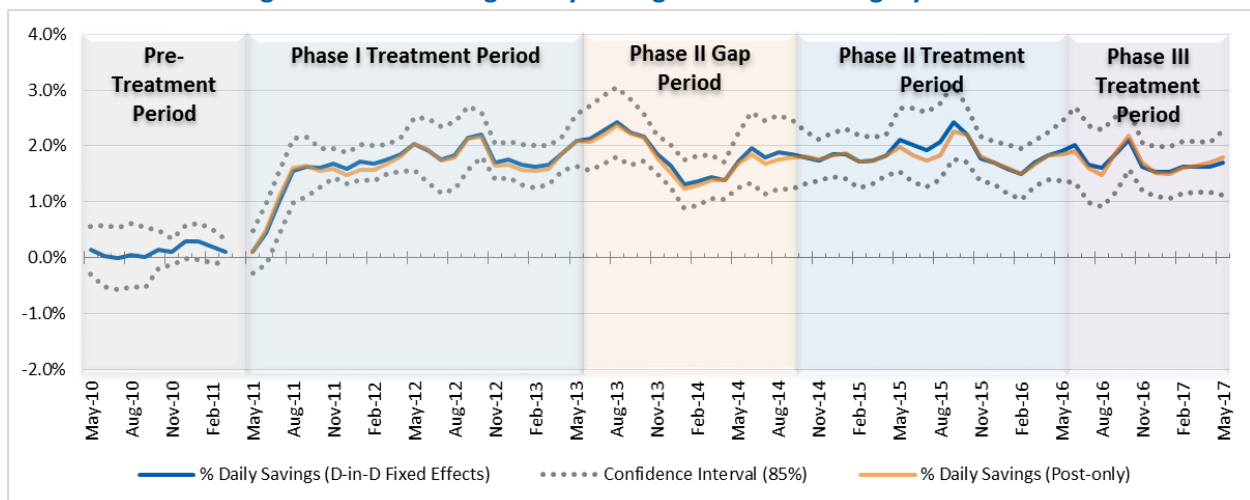


Figure C-3 shows savings for Expansion Wave 1 increased until the beginning of Phase III. Monthly percentage savings remain unchanged from PY7, which suggests that savings are beginning to plateau. This is consistent with the trends of Legacy Wave 1 and Legacy Wave 2, where savings reached a steady state after the second year of treatment.

Figure C-3. Percent Daily Savings across Time: Expansion Wave 1

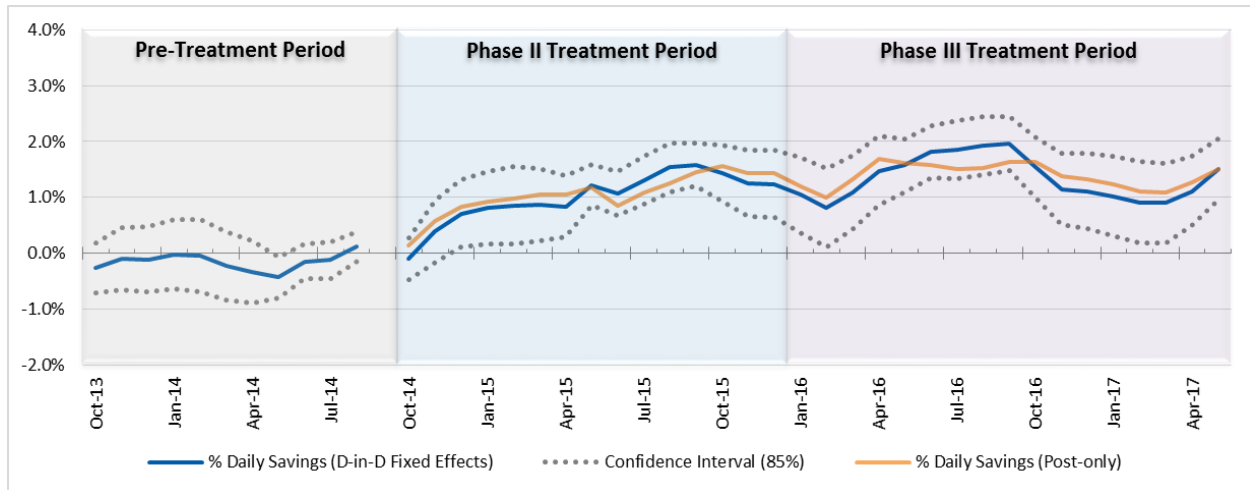


Figure C-4 shows that despite not receiving treatment until May 2017, Low-Income Wave 1 savings from Phase II persisted through October 2016 before decreasing to levels observed in its first year of treatment. However, savings quickly ramped up again by the end of PY8 after treatment resumed. Savings also reflect changes in weather.

Figure C-4. Percent Daily Savings across Time: Low-Income Wave 1

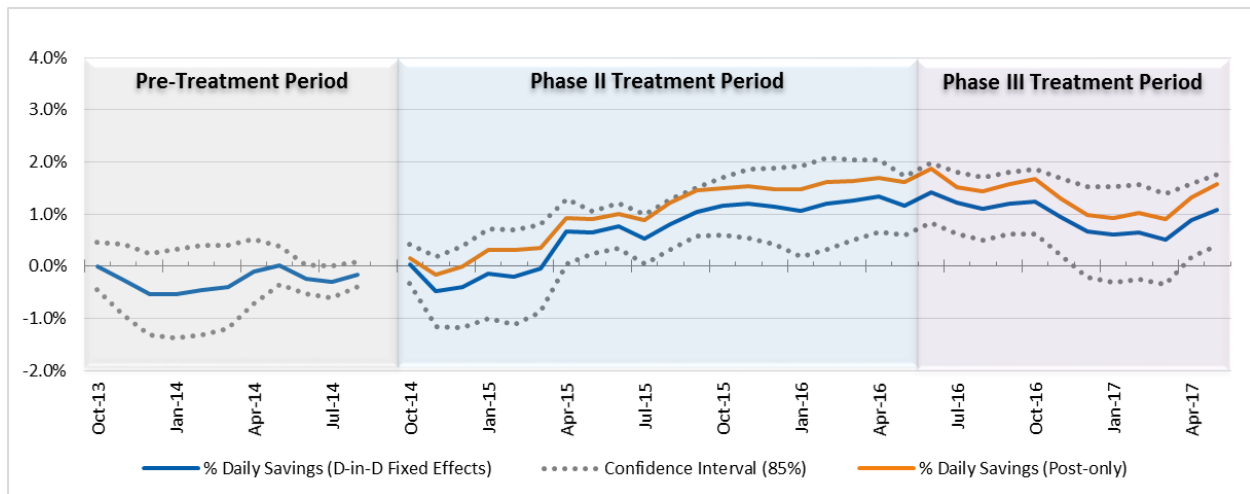


Figure C-5 shows the percentage daily savings by month for the Low-Income Wave 2. The confidence interval around monthly savings is wider for this wave than any other wave and includes zero savings for most months, which is consistent with Cadmus' finding that savings in PY8 were imprecisely estimated.

Figure C-5. Percent Daily Savings across Time: Low-Income Wave 2

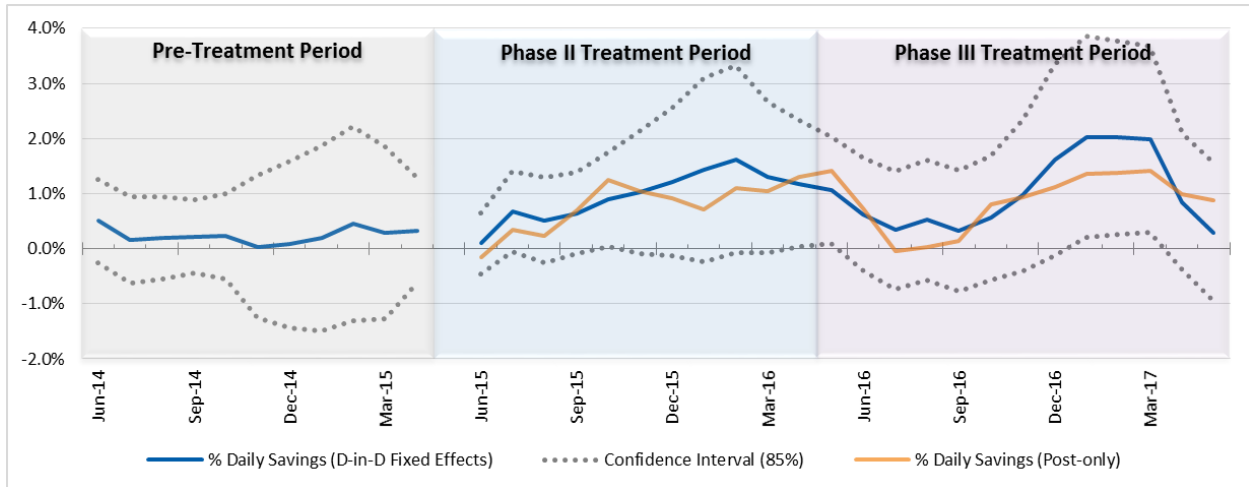
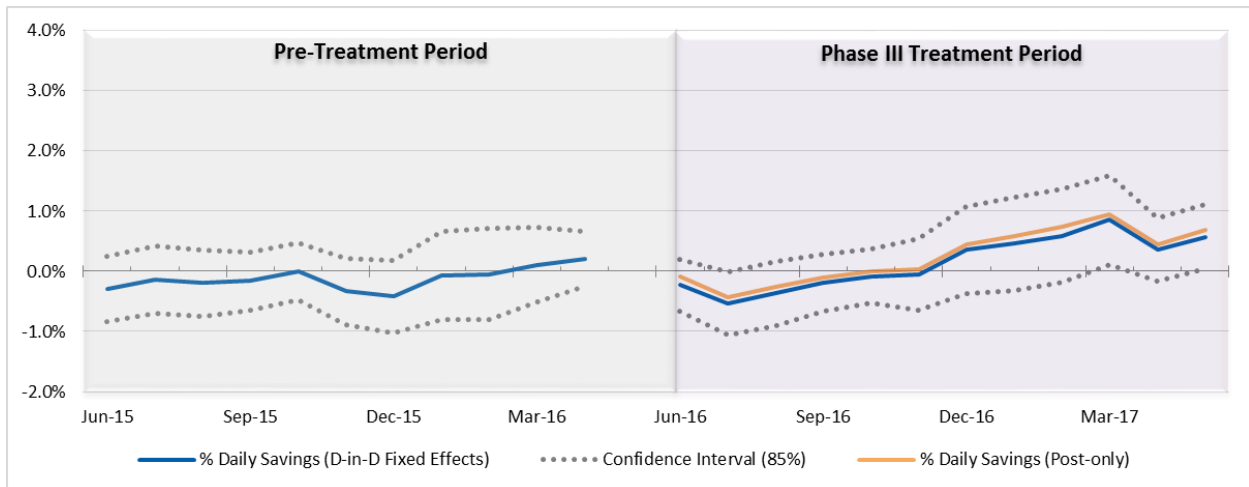


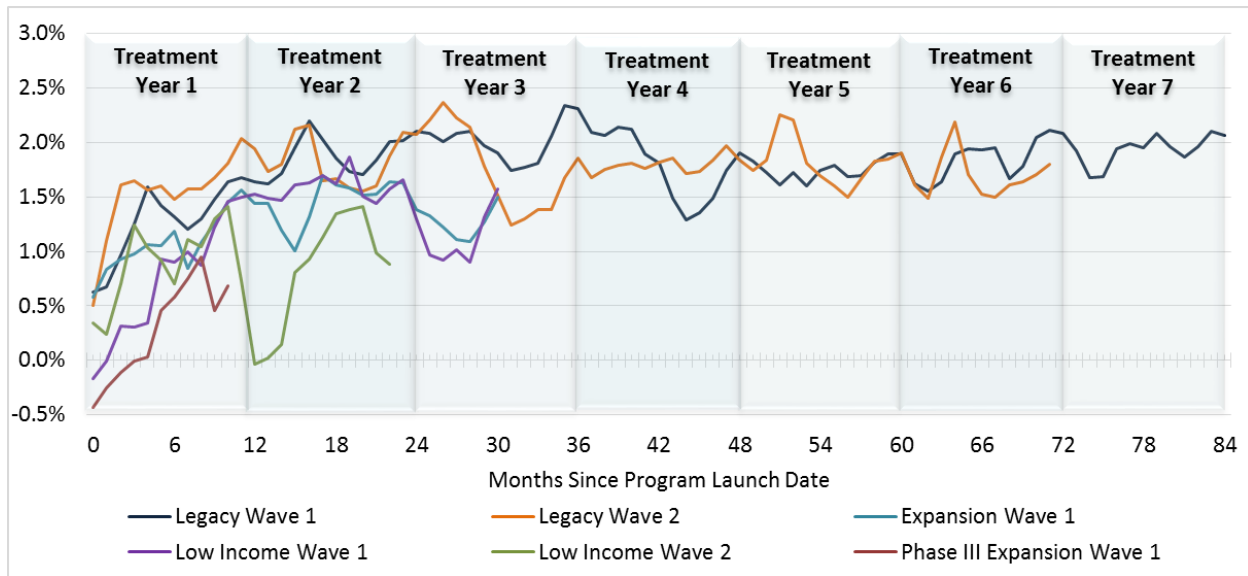
Figure C-6 shows the percentage daily savings by month for the Phase III Expansion Wave. The monthly percentage daily savings hover near 0.0 kWh for the first six months of PY8 but steadily increase beginning in January 2017, reaching an average of 0.7% across the last six months of PY8.

Figure C-6. Percent Daily Savings across Time: Phase III Expansion Wave 1



To compare savings trends across waves, Cadmus provides Figure C-7, which presents percentage daily savings by the number of months since first treatment for each wave. Across all waves, savings increased from 0% to between 0.8% and 1.7% in the first year of treatment. Savings for the two longest-running waves (Legacy Wave 1 and Legacy Wave 2) appear to plateau after the second year of treatment, with some peaks in savings occurring in years three and four that stabilize through year seven. Again, savings reflect changes in weather, which can explain some differences in savings by months of treatment.

Figure C-7. Percent Average Daily Savings from First Month of Treatment



Demand Reduction Evaluation Methodology

As in PY7, Cadmus did not evaluate demand reductions using hourly data in PY8. Instead, it converted each wave's PY8 average energy savings into demand reductions using the evaluated PY4 ratio of peak demand reduction values to average per-customer energy savings per hour. Across Legacy Wave 1 and Legacy Wave 2, Cadmus estimated average per-customer demand reductions of 0.041 kWh/hr and 0.056 kWh/hr for each wave, or 193% and 108% of each wave's average per-customer energy savings per hour, respectively. Cadmus used the weighted average of these ratios (148%) to convert PY8 program energy savings into demand reductions, assuming ratios stayed constant through time, and allowing demand reductions to be scaled by energy savings observed in PY8.

Note that the definition of peak demand changed between PY4 and PY8. In PY4, peak demand was calculated for the top 100 hours of PPL Electric Utilities' system demand. In PY8, peak hours are defined as hours with day-ahead forecasts for the PJM market that are 95% or more of the PJM peak summer forecast.

C.1.4 Uplift Analysis Methodology

Savings from the Home Energy Education Program reflected both behavioral changes, such as turning off lights in unoccupied rooms and adjusting thermostat settings, and investments in energy-efficient products, such as high-efficiency furnaces and LEDs. In PY8, some customers who installed efficiency products because of home energy reports may have received rebates from PPL Electric Utilities through other Act 129 programs. Customers could also have received rebates in previous program years following receipt of their first home energy report, and these efficiency products could have continued to save energy into PY8. In these cases, the Home Energy Education Program billing analysis would capture the savings from these products, causing them to be counted in both the Home Energy Education Program and PPL Electric Utilities' other efficiency programs.

To avoid double-counting of cross-program savings caused by the home energy report program, Cadmus subtracted cross-participation savings from the residential portfolio savings. To do this, Cadmus conducted an uplift analysis to estimate the impacts of the Home Energy Education Program on participation in PPL Electric Utilities' residential and low-income efficiency programs and the energy savings from that participation. Cadmus refers to any difference in the rate of participation and savings as "participation uplift" and "savings uplift."

The following sections provide details on uplift results.

Cross-Participation in Downstream Residential Rebate Programs

Cadmus used the experimental design of the Home Energy Education Program to estimate home energy report savings from PPL Electric Utilities' efficiency program participation.

To illustrate, suppose that there is an equal number of customers in the treatment and control groups and that the utility markets the benefits of installing Product A to all residential customers. Customers in the treatment and control groups will receive the same marketing and be eligible for incentives from the utility for Product A. The impact of energy reports on adoption of Product A can then be estimated as the difference in adoption of Product A—and savings—between the randomized treatment and control groups. Any differences can be attributed to the home energy report program.

For products and services promoted by utility programs and tracked at the customer level (downstream programs), Cadmus estimated the participation and savings uplift by matching Home Energy Education Program treatment and control customers in each wave to the energy efficiency program participation tracking data in PPL Electric Utilities' tracking database, starting in the month when treatment began through to the end of PY8.⁹

Home Energy Education Program treatment and control customers participated in 10 downstream PPL Electric Utilities rebate programs from PY2 through PY8. These were the Appliance Recycling Program, Energy Efficiency Kits and Education Program,¹⁰ Efficient Equipment Incentive Program, Energy Efficient Home Program, Low-Income WRAP, Prescriptive Equipment Program, Renewable Energy Program, Residential Energy Assessment and Weatherization Program, Residential Home Comfort Program, and Residential Retail Program (equipment component).

Participation Uplift

After matching tracking data to Home Energy Education Program customers, Cadmus calculated participation uplift. Cadmus defined participation uplift as the difference in the percentage of treatment group customers participating in at least one rebate program and the percentage of control group customers participating in at least one rebate program.

⁹ Each product's record in PPL Electric Utilities' tracking database includes the program to which it belongs along with the date the product was installed. Cadmus' database records the evaluated *ex post* annual savings.

¹⁰ Formerly named the E-Power Wise Program.

The control group's participation rate captured the business-as-usual effect of marketing and word-of-mouth impacts on customers' participation in other PPL Electric Utilities' Act 129 programs. This baseline participation rate is defined as the number of control group customers who participated in at least one other Act 129 program in PY8, divided by the total number of control group customers. The home energy reports had an additive effect on participation in the other programs if the cross-program participation rate was greater for treatment customers than it was for control customers.

Table C-11 shows the PY8 participation rate uplift results for each wave of the Home Energy Education, broken out by program. Cadmus first provides the differences in rates of cross-participation between treatment and control groups (uplift participation) then the percentage uplift participation relative to control group participation. The Appliance Recycling Program and Energy Efficient Home Program accounted for the majority of cross-program participation in PY8.

Since low-income waves did not receive treatment until May 2017, participation uplift in Table C-11 only captures cross-participation that began during this time. Low cross-participation observed in these waves is likely because these programs had slowed PY8 recruitment and marketing efforts during this time, as it was the last month of the program year.

Table C-11. Participation Uplift by Program (Per 1,000 Customers)

Program	Participation Uplift per 1,000 Customers (Percentage Participation Uplift)					
	Legacy Wave 1	Legacy Wave 2	Expansion Wave 1	Low-Income Wave 1	Low-Income Wave 2	Phase III Expansion Wave 1
Appliance Recycling	0.76 (7.51%)	1.04 (8.39%)	2.74 (30.71%)	-0.45 (-59.44%)	-0.46 (-62.34%)	3.16 (32.43%)
EE Kits	-0.38 (-15.24%)	0.6 (42.43%)	0.35 (48.83%)	-	-	-0.29 (-15.87%)
Energy Efficient Home	1.08 (6.89%)	0.57 (2.87%)	-1.25 (-6.82%)	0.0 (1.41%)	0.0 (0.0%)	1.71 (8.82%)
Low-Income WRAP	0.08 (20.21%)	0.06 (35.73%)	-0.09 (-48.23%)	-	-	-0.52 (-52.65%)

Savings Uplift

The savings uplift analysis followed a simple-differences approach. Similar to the approach suggested in the Behavior Section of the Phase III Evaluation Framework,¹¹ Cadmus followed these steps to estimate uplift savings from downstream programs:

1. Matched the program tracking data for each program year to the treatment and control customers by a unique identifier
2. Assigned each transaction to a month based on the participation date field in the tracking data
3. Excluded any installations that occurred prior to the customer being assigned to the treatment or control group

¹¹ Pennsylvania Public Utility Commission. *Phase III Evaluation Framework*. August 25, 2016. See Behavior Section 6.1.1.8.

4. Calculated the average monthly electricity savings of each efficient product installed by a Home Energy Education customer, proportioned across months by the accrued heating and cooling degree days in each month for products sensitive to weather (Cadmus proportioned annual savings across months equally for products not sensitive to weather). Cadmus used the *ex post* gross verified savings for each product in PPL Electric Utilities' tracking database.
5. Summed the monthly average savings, by customer, for all products installed prior to a given month through the end of PY8. Cadmus incorporated customer inactive dates and measure lives of products when aggregating monthly savings
6. Calculated the average annual savings accrued per customer for the treatment and control groups during PY8
7. Calculated the incremental average annual savings per customer from other programs by taking the difference in annual per-customer savings for the treatment group and control group

Multiplying the incremental average annual savings per customer by the number of program customers treated in PY8 yielded the estimate of the total Home Energy Education Program savings from participation in other PPL Electric Utilities energy efficiency programs and counted by the other efficiency programs.

Table C-12 provides the results of the savings uplift analysis by program. The largest proportion of cross-program savings came from the Appliance Recycling Program, which saved across all waves. Legacy Wave 1 and Legacy Wave 2 are the strongest cross-program savers across all waves, which makes sense since customers in these have had the longest time to participate in other programs while in the Home Energy Education Program.

Table C-12. Savings Uplift by Program

Program	Total Uplift Savings (MWh/yr) (Percentage of Program Total Savings)					
	Legacy Wave 1	Legacy Wave 2	Expansion Wave 1	Low-Income Wave 1	Low-Income Wave 2	Phase III Expansion Wave 1
Appliance Recycling	20.31 (0.21%)	10.52 (0.08%)	6.31 (0.07%)	0.30 (0.06%)	-0.41 (-0.86%)	1.93 (0.17%)
EE Kits	-0.58 (-0.01%)	0.39 (0.00%)	0.62 (0.01%)	0.26 (0.06%)	-0.02 (-0.05%)	-0.06 (-0.01%)
Efficient Equipment Incentive Program	8.06 (0.08%)	3.98 (0.03%)	-	-	-	-
Energy Efficient Home	0.91 (0.01%)	3.01 (0.02%)	0.39 (0.00%)	-0.02 (0.00%)	0.02 (0.05%)	1.84 (0.16%)
Low-Income WRAP	-0.13 (0.00%)	0.48 (0.00%)	0.26 (0.00%)	0.32 (0.07%)	0.35 (0.75%)	-0.19 (-0.02%)
Prescriptive Equipment	-	2.11 (0.02%)	-	-	-	-
Renewable Energy Program	-2.75 (-0.03%)	-	-	-	-	-
Residential Energy Assessment & Weatherization	5.01 (0.05%)	10.82 (0.08%)	-	-	-	-
Residential Home Comfort	0.22 (0.00%)	-2.63 (-0.02%)	1.23 (0.01%)	0.04 (0.01%)	-0.05 (-0.11%)	-
Residential Retail	1.66 (0.02%)	-0.31 (0.00%)	0.00 (0.00%)	0.02 (0.00%)	-0.03 (-0.06%)	-

Uplift from Upstream Lighting

From the treatment and control group customer surveys, Cadmus estimated the Home Energy Education Program's impact on upstream lighting (LED) purchases and energy savings. Cadmus asked lighting purchase questions taken from the general population survey for the Efficient Lighting Program and analyzed the responses to estimate the Home Energy Education Program savings that came from the adoption of efficient lighting products. Table C-13 provides the results of the survey analysis.

Table C-13. Results of Customer Survey for LED Purchases

Wave	Customer Responses		Average LEDs Purchased			p-value
	Treatment Group	Control Group	Treatment Group	Control Group	Difference	
Legacy Wave 1	49	60	12.0	6.7	5.2	0.0043***
Legacy Wave 2	66	45	9.4	10.4	-0.9	0.3602
Expansion Wave 1	104	108	11.0	9.3	1.7	0.1715
Phase III Expansion Wave 1	104	106	9.4	9.7	-0.2	0.4240

*** Indicates a difference in the number of LEDs purchased by customers in the treatment group compared to the control group that is statistically different from zero at the 5% significance level.

However, the survey sample was not large enough to detect the expected differences between treatment and control groups in the number of LEDs purchased for three of the four surveyed waves. To be consistent across waves, Cadmus applied the default upstream lighting reduction factors from Table

29 of the Evaluation Framework.¹² The framework requires the evaluator to apply upstream lighting reduction factors to program savings after first deducting uplift savings from downstream programs. Cadmus used this approach for waves that experienced positive downstream uplift. Low-Income Wave 2 experienced negative uplift from downstream cross-program participation; as such, Cadmus applied the upstream lighting reduction factor to the total savings achieved by this wave. Had it first deducted negative uplift savings, it would have over-estimated the uplift savings due to upstream lighting.

¹² *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Program.* Prepared by the Statewide Evaluation Team. August 25, 2016.

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Appendix D. Evaluation Detail—Efficient Lighting Program

D.1 Gross Impact Evaluation

D.1.1 Methodology

EM&V Sampling Approach

Cadmus conducted general population telephone surveys with a random sample of 300 residential customers to collect data for the process and impact evaluations. Cadmus collected similar data in a separate general population survey with 70 small businesses that purchased LEDs in the last six months, the primary purpose of which was to estimate the proportion of program sales to nonresidential customers (cross-sector sales) and measure customer willingness to pay at varying price points. Table D-14 lists the program sampling for the impact evaluation. The impact evaluation activities produced results with $\pm 4.26\%$ precision at 85% confidence.

Table D-14. PY8 Efficient Lighting Program Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Residential Customers	1,200,000	90/10	300	300	Survey
Small C&I Customers	79,047	90/10	300	465 ^[1]	Survey
Lighting Manufacturer Invoices	522	N/A	70	70	Strategic sample audit
Program Total	N/A		N/A		

^[1] 269 surveys were completed with respondents knowledgeable about lighting decisions and purchases. Of that, 70 surveys were completed with respondents who had purchased LEDs in the past six months.

D.1.2 Database Review Findings

Cadmus reviewed Efficient Lighting Program tracking data from PPL Electric Utilities tracking database and the ICSP for quality, to characterize and identify changes in program sales and review incentive levels by bulb type.

Invoice Quality Assurance/Quality Control

Cadmus' QA/QC review ensured PPL Electric Utilities' tracking database records matched the manufacturer invoices. For PY8, Cadmus sampled 70 invoices from unique combinations of manufacturers and retailers to ensure the bulb model numbers, prices, and sales totals matched as they were reported.¹³

¹³ Thirty invoices with unique retailer-manufacturer combinations from Q1 and Q2 together, 20 from Q3, and 20 from Q4.

Cadmus also used the invoices to verify the model numbers for bulbs sold in multi-packs. For invoices that did not provide pack size information, Cadmus checked each model number on the manufacturer or retailer websites. This review found no errors.

Savings Quality Assurance/Quality Control

First, Cadmus conducted reviews of PPL Electric Utilities' tracking database extracts to ensure consistency and reasonableness of data inputs. Cadmus methodically checked all data in PPL Electric Utilities' tracking database extracts and compared data from PPL Electric Utilities' tracking database with reports provided directly from the ICSP to ensure consistency. Cadmus confirmed that bulb-specific inputs such as bulb type, lumens, and wattages were consistent across all records for the same stock keeping unit (SKU). (Inconsistencies or errors can affect calculated savings because bulb type determines which PA TRM baseline wattage to use.) Cadmus also confirmed that every record's reported wattage was consistent with the wattage provided in the bulb type description. Finally, Cadmus checked for reasonableness in every record's reported lumens with respect to its bulb type and wattage. This review did not reveal any discrepancies in PY8.

Prior to computing savings according to the 2016 PA TRM algorithms, Cadmus assigned a baseline wattage assumption to each bulb record using the 2016 PA TRM tables 2-2, 2-3, and 2-4. Cadmus examined any measures not covered by these assumptions and made baseline adjustments where necessary.

Candelabra lamps comprise the majority of bulbs for which Cadmus adjusted baseline wattages, which resulted in higher *ex post* savings. For example, the ICSP used the "Post-EISA 2007" baseline assumptions (Column (d) in 2016 PA TRM Table 2-3) for candelabra-base bulbs, which are exempt from EISA 2007; Cadmus used the higher baselines in Column (c) of this table.¹⁴ Cadmus adjusted baseline wattages of reflector lamps according to Table 2-4 the 2016 PA TRM. The adjustments made to reflector lamps tended to decrease per-lamps savings. However, baseline adjustments increased overall savings by 2%.

For 17 SKUs, rated lumen equivalencies exceeded the maximum specified in PA TRM Table 2-4, thus the ICSP assigned higher (rated manufacturer equivalent) baseline wattages to them. Cadmus made *ex post* adjustments to the baseline wattages to reflect the maximum equivalent wattage per ENERGY STAR (65 W), where applicable. For five SKUs associated with higher lumen parabolic aluminized reflector (PAR) bulbs, Cadmus made *ex post* adjustments to the baseline wattages to account for the fact that these lamps are subject to federal reflector lamp standards. Cadmus identified one SKU as a 2-lamp linear shop light and adjusted its baseline wattage, per PA TRM Table 3-2.

The PY8 baseline adjustments are shown in Table D-15.

¹⁴ Pennsylvania Public Utility Commission. *2016 Technical Reference Manual*. Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards. June 2016.

Table D-15. PY8 Baseline Adjustments

PA TRM Bulb Category	Baseline Wattage		Number of Bulbs Adjusted
	Reported	Evaluated	
3-Way (Exempt)	72	100	15,053
Candelabra/Decorative	29	40	214,834
Candelabra/Decorative	43	60	61,288
Candelabra/Decorative	50	40	4
Globe	29	40	50,903
Linear Fixture	88	59	4
Reflector	40	50	2,773
Reflector	45	40	1,568
Reflector	50	40	3,021
Reflector	60	50	15,236
Reflector	60	40	752
Reflector	60	55	1,081
Reflector	60	65	62
Reflector	65	55	45
Reflector	65	50	11,819
Reflector	65	40	159
Reflector	75	50	1,286
Reflector	75	65	474
Reflector	75	55	29,471
Reflector	85	65	68
Reflector	90	75	705
Reflector	90	65	831
Reflector	120	65	3,831
Reflector	120	70	2,523
Reflector	120	55	1,351
Reflector	125	65	2,282
Reflector	150	105	1,026
Reflector	200	65	293
Total			422,743

Unit Price Quality Assurance/Quality Control

Cadmus reviewed pricing data provided by the ICSP and recorded in PPL Electric Utilities' tracking database. Although Cadmus expects bulb prices will fluctuate during the program, the review checked for outliers to ensure the pricing data made mathematical sense and did not fluctuate unreasonably.

The reported data contained three price columns: retail price, per-unit incentive, and promotional price. To ensure that the promotional price made mathematical sense, Cadmus subtracted per-unit incentive from retail price for each line item (consisting of total sales for a certain bulb on a certain date at a

unique retail location). Ideally, the calculation resulted in zero or a positive number, the latter of which might suggest that the retailer offered an incentive in addition to the upstream discount. This held true for all but one model number sold at one particular chain. It appeared that the per-unit incentive was recorded as twice its actual value.

To check for reasonable price variation, Cadmus calculated the variance of the promotional price for each unique combination of model number and retail location across all sales dates. As mentioned, some variance is expected, but too much could indicate an error in the database. The review found no unusual outliers that might signal a discrepancy.

Cross-Sector Sales Adjustments

The ratio between commercial and residential bulb sales reported in PPL Electric Utilities' tracking database for PY8 were based on the cross-sector sales analysis conducted in PY6. In PY6, Cadmus estimated that 12% of bulbs sold through the upstream lighting channel were purchased by small commercial customers.¹⁵ The PY8 analysis, detailed in *Appendix A Upstream Lighting Cross-Sector Sales*, estimated that 10% of bulbs were purchased by small commercial customers. In addition, Cadmus updated the estimated HOU and coincidence factor for commercial bulbs, based on a weighted distribution of building types for survey respondents who purchased LEDs from participating retailers.

D.1.3 Realization Rate Findings

Energy and demand realization rates are based on both census baseline adjustments and adjustments related to the estimation of cross-sector sales. However, because baseline adjustments were not based on sampling, the uncertainty surrounding energy and demand savings is related to the estimation of cross-sector sales. Uncertainty and associated precision are discussed in Section A.3.1.

D.1.4 Survey Findings

Cadmus used findings from the telephone surveys to estimate the number of participants and the proportion of sales to the residential and small commercial sectors. To derive the participant count, Cadmus divided the total number of bulbs sold through the program by the average number of bulbs purchased per customer, as reported by residential and small commercial survey respondents. The methodology and findings are detailed in *Appendix A Upstream Lighting Cross-Sector Sales*. The participant estimates by sector are shown in Table D-16.

Table D-16. PY8 Participant Estimates by Sector

Sector	Bulbs	Participants	Bulbs per Participant
Residential	3,174,906	318,766	9.96
Small C&I	352,767	17,455	20.21
Total	3,527,673	336,221	N/A

¹⁵ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

D.2 Net Impact Evaluation

D.2.1 Net-to-Gross Ratio Methodology

To estimate free ridership for the Efficient Lighting Program, Cadmus conducted demand elasticity modeling using bulb sales information (provided by the ICSP) in PY8. 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 free ridership is the same principle applied in the willingness to pay analyses using self-report survey responses as in Phases I and II. 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: demand for efficient lighting is elastic and changes in price and merchandising generate changes in quantities sold (i.e., the upstream buydown approach). Demand elasticity modeling uses sales and merchandising information to achieve the following:

- Quantify the relationship of price and merchandising to sales
- Predict the likely sales level without the program’s intervention (baseline sales)
- Estimate free ridership by comparing predicted baseline savings with predicted program savings

After estimating variable coefficients, Cadmus used the resulting model to predict sales that would have occurred *without* the program’s price and merchandising impact and sales that would have occurred *with* the program (which should be close to actual sales with a representative model). Cadmus then multiplied predicted bulb sales by verified savings by bulb type. Free ridership was then calculated using this formula:

$$FR\ Ratio = \left(\frac{Savings\ without\ Program}{Savings\ with\ Program} \right)$$

All available data were used for this analysis in PY8, though products without observed variation provide no information to the model. Overall, the model relied on products with price variation or products that were featured in the special promotions that accounted for 95% of total lamp sales in PY8. The sampling strategy is shown in Table 28 and the results of the NTG research are shown in Table 32.

The estimated free ridership from the demand elasticity model was 17%, down from 39% in PY7.¹⁶

Input Data

Because the demand elasticity approach relies exclusively on program data, a model’s robustness depends on data quality. Overall, in PY8 the available data achieved a sufficient quality to support the analysis, though there was a pricing anomaly and the product placement data was not consistent with

¹⁶ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

PPL Electric Utilities' tracking database so Cadmus was not able to incorporate this data into the model. These issues and their potential impact on the results are described in greater detail below.

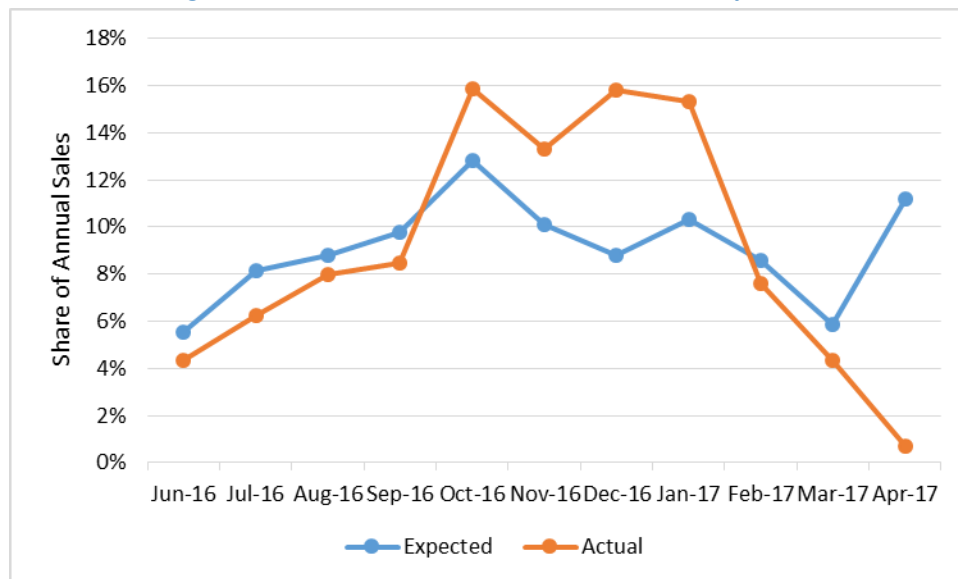
Seasonal Anomalies

In economic analysis, it is critical to separate data variations resulting from seasonality from those resulting from relevant external factors. To illustrate this, 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 control for seasonality, Cadmus used a trend provided by an evaluation partner that provides the expected share of annual sales for each month. This expected trend is based on national lighting sales from a major lighting manufacturer.

Lighting sales typically peak going into the fall, with October typically the highest volume month. However, as shown in Figure D-8, sales in PY8 were higher than expected in the fall and remained higher through January. This reflects the impact of special program promotions with retailers and multi-packs with aggressive incentives at key retailers.

Figure D-8. Share of Actual PY8 Sales Versus Expected



Controlling for seasonality with the national manufacturer trend allows Cadmus to attribute this additional lift, beyond what would typically occur, to program activities.

The program activity did not take place across all retail channels. To account for this, Cadmus interacted the seasonal trend with each retail channel.

Additional Incentives

Cadmus identified several instances where the reported promotional price was substantially different than the difference between the regular retail price and the program incentive. PPL Electric Utilities'

program tracking data contained a field that tracked additional manufacturer incentives, though this field was not consistently populated; some records for a particular bulb model would have a value for the additional manufacturer incentive and some would not, although the final price would remain the same. For example, one model had an original price of \$17.50 per bulb and a final price of \$2. The PPL Electric Utilities incentive for this product was \$5. For some records, there is an additional manufacturer incentive of \$10.50 but others the additional incentive is missing but the final price remains at \$2. The ICSP confirmed that the final prices and PPL Electric Utilities incentives were correct and the manufacturers had provided additional incentives, which accounted for the discrepancy.

The PY8 free ridership estimate assumed that the additional manufacturer incentives would not have occurred absent the program and that the program encouraged manufacturers to provide them.

Price Variation

For the demand elasticity model, Cadmus combined sales and prices across all comparable products within a given retailer store location. The average price for each bulb type within each store was the monthly sales-weighted, per-bulb price across all comparable products. Monthly sales were the sum of all sales within each store across the same group of comparable products. For example, Cadmus combined the prices and monthly sales for all 60-watt incandescent-equivalent general purpose bulbs at a single Home Depot store.

Combining sales and prices this way, rather than observing changes in price and sales for each individual model number, had the advantage of capturing any substitutions between comparable products, such as decreases in the average price per-bulb when a three-pack of an existing bulb or a new model was added to the program.

Similarly, suppose one bulb model was replaced with an updated version (with a different model number). Sales of the first model would likely drop because the retailer was running out of back-stock. Aggregating prices and sales captured variation across both products rather than trying to control for the influence on sales of factors unrelated to price (i.e., products being phased out and replaced).

Only sales with price variation or merchandising displays were included in the model. The greater the level of price variation across retailers and lamp styles, the more representative the elasticity estimates when applied to the portion of the program that did not exhibit price variation.

The program discounted bulbs in four retail channels: hard-to-reach (e.g., Habitat Restores), club (e.g., Costco), do-it-yourself (e.g., Lowe's), and mass market retailers (e.g., Target). Cadmus examined the variation across each channel and found a large degree of variation in prices across all channels. As shown in Table D-17, prices varied for more than 95% of total program sales, with the lowest share hard-to-reach retailers, at 72% (still a substantial majority).

Table D-17. PY8 Sales with Price Variation and Representativeness

Retail Channel	Modeled Sales	Total Sales	Percentage Represented	Percentage of Total Sales
Club	913,796	933,881	98%	27%
DIY	1,711,607	1,760,888	97%	50%
HTR	297,328	415,403	72%	12%
Mass-market	411,981	413,004	100%	12%

Promotional Displays

The ICSP provided records of specific bulb model numbers or retailer/manufacturers that were featured in special promotions during PY8, with associated time periods. These events included a mega-truckload sale in the fall of 2016, increased stocking and in-store promotion of certain bulbs through the first four months of PY8, and an instant-savings promotion at a membership club store.

The ICSP also provided a list of store locations, dates, and SKU numbers with associated off-shelf placement displays (e.g. end caps, wing stacks). Cadmus attempted to match these records to PPL Electric Utilities' program tracking data but the ICSP's placement tracking data recorded retailer SKU rather than the product model number in the program tracking data. Fewer than half of the SKUs matched to the model numbers directly.

Cadmus attempted to match by retailer, brand, and product descriptions but quickly noticed that the ICSP's placement tracking data had multiple descriptions for many SKUs and determined the descriptions to be unreliable. For example, the following SKU has five unique descriptions that are incompatible with one another.

Table D-18. SKU with Multiple Descriptions Example

Retailer SKU	Description
1001370384	LED 13W A-Line
1001370384	LED 15W PAR38 Specialty
1001370384	LED 18.1W Retro-Fit Specialty
1001370384	LED 4.1W Candle Specialty
1001370384	LED 7W R20 Specialty
1001370384	LED 9.5W A-Line

Given the unreliability of the data and the fact that fewer than half of the products matched, Cadmus could not include the displays in the model.

However, some model numbers in PPL Electric Utilities' program tracking data included an indicator in the measure code "(P)" which indicated a product was featured in a promotion during the time period associated with the indicator. These were included in the model.

Model Specification

Cadmus used an econometric model to organize bulb and pricing data as a panel, with a cross-section of program bulb quantities for each unique retail location, bulb type, and baseline wattage combination modeled over time as a function of price, retail channel (club, do-it-yourself, hard-to-reach, and mass market), and promotional events. This study also involved testing a variety of specifications to ascertain price impacts—the main instrument affected by the program—on the demand for bulbs. Cadmus estimated the basic equation for the model as follows (for cross-section i , in month t):

Equation 1

$$\ln(Q_{it}) = \sum_{\pi} (\beta_{\pi} ID_{\pi,i}) + \sum_{\theta, \delta} (\beta_{\theta, \delta} [\ln(P_{it}) * Retail Channel_{\delta} * Bulb Type_{\delta}]) + \beta_2 Display + \sum_{n=0}^2 (\beta_{4n} SpecialPromo_{t-n} * Retail Channel_i) + \varepsilon_{it}$$

Where:

ln	=	Natural log
Q	=	Quantity of bulb packs sold during the month
P	=	Retail price in that month
Retail Channel	=	Retailer category (do-it-yourself, mass market, hard-to-reach, club)
Bulb Type	=	Product category (general purpose, reflector, candelabra, globe)
Display	=	Share of products in month t with a model number including “(P)” indicating off-shelf placement
SpecialPromo	=	Share of products featured in a special promotion (e.g., mega-truckload sale, instant savings) in month t .
ID	=	Dummy variable equaling 1 for each unique retail location, bulb type, and base watt; 0 otherwise
ε_{it}	=	Cross-sectional random-error term in time period t

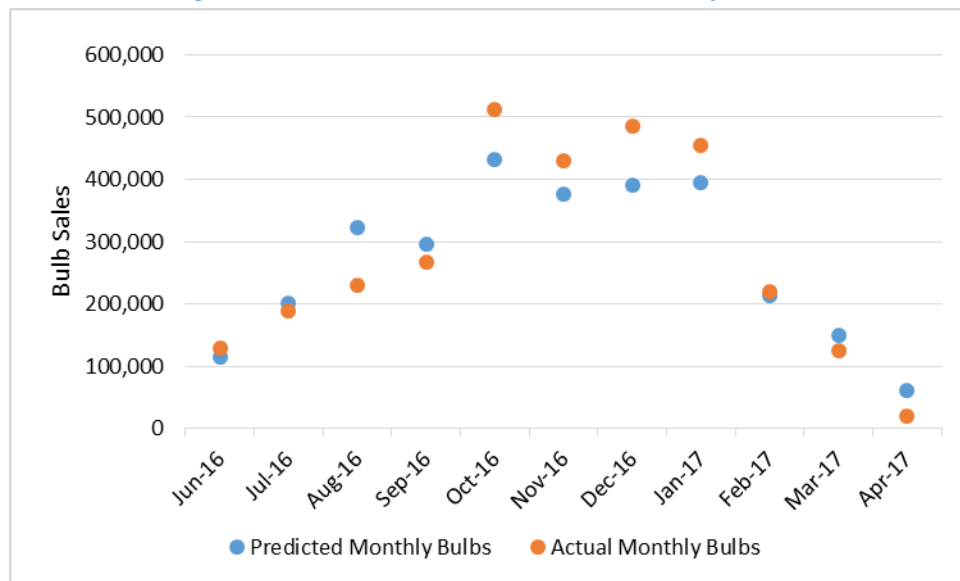
The model specification assumed a lognormal distribution. This distribution serves as the best fit of the plausible distributions (negative binomial, poisson, negative binomial, or gamma).

Cadmus ran numerous model scenarios to identify the model with the best parsimony and explanatory power using these criteria:

- Model coefficient p-values (keeping values less than <0.1)¹⁷
- Explanatory variable cross-correlation (minimizing where possible)
- Model AIC (minimizing between models)¹⁸
- Utilizing the heteroskedastic consistent covariance matrix and clustered standard errors to account for heteroskedasticity
- Minimizing multicollinearity
- Optimizing model fit

The fit of the model can be examined by comparing the model-predicted sales with the actual sales. As shown in Figure D-9, the model-predicted sales matched very closely the actual sales with no persistent bias in a single direction (over or under-predicting), indicating that the model fit the data well. As the figure shows, the model over-predicted slightly in the summer and under-predicted in the fall. Overall, predicted sales were within half a percent of actual sales.

Figure D-9. PY8 Predicted and Actual Sales by Month



¹⁷ 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.

¹⁸ 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.

D.2.2 Findings

Cadmus estimated an overall free ridership of 17%. The model could not account for any spillover or market effects as data for the model is limited to program sales. Additionally, because the estimate was based on only one program year, Cadmus could not capture the influence of the program over time. For example, the program also featured customer engagement and education events, during which the ICSP helped customers choose among the available options of bulbs and color temperatures. However, the model could not distinguish customers who may have been convinced to try an LED at one of these events who then returned to purchase additional bulbs in subsequent program years.

Free ridership varied by retail channel and bulb type based on the elasticity estimates within each of these (shown in Table D-19). Cadmus divided club store retailers into two channels because the pricing and promotional activities differed between retailers resulting in improved model fit.

Table D-19. Modeled Elasticity Estimates

Retail Channel	Bulb Type	Elasticity Estimate	p-value
Club1	LED A-Line	-2.03	0.00
	LED Candelabra	-0.24	0.52
	LED Globe	-3.90	0.01
	LED Reflector	-3.32	0.00
Club2	LED A-Line	-1.78	0.00
	LED Candelabra	-1.33	0.00
	LED Globe	-0.43	0.20
	LED Reflector	-0.93	0.02
DIY	LED A-Line	-1.68	0.00
	LED Candelabra	-2.58	0.00
	LED Globe	-1.46	0.00
	LED Reflector	-1.79	0.00
	LED Specialty	-1.73	0.00
HTR	LED A-Line	-1.27	0.00
	LED Candelabra	-3.90	0.00
	LED Globe	-2.93	0.00
	LED Reflector	-1.60	0.00
Mass market	LED A-Line	-1.75	0.00
	LED Candelabra	-0.91	0.02
	LED Globe	-0.32	0.09
	LED Reflector	-0.84	0.00
	LED Specialty	-0.84	0.34

Demand for A-line bulbs was elastic across all channels. Demand for reflector bulb was also elastic at all but mass market retailers. Elasticities for specialty, globe, and candelabra bulbs varied considerably but due to relatively low sales volume for these products, there is often a fair amount of noise in the data

(i.e., sales can fluctuate between 1-10 bulbs per month, which looks like large proportional changes in sales).

In addition to the price elasticity estimates, the special promotions (e.g., mega-truckload sales and instant savings promotions) had a pronounced impact on sales. Table D-20 shows the model coefficients for the special promotions.

Table D-20. Special Promotion Sales Lift Coefficient Estimates

Retail Channel	Bulb Type	Coefficient	Estimate	p-value
Club	LED A-Line	Promo share	85.62	0.00
	LED A-Line	Promo share Lag 1	56.26	0.00
	LED A-Line	Promo share Lag 2	127.66	0.00
	LED Reflector	Promo share	-0.02	0.98
	LED Reflector	Promo share Lag 1	-0.14	0.78
	LED Reflector	Promo share Lag 2	0.50	0.27
DIY	LED A-Line	Promo share	1.23	0.00
	LED A-Line	Promo share Lag 1	0.18	0.46
	LED A-Line	Promo share Lag 2	2.13	0.00
	LED Reflector	Promo share	3.68	0.00
	LED Reflector	Promo share Lag 1	9.55	0.00
	LED Reflector	Promo share Lag 2	0.40	0.00
	LED Candelabra	Promo share	0.54	0.00
	LED Candelabra	Promo share Lag 1	0.10	0.00
	LED Candelabra	Promo share Lag 2	0.12	0.58
	LED Globe	Promo share	0.07	0.49
	LED Globe	Promo share Lag 1	0.18	0.70
	LED Globe	Promo share Lag 2	9.55	0.42

Cadmus found that there was substantial sales lift even after the indicated promotion period so Cadmus tested for lag-effects in the model and found a two-period lag to optimize model fit. Only two retail channels had the promotional events. In some cases, the ICSP indicated specific SKUs that were featured in the promotions. In other instances, only the manufacturer was provided. Cadmus estimated separate effects by bulb type and channel. Some of the effects were small but it is plausible that this is either because customers delay or forego purchases of specialty, reflector, or decorative bulbs in favor of A-line bulbs, which would result in a negative coefficient (indicating a slight decrease in sales), or because of increased number of customers shopping for light bulbs, in which case, one would observe a positive coefficient indicating a slight increase in sales even for bulbs not featured simply because more customers are shopping for light bulbs.

The sales lift for club store A-line bulbs was by far the largest, with a 1% increase in the share of products featured in a promotion yielding an increase in sales of 86% during the initial month and the lift persisted for two months after the promotion ended, likely due to persistent substantial price discounts and increased customer awareness.

The lift was more modest for events at DIY stores, which were not coupled with the same low prices featured in the club stores, though sales of both reflectors and A-line bulbs increased. The DIY promotions also varied more over the course of PY8 and covered a wider variety of products.

Table D-21 shows the average per bulb prices by retail channel, which includes original price, final price, and markdown levels (the discount relative to original price).

Table D-21. Free Ridership and Prices by Retail Channel and Bulb Type

Retail Channel	Bulb Type	Average Original Price per-bulb	Average Final Price per-bulb	Markdown	Free Ridership
Club	LED A-Line	\$2.74	\$0.87	68%	13%
Club	LED Candelabra	\$4.21	\$2.09	50%	67%
Club	LED Globe	\$6.34	\$2.65	58%	62%
Club	LED Reflector	\$5.73	\$2.89	49%	22%
DIY	LED A-Line	\$7.60	\$2.31	70%	15%
DIY	LED Candelabra	\$5.31	\$2.14	60%	10%
DIY	LED Globe	\$8.56	\$2.58	70%	22%
DIY	LED Reflector	\$8.60	\$4.19	51%	24%
DIY	LED Specialty	\$13.48	\$2.16	84%	6%
HTR	LED A-Line	\$7.67	\$1.25	84%	9%
HTR	LED Candelabra	\$7.79	\$3.90	50%	7%
HTR	LED Globe	\$6.84	\$1.99	71%	4%
HTR	LED Reflector	\$11.57	\$6.61	43%	24%
Mass Market	LED A-Line	\$3.13	\$1.25	59%	22%
Mass Market	LED Candelabra	\$8.05	\$4.99	38%	65%
Mass Market	LED Globe	\$8.14	\$4.92	40%	83%
Mass Market	LED Reflector	\$10.47	\$5.69	46%	59%
Mass Market	LED Specialty	\$8.12	\$5.12	37%	68%

The average per-bulb price varied by retail channel. Club stores had the lowest prices for A-line bulbs with prices of less than \$1 per-bulb. This was due to substantial discounts and working to bring multi-packs into the program (which tend to have increasingly lower per-bulb prices as the pack size increases).

DIY stores also had substantial discounts, between 50% and 70% of the original price. Some of this was due to additional manufacturer incentives at some of the chain hardware stores. The same was true for some of the HTR stores, which helped to achieve substantial price reductions. However, as noted before, free ridership was high at HTR stores because of the observed increase in price for A-line and reflector bulbs.

Overall, the NTG ratio for LEDs was higher than other evaluations Cadmus has conducted during the last year, which typically showed NTG ratios in the range of 50% to 70%. The higher NTG ratio for PPL

Electric Utilities' program was likely because the programming featured bulbs for less than \$1 per bulb and the large impact of the special promotions, particularly at the club stores.

Special promotions appeared to be very successful in decreasing free ridership in PY8. Cadmus recommends the ICSP continue to work with retailers to use promotions to manage the pace of sales.

D.3 Precision

Once the final model specification was developed, Cadmus calculated "block bootstrap" standard errors to determine the sensitivity of the estimated free ridership ratios. To develop bootstrap standard errors, Cadmus drew 1,000 new samples (with replacements drawn at the cross-section level) from the original data, estimating coefficients with each sample and calculating a new NTG ratio. Using this method, the 7.5 and 92.5 percentiles in these NTG ratios represented the lower and upper bounds of the 85 confidence interval, as shown in Table D-22.

Table D-22. Net-to-Gross Ratio and Confidence Interval

Free Ridership	7.5% Lower Bound Confidence Interval	92.5% Upper Bound Confidence Interval	CV	Relative Precision at 85% Confidence
17%	15%	19%	9%	12%

D.3.1 Net-to-Gross Ratio Findings

Free ridership estimates were relatively consistent across bulb types, between 14% and 29%, with the exception of specialty bulbs at 6%, but specialty bulbs accounted for a small share of overall sales. The overall free ridership estimate was 17% for the program, which was down from 39% in PY7.¹⁹

Table D-23. Estimated Free Ridership by Bulb Type

Bulb Type	Free Ridership
LED A-Line	14%
LED Candelabra	29%
LED Globe	25%
LED Reflector	24%
LED Specialty	6%
Overall	17%

The demand elasticity model is one measure of the market impact of the upstream lighting program. Cadmus collected data through its general residential population survey.

D.4 Process Evaluation

The purpose of the process evaluation is to assess program processes and provide recommendations for improving program operation. Cadmus' process evaluation for the Efficient Lighting Program assessed

¹⁹ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

program delivery and market response (including adoption of energy-efficient lighting). Cadmus also examined the program's effectiveness in generating awareness, driving participation to achieve desired savings goals, and disseminating information.

D.4.1 Process Evaluation Methodology

To accomplish the objectives stated above, Cadmus interviewed PPL Electric Utilities and ICSP program staff, conducted general population surveys, reviewed program databases, and reviewed and updated the logic model.

Program Staff and ICSP Interviews

In February and March of 2017, Cadmus conducted two interviews with the program managers from PPL Electric Utilities and the ICSP. The interviews ensured that Cadmus thoroughly understood the program's objectives, design, and progress to provide well-rounded and balanced observations and recommendations. The interviews focused on program operations and goals and gathered program managers' perspectives on areas that are working well and those that could benefit from changes.

Manufacturer Interviews

In PY8, Cadmus and the ICSP collaborated to conduct in-depth interviews with 16 out of the 17 lighting manufacturers that participated in the program in PY8. The sample frame was a convenience sample; manufacturers were contacted based on the ICSP's existing relationships and their current status as a program participant. Altogether, the manufacturers interviewed represented 99.5% of total program bulb sales. Cadmus provided a list of interview questions, and the ICSP conducted the interviews. The interviews sought to fulfill the following objectives:

- Explore whether sales by bulb type in Pennsylvania differ from national sales levels
- Explore whether proportions of sales by bulb type differ between program and non-program areas
- Assess what proportion of each manufacturer's light bulbs comply with various versions of ENERGY STAR requirements
- Understand whether manufacturers plan to produce non-ENERGY STAR light bulbs and, if so, why
- Understand the role, if any, that utilities play in shaping the market for LEDs
- Predict trends in LED market composition and consumer preferences

General Population Surveys

Because the Efficient Lighting Program offers upstream incentives to manufacturers, customers purchasing program-discounted bulbs in stores may have been unaware that they purchased bulbs sponsored by a PPL Electric Utilities program. Therefore, Cadmus conducted general population surveys to collect data for the process and impact evaluations. Surveys included questions designed to measure market progress indicators such as awareness, knowledge, satisfaction with and willingness to pay for energy-efficient lighting, purchase patterns and usage, and barriers to adopting energy-efficient technologies and practices, as well as customer demographics.

Cadmus collected similar data in a separate general population survey with small businesses. Although the primary purpose of this survey was to estimate the proportion of program sales to nonresidential customers (cross-sector sales), Cadmus also included questions designed to track market progress indicators, similar to the residential survey.

Surveys with a random sample of the general residential population (300 completed) obtained 73 surveys with residential customers who purchased LEDs at participating retailers within the last six months. This small business survey sample was drawn from the general population of PPL Electric Utilities' small commercial customers. Cadmus completed 465 surveys; 265 were knowledgeable about their company's lighting purchases. Of those, 70 small businesses purchased LEDs in the last six months.

Cadmus administered the telephone surveys between April and May 2017.

Table D-24. PY8 Participant Survey Sampling Strategy

Survey Mode and Audience	Population Size	Target Sample Size	Achieved Sample Size	Telephone Response Rate
Residential general population	~1,2M	300 minimum completes 70 purchasers	300/70 purchasers	3%
Small C&I general population	79,047	300 minimum completes 70 purchasers	465 ^[1]	4%
Total Surveys Completed	1,279,047	600	765	N/A
^[1] 269 surveys were completed by respondents knowledgeable about lighting decisions and purchases. Of those, 70 surveys were completed by respondents who had purchased LEDs in the past six months.				

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. Cadmus addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys did not include leading or ambiguous questions nor double-barreled questions. Cadmus provided clear interviewing and programming instructions so that they were implemented consistently. The SWE team and PPL Electric Utilities reviewed and approved surveys before fielding.

Contact Instructions

PPL Electric Utilities provided survey contact instructions for conducting surveys. Customers could not be contacted for a survey if they completed a PPL Electric Utilities or Cadmus survey in the past three months, had opted out of a survey, or had asked not to be contacted again. Telephone survey calls could not take place on Sundays or national holidays

See Section D.4.3 for sampling cleaning and attrition.

D.4.2 Additional Findings

This section includes additional survey and interview findings.

Program Delivery

Prior to the Efficient Lighting Program starting June 1, 2016, the ICSP collected responses to a request for proposal (RFP) to identify manufacturers within PPL Electric Utilities' service territory and compile a master product list. PPL Electric Utilities chose to include fixtures as well as specialty and reflector bulbs

among its incented products in PY8. Updated ENERGY STAR specifications did not limit program offerings nor did less-expensive non-ENERGY STAR LEDs adversely affect demand for incented bulbs.

PPL Electric Utilities said the program was “more successful than anticipated.” The ICSP expressed concerns early on about the difficulty of recruiting retailers because of limited field staff. However, the program’s rapid and robust sales caused the ICSP to consider scaling back the incented product list midyear to slow participation growth.

Key Performance Indicators

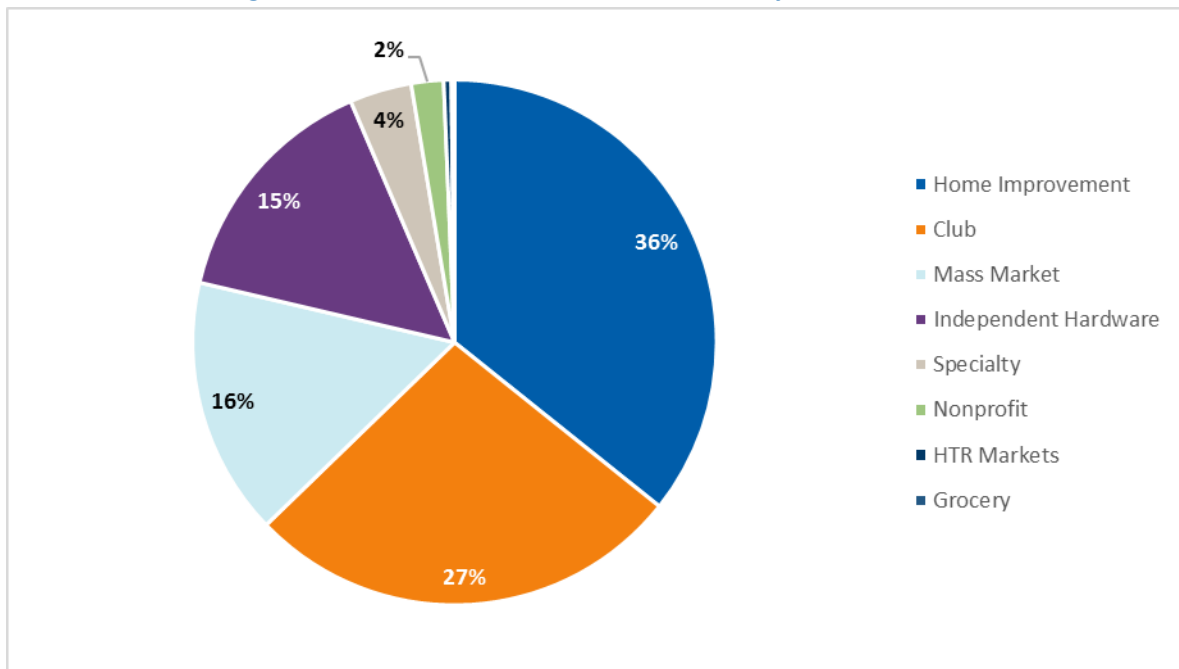
PPL Electric Utilities and the ICSP defined plans for participation for the Efficient Lighting Program. Performance for those metrics in PY8 shown in Table D-25. The program sold approximately 3.6 million bulbs in PY8, equal to roughly 40% of Phase III’s four-year target in its first program year. PY8 sales exceeded planned savings, requiring the ICSP to reduce incentives toward the end of the program year to manage the pace of the program.

Table D-25. PY8 Efficient Lighting Program Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
Participation	Estimated number of incented bulbs sold	8.6 million bulbs sold during Phase III	3.6 million bulbs sold

The program strives to ensure incentives are offered through a sufficient diversity of retailers. In PY8, the mass market and independent hardware channels were well represented, as shown in Figure D-10.

Figure D-10. PY8 Distribution of Bulbs Sold, by Retail Channel



Logic Model Development and Review

A program logic model identifies the relationships between activities and expected results. The Phase III PY8 Efficient Lighting Program had a similar logic model to the Phase II Efficient Lighting Program. Cadmus reviewed the Efficient Lighting Program’s logic model and determined that the program operated as expected in PY8. Table D-26 shows the program logic model’s expected versus actual outcomes.

Table D-26. PY8 Efficient Lighting Program Logic Model Review

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
Manufacturer and retailer recruitment, program materials dissemination, no-cost bulb distribution, bulk purchases	Program Activities	Delivered program activities as expected
Variety of retailer recruitment, number of discounted LED bulbs purchased	Outputs Produced by Program Activities	Delivered outputs as expected; exceeded estimated annual bulb sales
Increased LED availability, reduced LED prices, energy and demand savings	Short-term Outcomes	Produced short-term outcomes as expected
Increased customer familiarity and satisfaction, improved economies of scale, better program implementation	Intermediate Outcomes	On track to produced outcomes
Transformed lighting market, substantial energy and demand savings	Long-term Outcomes	Will be assessed at the end of Phase III

Participant Profile

Using data collected in the general population residential survey (n=300), Cadmus established a profile of customers who purchased LEDs in the upstream lighting component of the Residential Retail Program. Table D-27 shows the breakdown of respondents into recent LED purchasers and non-purchasers. Most of the recent purchases were from retailers currently participating in the Efficient Lighting Program; 79% of the bulbs respondents reported having purchased were from participating retailers.

Table D-27. PY8 General Residential Population Recent LED Purchasers and Non-Purchasers

Customer Base	Respondent Type	Percentage of Respondents		Percentage of LEDs Purchased
Residential general population (n=300)	Recent LED purchasers	From participating retailers	24%	79%
		From other retailers	11%	21%
	Non-recent LED purchasers and non-purchasers		65%	N/A

Among residential respondents who had purchased or currently use LEDs (n=167), the majority (73%) lived in single-family detached residences, 11% lived in multifamily apartments, 11% lived in attached houses, and 3% lived in manufactured or mobile homes. Of LED users, most (94%) had at least a high school diploma. Thirty-one percent each had a high school diploma or a technical degree as the highest level of education, and one-third had at least a bachelor’s degree.

In contrast to Cadmus' findings in PY7, which were inconclusive with regard to differences in housing types and education levels between residential survey respondents who had and had not used LEDs, in PY8 there were statistically significant differences between these respondent groups.²⁰

Consistent with findings in PY7, there was a statistically significant difference in household income levels between respondents who had and had not used LEDs.²¹ More LED users in PY8 lived in single-family homes (73%, compared to 58% of non-users) and earned household incomes above \$50,000 (53%, compared to 38% of non-users).

Non-users were more likely to live in multifamily apartments (23% non-users compared to 11% LED users), have high school diplomas as the highest level of education (50% non-users compared to 31% LED users), and earn household incomes below \$50,000 (62% non-users compared to 45% LED users). These metrics indicate that wealthier, more educated customers are more likely to purchase LEDs.

Opinion of PPL Electric Utilities

Seventeen percent of residential general population survey respondents (n=300) and 36% of small business general population survey respondents (n=269) knew that PPL Electric Utilities provides funding and discounts to reduce the prices of LED bulbs in local stores. Among the 19 residential general population survey respondents who were aware that their recently purchased LEDs were discounted courtesy of PPL Electric Utilities, seven (37%) said their opinions of PPL Electric Utilities *improved significantly* (5%) or *improved somewhat* (32%) and none said their opinions had decreased. More than half (10 respondents, 53%) said their opinions had not changed.

Among the 18 small business LED purchasers who were aware that PPL Electric Utilities provided their discount, nine (50%) said their opinions of PPL Electric Utilities *improved significantly* (22%) or *improved somewhat* (28%) and none said their opinion decreased. Half (nine respondents, 50%) said their opinions had not changed.

Marketing and Outreach

The ICSP recruited retailers to the Efficient Lighting Program using an RFP. The ICSP communicated with retailers on behalf of the program and was responsible for setting and adjusting incentive levels based on the available budget and observed sales. The ICSP also marketed the program (subject to PPL Electric Utilities' review and approval) using bill inserts, articles in PPL Electric Utilities' monthly customer newsletter, PPL Electric Utilities' website, social media, and radio advertising. It also coordinated with one of the primary retailers to update in-store signage to market program-incented bulbs.

ICSP marketing materials highlighted the ENERGY STAR designation for program bulbs but did not discuss the differences between ENERGY STAR and non-ENERGY STAR bulbs. Cadmus found that

²⁰ Cadmus used a two sample t-test for the difference in proportions. The results presented are significant at an alpha=0.10 level..

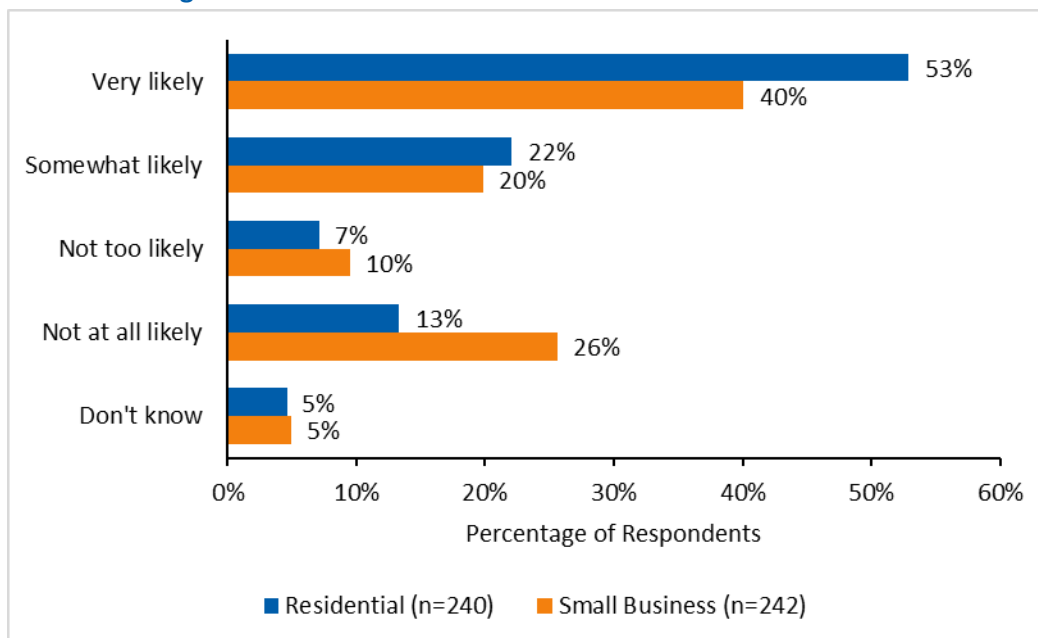
²¹ Cadmus used a two sample t-test for the difference in proportions. The results presented are significant at an alpha=0.10 level.

marketing efforts reached residential and small business customers at about the same rate: 38% of residential respondents (n=240) and 39% of small business respondents (n=235) had seen brochures, store signs and displays, or other materials from PPL Electric Utilities explaining the energy-saving benefits of LEDs.

Likelihood to Install LEDs

Among general population survey respondents who had heard of LEDs before, 75% of residential customers said they are at least *somewhat likely* to install screw-in LEDs in the next 12 months compared to 60% of small business customers. Small business customers were twice as likely as residential customers to be *not at all likely* to install a LED, as shown in Figure D-11.

Figure D-11. PY8 Likelihood to Install LEDs in Next 12 Months



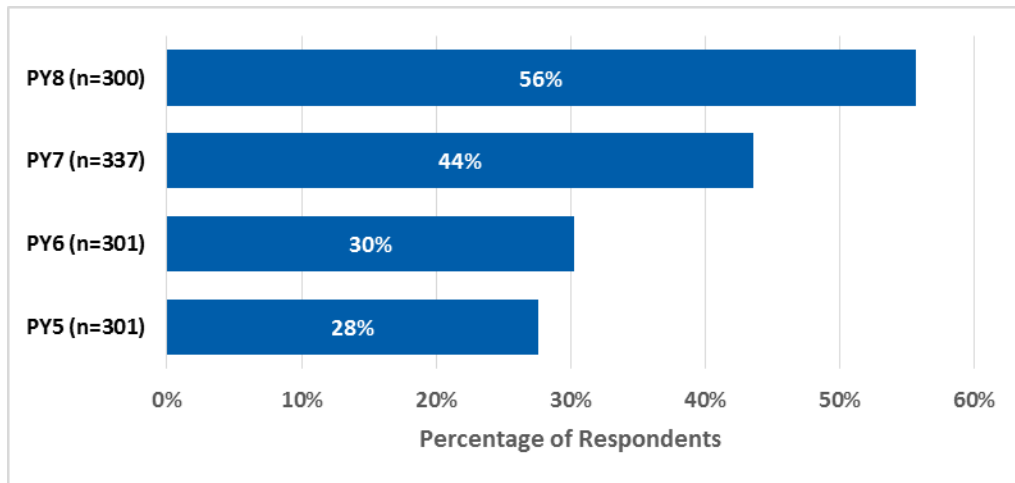
General Population Surveys. Residential Question B4, Small Business Question C2: "How likely are you to install screw-in LEDs in your [home]/[place of business] in the next 12 months?"

Among respondents who were less than *very likely* to install LEDs in the next 12 months (n=93), 39% of residential respondents (n=93) and 26% of small business respondents (n=121) did not expect to have to replace any bulbs. Approximately one third of small business respondents said that screw-in LEDs do not fit in their facilities (either they do not use screw-in bulbs or their fixtures were not set up for them). Additionally, 24% of residential respondents and 13% of small business respondents thought the bulbs cost too much.

LED Use and Program Sales

The number of residential customers reporting having used LEDs has increased since PY5, mostly over the past two years, as shown in Figure D-12.

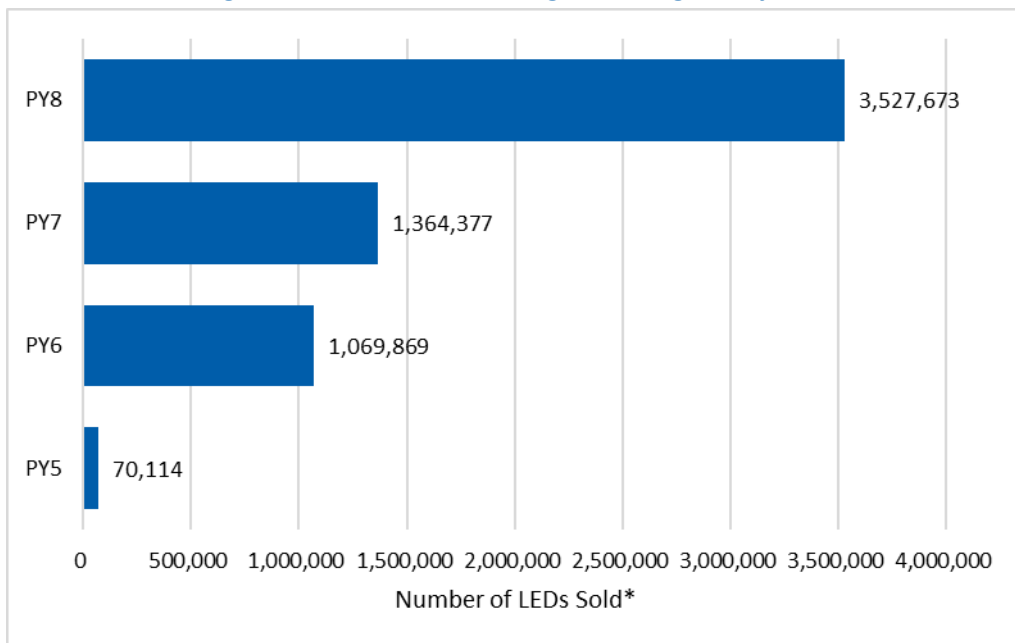
Figure D-12. PY8 Residential Customers Use of LEDs



General Residential Population Survey Questions C3: “Of these [READ IN QUANTITY FROM C2] screw-in bulbs purchased in the past 6 months, approximately how many were screw-in LEDs?” and “F2: “Have you ever used screw-in LEDs inside or outside your home?”

The increase in customers’ use of LEDs falls in tandem with the increase in the number of LEDs sold through PPL Electric Utilities’ program, as shown in Figure D-13.

Figure D-13. LEDs Sold through the Program by Year

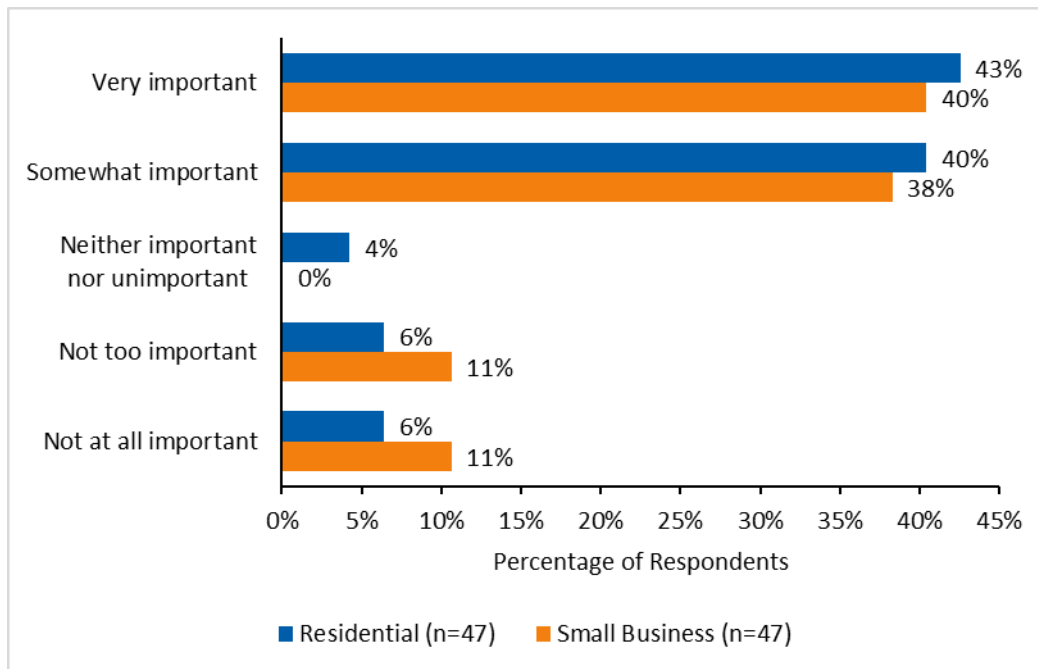


*The number of LEDs sold excludes bulbs given away. PPL Electric Utilities gave 48,000 LEDs to low-income customers in PY7.

Importance of ENERGY STAR Certification

Forty-five percent of residential survey respondents who recently purchased LEDs (n=104) and 47% of small business survey respondents who recently purchased LEDs (n=103) were aware that some LEDs are qualified for ENERGY STAR certification. Among those who were aware of the certification, 83% of residential customers (n=47) and 78% of small business customers (n=47) said certification plays at least a *somewhat important* role in their purchase decisions while shopping for LEDs, as shown in Figure D-14.

Figure D-14. PY8 Importance of ENERGY STAR Certification to LED Purchase

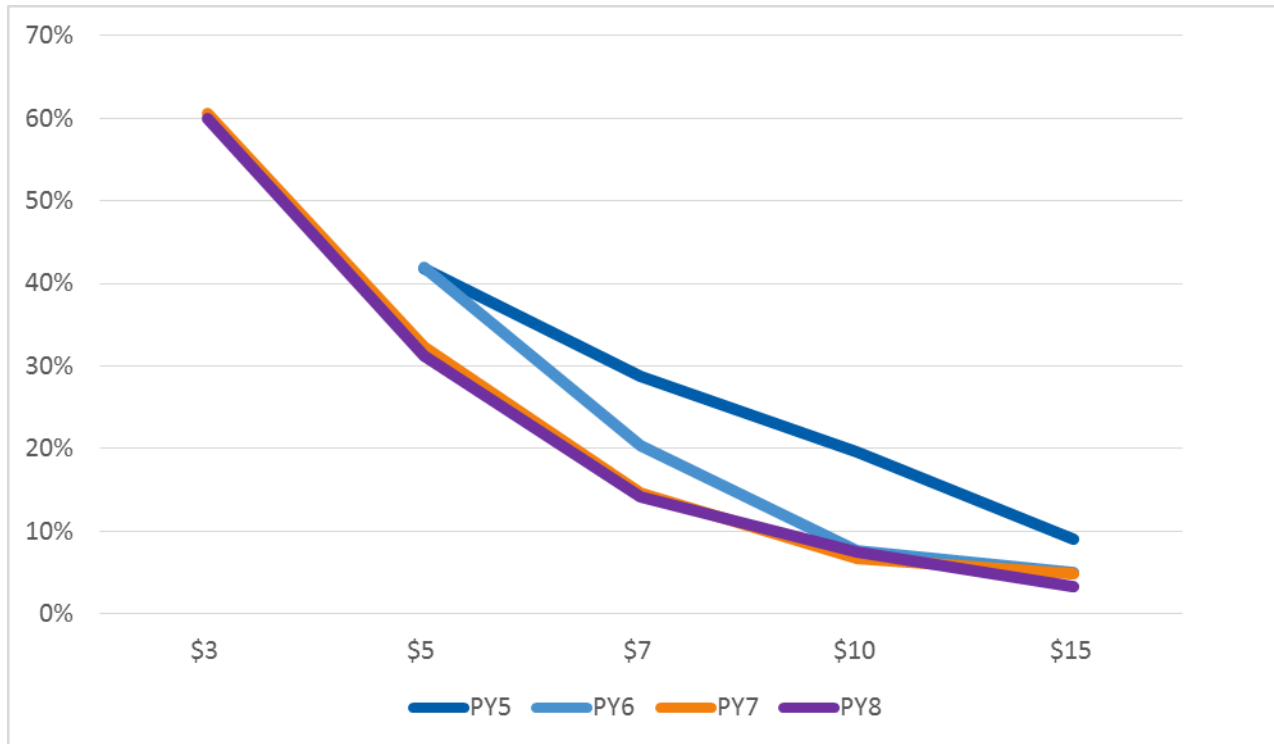


General Population Surveys. Residential Question D13, Small Business Question F13: “When shopping for LEDs, how important is ENERGY STAR certification in your decision to purchase a particular bulb?”

Willingness to Pay

Cadmus has measured residential survey respondent willingness to pay for a LED in place of a CFL or incandescent bulb using survey data in each of the last four years. Figure D-15 shows that most respondents (60%) were *very likely* to pay \$3 for an LED. This percentage declined almost uniformly with each increased price point, by 24 percentage points from \$3 to \$5 and another 25 percentage points from \$5 to \$7. Compared to previous program years, willingness to pay declined slightly at lower price points (\$3 and \$5) and held steady at higher price points (\$10 and \$15).

Figure D-15. Percentage of Residential Customers *Very Likely* to Purchase LED at Various Price Points, by Year

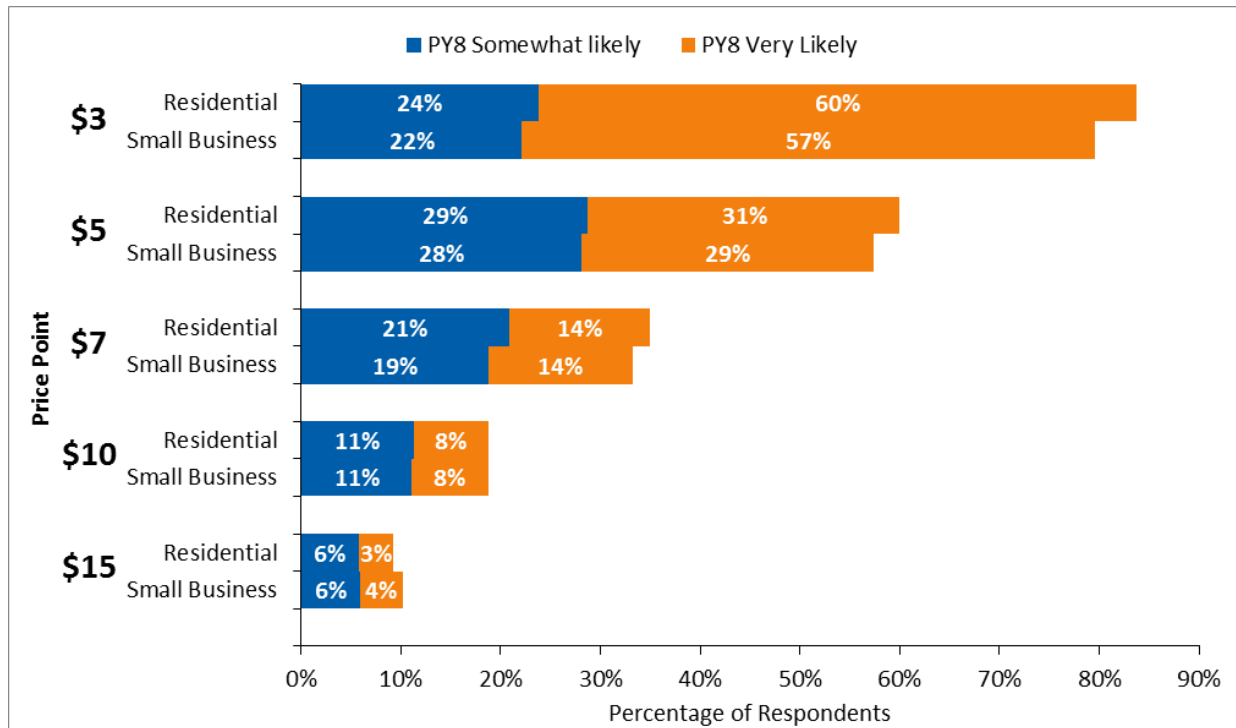


Residential General Population Survey Questions G3-G7: "Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-in LED cost [\$X], how likely would you be to purchase the LED instead of a CFL or halogen incandescent bulb?"²²

Willingness to pay for residential respondents was very similar to that of small business respondents, as shown in Figure D-16. Residential customers were more likely to purchase an LED at most price points, although not by a statistically significant margin. In past program years, however, commercial customers generally demonstrated a higher willingness to pay than did residential customers.

²² The survey offered price points in ascending order. If a respondent said he/she was *not at all likely* to purchase a LED, the survey skipped the remainder of the willingness to pay questions.

Figure D-16. PY8 Willingness to Pay for LEDs – Residential and Small Business



Residential questions G3-G7; small business questions I3-I7: "If the screw-in LED cost \$[X], how likely would you be to purchase the LED?"²³ (n=240 for residential, n=235 for small business)

Residential LED users reported they were more likely to purchase LEDs when needed instead of a CFL or halogen incandescent bulb at all price points than were non-users, as shown in Figure D-17.

As measured by the percentage of *very likely* responses, LED users, compared to non-users, are these:

- About one and a half times as likely to purchase \$3 LEDs
- Almost twice as likely to purchase \$5 LEDs
- Almost two and a half times as likely to purchase \$7 LEDs

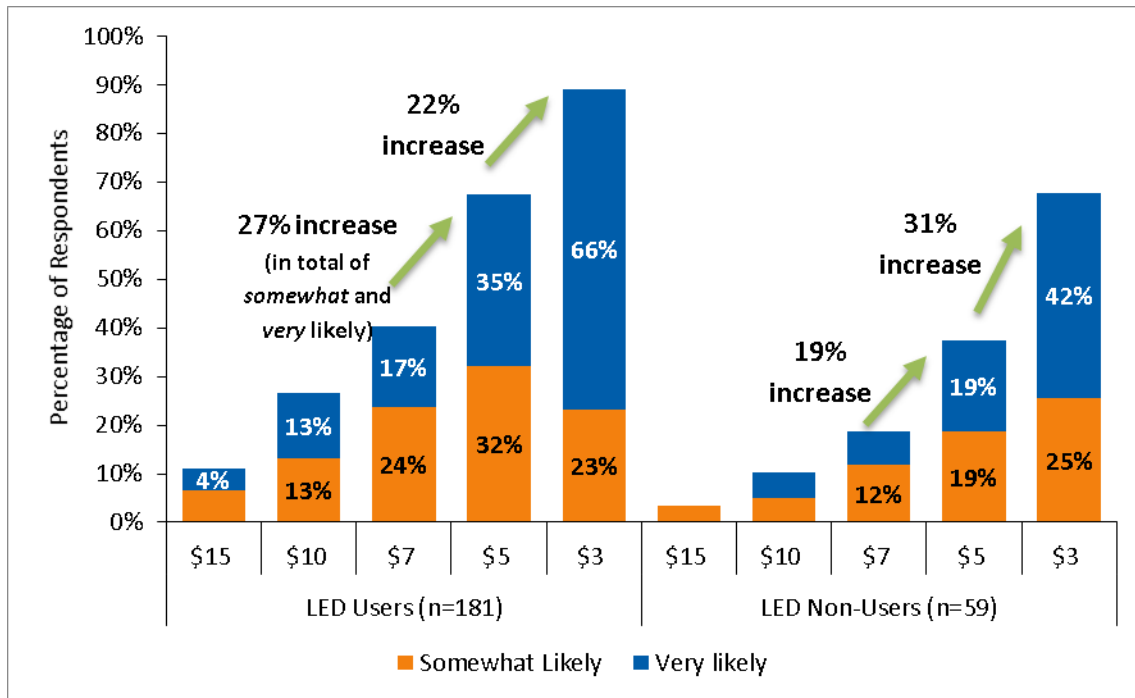
In terms of the combined percentage of *very likely* and *somewhat likely* responses, LED users, compared to non-users, are these:

- About one third more likely to purchase \$3 LEDs
- Almost twice as likely to purchase \$5 LEDs
- More than twice as likely to purchase \$7 LEDs

²³ The survey offered price points in ascending order. If a respondent said he/she was *not at all likely* to purchase a LED at a certain price point, Cadmus coded the remaining higher price points as *not at all likely*.

Overall, when looking at the combination of *very likely* and *somewhat likely* responses, Figure D-17 shows the steepest increase in likelihood to purchase LEDs in non-users, when prices drop from \$5 to \$3. This was also the pattern in PY7.²⁴

Figure D-17. PY8 Willingness to Pay for LEDs – Residential Users and Non-Users



Residential General Population Survey Questions G3-G7: “Suppose one of your light bulbs burns out or stops working and you need to buy a new bulb. If a typical screw-in LED cost [\$X], how likely would you be to purchase the LED instead of a CFL or halogen incandescent bulb?” (n=181 for LED users, n=59 for LED non-users)

Satisfaction with LEDs

Cadmus asked questions about general satisfaction with LEDs.²⁵ Results, indicating both residential and commercial customers are very satisfied with LEDs, 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. The number of respondents is indicated.

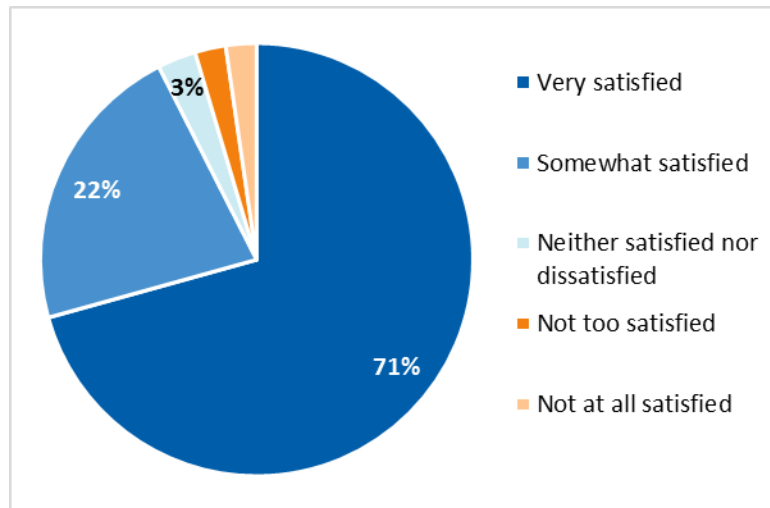
General Satisfaction with LEDs

Nearly all residential general population respondents who have used LEDs were *very satisfied* (71%) or *somewhat satisfied* (22%) with the screw-in LEDs they installed, as shown in Figure D-18.

²⁴ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

²⁵ The survey did not ask satisfaction questions about the program because few participants realized they were participating in the program due to the program offering its rebates upstream.

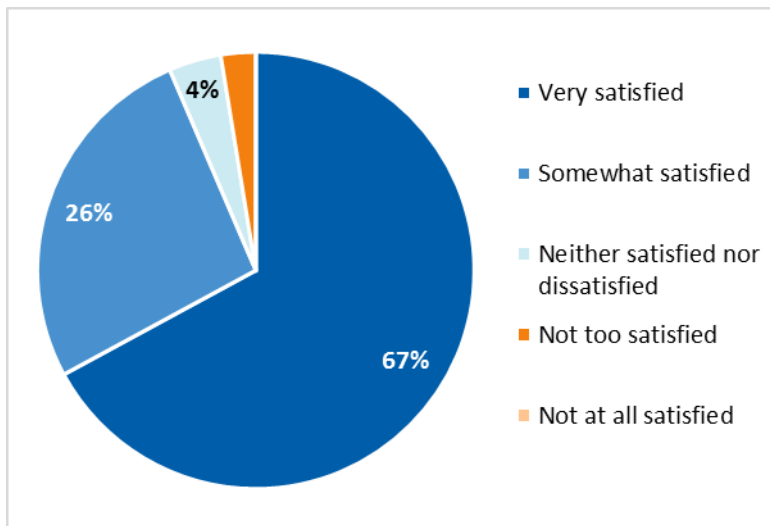
Figure D-18. PY8 Satisfaction with LEDs – Residential



Residential General Population Survey Question H1: “How satisfied, in general, were you with the screw-in LEDs you installed?” (n=174)

Similarly, 92% of small business LED purchasers (n=157) were *very satisfied* (67%) or *somewhat satisfied* (26%) with the screw-in LEDs they installed, as shown in Figure D-19.

Figure D-19. PY8 Satisfaction with LEDs – Small Business



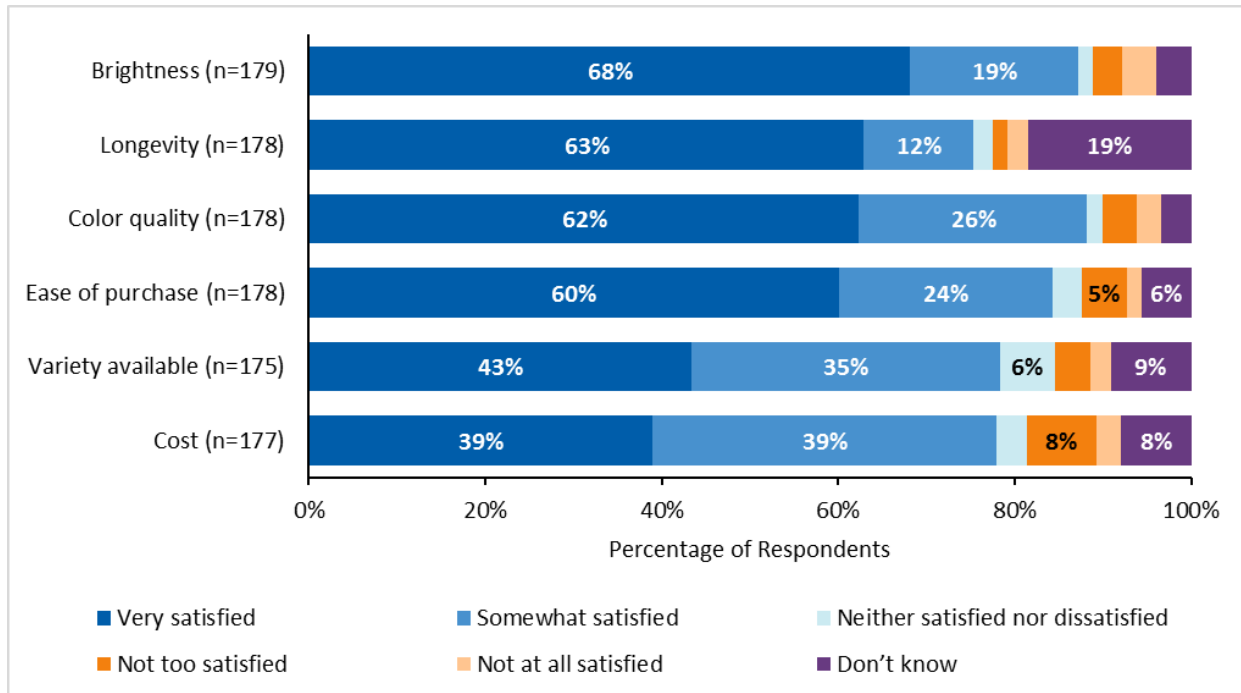
Small Business General Population Survey Question J1: “How satisfied, in general, are you with the screw-in LEDs you installed?” (n=157)

Satisfaction with LED Traits

The survey investigated how satisfied LED users were with various bulb traits. At least 78% of respondents said they were *very satisfied* or *somewhat satisfied* with each LED trait about which Cadmus inquired, as shown in Figure D-20. Residential respondents most frequently reported being *very satisfied* with the brightness of the light (68%) and least frequently with the cost to purchase the bulb

(39% very satisfied). Respondents were *very satisfied* or *somewhat satisfied* most frequently with the color quality of the light (88%).

Figure D-20. PY8 Satisfaction with LED Traits – Residential



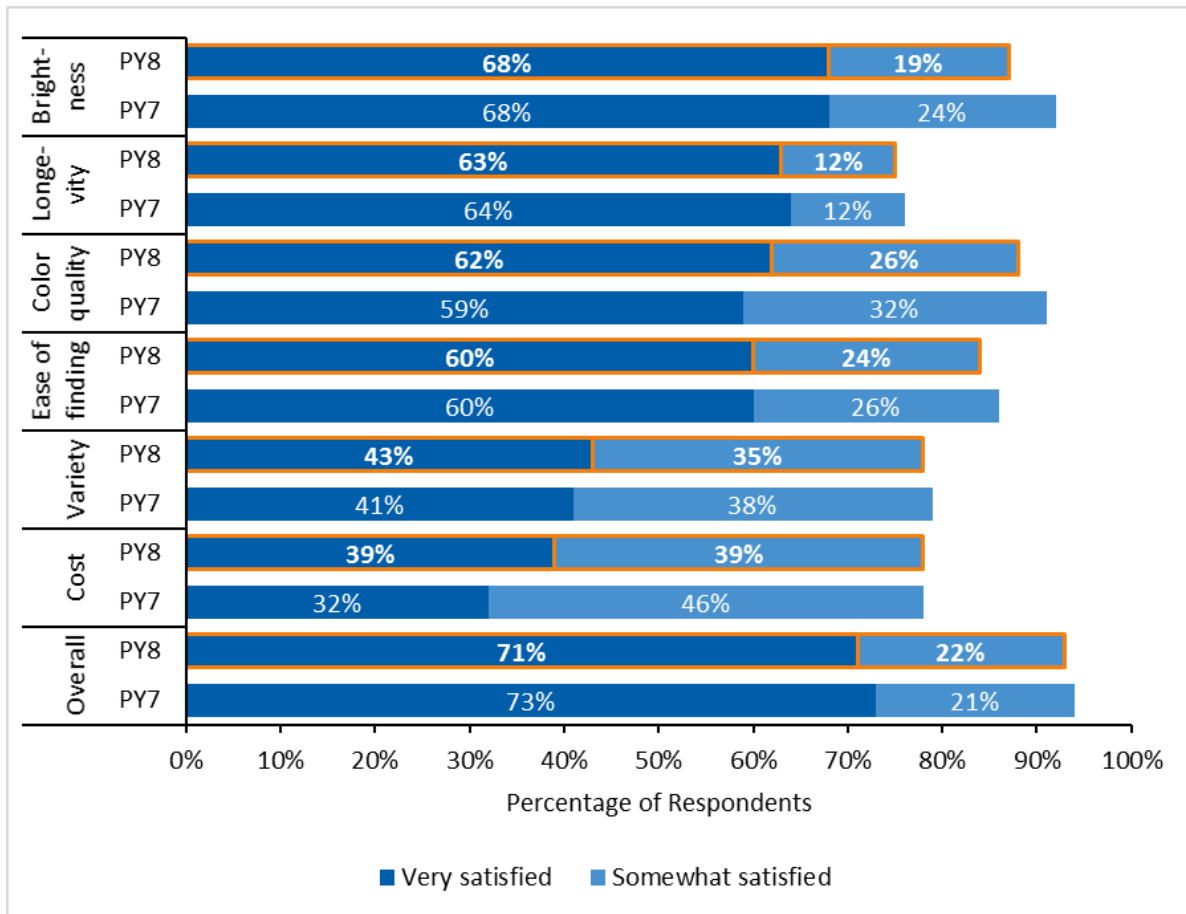
Residential General Population Survey Questions H2a-f: “How satisfied were you with the screw-in LEDs you installed in terms of...”

Note: Small business LED users were very similarly satisfied with bulb traits compared to their residential counterparts.

Compared to PY7 results, residential LED user satisfaction with the bulb traits was extremely similar.²⁶ These metrics are shown in Figure D-21.

²⁶ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

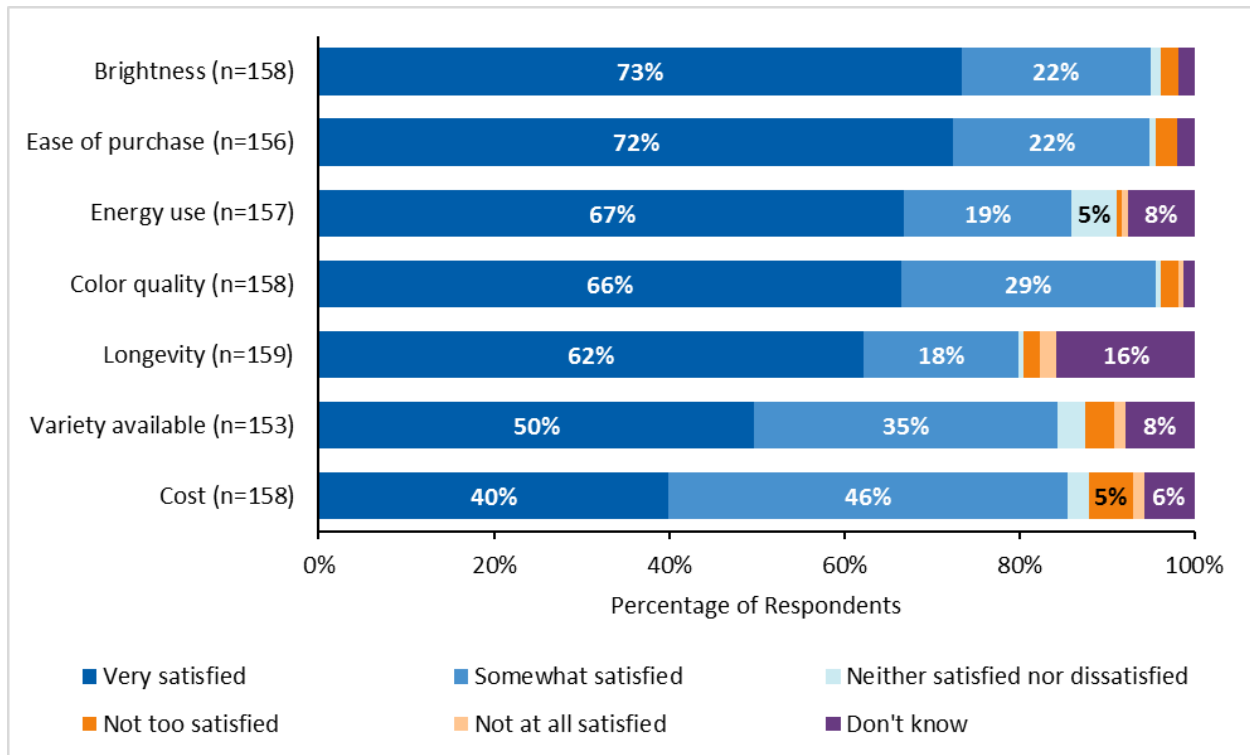
Figure D-21. Satisfaction with LED Traits by Program Year – Residential



Residential General Population Survey: “How satisfied were you with the screw-in LEDs you installed in terms of....” PY8: Questions H1, H2a-f (n=179); PY7: Questions G2, J3a-f (n=158)

At least 80% of small business respondents said they were *very satisfied* or *somewhat satisfied* with each LED trait about which the Cadmus team inquired, as shown in Figure D-22.

Figure D-22. PY8 Satisfaction with LED Traits – Small Business



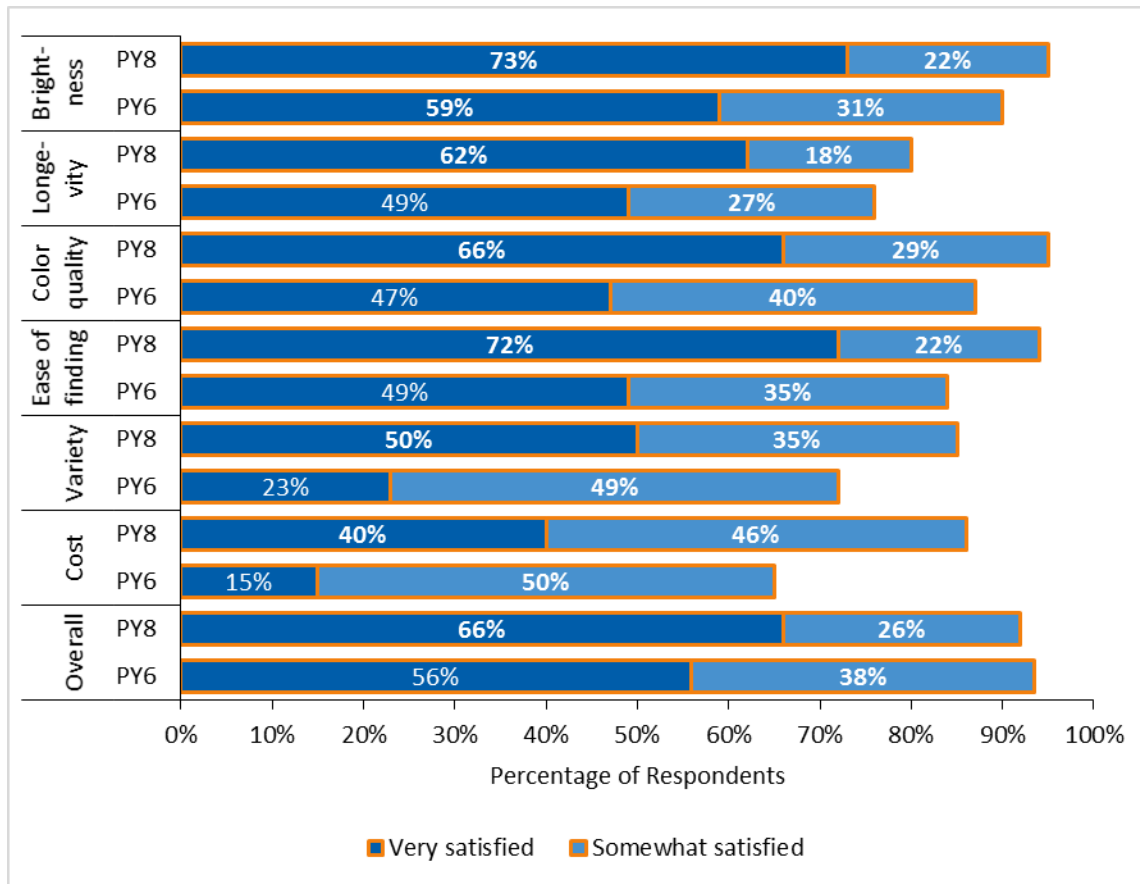
Small Business General Population Survey Questions J2a-g: “How satisfied were you with the screw-in LEDs you installed in terms of...”

Compared to PY6 results,²⁷ small business LED user satisfaction with the bulb traits was higher than in PY6.²⁸ These metrics are shown in Figure D-23.

²⁷ PPL Electric Utilities. Annual Report Program Year 6: June 1, 2014–May 31, 2015. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

²⁸ Cadmus used a two sample t-test for the difference in proportions. The results presented are significant at an alpha=0.10 level.

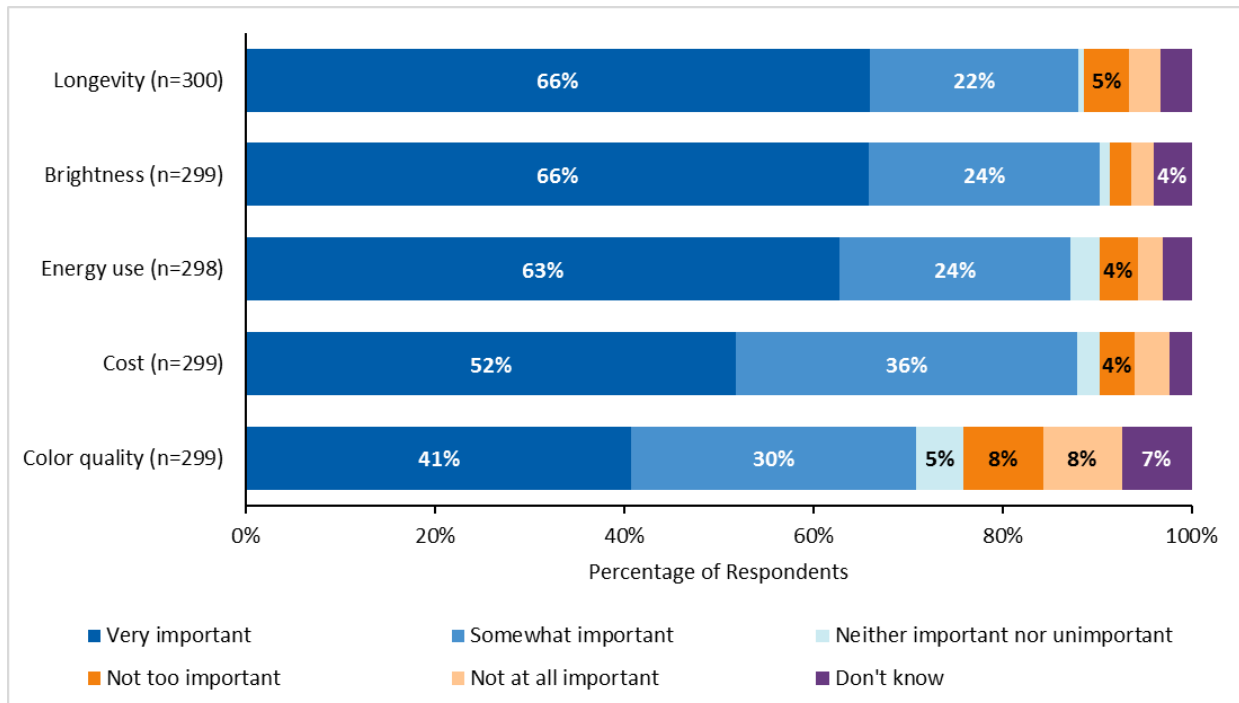
Figure D-23. Satisfaction with LED Traits by Program Year – Small Business



Importance of LED Traits to Purchase Decision

Residential survey respondents most frequently considered brightness at least *somewhat important* (90%) to their purchase decisions, followed by longevity and cost (88% each), as shown in Figure D-24. In addition, respondents most frequently considered bulb longevity and brightness *very important* (66% each), followed by bulb energy use (63%) and cost (52%). Respondents least frequently considered color quality *very important* (41%).

Figure D-24. Importance of LED Traits to Purchase Decision – Residential



Residential General Population Survey Questions E1a-e: “Please indicate the importance of...”

The manufacturers Cadmus interviewed said that the top performance characteristics consumers look for when purchasing LEDs are cost, color quality, and longevity. The manufacturers believed cost was the most important factor in a customer’s decision when choosing a bulb; however, fewer of residential respondents ranked cost as *very important* compared to other traits. The discrepancy suggests that manufacturers, although they adequately characterize the importance of cost as it relates to LED demand, underrate other drivers of demand.

The importance of LED traits to residential survey respondents fluctuated from previous program year reports, as shown in Figure D-25. Longevity and cost are declining in importance and energy use is increasing in importance over the last three years. The trends are statistically significant when comparing the importance of color quality, cost, longevity, and brightness between PY6 and PY8 and the importance of color quality and brightness between PY7 and PY8.^{29,30,31} These trends suggest that the preferences affecting purchase decisions are shifting from point-of-sale cost and aesthetic characteristics to bulb longevity and energy savings.

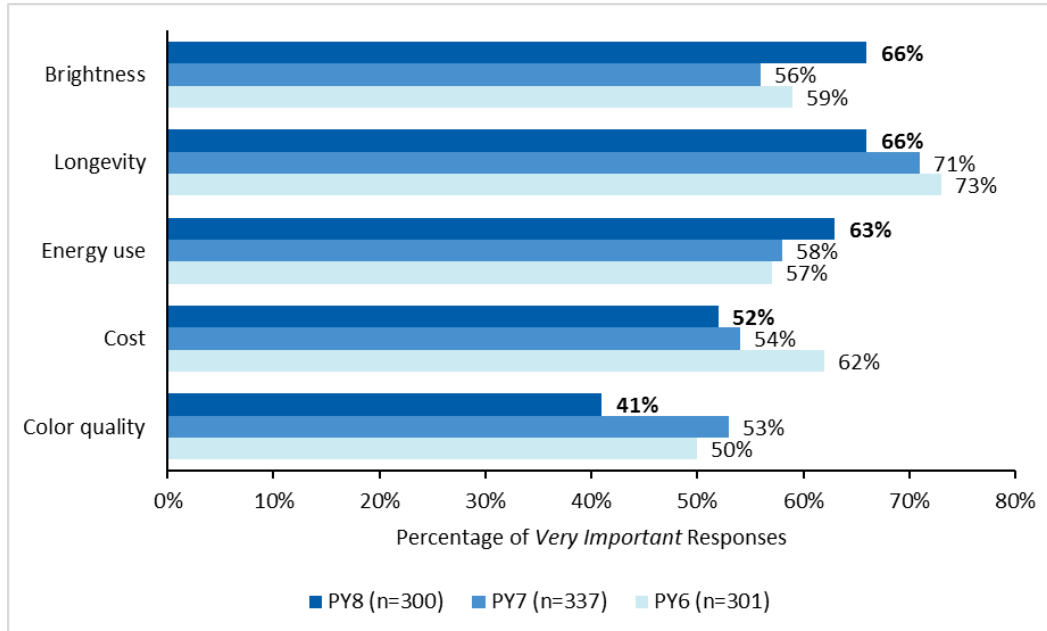
²⁹ Cadmus used a two sample t-test for the difference in proportions. The results presented are significant at an alpha=0.10 level.

³⁰ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

³¹ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Among residential respondents who were aware of PPL Electric Utilities' discounts, nearly all (18 of 19) said the discounted price played a *very important* (68%) or *somewhat important* (26%) role in their decision to purchase screw-in LEDs instead of some other type of bulb.

Figure D-25. Importance of LED Traits to Purchase Decision by Program Year - Residential

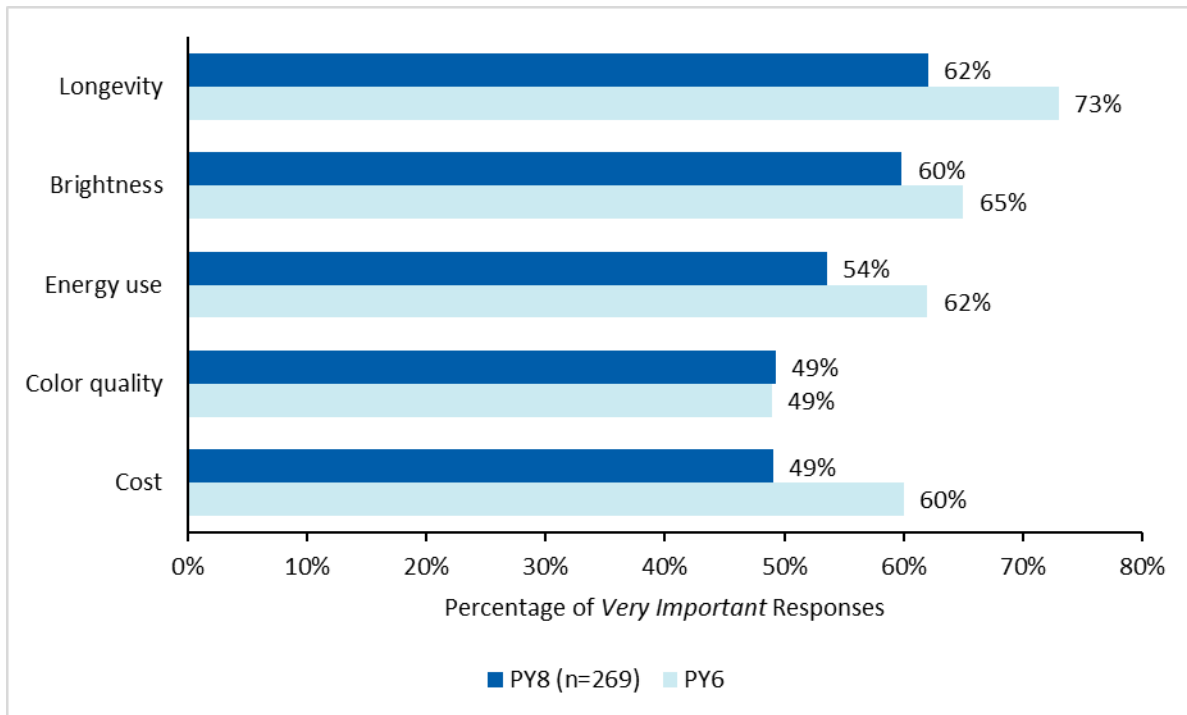


Residential General Population Survey Questions: "Please indicate the importance of..." PY8: QE1a-e.

Small business survey respondents most frequently considered bulb longevity *very important* (62%, n=269) in their decision to purchase, followed by brightness (60%) and energy use (54%).

The importance of LED traits to small business respondents generally declined from PY6 to PY8, as shown in Figure D-26. Cost, energy use, and longevity exhibited statistically significant declines in *very important* responses from PY6 to PY8.³²

³² Cadmus used a two sample t-test for the difference in proportions. The results presented are significant at an alpha=0.10 level.

Figure D-26. Importance of LED Traits to Purchase Decision by Program Year – Small Business

Small business survey questions: "Please indicate the importance of..." PY8: G1a-e.

Only 19 of the 83 small business survey respondents who recently purchased LEDs said they knew that the bulbs they purchased were discounted courtesy of PPL Electric Utilities. Of these, 15 said the discounted price played a *very important* (14) or *somewhat important* (1) role in their decision to purchase screw-in LEDs instead of some other type of bulb. Only one each said the discounted price was *not too important* or *not at all important*.

D.4.3 Sample Cleaning and Attrition for General Population Surveys

Cadmus coordinated with PPL Electric Utilities' survey contractor to screen the sample and remove the records of any customers who were called in the past three months (whether for a Cadmus survey or a PPL Electric Utilities survey) and any who requested not to be contacted again. Cadmus also removed records with incomplete information and excluded inactive customers and nonresidential customers from the sample.

Cadmus attempted to reach respondents up to five times over several days, at different times of the day, and scheduled callbacks whenever possible. Table D-28 lists total numbers of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table D-28. PY8 General Population Survey Sample Attrition Table

Description of Call Outcomes	Number of Records	
	Residential	Small Business
Telephone		
Population (number of PPL customers) ^[1]	1,202,758	175,299
Removed: excluded rate or SIC codes, inactive customer, completed survey in past 3 months, on "do not contact" list, opted out of survey, selected for a different survey, duplicate contact	92,748	90,951
Incomplete or bad phone number	24,376	11,432
Survey Sample Frame ^[2]	1,085,634	72,916
Sampled	9,000	11,000
Not attempted ^[3]	2	1
Records Attempted	8,998	10,999
Non-working number	1,227	1,560
Wrong number, business (for Residential survey)/home (for business survey)	73	492
No answer/answering machine/phone busy	5,851	6,115
Language barrier	58	52
PPL Electric Utilities or market research employee	40	30
Refusal	363	671
Terminated survey	110	189
Non-specific or specific callback scheduled	976	1,425
Completed Surveys	300	465
Total Completed Surveys (total for all modes)	3%	4%
^[1] Number of records available at the time of the survey. ^[2] Not selected for sample because more records than were needed for telephone survey. ^[3] Selected for sample but target was reached before attempted.		

Appendix E. Evaluation Detail—Efficient Equipment Program

E.1 Gross Impact Evaluation for Lighting and Equipment Channels

E.1.1 Methodology

EM&V Sampling Approach

Equipment Projects

In PY8, 103 unique customers (billing accounts) completed 111 projects.³³ PPL Electric Utilities issued rebates for 37 types of equipment during PY8. Table E-29 lists the equipment description and database code by four substrata—HVAC, motors, other, and refrigeration—along with the number of projects sampled per substrata. Cadmus evaluated all equipment projects with a basic level of rigor, according to the Phase III Evaluation Framework.³⁴

The PY8 evaluation sampling plan was designed to meet levels of 85% confidence and 15% precision (85/15) for the equipment stratum. Cadmus drew a simple random sample from each substratum and ensured that the energy savings from sampled projects accounted for over 50% of the population's savings. Of these, Cadmus reviewed the sample of 26 project records (desk audit), which involved verifying information from PPL Electric Utilities' tracking database using rebate applications, customer-submitted supporting documentation, and information recorded by the ICSP.

In PY8, Cadmus conducted site visits to verify 21 of the 26 records sampled.

Table E-29. PY8 Efficient Equipment – Equipment Types

Substratum	Equipment Description	Database Code	Sampled Projects
HVAC	Air-Cooled Electric Chillers	ACCCHILL	9
	Water Centrifugal Chiller	WCCHILL	
	Commercial CAC <= 5.4 Tons	CAC<5.4TONS	
	Commercial ASHP <= 5.4 Tons	ASHP<5.4TONS	
	Commercial ASHP > 5.4 Tons IEER	ASHP IEER	
	Commercial CAC > 5.4 Tons IEER	CAC IEER	
	Guest Room Occupancy Sensors	GROOC SENSOR	
	Water cooled EER	WEAC	
Motors	Variable Frequency Drive (VFD) Improvements	VFD	5
	Air Tanks for Load/No Load Compressors	AIRTANK	
	Cycling Refrigerated Thermal Mass Dryer	THERMMASSDRYER	
	No-Loss Condensate Drains	CONDDRAIN	
	VSD on Kitchen Exhaust Fan	VSDKITCHENFAN	

³³ Includes one HVAC project that was incorrectly reported under the Custom Program.

³⁴ Levels of rigor are described in the Evaluation Framework for Pennsylvania Act 129 EE&C Programs, section 3.3.2.2., October 21, 2016.

Substratum	Equipment Description	Database Code	Sampled Projects
Other	Refrigerated Beverage Vending Machine Controls	REFBEVVENDCNTRL	5
	Commercial Ice Machines	COMMICEMAKER	
	Multifunction (Printer, Copier, Scanner)	MULTIFNCTN	
	VSD Controller for Dairy Vacuum Pumps ^[1]	VSDCNTRLDRYVACPMP	
Refrigeration	High Efficiency Evaporator Fans-Reach in Cooler, SP >36W	HEEVAPFANRICOOLCASE3	7
	High-Efficiency Evaporator Fans-Walk-In Cooler, PSC 1/20 HP 37 Watt	HEEVAPFANWICOOLCASE7	
	Door Gaskets for Walk-in and Reach-in Coolers Convenience Store	DOORGASKETCONCOOL	
	HE Freezer Cases	HEFRZCASE	
	High Efficiency Evaporator Fans-Reach in Cooler, SP <16W	HEEVAPFANRICOOLCASE1	
	High Efficiency Evaporator Fans-Reach in Freezer, SP <16W	HEEVAPFANRIFRZCASE1	
	High Efficiency Evaporator Fans-Reach in Freezer, SP >36W	HEEVAPFANRIFRZCASE3	
	High-Efficiency Evaporator Fans-Walk-In Freezer, PSC, 1/20 HP 37 Watt	HEEVAPFANWIFRZCASE7	
	High-Efficiency Evaporator Fans-Walk-In Cooler, PSC 1/15 HP 49 Watt	HEEVAPFANWICOOLCASE8	
	Anti-Sweat Heater Controls Medium Temp	ASHTRCNTRLMED	
	Evaporator Fan Controllers	EVAPFANCNTRL	
	Anti-Sweat Heater Controls Low Temp	ASHTRCNTRLLOW	
	Zero Heat Door added to Open Cases	ZEROENERGYDOOR	
	Add Door to Existing Ref Display Cases	ZEROSWEATDOOR	
	Night Covers for Display Cases	NIGHTCOVER	
	Special Doors	SPECDOORS	
	High Efficiency Evaporator Fans-Reach in Cooler, SP 16W-36W	HEEVAPFANRICOOLCASE2	
	High-Efficiency Evaporator Fans-Walk-In Cooler, PSC 16W-23W	HEEVAPFANWICOOLCASE6	
	High-Efficiency Evaporator Fans-Walk-In Freezer, PSC 16W-23W	HEEVAPFANWIFRZCASE6	
HE Cooler Cases	HECOOLCASE		
Total Sampled Projects			26
^[1] There was only one agriculture project in the population (sampled); it was included in the Other stratum for the purposes of this evaluation.			

Lighting Projects

Cadmus calculated an annual sample size for lighting projects to meet the evaluation requirements described in the Evaluation Framework. The PY8 evaluation sampling plan was designed to meet 90% confidence and 10% precision for the lighting stratum because lighting is a high impact measure, contributing the majority of savings to the program and to the nonresidential portfolio.

The sample plan was based on the number and characteristics of the nonresidential lighting projects anticipated in PY8. The sample size calculation used an error ratio of 0.50 for MWh/yr. The Evaluation Framework requires evaluating all projects with *ex ante* annual savings greater than 750,000 kWh.

Cadmus evaluated all lighting projects below the threshold with a basic level of rigor and all threshold lighting projects with an enhanced level of rigor.³⁵

In PY8, because the direct discount delivery channel's population was so small (seven jobs), Cadmus grouped the projects with the standard path lighting stratum.

Table E-30 shows the PY8 sampling plan by quarter for a final sample size of 68 projects. Cadmus drew samples, conducted site visits, and reviewed records in Q3 and Q4. Cadmus did not receive project files until the end of Q2 in PY8.

Table E-30. PY8 Quarterly Efficient Equipment Program Lighting Participant Site Visit Sampling Plan

Sample Count Allocation Plan	Q1	Q2	Q3	Q4	Total
Total, Planned	21	20	23	0	64
Total, Actual	20	18	24	6	68

Cadmus used a stratified ratio estimation approach because this promotes evaluation efficiency compared to using a simple random sampling approach and results in smaller sample sizes. Cadmus further divided lighting into four substrata—small, small-medium, medium-large, and large.

These substrata boundaries were established by the substratum's contribution to total gross reported kWh savings, following the methods in Chapter 13: Sampling in The California Evaluation Framework.³⁶ Cadmus determined the number of sample points, where a point was a job, for each stratum using a Neyman allocation routine that accounts for the variance in each stratum.³⁷

Table E-31 shows the substrata lighting boundaries for high and low energy savings by quarter. In all quarters, Cadmus defined large projects as those with *ex ante* energy savings greater than 750,000 kWh, which require enhanced levels of rigor according to the PA TRM. In PY8, there were 11 threshold lighting participants.

Table E-31. PY8 Quarterly Efficient Equipment Lighting Program by Substratum

Substratum	Q1		Q2		Q3		Q4	
	kWh High	kWh Low	kWh High	kWh Low	kWh High	kWh Low	kWh High	kWh Low
Small	44,740	564	105,467	399	77,493	240	91,120	322
Small-Medium	94,129	45,936	387,955	114,097	307,221	78,842	520,549	95,618
Medium-Large	320,269	99,501	570,389	461,329	720,323	310,303	2,170,255	598,325
Large	N/A	750,000	3,741,417	750,000	N/A	750,000	2,170,255	750,000

³⁵ Table 1-2 in the PA TRM defines the thresholds for end-use categories that must be reviewed with enhanced levels of rigor.

³⁶ TecMarket Works. *The California Evaluation Framework*. 2004. Pages 368-371.

³⁷ Neyman allocation is a sample allocation method that may be used with stratified samples. The purpose of the method is to maximize survey precision, given a fixed sample size.

A breakdown of reported savings by substratum is shown in Table E-32.

Table E-32. PY8 Efficient Equipment Lighting Program, Summary by Substratum

Substratum	Reported Participants ^[1]	Reported Savings (MWh/yr)	Percentage Reported Savings
Small	671	13,638	20%
Small-Medium	130	19,352	28%
Medium-Large	39	16,633	24%
Large	11	19,813	29%
Total	851	69,437^[2]	100%^[2]

^[1] Defined by unique job number.
^[2] Total does not match sum of rows due to rounding.

Table E-33 presents annual population and sample sizes by substrata.

Table E-33. Efficient Equipment Program Sampling Strategy

Substratum	Population Size ^[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Equipment					
HVAC	46	N/A ^[2]	9	9	Site visit, record review
Motors	15		5	5	Site visit, record review
Other	9		5	5	Record review
Refrigeration	45		7	7	Site visit, record review
Equipment Total	111 ^[2]	85/15	26	26	
Lighting					
Q1	68	N/A ^[3]	21	20	Site visit, record review
Q2	246		20	18	Site visit, record review
Q3	263		23	24	Site visit, record review
Q4	274		0	6	Site visit, record review
Lighting Total	851	90/10	64	68	
Program Total		85/15			

^[1] Population size refers to the number of unique project job numbers per equipment type.
^[2] Includes one HVAC project that was incorrectly reported under the Custom program. The equipment total is less than the sum of job numbers by substratum because some job numbers are included in multiple substratum.
^[3] **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.**

Ex Post Verified Savings Methodology

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

E.1.2 Database Review Findings

Equipment

Cadmus conducted a desk audit of a sample of 26 equipment participants; projects were sampled and reviewed quarterly as they became available in PPL Electric Utilities' tracking database. Cadmus verified records in PPL Electric Utilities' tracking database and compared these with corresponding rebate applications, customer-submitted supporting documentation, and information recorded by the ICSP. The purpose of the review was to check the database and project data for accuracy and compliance with the PA TRM requirements.

Lighting

Cadmus conducted desk reviews and site visits for 68 lighting projects. The purpose of the review was to check the database and project data for accuracy and compliance with the PA TRM requirements. Cadmus verified information recorded in PPL Electric Utilities' tracking database and compared it to corresponding rebate applications, customer-submitted supporting documentation, and information recorded by the ICSP. Cadmus also reviewed logger data files from lighting hours of use measurement devices and the ICSP's logger data analysis if the ICSP assumed hours of use using a light metering study. Cadmus combined the results of its records review with the findings from site visits to determine the verified savings for each of the sampled projects.

E.1.3 Site Visit Findings

Equipment

Cadmus completed site visits for 20 unique customers who received rebates for 21 equipment projects to verify the as-built conditions for each project and to identify any discrepancies in the data reported by the ICSP in the project file. Table E-34 summarizes the results of the site visits.

Table E-34. PY8 Efficient Equipment Summary of Equipment Site Visits

Substratum	Total Site Visits per Substratum ^[1]	Equipment Description	Discrepancy	Projects Affected
HVAC	9	Guest Room Occupancy Sensors	Baseline setback control was incorrectly reported	2
			Verified quantity of operational sensors was less than reported	1
			Verified HVAC unit capacity was less than reported	1
		Commercial ASHP > 5.4 Tons IEER	Verified installed unit quantity and capacity varied from reported	1
Motors	5	Variable Frequency Drive Improvements	Double-counted kitchen exhaust fan VFDs as VFD improvements	1
			Verified motor quantity and horsepower varied from reported	1
		Kitchen Exhaust Fan VFDs	Double-counted kitchen exhaust fan VFDs as VFD improvements	1
Refrigeration	7	Anti-Sweat Heater Controls	Verified quantity less than reported	1
		High-Efficiency Evaporator Fans-Walk-In Freezer, PSC 16W-23W	Verified unit type was a cooler, not freezer	1
		High Efficiency Evaporator Fans-Reach in Cooler, SP <16W	Verified quantity higher than reported	1
		High Efficiency Evaporator Fans-Reach in Freezer, SP <16W	Verified quantity higher than reported	1
		Add Door to Existing Ref Display Cases	Verified quantity less than reported	1
		Night Covers for Display Cases	Verified quantity less than reported	1
		Special Doors	Verified quantity less than reported	1
Total	21			

^[1] Unique projects

Lighting

Cadmus conducted site visits for each of the 68 projects in the impact evaluation sample to verify the as-built conditions for each project and identify any discrepancies reported by the ICSP in the project file. If a project had many records (approximately 20 or more) in the PA TRM Appendix C Lighting Audit and Design Tool for Commercial and Industrial Projects,³⁸ Cadmus selected and inspected a sample using 90/20 criteria for confidence and precision according to the Phase III Evaluation Framework.³⁹ Cadmus

³⁸ The PA TRM Appendix C Lighting Audit & Design Tool was designed to (1) document the pre- and post-installation cases of the lighting retrofit and (2) facilitate the calculation of energy and demand reductions for large lighting installations.

³⁹ Sampling to meet 90/20 within a facility is based on Section 3.3.3.2.3 of the Phase III Evaluation Framework. Pennsylvania Public Utility Commission. Phase III Evaluation Framework. October 21, 2016.

also interviewed facility representatives to determine operating schedules and estimate lighting hours of use. Cadmus incorporated findings from the site visits and calculated verified savings.

Verified savings incorporated site-specific data. Reasons for adjustments to the ICSP's reported data included corrections to the following:

- 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
- Fixture control type

Table E-35 summarizes results of the site visits.

Table E-35. PY8 Efficient Equipment Summary of Lighting Site Visits

Description of Discrepancy	Number of Sites with Discrepancy ^[1]	Impact on Realization Rates
Verified TRM facility type varied from reported TRM facility type	6	Affected TRM hours of use and peak demand coincidence factors
Verified baseline and/or installed lighting fixture controls varied from the reported controls	7	Affected TRM hours of use and peak demand coincidence factors
Verified baseline and/or installed lighting fixture quantities varied from the reported quantities	13	Affected total baseline and/or installed fixture wattage
Verified baseline and/or installed lighting fixture wattage varied from the reported wattage	7	Affected total baseline and/or installed fixture wattage
Reported TRM hours of use incorrect for installed fixture type (e.g., screw-in hours of use were used instead of general service lamp hours of use)	5	Affected TRM hours of use and peak demand coincidence factors
Verified space conditioning type (air conditioned, no cooling) varied from reported conditioning type	6	Affected peak demand reduction
Reported custom hours of use not calculated correctly	8	Affected TRM hours of use and peak demand coincidence factors

^[1] 14 of the 68 sampled projects had more than one discrepancy.

E.1.4 Realization Rate Findings

Equipment

Equipment projects achieved 3,671 MWh per year of verified energy savings with an 88.9% energy realization rate. Equipment projects achieved 296 kW of verified demand reduction with an 83.5% demand realization rate. The primary contributors to the energy and demand realization rates that were less than 100% were three sampled guest room occupancy sensor projects.

Lighting

Lighting products achieved 67,245 MWh per year of verified energy savings with a 96.8% energy realization rate. Lighting projects achieved 9,576 kW of verified savings with a 102.9% demand realization rate.

Lighting project savings from GNE customers accounted for 19.8% of overall reported lighting savings. The evaluation sample included nine GNE projects, out of 199 GNE projects completed in PY8. The Evaluation Framework requires that these savings be reported separately as though from an independent program;⁴⁰ therefore, GNE sector lighting savings are reported as shown in Table E-36 for energy and Table E-37 for demand.

Table E-36. PY8 Efficient Equipment Program Summary of Evaluation Results for Energy (GNE Lighting Sector) ^[1]

Sector	Reported Gross Energy Savings (MWh/yr)	GNE MWh/Total Lighting (%)	Energy Realization Rate (%)	Verified Gross Energy Savings (MWh/yr)	Relative Precision at 85% C.L.
GNE	13,715	19.8%	97.1%	13,320	1.4%

^[1] Realization rate based on sample size (n) of 9 projects.

Table E-37. PY8 Efficient Equipment Program Summary of Evaluation Results for Demand (GNE Lighting Sector) ^[1]

Sector	Reported Gross Demand Savings (kW)	GNE W/Total Lighting (%)	Demand Realization Rate (%)	Verified Gross Demand Savings ^[2] (kW)	Relative Precision at 85% C.L.
GNE	1,592	17.1%	103.4%	1,645	2.4%

^[1] Realization rate based on sample size (n) of 9 projects.
^[2] Verified gross demand savings for the GNE Lighting Sector do not include transmission and distribution (T&D) losses.

E.2 Net Impact Evaluation for Lighting and Equipment Channels

E.2.1 Net-to-Gross Ratio Methodology

Cadmus used self-report surveys to assess net savings for the lighting and equipment projects within the Efficient Equipment Program's standard path prescriptive rebate delivery channel. Cadmus researched customer communications with PPL Electric Utilities and the ICSP to provide additional context about possible free ridership.

Self-Report Survey

Cadmus used self-report surveys to assess net savings for the lighting (n=62) and equipment (n=7) strata of the Efficient Equipment Program, following the Evaluation Framework's recommended

⁴⁰ Section 3.6.1 Evaluation Precision Requirements of the Phase III Evaluation Framework. Pennsylvania Public Utility Commission. Phase III Evaluation Framework. October 21, 2016.

common method for assessing free ridership.⁴¹ The SWE team and PPL Electric Utilities reviewed and approved the survey prior to fielding.

The assessment includes two components of free ridership—the *intention* of the customer to implement an energy-efficient project without a rebate and the *influence* of the program on the customer’s decision to implement the energy-efficient project. When scored, each component has a value from zero to 50 and a combined total free ridership score from zero to 100.

E.2.2 Net-to-Gross Ratio Sampling

In PY8, Cadmus conducted an online and telephone survey with Efficient Equipment Program participants within the standard path delivery channel. In some instances, multiple projects were initiated or completed by the same customer. This required Cadmus to generate a sample of unique decision makers to ensure that no customer was contacted more than once every three months (according to PPL Electric Utilities requirements). Cadmus generated the final sample following these steps:

- Identify unique decision maker phone numbers and contact information.
- Remove accounts contacted in the past three months for a PPL Electric Utilities or Cadmus survey effort.

Table E-38 lists the sampling strategy for the lighting and equipment stratum within the standard path delivery channel.

Table E-38. PY8 Efficient Equipment Program Lighting and Equipment Stratum Sampling Strategy for Net Savings 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	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample ^[2]
Equipment	Non-lighting projects	111 ^[3]	0.5	85/15	All eligible	81	7	100%
Lighting	Lighting projects	851	0.5	85/15	All eligible	660	62	100%

^[1] Population refers to number of paid projects in PY8.

^[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 surveys.

^[3] Includes one HVAC project that was incorrectly reported under the Custom Program.

⁴¹ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

E.2.3 Net-to-Gross Ratio Findings

Table E-39 shows the NTG ratio results for the equipment and lighting stratum of the Efficient Equipment Program.

Table E-39. PY8 Efficient Equipment Program NTG Findings Summary

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.
Equipment	7	22%	0%	0.78	33%
Lighting	62	23%	0%	0.77	9%

Intention Score for Prescriptive Equipment and Lighting

Under the intention and influence method used to determine free ridership, Cadmus assessed intention by asking the following key questions to determine how the organization's project-related decisions would have differed in the absence of the Efficient Equipment Program:

- “Which of the following would have happened if you had not received the rebate for \$[REBATE AMOUNT] from PPL Electric Utilities for the [MEASURE OR C_MEASURE] project?”
- “By how much would you have reduced the size, scope, or efficiency?”
- “How likely is it that your organization would have paid the full cost to install the same quantity and efficiency of that equipment at the same time you conducted this project?”

Cadmus used the responses to these questions to determine a respondent's final intention score, which was multiplied by the respective *ex post* kWh savings to calculate intention-based free rider savings. The savings-weighted average intention scores showed 15% of the equipment stratum savings and 21% of the lighting stratum savings could be classified as free ridership.

Influence for Prescriptive Equipment and Lighting

Influence is assessed by asking about how much influence—from 1 (no influence) to 5 (extreme influence)—various program elements had on the decision to do the project the way it was done.

The survey asked the following influence question:

- “Please rate each item on how much influence it had on the decision to complete the project the way it was completed. Please use a scale from 1, meaning no influence, to 5, meaning the item was extremely influential in your decisions. If a statement is not applicable, indicate that as well.”

From responses to this question, Cadmus obtained data about the influence of PPL Electric Utilities rebates, information from PPL Electric Utilities about ways to save energy, any assistance from PPL Electric Utilities on planning the project, and any past participation in a PPL Electric Utilities program. Cadmus assessed influence from participants' ratings of how important various program elements were in their decision to purchase energy-efficient equipment. The savings weighted influence score found 7% of the equipment savings and 2% of the lighting stratum savings could be classified as free ridership.

Cadmus then summed the intention and influence components to estimate the total intention/influence method free ridership average by stratum, weighted by *ex post* gross kWh savings. Table E-40 summarizes the intention, influence, and free ridership scores for each stratum.

**Table E-40. Energy Equipment Program
Intention, Influence, and Free Ridership Score by Stratum**

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
Equipment	7	15%	7%	22%
Lighting	62	21%	2%	23%

Customer Communication Research

To determine if Efficient Equipment Program components influenced customers' decisions to purchase rebated lighting or equipment, Cadmus researched 76 communication documents between the ICSP and 19 participants of the 69 lighting and equipment participants who completed the self-report survey. Cadmus selected this random sample from the first three quarters of PY8. Documents included email conversations, incentive reservation letters, and final savings notices. Cadmus did not find any information to support making an adjustment to the free ridership score determined through the self-report surveys.

E.3 Process Evaluation for Standard Path Prescriptive Rebate Channel

E.3.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In February and March of 2017, Cadmus conducted interviews with the program managers from PPL Electric Utilities and the ICSP. The interviews focused on the following:

- Gathering insights into program design and delivery
- Identifying areas that worked well and others that could be improved
- Evaluating key performance indicators (KPIs) and program objectives
- Assessing design engineer, contractor, and customer satisfaction
- Assessing communication strengths and weaknesses
- Assessing possible areas to address free ridership

Design Engineer and Contractor Interviews

In June 2017, Cadmus conducted interviews with design engineers and contractors who provided design and installation products and services to participants of the Efficient Equipment Program lighting and equipment channels. Cadmus interviewed five lighting contractors and four equipment contractors. Two equipment contractors completed refrigeration projects and two completed HVAC projects.

These interviews were designed to assess the following:

- Design engineer and contractor support for Efficient Equipment Program
- Program influence on design engineer and contractor business practices
- Design engineer, contractor, and program influence on customer decision-making process
- Design engineer and contractor satisfaction
- Areas that work well and areas that could be improved
- Cadmus relied on the PPL Electric Utilities' tracking database to develop the contractor list and filtered out the projects that did not have a contractor name or were self-installed. Eighty-two lighting contractors and 20 equipment contractors were identified as eligible for interviews.

Participant Surveys

Cadmus conducted online and telephone surveys with participants. These two surveys asked identical questions to assess program satisfaction and net savings and focused on the following:

- Program performance and implementation
- Effectiveness of program to generate awareness and disseminate information
- Customer response and willingness to recommend the program
- Influence of the program and contractor or design engineer on project design, purchase decision, and program participation
- Free ridership and spillover to inform net savings

Cadmus administered the online and telephone survey between November 2016 and August 2017. Cadmus first contacted customers with email addresses to complete an online survey then telephoned any who did not have a valid email address or did not respond to the online survey. Giving customers two ways to participate in the evaluation surveys increased the response rates.

To prepare the contact list, Cadmus removed the records of anyone who had completed a PPL Electric Utilities or Cadmus survey in the past three months or had requested not to be contacted. If a customer completed more than one Efficient Equipment Program project in the program year, Cadmus attempted to contact the customer for each project. See *Appendix E.6.3 Sample Cleaning and Attrition for Lighting and Equipment Participant Surveys*.

Potential sources of bias in all surveys include nonresponse, recall, and social desirability biases. Cadmus addressed these potential sources of bias by applying survey design and survey data collection best practices where possible. Surveys did not include leading or ambiguous questions nor double-barreled questions. Cadmus provided clear interviewing and programming instructions so questions could be implemented consistently. The SWE team and PPL Electric Utilities reviewed and approved the survey before fielding.

Of the 69 participants who completed a survey, seven received rebates for efficient equipment and 62 received rebates for lighting equipment; 31 completed the survey online and 38 completed it via telephone. Social desirability biases are often more present in telephone surveys than in online surveys

because of the verbal conversation with an interviewer, so Cadmus tested for any significant differences in program satisfaction between modes and found no differences. All online respondents (n=31) and 95% of phone respondents (n=38) reported being *very satisfied* or *somewhat satisfied* with the program.

Cadmus tested for significant differences between responses to the online and phone surveys. Cadmus reviewed key questions such as free ridership and overall satisfaction and found no statistically significant difference in responses for these key questions.⁴² Cadmus tested for significance in all remaining survey questions and reported online and phone survey results separately when there was a significant difference. Cadmus also tested for differences between equipment and lighting participants but there were no statistically significant differences in results for any questions.⁴³

E.3.2 Additional Findings for Lighting and Equipment Standard Path Delivery Channel

This section presents additional survey and interview findings for the standard path delivery channel.

Standard Path Delivery Channel

Customers submit applications through the ICSP's web portal. This is a change from the way Phase II was implemented and has helped improved customer and trade ally satisfaction. Applications are started by PPL Electric Utilities key account manager (KAM), the ICSP, a trade ally, or the customer. Once completed, applications are submitted for preapproval. The ICSP reviews and approves the project and emails a reservation letter to the customer. Once the customer completes the project and submits all required paperwork, the ICSP processes the application. PPL Electric Utilities reviews the final application, approves the project, and the ICSP sends the incentive payment to the customer. The ICSP follows up by sending a postcard thanking the participant for their support of the program.

The online portal is working well among contractors and customers. Contractors can track the progress of the incentive application and give their customers current information. The online portal has led to shorter incentive processing times, which has increased customer satisfaction.

Both PPL Electric Utilities and the ICSP said their communication is very successful. One reason is that they meet weekly to discuss the status of potential and current projects and to address challenges throughout each project's lifecycle.

Key Performance Indicators

PPL Electric Utilities and the ICSP defined plans for energy savings and set a KPI for customer satisfaction. The program's performance plans for the KPI in PY8 for the lighting and equipment channels is shown in Table E-41.

⁴² Cadmus used a t-test to determine significance at the 10% significance levels.

⁴³ Cadmus used a t-test to determine significance at the 10% significance levels.

Table E-41. Efficient Equipment Program Lighting and Equipment Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
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.	80% of participants said <i>very satisfied</i> and 17% said <i>somewhat satisfied</i> with the program.

Logic Model Review

Cadmus reviewed the Efficient Equipment Program’s logic model for the lighting and equipment prescriptive rebate channel and determined this channel is operating as expected. Table E-42 lists the outcome of the logic model review.

Table E-42. Logic Model Review Efficient Equipment Program Lighting and Equipment

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
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	Program Activities	Delivered program activities as expected
Marketing materials, customers submit rebate forms, customers’ projects verified as eligible, units installed, and rebates paid	Outputs Produced by Program Activities	Delivered outputs as expected, participation was lower than expected but energy savings are on track
Increased program awareness, increased customer and trade ally awareness of energy-efficient equipment, and increase in the installations of energy-efficient equipment; immediate energy and demand savings	Short-term Outcomes	Produced short-term outcomes as expected
Reduction in annual energy consumption and peak load and lower electric bills for program participants	Intermediate Outcomes	On track to produce intermediate outcomes
Continued energy savings; PPL Electric meets its goal of reducing energy consumption and peak demand	Long-term Outcomes (end of Phase III)	On track to produce long-term outcomes

Lighting and Equipment Participant Profile

Cadmus reviewed PPL Electric Utilities’ tracking database and developed a profile of the 962 unique Efficient Equipment Program standard path delivery channel participants. In PY8, 111 participants received rebates for equipment, and 851 participants received rebates for lighting equipment.⁴⁴ Six lighting participants participated in the direct discount channel of the program.

⁴⁴ Includes one HVAC project that was incorrectly reported under the Custom program.

Table E-43 lists program participants by sector and by lighting and equipment stratum. The majority of program participants were from the small C&I sector. Survey respondents (n=69) represented 6% of the total equipment participants and 7% of the total lighting participants.

Table E-43. Efficient Equipment Program Lighting and Equipment Participation by Sector

Strata	Population Size	Residential ^[1]	GNE	Large C&I	Small C&I
Equipment ^[1]	111 ^[2]	1	23	5	82
Lighting	851	4	199	105	543
Total Program	962	5	224	110	626
Participation Percentage by Sector ^[3]	100%	1%	23%	11%	65%

^[1] Some agriculture customers have a residential rate class; all sectors are eligible for the Efficient Equipment Program.
^[2] Includes one HVAC project that was incorrectly reported under the Custom Program.
^[3] May not match due to rounding.

Table E-44 shows the survey population and total participant population by sector.

Table E-44. Sector Breakdown

Sector	Survey Respondents (n=69)	Total Population (n=962)
Large	16%	11%
Small	67%	65%
GNE	17%	23%
Residential	0%	1%

Source: PPL Electric Utilities' tracking database; may not total 100% due to rounding

More than half of the survey respondents (59%; n=69) had participated in the Efficient Equipment Program before, and of these 41 respondents, 17% said they worked with an energy services company in a performance contract for their project. The difference in responses between equipment and lighting participants was not significant.

There was a significant difference between the size of facilities that responded to the phone survey or online survey,⁴⁵ as shown in Table E-45. Eighty-six percent of the online survey respondents represented a facility of less than 100,000 square feet. In contrast, of telephone survey respondents, 52% represented facilities of less than 100,000 square feet and 48% represented facilities of 100,000 square feet or larger. Smaller facilities were more likely to respond to the online survey than were large facilities. Overall, the majority of total survey respondents (67%) represented facilities of less than 100,000 square feet, which is in line with the program participation by sector shown in Table E-43, where 65% of participants were from the small C&I sector. Cadmus will continue to offer two survey modes to reach a representative sample of participants from facilities larger and smaller than 100,000 square feet.

⁴⁵ Cadmus used a t-test to determine significance at the 10% (p<0.05) significance levels.

Table E-45. Facility Size of Online and Phone Survey Respondents^[1]

Facility Size	Online Survey Respondents (n=22)	Phone Survey Respondents (n=27)	Total Survey Respondents (n=49)
Below 100,000 sq. ft.	86%	52%	67%
100,000 sq. ft. or larger	14%	48%	33%

Source: Survey question "What is the total square footage of this facility?"
^[1] The difference between facility size of phone and online survey respondents was statistically significant.

Net Promoter Score

The net promoter score (NPS) is a metric of brand loyalty that measures how likely customers are to recommend the program to others. Respondents rated their likelihood to recommend the program on a 10-point scale where 0 means *not at all likely* and 10 means *extremely likely*. Respondents giving a rating of 9 or 10 are known as promoters. Respondents giving a rating of 7 or 8 are known as passives, and respondents giving a 0 to 6 rating are known as detractors. The NPS is expressed as a number between -100 and +100 that represents the difference between the percentage of promoters and detractors.

As shown in Table E-46, the Efficient Equipment Program achieved an NPS of +82.0, indicating more promoters than detractors among the respondents.

Table E-46. Net Promoter Score. Likelihood to Recommend the Program

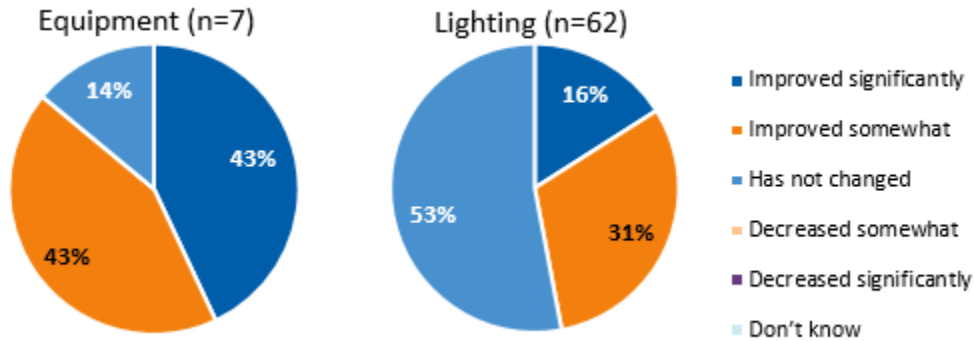
Rating Classification	Percentage of Respondents (n=69)
Promoters (9-10)	82.0%
Passives (7-8)	17.0%
Detractors (0-6)	0.0%
NPS	82.0

There were 12 passive respondents; all were lighting participants. Eleven were *very* or *somewhat satisfied* with the program and one was *neither satisfied nor dissatisfied*. Five provided suggestions to improve the program. One suggested increasing the incentive amount, one recommended a shorter rebate processing time, one requested more program information to better communicate with other departments within their organization, one asked for better communication during the application process, and one asked for a shorter application.

Opinion of PPL Electric Utilities

Survey respondents were asked if their opinion of PPL Electric Utilities had changed since participating in the program. Responses are shown in Figure E-27, by respondents who received rebates for equipment or lighting. Participants receiving a rebate for efficient equipment were more likely to say their opinion of PPL Electric Utilities had improved than those receiving a rebate for lighting; however, the sample size equipment participants was small and differences are not statistically significant.

Figure E-27. Opinion Shifts of PPL Electric Utilities by Equipment and Lighting Participants

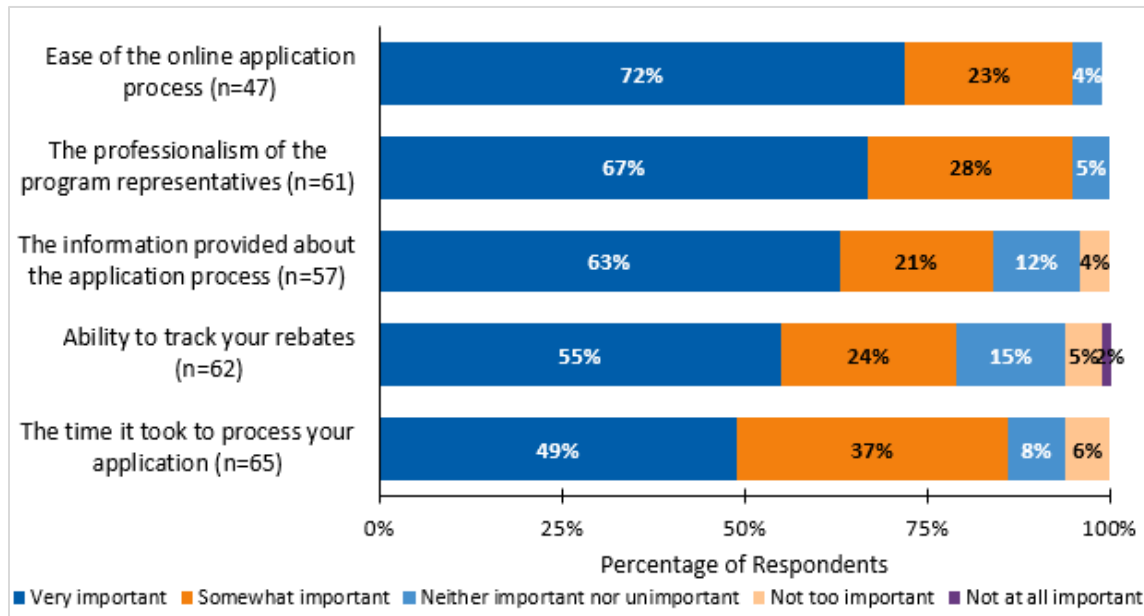


Source: Survey question “After participating in the PPL Electric Utilities business energy-efficiency program, has your opinion of PPL Electric Utilities improved significantly, improved somewhat, has not changed, decreased somewhat, decreased significantly?”

Importance of Program Components

The majority of survey respondents ranked each program component as *very important*. Responses from phone and online participants were combined in Figure E-28.

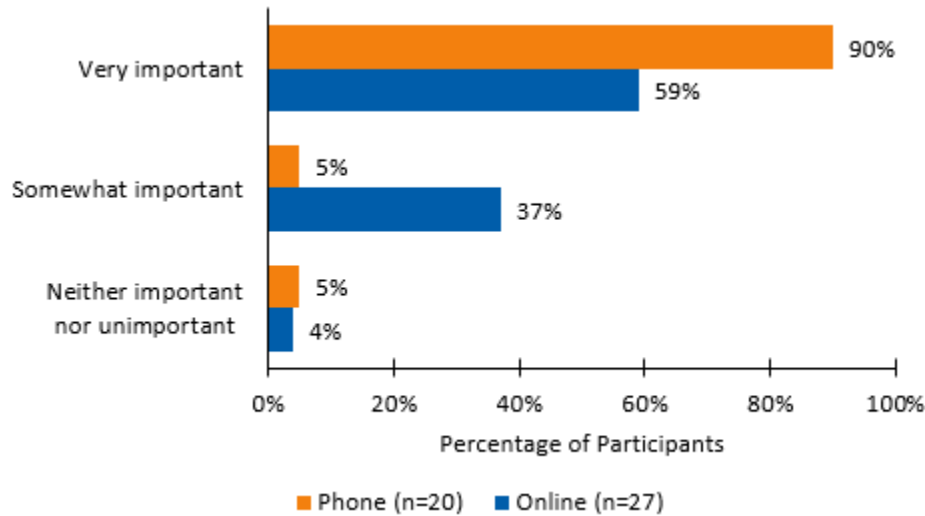
Figure E-28. Importance of Program Components to Participants



Source: Participant survey question “Please indicate how important each of the following items are to you.”

As shown in Figure E-29, 90% of phone respondents said the ease of the online application was *very important* compared to 59% of online respondents. The difference between the *very important* and *somewhat important* responses is statistically significant.⁴⁶

Figure E-29. Importance of the Ease of the Online Application Process by Survey Mode



Source: Participant survey question “Please indicate how important each of the following items are to you. - Ease of the online application process.”

Suggested Program Improvements

Contractors and program participants were asked for suggestions to improve the program. Most suggestions were about the application process. Seven participants suggested simplifying or streamlining the process, four participants asked for a shorter rebate processing time, and one contractor suggested making the portal easier to use. Four participants suggested improving communications about the process. Specifically, one participant had difficulty identifying which equipment was eligible, another asked for clarity on what requires preapproval, and two asked for better communication during the application process.

Eight participants suggested that PPL Electric Utilities provide more information about the program, even though the information requested is currently available on PPL Electric Utilities’ website. For example, seven participants requested information about available rebates.

Contractors and program participants had recommendations to increase participation. Seven participants and one contractor recommended more program marketing, six participants and three contractors suggested increasing incentives, and one contractor suggested promoting tax credits.⁴⁷

⁴⁶ Cadmus used a t-test to determine significance at the 5% significance levels

⁴⁷ Since PPL Electric Utilities’ targets are based on energy savings and it is on track with projections, it does not appear necessary to increase participation in the Efficient Equipment Program at this time.

Marketing and Outreach

PPL Electric Utilities and the ICSP review marketing and outreach plans in weekly meetings and say these weekly meetings are useful because it allows them to discuss marketing and outreach on an ongoing basis and make adjustments as necessary.

The ICSP and PPL Electric Utilities have implemented the following methods for marketing and outreach:

- In-person meetings with contractors to explain how to participate in the program and how to complete the new lighting form
- Monthly webinars with contractors to answer questions and review any program changes or difficulties
- Lunch and learn meetings with contractors to share information about new technologies and new opportunities to help customers save energy
- Webinars about specific industries and equipment types to help companies design appropriate projects to reduce their energy use; these webinars are presented to contractors and customers and are posted on PPL Electric Utilities' website for reference
- Biannual meetings with the KAMs, business specialists, and the ICSP to align marketing messaging so program information is consistent across all messengers
- Contractor newsletters

All contractors (n=9) said they were *very satisfied* with the communication they received from the ICSP about the program. Contractors were asked about the helpfulness of program support, and results are shown in Table E-47. Contractors found all components of program support helpful.

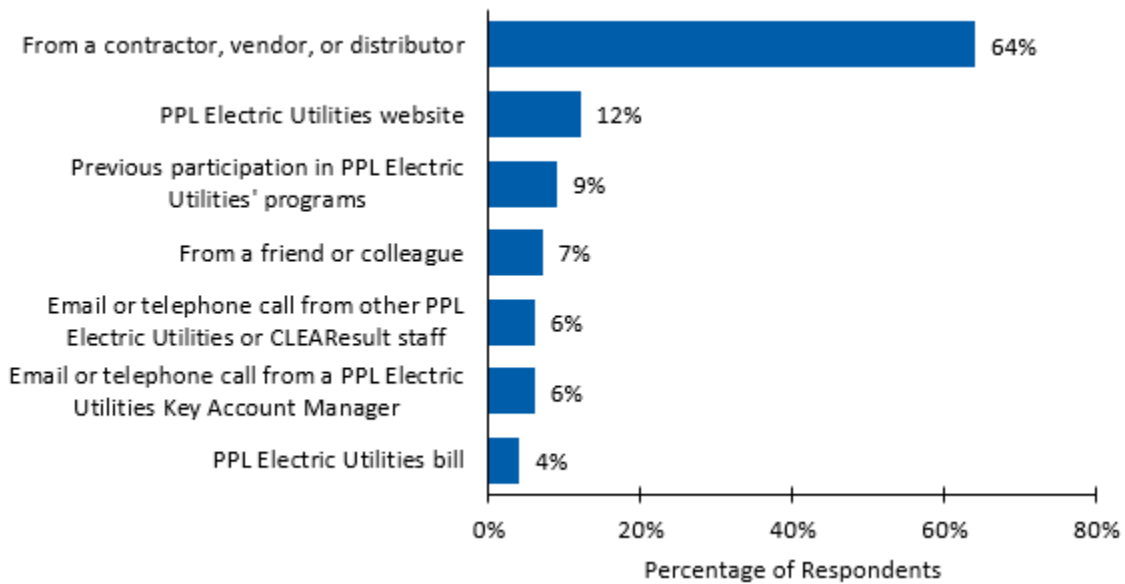
Table E-47. Helpfulness of Program Support

Component	Average Rating (Scale of 1 to 5 where 5 is most helpful)
Training/certifications (n=4)	4.75
Outreach events or webinars (n=7)	4.43
Program newsletters (n=9)	4.44
Source: Interview question "How helpful was this support?"	

Program Discovery

Figure E-30 shows how participants first heard about the program. The most common was from a contractor, vendor, or distributor (64%, n=69). There was not a significant difference between how equipment and lighting participants learned about the program. Respondents were also asked about the best way for PPL Electric Utilities to inform customers about the program. Thirty-eight percent said the best way was through direct mail, 32% said from their contractor, 26% said from their KAM at PPL Electric Utilities, 23% said an email from program staff, and 17% said through PPL Electric Utilities' website (n=69, multiple responses allowed).

Figure E-30. How Participants First Heard about the Program

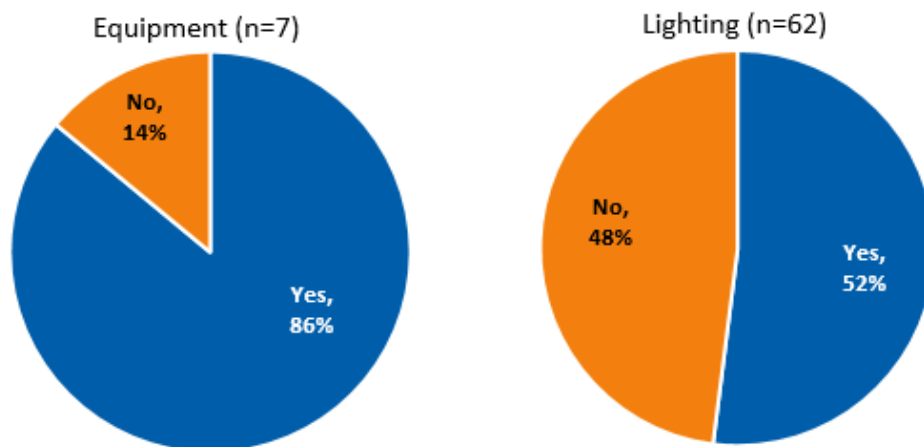


Source: Survey Question: "How did you first learn about PPL Electric Utilities' business energy-efficiency program?" (n=69)

Online Engagement

Survey respondents were asked if they had visited PPL Electric Utilities' website within the last six months. Fifty-five percent had visited the website. Equipment participants were more likely to have visited the website (86%, n=7) than were lighting participants (52%, n=62), as shown in Figure E-31.

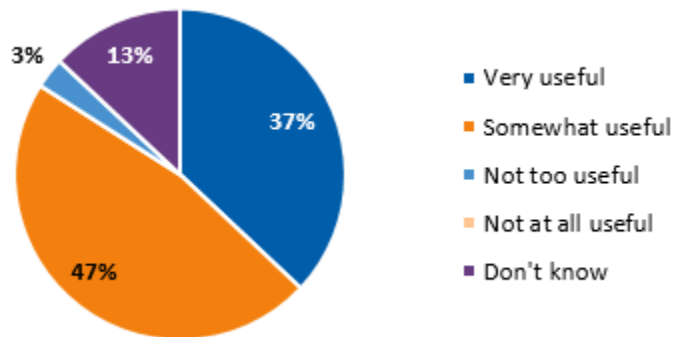
Figure E-31. Percentage of Participants that Visited PPL Electric Utilities' Website in Past Six Months



Source: Participant survey question: Have you visited the PPL Electric Utilities' website in the past 6 months?

Of those who had visited the website, the majority said it was *somewhat useful* (47%, n=38) or *very useful* (37%) in providing information about the available energy efficiency rebates, as shown in Figure E-32. There was no significant difference between equipment and lighting respondents. No respondents had used the website to find a contractor (n=53).

Figure E-32. Usefulness of Website Information about Energy-Efficiency Rebates



Source: Survey question "Overall, how useful is PPL Electric Utilities' website on providing information about available energy-efficiency rebates?" (n=38)

E.4 Gross Impact Evaluation for Distributor Discount Channel

E.4.1 Methodology

EM&V Sampling Approach

The Distributor Discount channel was a new offering launched late in PY8 and a new concept in the delivery of energy efficiency to PPL Electric Utilities' customers. The sampling methods and rigor for PY8 were designed to meet a 90/10 level of confidence and precision using a coefficient of variation of 0.5. Cadmus selected this high rigor because this is the first time that PPL Electric Utilities has offered a midstream option, and there was a high level of uncertainty around performance and energy savings.

Cadmus initially planned for a sample size of 63 jobs with a finite population correction allocated across four strata. These were defined by the savings reported for the sample points, where a point was a job (large, medium-large, medium-small, and small).

The thresholds or boundaries between each stratum were determined using the Neyman allocation method.⁴⁸

The Evaluation Framework requires enhanced M&V for projects with reported savings of 750 MWh/yr or more. However, because the largest job in the Distributor Discount delivery channel was approximately 208 MWh/yr, Cadmus did not create a census stratum for jobs requiring enhanced M&V.

The Distributor Discount delivery channel started late in PY8 (the first transaction was made in October 2016 and the first data report prepared in January 2017). As is common with new offerings, regular reporting and tracking can take some time to stabilize, and Cadmus' sampling schedule was irregular in the beginning and subject to the availability of the ICSP.

⁴⁸ The Neyman allocation method maximizes precision, given a fixed sample size, by allocating sample points to each stratum according to the expected variance in each stratum.

Cadmus drew random samples from the December 2016 and February, April, and May 2017 reports provided by the ICSP to ensure representation in the start-up and operations phases of the Distributor Discount channel.

To address the uncertainty about report timing and different stratum definitions for each reporting period, Cadmus post-stratified PPL Electric Utilities' complete PY8 Distributor Discount database by kWh/year reported savings and assigned all records, including the previously drawn sample jobs and alternates, to the post-stratification bins. This last step allowed Cadmus to use ratio estimators in calculating the realization rates and their uncertainty with uniform strata definitions. The final stratum definitions and achieved sample sizes are shown in Table E-48 and Table E-49.

Table E-48. Distributor Discount Delivery Channel Sample Thresholds

Stratum	Population Size	kWh High	kWh Low	Total Reported kWh
Small	548	2,298	19	423,316
Medium-Small	155	6,532	2,305	560,573
Medium-Large	68	16,409	6,560	679,558
Large	25	207,926	16,950	937,750
Total	796			2,601,197 ^[1]

^[1] Total may not match sum of rows due to rounding.

Table E-49. Distributor Discount Delivery Channel Sampling Strategy

Stratum	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Percent of Population kWh Included in Sample	Evaluation Activity
Small	N/A	16	42	8%	Record review and site visit
Medium-Small	N/A	11	21	14%	Record review and site visit
Medium-Large	N/A	11	10	18%	Record review and site visit
Large	N/A	25	8	30%	Record review and site visit
Delivery Channel Total	90/10	63	81		

Cadmus estimated there were 437 unique customers in the 796 records in the PPL Electric Utilities database (796 records corresponded to 789 unique participant purchases, installed for 437 customer accounts). Because an end-use customer usually cannot confirm which qualified lighting product was listed on which invoice or record in the PPL Electric Utilities database, Cadmus often had to consider and include these related or "sibling" records associated with the original sample job when conducting a site visit. Of the 81 records in the achieved sample size, 51 were sampled jobs and 30 were siblings.

Ex Ante Reported Savings Methodology

A Distributor Discount participant is a distributor, typically an electric equipment supply outlet. To receive an incentive for a qualified lighting product, the distributor must report each sale and include information about the product, the product quantity, the purchaser, and the address of the intended installation.

The ICSP looked up the end-user facility (building) type in the PPL Electric Utilities database then uploaded this information to its database. The hours of use were assigned for the reported building type using the PA TRM.

The ICSP assigned the *ex ante* baseline fixture types to qualified products as prescribed in the Lighting Improvements for Midstream Delivery Programs IMP. In this midstream program, contractors do not complete a PA TRM Appendix C lighting calculator to compute savings. *Ex ante* savings were computed by the ICSP using the IMP baseline and efficient products (and *ex ante* savings were confirmed by PPL Electric Utilities).

The *ex ante* savings were computed assuming a 98% installation rate, according to the IMP.

Ex Post Verified Savings Methodology

To calculate *ex post* verified savings, Cadmus visited the site for each sampled job and prepared a PA TRM Appendix C. If unable to distinguish between the sampled record and other sibling records associated with the site address, then Cadmus included the sibling records in the PA TRM Appendix C.

Baseline. Cadmus determined *in situ* baseline fixtures and lamps wattages through interviews with site contacts and examination of unchanged lighting equipment. The baseline equipment that Cadmus recorded in the PA TRM Appendix C baseline equipment was the *in situ* equipment, not the IMP baseline.

In-service rate. During site visits, Cadmus identified the program-qualified product that replaced the baseline equipment and verified the fixture or lamp counts, both installed and in storage. It applied these counts to calculate the in-service rate (ISR) for each project and for the program. At the time of site visit, end-use customers or their contractors were often in the process of installing equipment. If, in Cadmus' judgment, the customer showed intention to complete the installation and as a result the probability of savings was high, Cadmus assumed project completion and calculated the ISR.

Building type. Cadmus compared the actual building type to the ICSP's reported building type to determine accuracy. This is important because hours of use are determined by the building type.

Hours of use. Hours of use were based on PA TRM building types for each sampled site. Cadmus and the ICSP used site-specific hours of use for records with *ex ante* savings greater than 120 MWh/yr. (The ICSP selected this threshold.) Only one record fell into the sample for this large project category, and the end-use customer declined to schedule a site visit.

Additional factors. The independent variables of coincidence factors, interactive energy and demand factors, and savings factors for lighting controls were based on PA TRM building types and verified by Cadmus. The presence or absence of any space cooling was determined during the site visit.

Realization rate. Cadmus calculated each site's realization rate as the ratio of the PA TRM Appendix C savings calculated with site specific data to the *ex ante* savings reported in the PPL Electric Utilities database, for both kWh and kW.

E.4.2 Site Visit Findings

Cadmus conducted 51 site visits. Because some sites had multiple jobs, Cadmus verified 81 records in PPL Electric Utilities' tracking database.

Baseline. Where Cadmus located lamps and fixtures on site, the baseline lamps and fixture type were correct for all but two jobs. These two were minor errors, e.g., a CFL listed as an incandescent. Cadmus confirmed that the IMP baseline and efficient product pairs were accurate.

In-service rate. Cadmus cannot calculate an in-service rate until the current effort to locate missing lamps and fixtures for six jobs is completed. However, for those 75 projects where the investigation has been completed, the in-service rate was 99%.

Building type and hours of use. Cadmus adjusted the building type and therefore hours of use for six jobs, the jobs accounted for 3% of the reported kWh/year savings. Cadmus used PA TRM building type hours of use for the sampled jobs. The average job savings was 6,527 kWh/year, and the highest savings was 207,926 kWh/year. No jobs were large enough to require metering.

Additional factors. The IMP assigned 32 watts to every baseline 4-foot linear T8 lamp. When installed with a normal ballast factor, the actual fixture wattage was less than the sum of the lamp wattage. For example, a 2-lamp 4-foot T8 fixture has a PA TRM wattage of 59, while the sum of the lamp wattages is 64, a difference of approximately 8%. Linear lamps accounted for 81% of the job's product quantities and adjusting their baseline wattage reduced reported savings by approximately 6%.

E.4.3 Realization Rate Findings

Cadmus will report the realization rate and in-service rate in the January 2018 Interim Annual Report when the investigation to locate product is completed.

Table E-50 shows reported and unverified savings for the projects selected into the verification sample.

Table E-50. Distributor Discount Gross Impact Results for Energy

Ratio Estimator Results Stratum	Population Reported Savings (kWh/yr)	Realization Rate	Population Unverified Savings (kWh/yr)	Relative Precision at 90% CI (kWh)
Distributor Discount Small (unverified)	423,316	TBD	423,316	TBD
Distributor Discount Medium-Small (unverified)	560,573	TBD	560,573	TBD
Distributor Discount Medium-Large (unverified)	679,558	TBD	679,558	TBD
Distributor Discount Large (unverified)	937,750	TBD	937,750	TBD
Program Total ^[1]	2,601,197	TBD	2,601,197	TBD
^[1] May not match due to rounding.				

The reasons for site specific realization rate adjustments are described below and may be expanded after the completion of verification activities.

Fixture not found. The realization rate was adjusted for an in-service rate that was different from 1, where Cadmus could not verify installation of the reported quantity of rebated lighting equipment.

Baseline = replacement. Cadmus found records for jobs where 25-watt T8 lamps replaced the same type of fixture.

T8 wattage. An anomaly in the IMP prescribed full baseline lamp wattage when replaced by linear LED lamps but overstated the wattages in the installed demand. Therefore, when Cadmus created the PA TRM Appendix C for linear LED lamp replacements, the baseline was lower than in the IMP and in the PPL Electric Utilities database. For example, the IMP assumes that a 4-foot, 2-lamp fixture with 32 watts per lamp has a demand of 64 watts, but in the PA TRM Appendix C the same fixture draws 59 watts or 92% of the value provided in the IMP. The anomaly for T8 lamp baselines has been addressed in the revised IMP approved by the SWE and other EDCs (PY9 Q1).

Miscellaneous. Miscellaneous adjustments resulted in both positive and negative changes from the ex ante savings. These resulted from corrections to the assumed facility types and hours, equipment counts, baseline information, and cooling and interactive factors. None of these dominated or appeared to fit a pattern.

E.4.4 Site Visit Scheduling

Customers who refused a site visit or did not respond to the calls to schedule a site visit significantly affected scheduling and achieving the planned sampling. For example, Cadmus called 95 end-use customers during June and July 2017 but scheduled site visits with only 40 (42%) of these customers. Of the remainder, 20% refused to allow a site visit and 38% did not return calls. Cadmus made multiple calls to all sampled sites during different times of the day to minimize the non-response rate. Cadmus had similar difficulty scheduling for the earlier rounds of calls in April 2017 for the first 11 site visits.

The low recruitment is understandable because end-use customers in this Distributor Discount delivery channel do not interact directly with PPL Electric Utilities or the ICSP. Instead, customers interact with distributors, either directly when they make purchases or indirectly when an electrical contractor purchases on their behalf. Consequently, customers may not be aware that PPL Electric Utilities made their discounts possible and provided them with efficient lighting options through the distribution chain. The ICSP sent postcards to all end-users of record, thanking the end user for purchasing the discounted lighting and participating in the program. However, the postcard may not have reached the person who could respond to the site visit scheduling request.

E.4.5 Database Review Findings

Cadmus conducted a quality control check of the following to verify the sample records in the PPL Electric Utilities database:

- Baseline fixtures or lamps match the equipment prescribed in the IMP
- Hours of use for the given building and lamp types match the PA TRM, where lamp types could be either screw-based or general service lighting (GSL)

- Savings for each record match savings calculated by Cadmus using the IMP algorithms and lighting inputs

In all cases the savings reported in the PPL tracking database agreed with Cadmus' calculations, indicating that the database correctly calculated Distributor Discount *ex ante* savings according to the IMP. The PPL Electric Utilities database also selected the correct baseline equipment for each program-discounted product. Only one record did not match the PA TRM hours of use for the given building type. The PPL Electric Utilities database correctly implemented the IMP for midstream programs.

As part of the database review process, Cadmus also compared a sample of distributor invoices with information reported in the PPL Electric database. Information verified included quantities, manufacturer name and model numbers, and installed wattages. The examination of distributor sales data did not reveal discrepancies with reported values. The sample of invoices and distributor sales reports were also compiled to gather information regarding purchasers and contractors, per unit incentive and unit cost of efficient equipment.

E.5 Net Impact Evaluation for Distributor Discount Channel

E.5.1 Net-to-Gross Ratio Methodology

Cadmus used self-report surveys to assess net savings for the Distributor Discount delivery channel of the Efficient Equipment Program.

Self-Report Survey

Cadmus used self-report surveys to assess net savings, following the Evaluation Framework's recommended common method for assessing free ridership.⁴⁹ The SWE team and PPL Electric Utilities reviewed and approved the survey prior to fielding.

The assessment includes two components of free ridership—the *intention* to implement an energy-efficient project without a rebate and the *influence* of the program in the decision to implement the energy-efficient project. When scored, each component has a value ranging from zero to 50 and a combined total free ridership score ranging from zero to 100.

E.5.2 Net-to-Gross Ratio Sampling

In PY8, Cadmus conducted a survey with end users (including contractors who purchased products from distributors and those for whom the contractors purchased products) of the Distributor Discount delivery channel. In some instances, multiple projects were initiated or completed by the same customer. This required Cadmus to generate a sample of unique decision makers to ensure that no customer was contacted more than once every three months (according to PPL Electric Utilities

⁴⁹ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

requirements) and that none had requested not to be contacted. Cadmus generated the final sample following these steps:

- Identify unique decision maker phone numbers and contact information
- Remove accounts contacted in the past three months for a PPL Electric Utilities or Cadmus survey effort

Table E-51 provides the sampling strategy for the Distributor Discount stratum surveys.

Table E-51. PY8 Efficient Equipment Program Sampling Strategy for Distributor Discount

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	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample ^[2]
Distributor Discount	End Users (Purchasers and Non-Purchasers)	437	N/A	85/15	30	111	15	95%

^[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 surveys. In PY8, there were 437 unique end use facilities but Cadmus did not have purchaser contact information to determine which were purchasers vs. non-purchasers; therefore, the records selected for the sample frame were limited to those with purchaser contact data.

E.5.3 Net-to-Gross Ratio Findings

Table E-52 shows the NTG ratio results for the Distributor Discount delivery channel of the Efficient Equipment Program.

Table E-52. PY8 Efficient Equipment Program Distributor Discount NTG Ratio

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 90% C.L.
Distributor Discount	15	14%	0%	0.86	17%

Intention Score for Distributor Discount Delivery Channel

Under the intention and influence method described in the Evaluation Framework for determining the NTG ratio, Cadmus assessed intention by asking the following key questions to determine how the end-user's project-related decisions would have differed in the absence of the Efficient Equipment Program:

- “According to our records, your project cost was discounted by about [insert dollars for the referenced project]. Which of the following would have happened if you had not received the instant discount from PPL Eclectic Utilities for the qualified lighting products?”
- “By how much would you have reduced the size or scope?”

Cadmus used the responses to determine a participant's final intention score, which was multiplied by the participant's respective unverified kWh savings to calculate intention-based free rider savings. The savings-weighted average intention scores showed 11% of the end-user's unverified savings (Table D-39) could be classified as free ridership.

Influence for Distributor Discount Delivery Channel

Influence is assessed by asking about how much influence—from 1 (no influence) to 5 (extreme influence)—various program elements had on the decision to do the project the way it was done.

The survey asked the following influence questions:

- “Please use a scale from 1, meaning no influence, to 5, meaning extremely influential, to rate how influential you think the instant discount was in your decision to purchase the EnergyStar or DLC certified lighting?”
- “How influential was information or educational material provided by PPL or distributor sales staff in your decision to purchase the EnergyStar or DLC certified lighting?”
- “How influential was your distributor’s recommendation in your decision to purchase high efficiency equipment?”

Cadmus assessed influence from participants’ ratings of how important these program elements were in their decision to purchase energy-efficient equipment. The savings weighted influence score found 2% of the end user’s unverified savings could be classified as free ridership.

Cadmus summed the intention and influence components to estimate the total intention and influence method’s free ridership average, weighted by unverified gross program savings. Table E-53 summarizes the intention, influence, and free ridership score by the equipment and lighting program stratum. One participant accounted for 50% of the analysis sample unverified gross program kWh savings and was estimated as a 0% free rider. No other participant in the analysis accounted for more than 14% of the analysis sample unverified gross program kWh savings.

Table E-53. PY8 Efficient Equipment Program Intention, Influence, and Free Ridership Score for Distributor Discount

Stratum	n	Intention Score	Influence Score	Free Ridership Score
Distributor Discount	15	11%	3%	14%

E.6 Process Evaluation for Distributor Discount Channel

E.6.1 Process Evaluation Methodology

Participating Distributor Interviews

In PY8, 12 distributors participated in the Distributor Discount delivery channel. Cadmus conducted in-depth interviews with eight representatives from seven distributors, representing approximately half of reported PY8 sales, who participated in the Distributor Discount channel. These participants were selected by the ICSP, who selected participants who had significant enough experience with the program to provide feedback.

Cadmus developed the distributor interview guide to inform the following objectives:

- Assess program satisfaction

- Identify motivations for and barriers to participating in the Distributor Discount channel
- Ask about baseline stocking and sales prior to and after the Distributor Discount channel launched, and the influence of program participation on promotion practices

Purchaser and End User Interviews

Cadmus conducted interviews with purchasers (both contractors and end-use customers) and non-purchasers (customers for whom contractors purchased lighting products). Cadmus developed the purchaser and end-user interview guide to inform the following objectives:

- Identify respondent characteristics (type of end-use facilities, contractors' business focus)
- Perceptions of the cost-effectiveness of efficient lighting products
- Incorporation of efficient products into project design considerations
- Assess influence of distributors and the program on purchaser decisions
- Ask contractors about the influence of the program on their business
- Identify barriers to participation
- Assess purchaser satisfaction
- Estimate free ridership and spillover

End-User Segmentation Analysis

Cadmus conducted four comparative analyses:

- End-use customers in the Distributor Discount channel to customers in the rebate (including standard path and direct discount) lighting channels to identify any differences in the size and market segments of these two groups
- Lighting customers in the PY8 Efficient Equipment Program to those in Phase II to determine if the new Distributor Discount channel changed the overall makeup of these lighting participants
- Distribution of rebate path lighting and Distributor Discount participants to the overall commercial customer base in terms of annual energy consumption
- Market segments provided by PPL Electric Utilities in its quarterly customer information system (CIS) extracts, aggregated by Cadmus into less granular groups

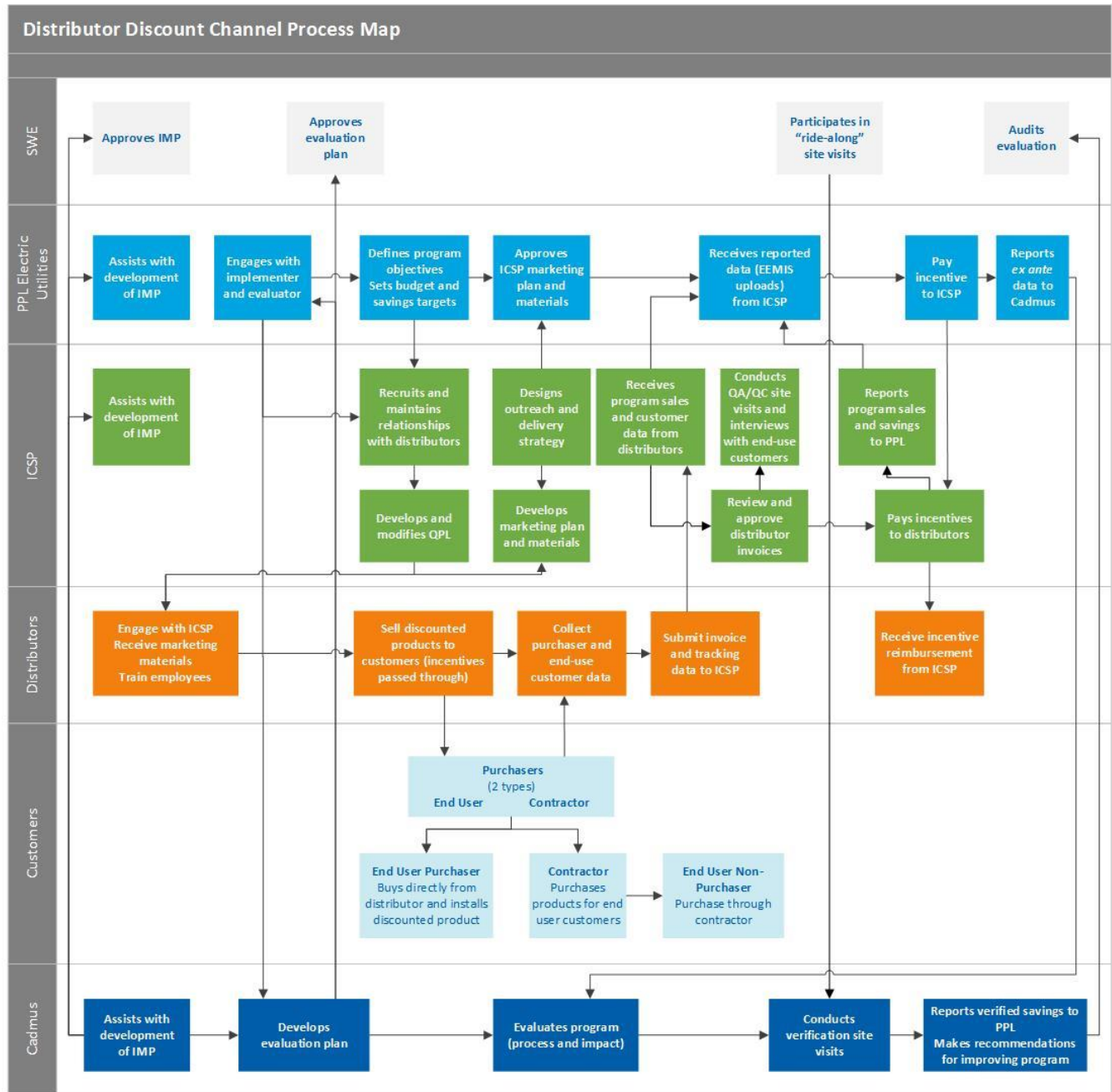
E.6.2 Additional Findings for Distributor Discount

This section includes additional findings from developing the process map, reviewing the logic model, and conducting interviews and surveys about the Distributor Discount channel of the Efficient Equipment Program.

Process Map and Logic Model

Based on interviews with program staff and distributors, Cadmus developed the process map shown in Figure E-33.

Figure E-33. PY8 Efficient Equipment Program Distributor Discount Channel Process Map



The program theory for the Distributor Discount program delivery channel can be summarized as follows:

By providing a mechanism for purchasers of commercial lighting equipment to receive an instant discount, the program will encourage sales of efficient lighting. This approach streamlines purchase of efficient lighting by removing the rebate application and processing steps required in the prescriptive rebate delivery channel. The streamlined approach is expected to encourage customers to participate who would not otherwise seek a prescriptive rebate.

By providing discounts for participating distributors to sell high-efficiency lighting products to their customers at reduced cost, and by providing distributors with educational and promotional materials, the program influence distributors stocking practices and help customers choose the most efficient lighting options. Customers will learn about the benefits and achieve energy and demand savings by installing qualified products. Increased market acceptance and penetration of high-efficiency and ENERGY STAR or Design Lights Consortium-rated products will further increase sales, achieving additional energy and demand savings.

Cadmus developed a logic model for this delivery channel, based on interviews with program staff, and determined the program is operating as expected, given the relatively short time it has been operational. Table E-54 summarizes the logic model review.

Table E-54. Logic Model Review Distributor Discount Delivery Channel

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
Recruit and educate distributors, provide distributors with marketing materials, determine eligibility verification processes, reimburse distributors for discounts, qualified product sales, and inform the end-use customer of the discount via a postcard.	Program Activities	Launched later than expected with fewer than planned sales; otherwise, delivered program activities as expected
Develop marketing materials, purchasers receive instant discounts, rebates paid to distributors, units installed	Outputs Produced by Program Activities	Delivered outputs as expected
Increase program awareness, increase customer and contractor awareness of energy-efficient lighting, and increase installations of energy-efficient lighting; immediate energy and demand savings	Short-Term Outcomes	Program is ramping up, awareness is still low, distributors and contractors report some increase in efficient sales, especially to smaller customers
Reduce annual energy consumption and peak load, and lower electric bills for program participants	Intermediate Outcomes	On track to produce intermediate outcomes
Continued energy savings; PPL Electric meets its goal to reduce energy consumption and peak demand	Long-Term Outcomes (end of Phase III)	On track to produce long-term outcomes

Participant Profile – Distributors

Twelve distributors participated in the Distributor Discount channel. Cadmus interviewed seven distributors who said they were highly focused on the customer experience and frequently recommended products and provided incentive information to help inform their customers' purchase decisions. Although five of these seven had a multi-state presence, they said sales at their participating branches were largely to customers in Pennsylvania and estimated between 35% and 100% of sales were to customers in PPL Electric Utilities' service territory. None reported making changes to stocking or promotional practices at branches outside of Pennsylvania because of their participation in the Distributor Discount channel.

Participant Profile – Contractors

Cadmus interviewed seven contractors (37% of the sample frame of 19 identified through a review of invoices). Two said they worked alone, while the rest were part of larger teams. All said that they focused almost exclusively on commercial customers across many industries and company sizes. Only one contractor reported specifically serving smaller customers that do not have an in-house electrician.

Participant Profile – End Users

End-users include those who purchased products for their own facilities (end-user purchasers) and those who had a third-party contractor purchase products (end-user non-purchasers).⁵⁰ The facilities of both types of end-user respondents (n=15) ranged from a three-person family farm to a corporation that employed more than 400 people. Most end-user respondents said they replaced lighting as part of maintenance repair operations (MROs) as lamps fail, three typically made large-scale replacements, and five did both (MRO and large replacements). Most said they kept very little to no lighting in stock; the largest estimate was 25%, but most were below 5%. Most found efficient lighting was cost-effective. All 15 respondents said their primary considerations for choosing high-efficiency lighting were energy savings, and seven said longevity (some gave multiple responses).

Program Awareness

Table E-55 summarizes how respondents in each of the participant groups heard about the Efficient Equipment Program and Distributor Discounts. These findings indicate that contractors and distributors are informing customers about this midstream delivery channel. Distributors are telling contractors about the instant discounts offered by PPL Electric Utilities, and contractors pass the information to their end-use customers. Notably, fewer than half of the end users (PPL Electric Utilities' commercial customers) knew about the Efficient Equipment Program's standard path prescriptive rebates.

Table E-55. Efficient Equipment Program and Distributor Discount Delivery Channel Awareness

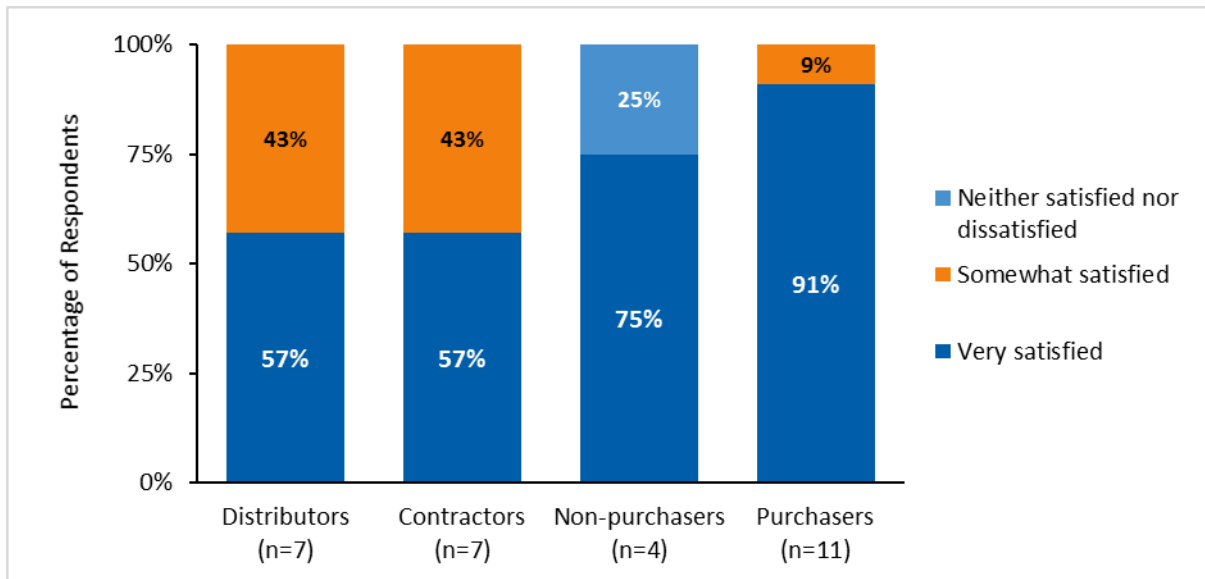
Participant group	Definition	How they learned about Distributor Discount delivery channel	Knew PPL provided the discount	Knew the amount of the discount	Knew about program prescriptive rebates
Contractors (n=7)	Purchased qualified products for their customers	7 heard from distributor	6 knew; 1 did not	Discount listed on invoice	6
End-user non-purchaser (n=4)	Received qualified discounted products from their contractor	4 heard from contractor	Yes	1 knew amount	2
End-user purchasers (n=11)	Purchased products for their business directly from participating distributor	9 heard from distributor; 1 heard from PPL directly; 1 did not know	9 knew; 2 were unsure	6 knew amount; 5 did not or forgot	4

⁵⁰ The distribution of end-user purchasers vs. end-user non-purchasers in PY8 is not known, due to limited purchaser contact information available for sales reported in PY8.

Participant Satisfaction

Cadmus interviewed seven participating distributors, seven contractors, 11 end-user purchasers, and four end-user non-purchasers. Satisfaction was relatively high across all groups, with only one providing a neutral response. Figure E-34 shows full satisfaction results.

Figure E-34. Contractor and End-User Satisfaction



Source: Distributor, Contractor, and End-User survey question: Thinking about your overall experience with PPL Electric Utilities' Distributor Discount Program, how would you rate your satisfaction? Would you say you are...?

Overall, none of the distributors interviewed reported major issues with program implementation. Although there were minor start-up issues, to be expected with a new program, none indicated any major issues with program delivery. In general, the program met or exceeded the distributors' expectations and has been successful because of its simple concept and instant rebate. This made it easier to sell discounted products to customers. Distributors and contractors agreed rebate levels were sufficient to encourage efficient lighting purchases that likely would not have been made otherwise.

Distributor Motivations to Participate

All distributors chose to participate in the Distributor Discount channel to stay competitive and provide good customer experience. They said their businesses were highly relationship-driven, depending on repeat customers to drive sales. Three said they wanted to help their customers take advantage of available and low-hassle discounts on high-quality products.

Since the launch of the Distributor Discount program delivery path, four distributors reported an increase in customers completing smaller projects, specifically where the time and paperwork necessary to get a rebate through the standard prescriptive rebate channel would not be warranted. Although no distributors could state definitively that the number of small business customers has increased, they thought the program had encouraged more of these customers to purchase efficient lighting products.

Asked to compare the Distributor Discount and the standard path prescriptive rebate channel:

- Most distributors appreciated the simplicity of the Distributor Discount channel, especially for smaller projects. Two said all customers would choose the Distributor Discount channel if no limits were placed on products or total rebate amounts per sale.
- Several thought contractors or clients tended to choose the option with less paperwork, even when they were not maximizing incentives.
- One distributor said the standard path made sense for larger projects that required more data collection.
- Three contractors and two distributors said the Distributor Discount channel was easier administratively than the standard path, and two contractors said the instant discount was better for their clients.

Suggestions for Improvement

The most common suggestions for improvement were these: six distributors said expand the product list or make it easier to add products, two said reduce the administrative burden or compensate distributors for processing paperwork (both were *somewhat satisfied*), and one said they had issues receiving incentive reimbursements in a timely fashion. Four contractor and end-use purchasers also suggested adding products.

All distributors requested more products to fit their customers' needs, such as outdoor lighting (e.g., pole and wall lighting), 2x2s, 2x4s, and recessed troughs. Two said the ICSP added products to the qualified products list, but others apparently did not know they could make such requests.

Distributors' Stocking and Sales Patterns

The interviewed distributors said the primary driver in their stocking decisions was the value of the products, i.e., the balance between quality and price, because customers always consider return on investment of upgrade projects. One of seven distributors interviewed took brand name into account when deciding what to stock.

Before participating in the program, distributors said the majority of lighting products they sold was efficient, with a consistently decreasing share of standard efficiency lighting; although they could not give exact figures, five estimated between 20% and 50% of the efficient products they sold, in units, were covered by the program. One said most of the eligible products had lower price points to begin with and that higher price-tag products, such as parking lot lights, were typically not on the qualifying products list.

Distributors estimated that between 50% and 80% of their sales, in dollars, before the program launched were products that are now covered by the Distributor Discount channel. Since the program launched, five had noticed a small shift in sales toward qualifying products. All distributors thought there has been a natural trend toward efficiency in the market; two said this trend was because customers were becoming more cognizant of opportunities to realize energy savings and take advantage of rebates for efficient lighting products.

Program Influence on Contractors' Promotional Practices and Sales

None of the contractors interviewed thought their customers knew the difference between products certified by ENERGY STAR and Design Lights Consortium and non-certified products. Only two said their clients rarely or sometimes specifically request certified products. All contractors rated the influence of discounts on their clients' decisions to install high efficiency lighting *somewhat* or *very influential*.

As shown in Table E-56, most distributors said that they program has had an influence on how they promote and sell program-eligible products.

Table E-56. Program Influence on Distributor Promotion Behavior

Recommend efficient lighting to clients (n=7)	Promote ES and DLC more often (n=7)	Discounts influence sales practices (n=7)	Distributor recommendations influence contractor (n=7)	Incorporate discount into project bid (n=7)
6	5	6 said highly influential	5 said highly influential	6

When asked what percentage of 2016 and 2017 projects included lighting that could qualify for PPL Electric Utility instant discounts, all but one of the contractors interviewed provided estimates. These estimates ranged widely (5% to 80%); however, four of the six contractors estimated the percentage to be at least 50%. Four of seven contractors said the program had at least some positive influence on their revenue and sales volume. None had participated in any other utility instant-discount (midstream) programs.

These findings are in line with the expected outcomes of the program in terms of the influence of incentives on contractors' promotion and sales of efficient products as well as on the expectation that contractors will pass the discounts on to their customers.

Influence on Distributors' Customer Interactions & Promotion Practices

All distributors helped their clients with their lighting purchases both prior to and after the launch of the program. Distributors in general see their role as lighting experts, with clients looking to them for guidance on all aspects of their purchases. All distributors believed their responsibility was to inform customers about available rebates and said they did so for all eligible customers. This is corroborated by nine out of 10 end-user purchasers who said a distributor influenced their decision to purchase efficient lighting products. Two respondents said more clients were looking for energy-efficient products, although very few customers knew about the Distributor Discount channel specifically.

When asked about the most effective marketing tactics, one distributor said customer education and explaining the return on investment of efficient lighting as the best way to drive sales. Distributors focused primary promotion efforts on direct customer outreach through sales representatives, stating that their businesses were highly relationship-driven. Two distributors said they sent their sales representatives to meet with some of their largest potential customers to help them better meet their needs. Other methods of promotion varied; two distributors used in-store signage, one used email blasts, and one went to trade shows. Since the launch of the program, three distributors modified their

promotion strategy to focus more on program products. Two distributors co-branded with PPL Electric Utilities, which helped increase program awareness.

All seven of the distributors interviewed used some of the marketing materials provided by the ICSP, such as flyers or other counter literature. Six distributors said the materials provided by the ICSP were sufficient and they plan to increase their use of these materials as the program matures. One wanted more digital marketing presence and was working with ICSP to develop this.

Although the Distributor Discount channel did not have a significant impact on the manner in which distributors interacted with their customers and the frequency with which they promoted efficient products, these findings indicate that the instant discounts and marketing materials made it easier for distributors to increase sales of efficient products.

End-User Segmentation Analysis

Cadmus' comparative analyses of end-use customers in the Distributor Discount channel (new in Phase III) to lighting customers in the standard path (Phase II and Phase III) and to PPL Electric Utilities' commercial customer base from Phase II and III (described in *Section E.6.1*, above) led to the following findings.

A review of end use participants across programs revealed an overlap of 25 customers between the standard path and distributor discount channels, installing linear and non-linear LED lighting. The analyses showed that there were differences between the customers who chose the Distributor Discount delivery channel and those who chose the standard path. This is not surprising and is in line with PPL Electric Utilities' objective to capture savings from smaller lighting jobs through the new Distributor Discount channel.

The sizes of the participant groups analyzed are shown in Table E-57. The Distributor Discount customers were the smallest participant group in Cadmus' comparative analysis with just five months of participation, and the Phase II lighting participants were the largest with three years of participation.

Table E-57. Participant Counts by Analysis Group

Participant Group	Number of Customers ^[1] (Unique PPL Billing Account Numbers)
Distributor Discount (5 months)	437
Phase III PY8 Lighting (standard path, 1 year)	733
Phase II Lighting (standard path, 3 years)	5,401
^[1] PPL Electric Utilities' tracking data from PY5-PY8 ^[2] Phase II lighting participants span three years; for comparison purposes, in PY7, there were 1,560 commercial lighting jobs reported for this program.	

Annual energy consumption. Cadmus examined annual energy consumption (as one proxy for customer size) of lighting participants and the overall PPL Electric Utility commercial customer base.

Both Phase II and Phase III participants (for the Distributor Discount and standard path) were highly concentrated in the fourth quartile of all commercial customers' energy consumption. This difference in

concentration was more pronounced in Phase III participants. These results, which demonstrate that lighting participants tended to have higher consumption than the general customer base, are shown in Table E-58. In this table, the p values for all but the first quartile show significant differences between the Phase II and Phase III lighting participants.⁵¹ This warrants further analysis in PY9, because this analysis involves three years of Phase II and one year of Phase III; it may be that the percentages will change over time.

**Table E-58. Phase II vs. Phase III Participant Distribution
Across Commercial Customer Base Energy Consumption Quartiles**

Quartile (All Commercial Customers)	Annual Energy Consumption, kWh	Phase II Percentage	Phase III Percentage	P Value
1	6,402	7%	6%	0.3595
2	16,728	14%	6%	0
3	52,100	24%	20%	0.0059
4	336,548,000	56%	69%	0

In Table E-59, the annotated percentages show tests for statistical significance within each consumption quartile.⁵²

Table E-59. Lighting Participant Groups Across Participant Energy Consumption Quartiles

Annual Consumption Quartile	Annual Energy Consumption, kWh	Phase II Standard Path Participants	Phase III Participants	Phase III Standard Path Participants	Distributor Discount Participants
1	25,817	27% ^[1]	15% ^[1]	7% ^[2]	28% ^[2]
2	84,133	25%	25%	24%	28%
3	385,970	25% ^[3]	24%	27%	19% ^[3]
4	306,548,000	23% ^[1]	36% ^[1]	42% ^[2]	26% ^[2]

^[1] The differences between the Phase II and Phase III participant proportions in the first and fourth quartiles are statistically significant ($p < .05$).

^[2] The differences between the Phase III standard path and Distributor Discount participant proportions in the first and fourth quartiles are statistically significant ($p < .05$).

^[3] The differences between the Phase II and standard path and Distributor Discount participant proportions in the third quartile is statistically significant ($p < .05$).

Because the Phase II participants made up the largest portion of all participants, they were most evenly split across the overall participant quartiles, as expected. Table E-59 shows the moderate concentration of Phase III participants in the highest quartile and, most strikingly, the heavy concentration of Phase III standard path participants in the highest quartile and lower representation in the lowest quartile. This

⁵¹ Cadmus used a two sample t-test for the difference in proportions. The results presented are significant at an alpha=0.05 level

⁵² Cadmus used a two sample t-test for the difference in proportions. The results presented are significant at an alpha=0.05 level

suggests that the introduction of the Distributor Discount channel changed the makeup of standard path participants, leaving mostly larger participants (in annual energy consumption) in this delivery channel.

In Phase III, compared to the Distributor Discount channel, fewer of the smallest customers (in annual energy consumption) were in the standard path; the standard path had more customers in the third and fourth quartiles.

There is no significant difference between the Distributor Discount and the Phase II Efficient Equipment (standard path) participants in the first, second, or fourth quartiles of participant energy usage.

Types of businesses. In Phase III, the Distributor Discount channel had significantly more industrial and office facility participation than the standard path but fewer education, grocery, and retail facilities (Table E-60), suggesting that this channel served a somewhat different market segment than the rebate channel. Cadmus will investigate whether this trend is due to correlation with size (annual consumption) or other qualitative factors, as more data are available in PY9.

Table E-60. Phase III Distributor Discount and Standard Path Participant Proportions of Customers by Business Type

Business Type	Distributor Discount	Prescriptive Rebate Channel	P Value	All Commercial Customers
Education	4%	7%	0.0303 ^[1]	2.2%
Grocery	3%	7%	0.0031 ^[1]	2.0%
Health	7%	5%	0.1713	4.9%
Industrial	16%	11%	0.0173 ^[1]	8.2%
Lodging	2%	2%	0.7187	1.7%
Misc.	13%	12%	0.7001	17.1%
Office	27%	21%	0.0286 ^[1]	38.0%
Public Service/Inst.	5%	5%	0.9649	5.1%
Restaurant	4%	3%	0.5845	4.5%
Retail	10%	18%	0.0002 ^[1]	9.0%
Warehouse	10%	9%	0.5387	7.2%

^[1] Differences between Distributor Discount and rebate path participants are significant.

Average savings per job. The average savings per job is not statistically different between Phase II and Phase III (Table E-61) when analyzing all Efficient Equipment Program lighting customers, including both the Distributor Discount and the standard path prescriptive rebate projects.

Table E-61. Phase II vs Phase III Lighting Participant Average Energy Savings per Job

Phase (duration of data)	Average Energy Savings per Job, kWh	P Value
Phase II (3 years)	54,041	0.4835
Phase III standard path and Distributor Discount (1 year)	59,320	

Table E-62 shows that, not surprisingly, the energy savings for the average Distributor Discount job is considerably smaller than the average Phase II job and much less than the average Phase III prescriptive, standard path job.

Table E-62. Phase II vs Distributor Discount Energy Savings per Job

Phase	Average Energy Savings per Job, kWh	P Value
Phase II (3 years)	54,041	0.0000
Phase III Standard Path (1 year)	104,821	
Distributor Discount (5 months)	6,274	

However, in Phase III significantly more jobs (38%) claimed energy savings under 4,400 kWh, compared to Phase II (21%). More median-savings jobs (those with approximately equal numbers of jobs with higher and lower savings) were reported in Phase II, but approximately the same proportion of the highest savings jobs were reported between the two phases. This indicates a shift in the distribution of lighting jobs taking advantage of incentives toward the lower end of the savings spectrum, consistent with the program theory for the Distributor Discount channel. These results are shown in Table E-63.

Table E-63. Phase II vs. Phase III Quartiles

Savings Quartile	Job Savings (kWh)	Phase II Overall	Phase III Overall	P Value
Q1	4,402	21.1%	38.4%	0.0000
Q2	12,162	26.6%	19.8%	0.0000
Q3	33,532	26.8%	18.7%	0.0000
Q4	12,508,597	25.6%	23.1%	0.0413

In Phase III, most of the Distributor Discount jobs fall into the lowest quartile of savings then drop substantially after that, while the standard path shows the opposite but less drastic trend (Table E-64).

Table E-64. Phase III Distributor Discount and Standard Path

Savings Quartile	Job Savings (kWh)	Distributor Discount	Standard Path (Prescriptive Rebate)	P Value
Q1	4,402	67.3%	13.6%	0.000
Q2	12,162	19.6%	20.0%	0.8932
Q3	33,532	10.2%	25.9%	0.0000
Q4	12,508,597	2.8%	40.5%	0.0000

Table E-65. shows reported energy savings and the percentage contribution of each sector to the total energy savings reported for the Distributor Discount component. The table shows that smaller businesses are driving savings accomplishments for the Distributor Discount channel with 69.8% of its reported savings attributed to the small C&I sector. The GNE customers accounted for 23.5% of overall reported savings for the Distributor Discount channel. Savings will be verified in PY9.

Table E-65. PY8 Distributor Discount Summary of Evaluation Results for Energy By Sector

Sector	Number of Participants (Jobs)	Unverified Gross Energy Savings (kWh/yr)	GNE kWh/Total Distributor Discount (%)	Energy Realization Rate (%)	Verified Gross Energy Savings (kWh/yr)
Small C&I	549	1,815,053	69.8%	--	--
Government, Nonprofit, Education	180	611,426	23.5%	--	--
Large C&I	36	145,297	5.6%	--	--
Residential	24	29,421	1.1%	--	--
Program Total ^[1]	789	2,601,197	100%	--	--

^[1] May not match due to rounding.

E.6.3 Sample Cleaning and Attrition for Lighting and Equipment Participant Surveys

Cadmus coordinated with PPL Electric Utilities' survey contractor to screen the sample and remove the records of any customers who had been called in the past three months (for a Cadmus or a PPL Electric Utilities survey), had requested not to be contacted again, and had incomplete information. This cleaning and survey sample preparation process reduced the available sample.

Cadmus emailed an initial survey invitation to the remaining contacts with email addresses and followed up with two reminder email invitations. If the contact did not complete an online survey, Cadmus telephoned the participants, attempting to reach respondents up to five times over several days, at different times of the day, and scheduling callbacks whenever possible. Table E-66 lists total numbers of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table E-66. Efficient Equipment Sample Attrition Table for Equipment and Lighting

Description of Call Outcomes	Number of Records	
	Equipment	Lighting
Online Survey		
Population (number of unique jobs) ^[1]	111 ^[2]	851
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on "do not contact" list	28	184
Removed: incomplete or invalid email address	2	7
Survey Sample Frame (email invitations sent)	81	660
Email was returned (bounce back)	4	28
Did not respond	67	592
Opt out	1	3
PPL Electric Utilities or market research employee	1	1
Cannot confirm project location	2	1
Did not complete survey	4	5
Completed Surveys	2	29
Online Response Rate	2%	4%
Telephone		
Population (number of unique jobs) ^[1]	111 ^[2]	851
Removed: inactive customer, completed survey in past 3 months, on "do not contact" list, opted out of survey, selected for a different survey (including the online survey), duplicate contact	89	347
Removed: incomplete or bad phone number	0	0
Survey Sample Frame (used for survey calls)	22	504
Not Attempted ^[3]	0	391
Records Attempted	22	113
Non-working number	1	3
Wrong number, business	0	2
PPL Electric Utilities or market research employee	1	0
Refusal	0	17
No answer/answering machine/phone busy	14	54
Non-specific or specific callback scheduled	0	3
Partial complete (not included in survey findings analysis)	1	1
Completed Surveys	5	33
Telephone Response Rate	23%	29%
Total Completed Surveys (total for all modes)	7	62
^[1] Number of unique jobs available in PPL Electric Utilities' tracking database at the time of the survey effort.		
^[2] Includes one HVAC project that was incorrectly reported under the Custom project.		
^[3] Selected for sample but target was reached before attempted.		

E.6.4 Attrition for Distributor Discount Interviews

Table E-67 lists total numbers of records and the outcome (final disposition) of each record.

Table E-67. Efficient Equipment Sample Attrition Table for Distributor Discount

Description of Call Outcomes	Number of Records			
	Distributors	Contractors	Purchasers	End Users (Non-Purchasers)
Telephone Interview				
Population (number of contact names) ^[1]	12	19	81	36
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on "do not contact" list	0	0	6	0
Removed: incomplete or invalid phone number	0	0	0	0
Interview Sample Frame (used for interview calls)	12	19	75	36
Not attempted	0	0	21	0
Records Attempted	12	19	54	36
Non-working number	0	1	2	2
Wrong number	0	1	0	0
Refusal	0	3	6	5
No answer/answering machine/phone busy	5	7	27	20
Non-specific or specific callback scheduled	0	0	6	5
Partial complete (not included in interview findings analysis)	0	0	2	0
Total Completed Surveys	7	7	11	4
Telephone response rate	58%	37%	15%	11%
^[1] Number of contacts available at the time of the survey effort.				

Appendix F. Evaluation Detail—Custom Program

F.1 Gross Impact Evaluation

F.1.1 Methodology

EM&V Sampling Approach

Cadmus evaluated the census of large stratum projects in the Custom Program. Cadmus selected a random sample of small sample projects at the close of each program quarter and independently verified their savings.

High Interest stratum. No additional “high interest” substratum within the small strata was identified in PY8, but it may be identified in future program years. High-interest equipment and systems are those that are expected to contribute a significant amount of savings, those with high uncertainty, or those for which PPL Electric Utilities and the ICSP are considering new offerings or approaches. All small strata projects in these equipment and system categories will be placed into a substratum. The number of sample points assigned to the high-interest stratum will be determined by the percentage of savings obtained from the small stratum.

Large stratum. Large projects generally have savings greater than 500,000 kWh/yr. In PY8, Cadmus evaluated all 17 large stratum projects.

In PY8, savings were claimed and partial incentives were paid for three projects; however, verification activities will not be complete until PY9. These projects accounted for 35% of the annual reported savings. These projects were completed (installed and operating as designed) in PY8 but received only a partial incentive based on the claimed savings. Because all of these projects are being verified, there will be no uncertainty in these projects once verification concludes and verified savings are reported in PY9.

Small stratum. The sample size for the small stratum projects was based on 85% confidence and 20% precision and a coefficient of variation of 0.64. Cadmus reduced the small stratum sample to 10 from 15, as the reported savings attributed to that stratum were less than expected when the sampling plan was developed. The basis for the target sample is 25% of program savings coming from small stratum projects. In PY8, only 12% of the reported savings are from small stratum project. As such, Cadmus was confident the desired precision would be met at the program level with a smaller sample.

Table F-68. Custom Program Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision (Cv)	Target Sample Size	Achieved Sample Size	Evaluation Activity
Large	17	N/A	Census	17	Site visit, data collection, custom savings analysis, verification report
Small	51	85/20	15	10	Site visit, data collection, custom savings analysis, verification report
Large Unverified	3	N/A	Census	3	Site visit, data collection, custom savings analysis, verification report
Program Total	71	85/15		30	Site visit, data collection, custom savings analysis, verification report

Ex Post Verified Savings Methodology

For most of the large stratum, savings were verified before being reported to PPL Electric Utilities, so the *ex ante* and *ex post* savings were equal. For PY8, 3 projects in the large stratum were paid partial incentives and reported prior to verification. The *ex post* savings calculated for those large projects were not applied to any other projects in that stratum. Calculation methodologies and verification approaches vary by project, and individual results are found in the verification reports generated for each project.

For the small stratum, Cadmus calculated the realization rate as the ratio of *ex post* verified gross savings to *ex ante* savings then applied this realization rate for the selected sample to the entire small stratum population. Calculation methodologies and verification approaches vary by project, and individual results are found in the verification reports generated for each project.

F.1.2 Database Review Findings

The reported savings for large stratum projects matched the savings provided by Cadmus to the ICSP and PPL Electric Utilities. In one instance, the ICSP calculated savings for a project and reported it as two separate projects. In this project, two chillers served different areas of the facility and were expected to become operational at different times of the year. However, they came online at the same time, so Cadmus calculated savings for the overall project.

Cadmus found that equipment type codes may have varied when applied to records with similar equipment. For example, air compressor projects may have been recorded as either nonresidential or motor products. The PPL Electric Utilities' tracking database uses these codes to indicate the equipment type:

- Refrigeration
- Motor
- Nonresidential
- Lighting
- Agricultural
- HVAC
- Incentive adjustment

There were no records in the database with an agricultural equipment type.

F.1.3 Site Visit Findings

Cadmus conducts site visits to all Custom Program projects, both large and small strata, selected into the evaluation sample. Visits are used to verify equipment installation, gather information about operations affecting the equipment or systems for which incentives were paid, install logging equipment, take spot observations, and conduct interviews with facility personnel.

Large stratum projects typically have both baseline and post-installation visits. These visits are typically conducted with the ICSP to reduce the number of facility staff required for the evaluation process. Visits to small stratum projects are conducted only after the project incentive is paid. There is no opportunity for Cadmus to conduct a baseline visit because only a sample of small stratum projects are verified, and these cannot be selected until after the equipment is installed.

All projects verified in PY8 involved equipment or processes that were operating as planned. Following the site visit, assumed parameters or equipment operations used to determine the reported savings were updated to calculate the verified savings.

F.1.4 Realization Rate Findings

The Custom Program evaluation found various reasons for discrepancies between *ex ante* and *ex post* savings.

Large stratum projects are typically verified prior to payment, although several projects were paid prior to verification in PY8, so there is a difference between overall reported and verified savings for that stratum.

In the small stratum, the ICSP's and Cadmus' savings methodologies may differ, depending on information available, customer trending capabilities, the ratio of estimated savings to overall customer usage, and the ability of Cadmus to deploy logging equipment. A difference in methodology is to be expected. Some sources for the differences were these:

- For operating hours, the ICSP used PA TRM defaults by building type to determine *ex ante* savings. Verified savings used the site-specific operating hours.
- Several projects used ICSP savings calculators to determine reservation savings. The verified results used actual operating data, including equipment energy use and run hours, to determine savings.
- Projects affected by production did not account for variations in production when comparing baseline and post-installation periods in the *ex ante* analysis. For production-dependent energy efficiency equipment and systems, an independent variable (e.g., production quantity, production volume, chilled water load) needs to be used to compare the energy use of affected equipment and systems at various loads. A common annual load profile of the independent variable is also used in verified results to simulate the baseline and post-installation operations under similar conditions.

- Cadmus may have determined that the equipment baseline used in an *ex ante* analysis was incorrect. For example, the ICSP may have used minimally code-compliant efficient equipment to model the baseline energy use in an industrial application. In that case, Cadmus updated the baseline to use industry standard equipment.

F.2 Net Impact Evaluation

F.2.1 Net-to-Gross Ratio Methodology

Cadmus used self-report surveys to assess the net savings for the Custom Program and researched participant documents to provide additional context about free ridership. Cadmus followed the Evaluation Framework's recommended common method for self-report surveys. The SWE team reviewed and approved the surveys prior to fielding.⁵³

An assessment of free ridership involves two components—the *intention* to implement an energy-efficient project without a rebate and the *influence* of the program in the decision to implement the energy-efficient project. When scored, each component has a value ranging from zero to 50 and a combined total free ridership score ranging from zero to 100.

F.2.2 Net-to-Gross Ratio Sampling

Cadmus conducted online and telephone surveys with Custom Program participants in PY8. Some customers initiated or completed multiple custom projects. This required Cadmus to generate a sample of unique decision makers to ensure that no customer was contacted more than once every three months (per PPL Electric Utilities; requirements). Cadmus generated the final sample following these steps:

- Identify unique decision maker phone numbers and contact information
- Remove accounts contacted in the past three months for a PPL Electric Utilities or Cadmus survey effort

The final sample frame contained 64 unique decision makers representing 71 projects (Table F-69). Cadmus first contacted all participants with email addresses to complete an online survey then contacted participants who did not have a valid email address or did not respond to the online survey via telephone. One survey included questions for both the process evaluation and the net savings evaluation. The online and phone surveys were identical.

⁵³ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

Table F-69. PY8 Custom 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	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample ^[2]
Participants	Participants	71	0.5	85/15	All eligible	64	15	100%

^[1] Represents number of paid projects in PY8.
^[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 surveys.

F.2.3 Net-to-Gross Ratio Findings

Cadmus summed the intention and influence components to estimate the total intention and influence method free ridership average, weighted by *ex post* gross program savings. Table F-70 summarizes the intention, influence, and free ridership score.

Table F-70. Custom Program Intention/Influence Free ridership Score

n	Intention Score	Influence Score	Free Ridership Score
15	10%	11%	21%

Table F-71 shows the NTG ratio results for the Custom Program. Free ridership was 21% and the NTG ratio was 0.79, determined with 11% precision at the 85% confidence level. The level of free ridership is lower than PY7 when free ridership was 39% and the NTG ratio was 0.61.⁵⁴

Table F-71. Custom Program Net-to-Gross Ratio

Program	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.
Custom	15	21%	0%	0.79	11%

Intention Score

Under the intention and influence method, Cadmus assessed intention by asking questions to determine how the organization's project-related decisions would have differed in the absence of the Custom Program. Cadmus used the responses to determine a participant's final intention score, which was multiplied by the participant's respective *ex post* kWh/yr savings to calculate intention-based free rider savings. The savings-weighted average intention score showed 11% of savings could be classified as free ridership.

⁵⁴ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Influence Score

Influence is assessed by asking about how much influence—from 1 (no influence) to 5 (extremely influential)—various program elements had on the customer’s decision to purchase energy-efficient equipment.

The survey asked the following influence question:

“N8. Please rate each item on how much influence it had on the decision to complete the project the way it was completed. Please use a scale from 1, meaning no influence, to 5, meaning the item was extremely influential in your decisions.”

From responses to this question, Cadmus obtained data about the influence of PPL Electric Utilities rebates, information from PPL Electric Utilities about ways to save energy, and any assistance from the ICSP. Cadmus assessed influence from participants’ ratings of how important various program elements were in their decision to purchase energy-efficient equipment. The average maximum influence rating was 4.0. The savings weighted influence score found 10% of the savings could be classified as free ridership.

Spillover Findings

No data collected through the participant surveys indicated spillover activity attributable to PPL Electric Utilities.

F.3 Process Evaluation

F.3.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In February and March of 2017, Cadmus conducted interviews with the program managers from PPL Electric Utilities and the ICSP. The interviews focused on the following:

- Gathering insights into program design and delivery
- Identifying areas that worked well and others that could be improved
- Evaluating KPIs and goals
- Assessing design engineer, contractor, and customer satisfaction
- Assessing communication strengths and weaknesses
- Assessing areas to address free ridership
- Identifying evaluation topics of greatest interest

Design Engineer and Contractor Interviews

In June 2017, Cadmus conducted interviews with six design engineers and contractors who provided design and installation products and services to participants of the Custom Program. Cadmus relied on PPL Electric Utilities’ tracking database to filter out any projects that did not have a contractor name or were self-installed and identified 17 contractors as eligible for interviews.

Interviews with design engineers and contractors concerned the following topics:

- Design engineer and contractor support for the Custom Program
- Program influence on design engineer and contractor business practices
- Design engineer, contractor, and program influence on customer decision-making process
- Design engineer and contractor satisfaction
- Areas that work well and others that could be improved

Participant Surveys

Cadmus conducted online and telephone self-report surveys with 15 of 71 Custom Program participants between November 2016 and August 2017. Five participants responded to the online survey and 10 to the telephone survey. These surveys asked identical questions to assess program satisfaction and net savings and focused on the following:

- Program performance and implementation
- Effectiveness of program to generate awareness and disseminate information
- Customer response and willingness to recommend the program
- Influence of the program and contractor or design engineer on project design, purchase decision, and program participation
- Free ridership and spillover to inform net savings

Cadmus attempted to contact a census of participants. Cadmus first contacted all participants with email addresses to complete an online survey then telephoned participants who did not have a valid email address or did not respond to the online survey. Giving participants two avenues to respond to the survey increased response rates in this limited population.

Cadmus cleaned the contact list by removing records of anyone who had completed a PPL Electric Utilities or Cadmus survey in the past three months or had requested not to be contacted. If a participant completed more than one custom project in the program year, Cadmus attempted to contact the participant for each project. See *F.3.3 Sample Cleaning and Attrition for Participant Surveys*.

Potential sources of bias in all surveys include nonresponse, recall, and social desirability biases. Cadmus addressed these potential sources of bias by applying survey design and survey data collection best practices where possible. Surveys did not include leading or ambiguous questions nor double-barreled questions. Cadmus provided clear interviewing and programming instructions so that they were implemented consistently. The SWE team and PPL Electric Utilities reviewed and approved the survey before fielding.

Social desirability biases are often more present in telephone surveys than in online surveys because of the verbal conversation with an interviewer. For that reason, Cadmus tested for any significant differences in program satisfaction between modes and found no differences. All online respondents (n=5) reported being *very satisfied* with the program, and all phone respondents (n=10) reported the same.

F.3.2 Additional Findings

This section includes survey and interview findings. In this section, Cadmus presents interview and survey data as follows: the report contains the percentage or frequency of responses, followed by the sample size for the question at hand. Sample size (denoted by “n”) refers to the number for respondents who were asked the question, not the number of respondents who answered. Note that sample sizes vary according to each question, due to survey logic and skipped questions.

Program Delivery

Applications for custom projects are submitted through the ICSP’s web portal. This is a change from the way Phase II was implemented and has helped improve customer and trade ally satisfaction. The application can be initiated by the PPL Electric Utilities KAM, the ICSP, a trade ally, or the customer. Once completed by the customer or trade ally, the application is submitted to the ICSP for preapproval. The ICSP reviews and approves the project and emails a reservation letter to the customer. Once the customer completes the project and submits all required paperwork, the ICSP processes the application. PPL Electric Utilities reviews the final application, approves the project, and sends the customer the incentive payment. The ICSP follows up by sending each participant a postcard thanking them for their support of the Custom Program.

Both PPL Electric Utilities and the ICSP said their communication is very successful. One reason is that they hold weekly meetings to discuss the status of potential and current projects and to address any challenges throughout each project’s lifecycle. The only suggestion for improving communication is to make the PPL Electric Utilities’ KAMs more aware of scheduled ICSP and Cadmus site visits.

The ICSP creates and distributes all marketing materials with approval from PPL Electric Utilities. PPL Electric Utilities and the ICSP discuss marketing and outreach plans during their weekly meetings.

The ICSP provides resources to contractors and design engineers through the online portal and also provides them with engineering assistance.

Key Performance Indicators

PPL Electric Utilities and the ICSP defined plans for energy savings for the Custom Program and set levels for customer satisfaction. PPL Electric Utilities met its PY8 customer satisfaction KPI. The Custom Program satisfaction performance KPI in PY8 is shown in Table F-72.

Table F-72. Custom Program Key Performance Indicators

Key Performance Indicator	Metric	PY8 Goal	PY8 Result
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	100% of surveyed participants were <i>very satisfied</i> with the program (n=15)

Logic Model Review

Cadmus reviewed the logic model and determined that the program is operating as expected. Table F-73 lists the outcome of the logic model review.

Table F-73. Logic Model Review

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
Program implementation, technology assistance, and education provided to customers and trade allies, marketing and outreach, applications processed, QA/QC and evaluation processes developed and implemented, and incentive payments processed	Program Activities	Delivered program activities as expected
Trade allies are active and informed, marketing materials distributed, incentives paid, and rebate application and processing/payment systems implemented and functioning	Outputs Produced by Program Activities	Delivered outputs as expected
Customer and trade ally awareness of the program and its energy-efficient opportunities increases, equipment is rebated, and immediate energy savings and demand reduction are achieved	Short-term Outcomes	Produced short-term outcomes as expected
Experience and feedback will lead to program updates; additional marketing will occur; continued equipment installations and energy and demand savings will be achieved; customer and trade ally awareness of PPL Electric Utilities programs will continue to increase; and the program will gain sufficient experience and data to add some custom products and services to the PA TRM so they can be rebated as prescriptive equipment	Intermediate Outcomes	On track to produce intermediate outcomes
PPL Electric Utilities' will increase its knowledge and experience operating this type of program, long-term energy savings and demand reductions will be achieved, and environmental benefits accrue	Long-term Outcomes (end of Phase III)	On track to produced long-term outcomes

Participant Profile

This section provides a profile of all customers who participated in the Custom Program and summarizes the firmographics of survey respondents. Table F-74 shows the sectors represented in the survey population and in the full participant population.

Table F-74. Sector Breakdown

Sector	Total Population (n=71)	Survey Respondents (n=15)
Large	41%	47%
Small	38%	27%
GNE	20%	20%
Residential	1%	7%

Source: PPL Electric Utilities' Tracking Database; may not total 100% due to rounding.

Nearly half of the survey respondents (40%; n=15) had participated in the Custom Program before. Four of the 12 who answered the question said they worked with an energy services company in a performance contract for their project. Eight of the 11 who answered the question said their facilities were over 100,000 square feet. Ten of the 13 who answered the question said the facility had more than 100 employees.

Table F-75 shows the types of facilities participating in the Custom Program and responses to the survey. The majority of total population and survey respondents were from the manufacturing segment. Because respondents could skip questions if they did not want to answer them, not all respondents provided an answer to every question.

Table F-75. Facility Types Responding to the Survey and Participating in the Custom Program

Facility Use	Total Population (n=64) ^[1]	Survey Respondents (n=15) ^[2]
Manufacturing	36%	40%
Education	14%	27%
Grocery – supermarket or convenience store	25%	7%
Hospital or healthcare	6%	7%
Lodging	2%	0%
Office	2%	7%
Restaurant	2%	0%
Retail	2%	0%
Transportation	2%	0%
Warehouse	2%	7%
Agriculture	3%	7%
Penitentiary	2%	0%
Public Assembly	2%	0%
Religious Building	2%	0%
Other	2%	0%

^[1] Source: PPL Electric Utilities' Tracking Database based on unique bill account numbers; may not total 100% because of rounding.
^[2] Source: Survey question, "What is the primary use of your facility?"; may not total 100% because of rounding.

Table F-76 lists the types of projects completed in PY8.

Table F-76. PY8 Custom Program Project Types

Project Type	Number of Projects (n=71)	Percentage of Projects (n=71)	Percentage of Survey Respondents' Projects (n=15)
Motors	32	45%	53%
HVAC	12	17%	7%
Refrigeration	10	14%	7%
Combined heating and power (CHP)	5	7%	0%
Lighting	4	6%	0%
Other	8	11%	33%

Source: PPL Electric Utilities' Tracking Database; may not total 100% because of rounding.

Net Promoter Score

The net promoter score (NPS) is a metric of brand loyalty that specifically measures how likely customers are to recommend the program to others. Respondents use a 10-point scale where 0 means *not at all likely* and 10 means *extremely likely*. Respondents giving a rating of 9 or 10 are known as promoters, respondents giving a rating of 7 or 8 are known as passives, and respondents giving a 0 to 6 rating are known as detractors. The NPS is expressed as a number between -100 and +100 that represents the difference in percentage points between the promoters and detractors. As shown in Table F-77, the Custom Incentive Program achieved a NPS of +66, indicating more promoters than detractors among the respondents. The one detractor did not have suggestions to improve the program. The passive respondents suggested providing notifications about rebate amount changes, making the application simpler, and providing more information about what is needed to participate and submit an application.

Table F-77. Net Promoter Score – Likelihood to Recommend the Program

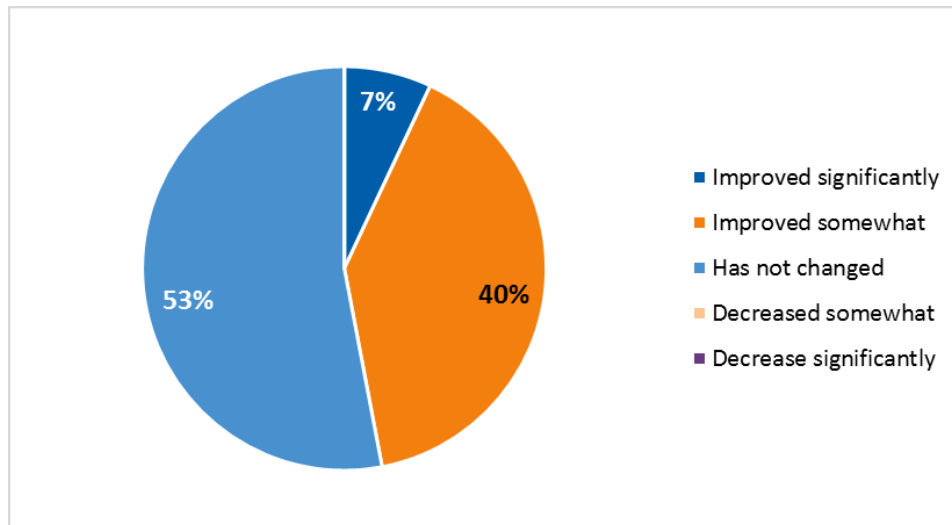
Rating Classification	Percentage of Respondents (n=15)
Promoters (9-10)	73%
Passives (7-8)	20%
Detractors (0-6)	7%
NPS	66

Source: Survey question "How likely is it that you would recommend this program to a friend, family member, or colleague?"

Opinion of PPL Electric Utilities

Survey respondents were asked if their opinion of PPL Electric Utilities had changed since participating in the Custom Program. The majority of respondents (53%, n=15) reported their opinion *had not changed*, 40% said their opinion *improved somewhat*, and 7% said their opinion *improved significantly*.

Figure F-35. Opinion Shifts of PPL Electric Utilities Due to Program

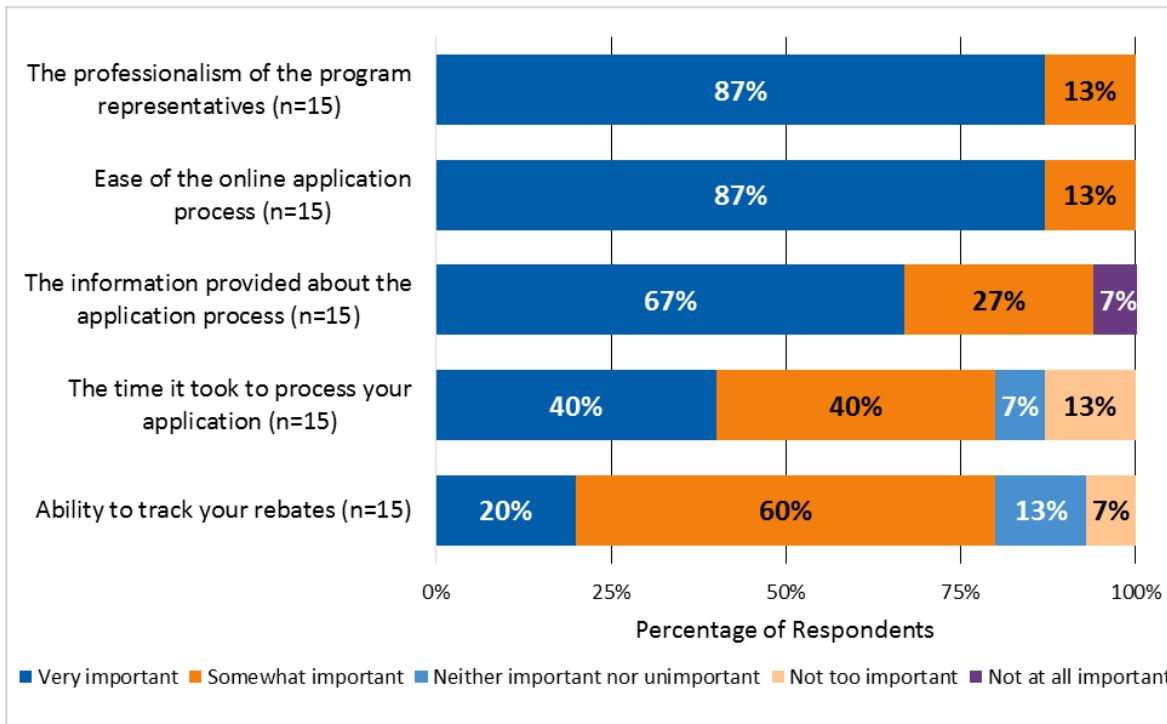


Source: Survey Question “After participating in the PPL Electric Utilities’ business energy efficiency program, has your opinion of PPL Electric Utilities improved significantly, improved somewhat, has not changed, decreased somewhat, decreased significantly?” (n=15)

Importance of Program Components

Survey respondents (n=15) were asked about the importance of different program components and results are shown in Figure F-36. The professionalism of program representatives and the ease of the online application process were most important to respondents.

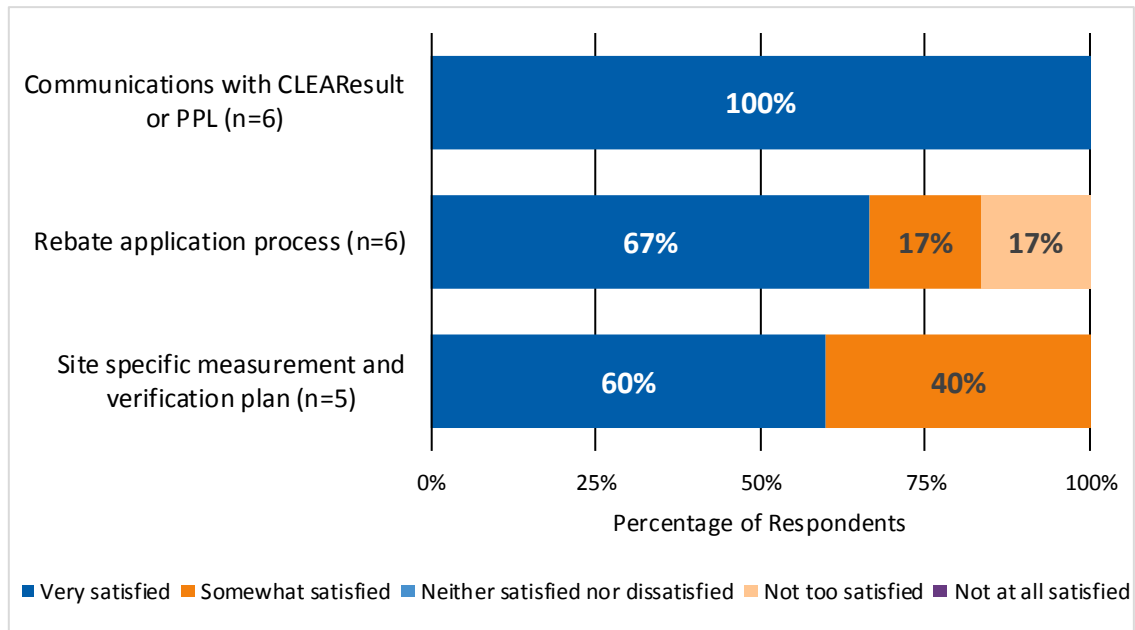
Figure F-36. Importance of Custom Program Components to Program Participants



Source: Survey question “Please indicate how important each of the following items are to you.”

Design Engineer and Contractor Satisfaction

Cadmus interviewed six design engineers and contractors about the satisfaction of participating in the Custom Program (Figure F-37). Four of six contractors said they enjoyed working with the ICSP. One said the application portal worked very well, and another said the application was “pretty good compared to other utilities.” Two said that customers usually did not want to do the application paperwork.

Figure F-37. Design Engineer and Contractor Satisfaction with Program Components

Source: Design engineer and contractor interview question "How satisfied were you with the following aspects of the program?"

Suggested Program Improvements

Eight of the 15 participant survey respondents had suggestions for program improvements:

- 3 suggested simplifying or streamlining the application process.
- 3 suggested providing more information up front, such as the requirements for participation, requirements for completing an application, and any changes in the rebate amount.
- 1 recommended not implementing a wait list (this respondent waited a long time for the incentive because of the waitlist implemented at the end of Phase II).
- 1 recommended continuing to run the program even if funds run out.⁵⁵

Two of six design engineers and contractors also had suggestions for program improvements:

- 1 suggested providing clearer explanations of the requirements during the SSMVP process and making the process less time-consuming. This contractor also suggested adding incentives and support for daylight harvesting and skylights.⁵⁶
- 1 suggested offering design support and estimates of incentives for new construction projects.

⁵⁵ Continuing the program if funds run out is not allowed by the Pa PUC or PPL Electric Utilities.

⁵⁶ This equipment is offered in the Efficient Equipment Program.

Contractors and design engineers were also asked how the program could increase participation and five of the six provided suggestions:

- 3 recommended advertising more.
- 1 suggested providing customers with a recommended contractor list. Note that PPL Electric Utilities' website does provide a "Find a Contractor" page so users can search for local contractors by equipment or service.⁵⁷
- 1 suggested keeping the program open during the entire phase and not implementing a wait list.

PPL Electric Utilities and the ICSP have worked to simplify the application process to request only the information required for rebate processing and savings calculations, and it is unlikely the application can be further simplified. PPL Electric Utilities and the ICSP could consider improving communications during the application process, since this was mentioned by three of 15 participants and one of six contractors. One method may be to increase awareness about the program website, which contains an overview of participation requirements, the application process and requirements, and the contractor list. PPL Electric Utilities has previously considered how best to approach the end of phase funding, and it has determined that the best approach is the wait list and adding a pre-application requirement to improve budget tracking.

Marketing and Outreach

The ICSP is primarily responsible for marketing and outreach with support from PPL Electric Utilities. The PPL Electric Utilities KAMs and business specialists also have an important role in marketing and customer outreach because they are frequently in contact with their customers and can provide information about the Custom Program. PPL Electric Utilities holds biannual meetings with its KAMs, business specialists, and the ICSP to discuss marketing messaging and ensure that all parties consistently convey information about the Custom Program.

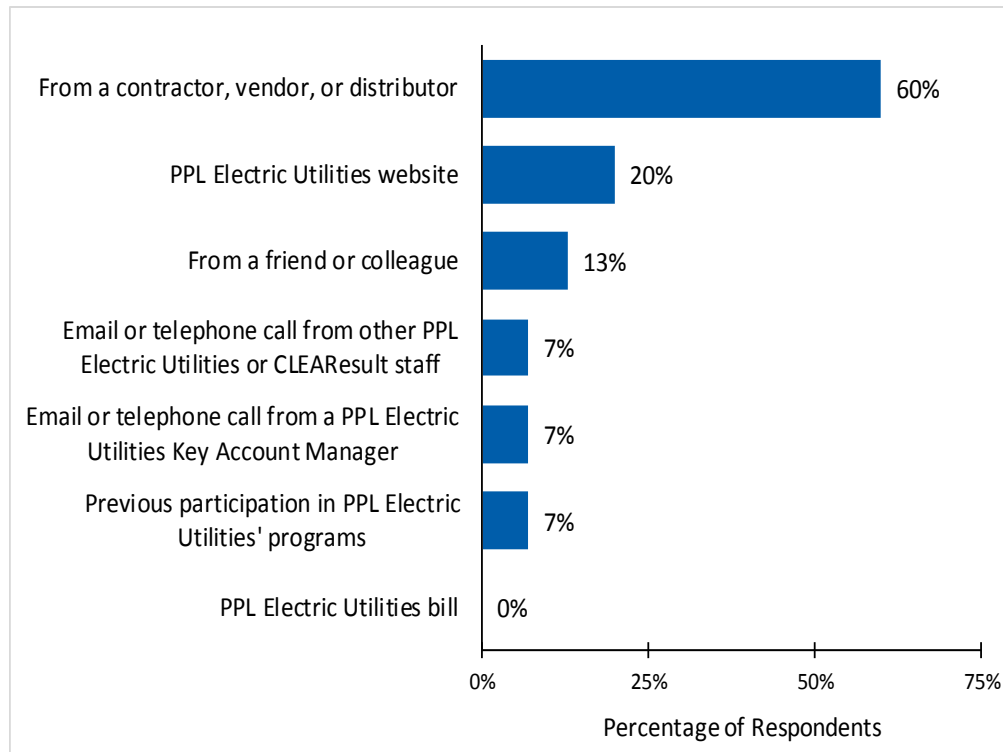
The ICSP creates webinars about specific industries and equipment types to help companies design projects to reduce their energy use. These webinars are available to trade allies and customers. KAMs and business specialists often present these webinars to encourage participation in PPL Electric Utilities' incentive programs.

PPL Electric Utilities and the ICSP also engage contractors and design engineers by sending them newsletters and holding lunch and learn meetings about new technologies and new opportunities to help customers save energy. The ICSP is also tracking and contacting the most active contractors and design engineers to increase their awareness of energy efficiency opportunities. This effort has been particularly important in driving customer participation, with most participants (60%, n=15) learning about the program from their contractor.

⁵⁷ PPL Electric Utilities. "Contractor Search." Accessed online September 2017:
<https://www.pplelectricbusinesssavings.com/contractor-search>

Figure F-38 shows how participant survey respondents (n=15) learned about the Custom Program.

Figure F-38. How Customers Learned About the Custom Incentive Program



Source: Survey question "How did you first learn about PPL Electric Utilities' business energy efficiency program?" (n=15)

Online Engagement

Fifty-three percent (8 of 15) of survey respondents had visited PPL Electric Utilities' website within the past six months. The survey then asked these eight respondents about the usefulness of the website. Four said the website was *very useful*, three said it was *somewhat useful*, and one *did not know*.

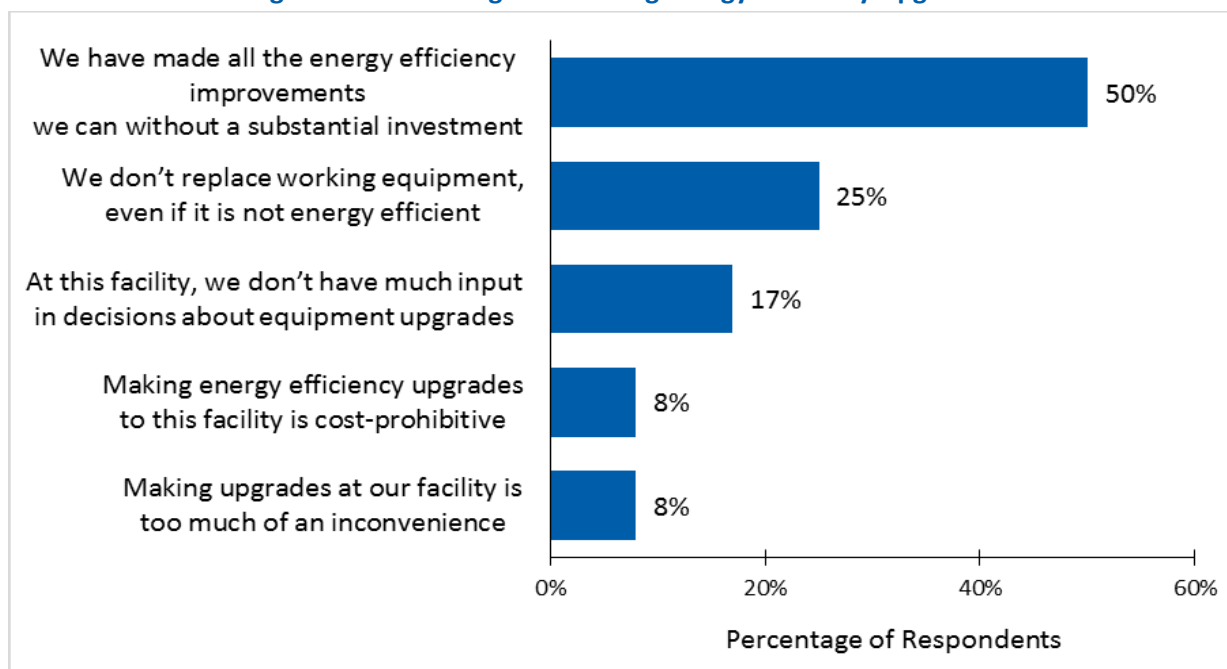
Three respondents provided recommendations to improve the website. One recommended making information easier to find, and one recommended adding tools to help scope potential projects. Although the Custom Program provides incentives to the GNE sector, one respondent said he was not able to determine whether the education sector qualified under the business energy efficiency program.

Attitudes Towards and Barriers to Saving Energy

PPL Electric Utilities' EE&C Plan identified three possible challenges that could hamper a successful implementation of the Custom Program: customers not prioritizing energy efficiency, customers replacing equipment only when it failed, and customers not aware of the benefits of the equipment.⁵⁸

Twelve of the 15 surveyed participants responded to scenarios posed in the survey, shown in Figure F-39. The most common scenario was that respondents had made all of the energy efficiency improvements they could without a substantial investment (50%). Three said they did not replace working equipment even if it was not energy-efficient, which was a challenge noticed in the EE&C Plan. This does seem to be a challenge for the Custom Program, as only five of the 15 respondents reported replacing working equipment, and two reported their replaced equipment had no problems.

Figure F-39. Challenges to Making Energy Efficiency Upgrades



Source: Participant survey question "Of the scenarios listed below that companies might face when purchasing new appliances or considering energy-efficient improvements, please indicate which are true for you" (n=12)

To address these potential challenges, the ICSP is providing more information to customers at various points during their project implementation about how energy efficiency projects provide benefits beyond energy savings. This information focuses on energy reliability, societal environmental impacts, increase in sales, and shorter payback.

Design engineers and contractors were also asked about challenges they or their customers faced when participating in the Custom Program. Two said the paperwork was a challenge. One said the difficulty of

⁵⁸ From PPL Electric Utilities Corporation. *Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642 Compliance Filing before the Pennsylvania Public Utility Commission. December 5, 2016. p. 93, 119, and 144.

scheduling project implementation to fit customers' operations schedules but added this would be a challenge for any new equipment, regardless of efficiency level. The other three did not cite any challenges.

F.3.3 Sample Cleaning and Attrition for Participant Surveys

Cadmus coordinated with the ICSP to screen the sample and remove the records of any customers who had been called in the past three months (whether for a Cadmus survey or a PPL Electric Utilities survey) or had requested not to be contacted again and any records with incomplete information.

This cleaning and survey sample preparation process reduced the available sample from 71 to 64. Cadmus sent online survey invitations to the 64 contacts with email addresses and followed up with two reminder email invitations. If the contact did not complete an online survey, Cadmus contacted the participants by telephone. Cadmus attempted to reach respondents up to five times over several days, at different times of the day, and scheduled callbacks whenever possible. Table F-78 lists the total records used for surveys and the outcome (final disposition) of each record.

Table F-78. Custom Program Participant Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Online	
Population (number of unique jobs) ^[1]	71
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on "do not contact" list	7
Removed: incomplete or invalid email address	0
Survey Sample Frame (email invitations sent)	64
Email was returned (bounce back)	2
Did not respond	54
Opt out	0
PPL Electric Utilities or market research employee	1
Cannot confirm project location	0
Did not complete survey	2
Completed Surveys	5
Online Response Rate	8%
Telephone	
Population (number of unique jobs) ^[1]	71
Removed: inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on "do not contact" list	33
Removed: incomplete or invalid phone number	0
Survey Sample Frame (used for telephone survey calls) ^[2]	38
Not attempted ^[3]	0
Records Attempted	38
Non-working number	0
Wrong number, business	0
Language barrier	0
PPL Electric Utilities or market research employee	0
Cannot confirm equipment/not aware of participation	0
Refusal	0
No answer/answering machine/phone busy	26
Non-specific or specific callback scheduled	2
Terminated survey	0
Completed Surveys	10
Telephone Response Rate	26%
Total Completed Surveys (total for all modes)	15
Overall Response Rate (for both modes)	23%

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Appendix G. Evaluation Detail—Home Energy Education Program

G.1 Gross Impact Evaluation

G.1.1 Database Review Findings

Cadmus compared the treated customers in PPL Electric Utilities' tracking database to the ICSP's tracking data. There were 184,257 treatment customers in both databases, resulting in 100% database accuracy. However, Cadmus noted the following:

- 1,218 treatment customers appeared in both databases but, according to Cadmus' legacy data, had gone inactive prior to the beginning of PY8 treatment.
- 41,181 treatment customers appeared in Cadmus' legacy data and not in the ICSP tracking database. These customers were all active in PY8. Although the majority of these customers were likely the low-propensity customers dropped from PY8 treatment, 21% of Low-Income Wave 1 customers and 25% of Low-Income Wave 2 customers (a total of 16,831 low-income wave customers) were missing from the ICSP database and could not be accounted for by attrition.

Cadmus included all customers in its regression analysis that were included its legacy tracking data or the tracking data from the ICSP's subcontractor. However, when estimating program savings, Cadmus only considered customers as treated if they were included in the ICSP's tracking data.

G.2 Process Evaluation

G.2.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In February of 2017, Cadmus conducted interviews with the program managers from PPL Electric Utilities, the ICSP, and the home energy reports vendor. The interviews focused on the program design and implementation processes, such as the various delivery channels and educational offerings, to identify areas that are working well, determine if any areas could benefit from changes, and discuss KPIs.

Treatment and Control Group Customer Surveys

Cadmus conducted 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 random sample of treatment and control group customers stratified by wave. For simplicity, waves were collapsed into the phase in which they had been launched rather than the year of deployment (Phase I Legacy Waves, Phase II Expansion Wave, and Phase III Expansion Wave).

The treatment and control group surveys did not include the low-income waves because of the delayed treatment of the low-income treatment group customers. Since they received only one home energy report, they could not properly assess the program experience.

The treatment and control group surveys asked the same questions about specific energy-saving product adoption, adoption of energy-saving behavioral practices, familiarity with energy efficiency programs, and attitudes toward and barriers to energy efficiency. The treatment group survey asked additional questions about engagement with the educational offerings and satisfaction with the home energy reports. The control group survey asked additional questions about awareness of energy-saving tips and what sources customers used to find information.

Surveys employ the self-report method, which can result in validity issues and biases (e.g., self-selection, recall, social desirability). Cadmus designed the surveys to minimize such validity issues and biases using these best practices:

- Avoiding questions that are leading, ambiguous, or double-barreled
- Designing a single survey instrument with questions that flowed in the identical order for both the treatment and control groups
- Designing the survey with identical group questions at the beginning of the survey and group-specific questions near the end (creates an initial “double blind” effect for interviewers)
- Employing randomization of list-based survey items to reduce order effects
- Employing stratified random sampling

Cadmus provided clear interviewing and programming instructions so that the surveys were conducted consistently. The SWE team and PPL Electric Utilities reviewed and approved the surveys before fielding.

Cadmus completed 750 surveys with treatment and control customers and 56 surveys with low-propensity customers who opted out (discussed in next section). Table G-79 contains the final number of completed surveys by strata. The surveys assessed participant satisfaction for treatment group customers; the number of completed surveys produced a measurement of program satisfaction with $\pm 3\%$ precision at 90% confidence.

Table G-79. PY8 Home Energy Education Program’s Telephone Survey Summary

Audience	Strata	Population Size ^[1]	Target Sample Size	Achieved Sample Size
Treatment Group Customers	Phase I Legacy Waves	74,563	125	125
	Phase II Expansion Wave	39,569	125	125
	Phase III Expansion Wave	28,228	125	125
Treatment Group Subtotal		142,360	375	375
Control Group Customers	Phase I Legacy Waves	52,495	125	125
	Phase II Expansion Wave	10,320	125	125
	Phase III Expansion Wave	11,309	125	125
Control Group Subtotal		74,124	375	375
Low-Propensity Customers Who Did Not Opt Back In	N/A	17,540	70	56
Total Surveys Completed		234,024	820	806

^[1] The total number of customers in the treatment and control groups at the time of survey activity. These numbers may not match those reported in the impact analysis sections of this report due to different timing.

Low-Propensity Survey

Cadmus conducted a telephone survey with a random sample of low-propensity customers who did not opt back into the program after receiving the notice letter. The low-propensity survey was intended to understand why customers did not engage with the program and gain insights about their attitudes and behaviors regarding energy efficiency. The survey included questions addressing customers' reasons for not opting back in, specific energy-saving improvements made, frequency of energy-saving actions taken, familiarity with energy efficiency programs, attitudes toward and barriers to energy efficiency, and satisfaction. Cadmus applied similar survey design and data collection best practices as explained in the previous section.

Contact Instructions

PPL Electric Utilities provided survey contact instructions for conducting surveys. Customers could not be contacted for a survey if they completed a PPL Electric Utilities or Cadmus survey in the past three months, had opted out of a survey, or had asked not to be contacted again. Telephone survey calls could not take place on Sundays or national holidays.

See *Section G.2.3* for sampling cleaning and attrition.

Survey Data Analysis

To analyze the survey data, Cadmus compiled frequency outputs, coded open-end survey responses, and ran statistical tests. To determine whether survey results significantly differed between the treatment and control groups and between waves, Cadmus ran t-tests for differences in proportions and means set at the 5% ($p \leq 0.05$) and 10% ($p \leq 0.10$) significance levels.

Cadmus reported survey results at the program level and applied statistical weights to the treatment and control group survey data at the wave level to reflect actual program population proportions. Table G-80 shows the wave-level statistical weights applied to the treatment and control group survey responses. Weighted survey data are indicated by the notation n_w . Cadmus did not apply any statistical weights to the low-propensity survey data because the analysis did not have group or wave comparisons.

Table G-80. Statistical Weights for Treatment and Control Group Customer Survey Data

Group and Wave Stratum	Population Count ^[1]	Proportion of Population	Survey Sample Achieved	Proportion of Total Survey Sample	Statistical Weight ^[2]
Treatment Group - Phase I Legacy Waves	74,586	34.4%	125	16.7%	2.07
Treatment Group - Phase II Expansion Wave	39,573	18.3%	125	16.7%	1.10
Treatment Group - Phase III Expansion Wave	28,228	13.0%	125	16.7%	0.78
Control Group - Phase I Legacy Waves	52,512	24.3%	125	16.7%	1.46
Control Group - Phase II Expansion Wave	10,320	4.8%	125	16.7%	0.29
Control Group - Phase III Expansion Wave	11,309	5.2%	125	16.7%	0.31
Total	216,528	100.0%	750	100.0%	N/A

^[1] The total number of customers in the treatment and control groups at the time of the survey activity. These numbers may not match those reported in the impact analysis sections of this report due to different time periods.

^[2] The statistical weight is calculated by dividing the proportion of population by the proportion of total survey sample.

G.2.2 Findings

This section presents detailed findings from interviews and surveys. The survey data include the percentage or frequency of responses, followed by the sample size for the specific question. Sample size (denoted by “n”) refers to the number of respondents who were asked the question, not the number who answered. Note that sample sizes vary according to each question according to survey logic and skipped questions. Whenever applicable, Cadmus compared PY8 customer survey results to the PY6 customer survey results.⁵⁹

Program Delivery

The Phase III PY8 Home Energy Education Program quickly made the transition to a new ICSP and new home energy report vendor (the ICSP’s subcontractor). Other program delivery changes were a new home energy report, the late inclusion of the low-income waves, the low-propensity removal process, and new online services.

New home energy report vendor and product. The PY8 Home Energy Education Program maintained the overall program design from Phase II but changed to a different report vendor. In Phase I and Phase II, Oracle Utilities Opower (formerly doing business as Opower) developed and distributed the reports. Beginning in PY8 of Phase III, Tendril developed and distributed the reports. The new report vendor changed the look and content of the report somewhat. Table G-81 summarizes key similarities and differences between the Phase II and Phase III home energy reports.

⁵⁹ PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

Table G-81. Key Similarities and Differences between Phase II and Phase III PY8 Home Energy Reports

Report Component	Phase II Home Energy Report (Oracle Utilities Opower)	Phase III PY8 Home Energy Report (Tendrill)
Overall Look and Feel	Has an infographic look and feel	Has a business letter look and feel
Neighbor Comparison	Uses the term “neighbor” and bases the comparison on proximity (average distance in miles)	Uses the term “nearby households” and bases the comparison on proximity and building characteristics (type of heating, square footage, year built, etc.)
Household Usage Data	Shows a line graph of 12-month household usage data compared to all neighbors and efficient neighbors	Shows a line graph of 12-month household usage data compared to average homes and efficient homes
Energy-Saving Tips	Provides two or three tips with detailed text and dollar savings per year	Provides two or three tips with detailed text and dollar savings per year
Cross-Program Marketing	Alternates promotion of other PPL Electric Utilities’ energy efficiency programs; provides web link on where to find more ways to save	Alternates promotion of other PPL Electric Utilities’ energy efficiency programs; provides web link on where to find more ways to save
Report Accuracy	Asks customers to contact the program’s call center and provide correct or updated home details to improve accuracy of the report	Asks customers to complete the online home energy assessment to improve accuracy of the report

Notably, PPL Electric Utilities said that since the home energy report no longer used the term “neighbor” the number of customer complaints to the program call center nearly ceased.

Late inclusion of the low-income waves. PPL Electric Utilities and the ICSP initially discontinued the two low-income waves from Phase II for the Phase III program. However, when they realized program savings were not on track to meet the estimated savings for PY8, they decided to reinstate the two low-income waves and send home energy reports to these customers in the last two months of PY8. Nevertheless, this did not allow enough time to generate substantial savings.

Low-propensity removal process. The PY8 Home Energy Education Program offered the usual voluntary opt-out process as well as a unique involuntary opt-out process specifically for low-propensity customers. Low-propensity customers are customers in the treatment group who are predicted to have low engagement with the program and not to benefit from the home energy reports. This PPL Electric Utilities’ behavior program has been around for many years and savings have leveled off over time; identifying low-propensity customers contributed toward filling the Phase III expansion wave with customers who are predicted to be more engaged.

The home energy reports vendor reviewed pre- and post-treatment usage data and conducted a common traits analysis. The vendor identified approximately 17,540 low-propensity customers and sent them a notice letter explaining they would stop receiving the home energy reports unless they opted back in by replying to a survey linked in the letter. Customers had up to three months to opt back in. A total of 181 low-propensity customers opted back in.

New online services. In PY8, the program launched two new online services, the energy management portal and an online home energy assessment. To create a single, seamless customer experience, the Home Energy Education Program integrated its energy management portal into PPL Electric Utilities’

Customer Engagement Hub (a website with information about all of the available rebates). All PPL Electric Utilities' customers have access to the Customer Engagement Hub and the energy management portal; treatment group customers received additional encouragement in the home energy reports to visit the energy management portal.

The energy management portal offers customers a place for the following:

- Set energy savings goals
- Receive recommendations for reaching energy savings goals
- Check off any completed actions toward goals
- View disaggregated usage data
- Update their home profile by completing a home energy assessment, which is used to further customize their home energy reports

Despite being able to track the number of visits to the portal, the ICSP and the home energy reports vendor did not have the ability to track who visits the portal (treatment or control group customer).

Key Performance Indicators

In addition to the program's energy savings, PPL Electric Utilities and the ICSP set one KPI, customer satisfaction with the home energy reports. As shown in Table F-72, PPL Electric Utilities and the ICSP did not meet the customer satisfaction goal.

Table G-82. Home Energy Education Program Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
Customer Satisfaction with Program (i.e., Home Energy Reports)	Percentage of customers satisfied with the home energy reports	80% or more of surveyed customers report they are satisfied with the reports.	Did not meet goal. 73% of surveyed customers were satisfied. Specifically 36% were <i>very satisfied</i> and 37% were <i>somewhat satisfied</i> .

Logic Model Review

A logic model identifies the relationships between the program activities and expected results. The Home Energy Education Program had a similar logic model to the Phase II Residential Energy-Efficiency Behavior and Education Program with only one exception; the Home Energy Education Program had one additional output from its program activities (the energy management portal). Cadmus reviewed the Home Energy Education Program's logic model and determined that the program operated as expected in PY8. Table G-83 shows the program logic model's expected and actual outcomes.

Table G-83. Home Energy Education Program Logic Model Review

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
Develop customer education and normative messaging about energy use	Program Activities	Delivered program activities as expected
Tailored print and electronic home energy reports; energy management portal	Outputs Produced by Program Activities	Delivered outputs as expected
Residential customers become better informed about their energy use and more aware of energy efficiency.	Short-term Outcomes	Produced short-term outcomes as expected
Residential customers take actions to reduce their energy use through product and/or behavior change adoption.	Intermediate Outcomes	On track to produce intermediate outcomes as expected. According to the customer surveys, treatment group customers reported installing LEDs.
Residential customers continue to take energy-saving actions, possibly with minimal encouragement (e.g., fewer home energy reports).	Long-term Outcomes	To be determined at the end of Phase III

Treatment and Control Group Customer Profile

The customer surveys also collected demographic details about the treatment group and control group customers, as shown in Table I-114. Survey results showed no significant differences, which suggests treatment and control group respondents were demographically similar. The majority of treatment group customers (home energy report recipients) had the following characteristics:

- Lived in a single-family detached residence (89%)
- Averaged 58 years of age
- Had completed some college education or more (69%)
- Had an annual household income of \$60,000 or greater (66%)

Table G-84. Home Energy Education Program Customer Survey Demographics

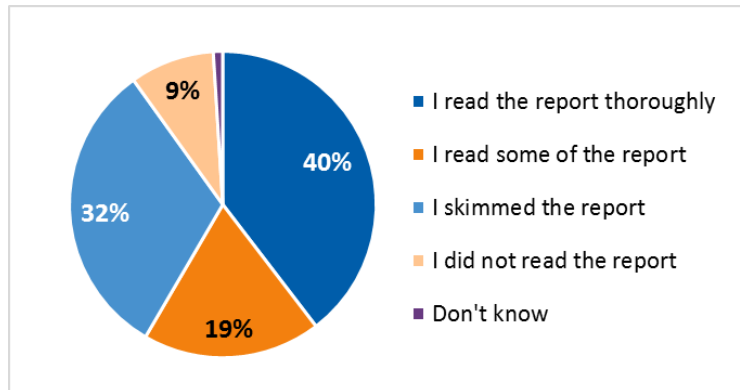
What type of residence do you live in? Is it...	Treatment Group (n _w =470)	Control Group (n _w =246)
A single-family detached residence	89%	87%
Multifamily apartment or condo building with 4 or more units	1%	1%
Attached house (townhouse, row house, or twin)	6%	7%
Mobile or manufactured home	2%	3%
Something else	1%	2%
What is the highest level of education that you have completed?	Treatment Group (n _w =463)	Control Group (n _w =241)
Less than high school diploma or equivalent	4%	4%
High school diploma or equivalent	26%	22%
Technical or business school certificate/two-year college degree/some college	26%	30%
Four-year college degree/bachelor's degree	24%	22%
Graduate or professional degree/masters or PhD	19%	22%
What year were you born?	Treatment Group (n _w =446)	Control Group (n _w =237)
Mean birth year (age)	1959 (58 years old)	1958 (59 years old)
Standard deviation	14.3 years	14.4 years
In 2016, what was your annual household income before taxes? Please stop me when I read your category. Was it...	Treatment Group (n _w =368)	Control Group (n _w =172)
Under \$10,000	0%	1%
\$10,000 to under \$15,000	1%	2%
\$15,000 to under \$20,000	2%	3%
\$20,000 to under \$25,000	2%	4%
\$25,000 to under \$30,000	4%	5%
\$30,000 to under \$35,000	3%	5%
\$35,000 to under \$40,000	7%	5%
\$40,000 to under \$45,000	2%	3%
\$45,000 to under \$50,000	3%	5%
\$50,000 to under \$60,000	8%	7%
\$60,000 to under \$75,000	13%	12%
\$75,000 to under \$100,000	23%	17%
\$100,000 to under \$150,000	15%	16%
\$150,000 to under \$200,000	9%	9%
\$200,000 or more	7%	6%

Readership of the Home Energy Reports

The survey responses showed high overall readership of the home energy reports (91%, 447 of n_w=492), although the time and level of attention paid to the reports varied. Specifically, 40% of treatment group respondents said they read the report thoroughly, 19% said they read some of the report, and 32% said they skimmed the report. Only 9% of respondents (44 of n_w=492) said they did not read the report. Figure G-40 shows the readership level of the home energy reports. PY8's readership level did not differ

from PY6 (the last time a survey was conducted), despite changing the report vendor and the design of the report. In PY6, the same readership question found that 43% (154 of n=358) of treatment group respondents said they read the report thoroughly, 21% said they read some of the report, 31% said they skimmed the report, and 5% did not read the report.

Figure G-40. PY8 Readership of Home Energy Reports



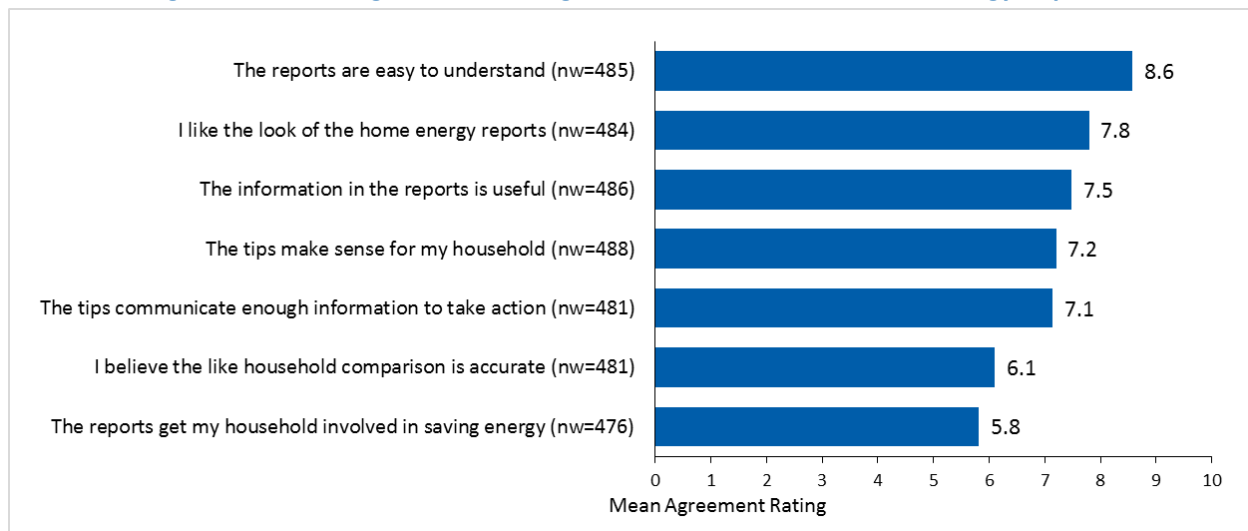
Source: Customer survey question, "Which of the following statements best describes what you did with the last Home Energy Report you received?" (n_w=492). Respondents could skip questions.

There was no significant difference between the treatment wave respondents on overall readership. However, significantly more Phase II respondents (39%, n_w=136) than Phase III respondents (26%, n_w=98) said they skimmed the report.⁶⁰

Reception to the Home Energy Reports

The survey asked treatment group respondents to agree or disagree with seven statements about the home energy reports using a 10-point scale, where 0 meant strongly disagree and 10 meant strongly agree. As shown in Figure G-41, the mean agreement ratings showed that respondents found the reports easy to understand, liked the look of the reports, and found the information in the reports useful.

⁶⁰ Difference is statistically significant, $p \leq 0.05$.

Figure G-41. PY8 Agreement Ratings to Statements About Home Energy Reports

Source: Customer survey question, "To what extent do you agree or disagree with the following statements about the Home Energy Reports? Use a 0 to 10 scale where 10 means strongly agree and 0 means strongly disagree." Respondents could skip questions.

Notably, Cadmus found a significant improvement in customer's perception of the neighbor comparison with the PY8 home energy reports. In the PY6 customer surveys, treatment group respondents gave a mean agreement rating of 4.8 (n=292) for the statement "I believe the neighbor comparison is accurate." In the PY8 customer surveys, which assessed the new home energy reports, treatment group respondents gave a significantly higher mean agreement rating of 6.1 (n_w=481) for the statement "I believe the like household comparison is accurate."⁶¹ Phase III treatment wave respondents gave a significantly higher mean agreement rating (7.2, n_w=95) compared to Phase I (5.3, n_w=252) and Phase II (5.8, n_w=134) treatment wave respondents.⁶² Phase III treatment wave respondents had been exposed only to the new home energy reports while the Phase I and Phase II treatment wave respondents had had a long history with the old home energy reports.

Net Promoter Score

The NPS is a metric of brand loyalty that measures how likely customers are to recommend the program (or product in this case) to others. Respondents rate their likelihood to recommend the program on a 10-point scale where 0 means "not at all likely" and 10 means "extremely likely." Respondents giving a rating of 9 or 10 are known as promoters, a rating of 7 or 8 are known as passives, and a rating of 0 to 6 are known as detractors. The NPS is expressed as a number between -100 and +100 that represents the difference between the percentage of promoters and detractors.

⁶¹ Difference is statistically significant, p≤0.05.

⁶² Difference is statistically significant, p≤0.05.

As shown in Table F-77, the home energy reports achieved an NPS of -25, indicating there are more detractors (50%) than promoters (25%) among the treatment group respondents. However, Phase III treatment wave respondents had a significantly lower proportion of detractors (34%) than Phase I (50%) and Phase II (57%) treatment wave respondents.⁶³ The NPS findings align with the results for program satisfaction and the perception of the neighbor comparison; Phase III treatment wave respondents were the most satisfied with the home energy reports and gave the highest agreement rating for the neighbor comparison accuracy statement. Addressing the accuracy of the reports may help to improve the NPS, though this will likely be more difficult with customers in the older waves.

Table G-85. Net Promoter Score: Likelihood to Recommend the Home Energy Reports

Rating Classification	Percentage of Respondents (n _w =479)
Promoters (9-10)	25%
Passives (7-8)	24%
Detractors (0-6)	50%
NPS	-25
Source: Customer survey question, "How likely is it that you would recommend the Home Energy Reports to a friend, family member, or colleague? Use a 0 to 10 scale where 10 is extremely likely and 0 is not at all likely."	

Opinion of PPL Electric Utilities

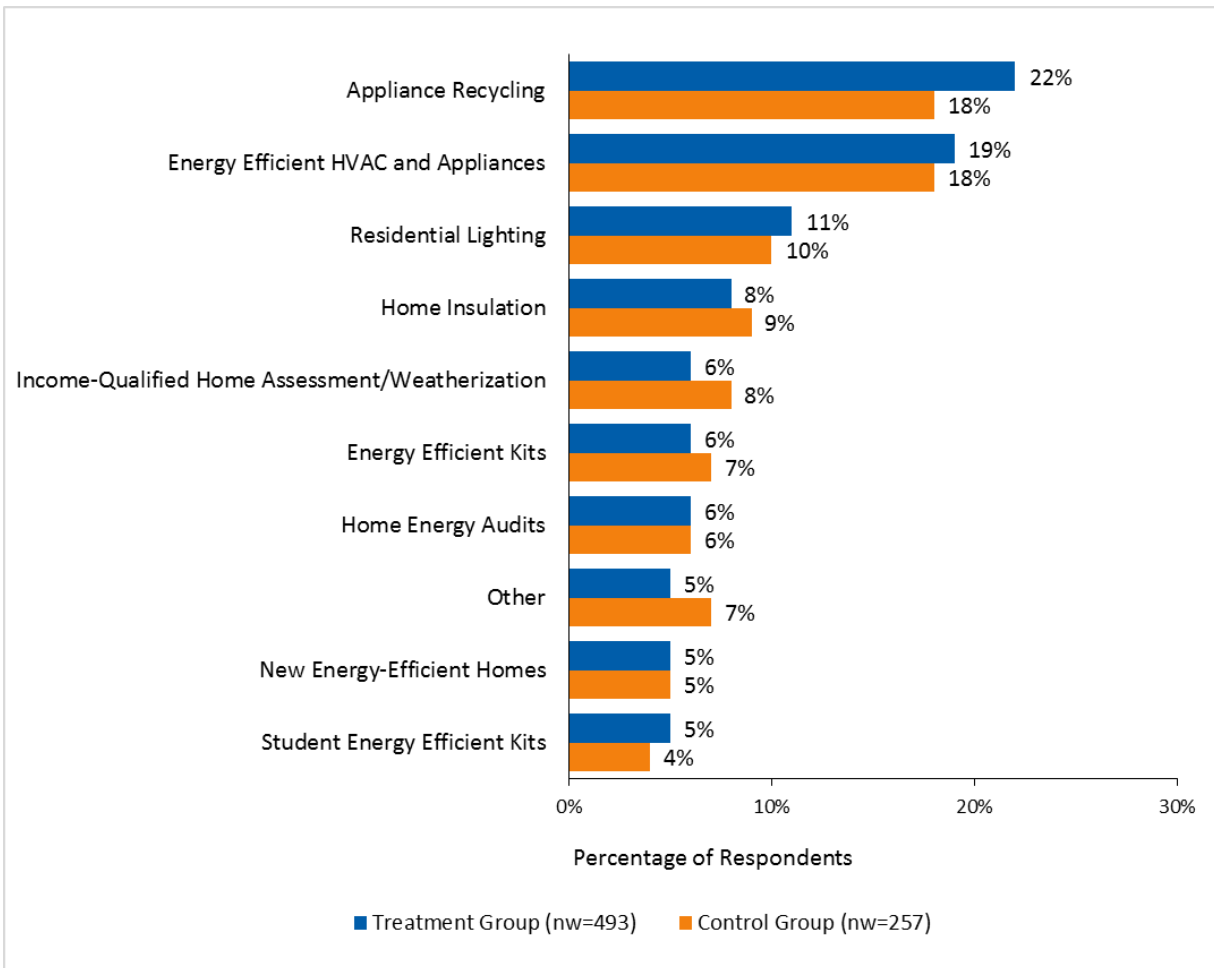
The majority of treatment group respondents (66%, n_w=477) did not change their opinion of PPL Electric Utilities after receiving the home energy reports. For the remaining respondents, 8% said their opinion of PPL Electric Utilities had *improved significantly*, 23% said their opinion *improved somewhat*, 1% said their opinion *decreased somewhat*, and less than 1% said their opinion *decreased significantly*. These PY8 shifts of opinion did not differ from PY6. In PY6, 64% of respondents did not change their opinion, 6% said their opinion *improved significantly*, 25% said their opinion *improved somewhat*, 3% said their opinion *decreased somewhat*, and 1% said their opinion *decreased significantly* (n=358).

Awareness of Energy Efficiency Programs

In PY8, the home energy reports promoted all residential energy efficiency programs offered by PPL Electric Utilities. Cadmus expected to see differences in awareness of energy efficiency programs by group. However, no differences emerged between treatment and control group respondents, as shown in Figure G-42; similar proportions of treatment and control group respondents had heard about the residential energy efficiency programs. A very large proportion of all customers reported they had not heard of any rebate programs at all (43% of treatment group respondents and 45% of control group respondents).

⁶³ Difference is statistically significant, p≤0.05.

Figure G-42. PY8 Awareness of Energy Efficiency Programs



Source: Customer survey question, "What energy efficiency rebates or programs have you heard about that PPL Electric Utilities offers?" (multiple answers allowed). Respondents could skip questions.

Some significant, and unexpected, differences emerged at the wave level. A significantly higher proportion of Phase III control wave respondents ($n_w=39$) than Phase III treatment wave respondents ($n_w=98$) heard about these programs:

- Home Insulation (Phase III control wave 11%; Phase III treatment wave 4%)⁶⁴
- Student Energy Efficiency Kits (Phase III control wave 9%; Phase III treatment wave 3%)⁶⁵
- Home Energy Audits (Phase III control wave 9%; Phase III treatment wave 3%)⁶⁶

⁶⁴ Difference is statistically significant, $p \leq 0.05$.

⁶⁵ Difference is statistically significant, $p \leq 0.05$.

⁶⁶ Difference is statistically significant, $p \leq 0.05$.

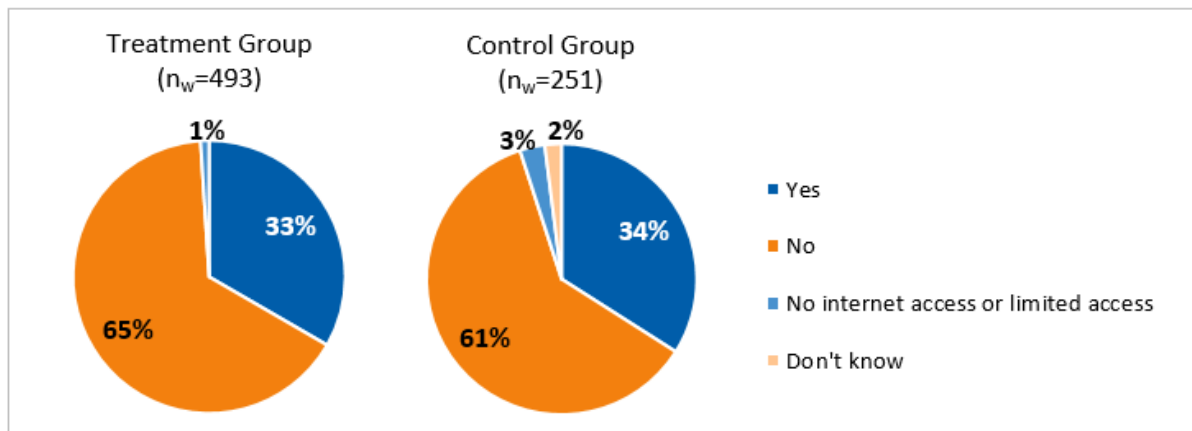
- New Energy-Efficient Homes (Phase III control wave 9%; Phase III treatment wave 4%)⁶⁷

The lack of group differences may be explained by PPL Electric Utilities' mass marketing efforts and customer access to its Customer Engagement Hub and energy management portal. Treatment and control group customers get the same exposure and access to mass marketing efforts, the Customer Engagement Hub, and the energy management portal. These awareness findings do not align with the uplift findings where treatment group customers participated in energy efficiency programs at a higher rate than control group customers.

Online Engagement

Treatment and control group respondents did not differ in reported visits to PPL Electric Utilities' website. As shown in Figure G-43, 33% of treatment group respondents and 34% of control group respondents reported visiting the utility website in the past six months.

Figure G-43. PY8 Self-Reported Visits to PPL Electric Utilities' Website



Source: Customer survey question, "Have you visited the PPL Electric Utilities' website in the past six months?" Respondents could skip questions. May not equal 100% due to rounding.

Of the respondents who said "yes" to visiting to the website, the survey asked a follow-up question about whether they had visited the section called "Ways to Save," which is the energy management portal.

Cadmus expected to see group differences in visits to the portal because treatment group customers received encouragement in the home energy reports to visit the portal. However, Cadmus found no differences between groups; 56% of treatment group respondents (n_w=165) and 55% of control group respondents (n_w=85) reported visiting the portal.

⁶⁷ Difference is statistically significant, p≤0.10.

However, a difference emerged at the wave level. A significantly higher proportion of Phase III treatment wave respondents (69%, $n_w=35$) reported visiting the portal than Phase III control wave respondents (51%, $n_w=14$).⁶⁸

The PY8 home energy reports were designed to encourage customers to take the online home energy assessment and enter detailed information about their home, in exchange for a kit that includes energy-saving products. This would improve the data accuracy in the reports, and the comparison of similar households. Cadmus reviewed the participation uplift of the online home energy assessment component of the Energy Efficient Home Program and found minimal positive participation uplift; on average, treatment group customers participated in the online assessment at a rate of 0.75%, or 0.04 customers (per 1,000 customers), more than customers in the control group. The home energy reports slightly increase the rate of treatment group customers completing the online home energy assessment over the control group customers.

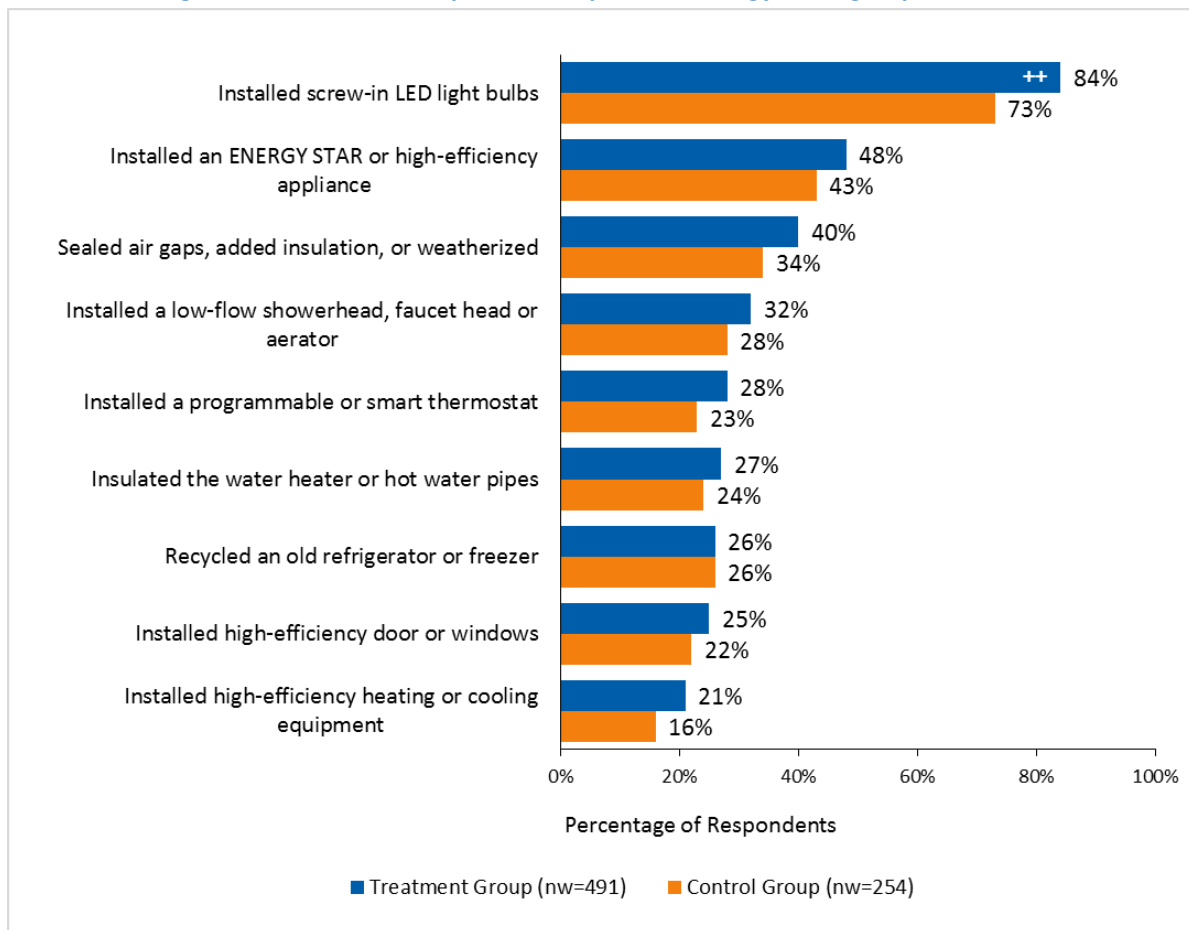
Self-Reported Adoption of Energy-Saving Improvements

The customer surveys asked treatment and control group respondents if in the last 12 months they had adopted any of the nine energy-saving improvements listed in Figure G-44. For eight of the nine energy-saving improvements, Cadmus found no significant differences between treatment and control group respondents. A significant difference emerged only for the installation of LED light bulbs. More treatment group respondents (84%) than control group respondents (73%) reported installing LED light bulbs.⁶⁹ Wave-level results varied and some significant differences were detected, but there were no consistent patterns to establish a clear finding.

⁶⁸ Difference is statistically significant, $p \leq 0.10$.

⁶⁹ Difference is statistically significant, $p \leq 0.05$.

Figure G-44. PY8 Self-Reported Adoption of Energy-Saving Improvements



++ Difference is statistically significant, $p \leq 0.05$.

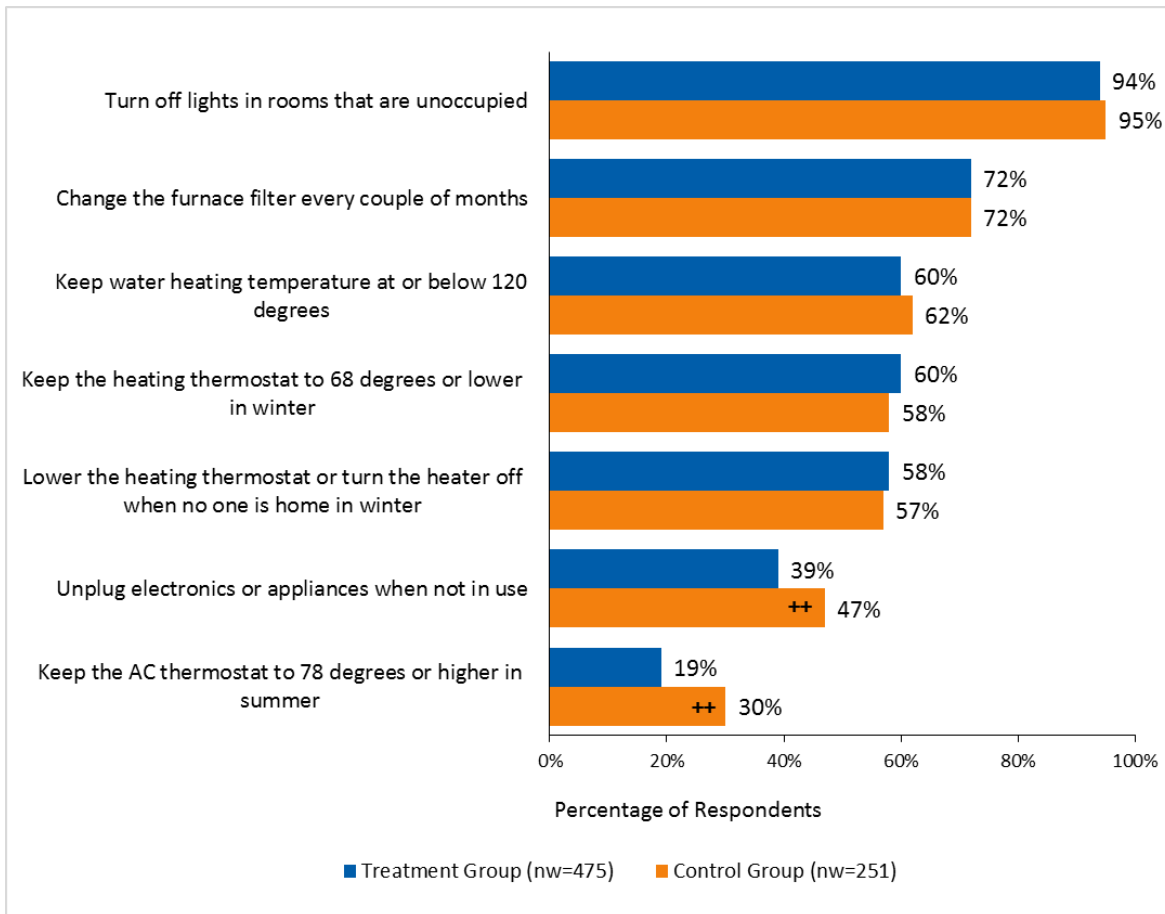
Source: Customer survey question, "I will read a list of energy-saving home improvements. Tell me yes or no whether you have done any of these in the past 12 months." Respondents could skip questions.

Self-Reported Energy-Saving Behavioral Practices

The customer surveys also asked treatment and control group respondents if they had adopted any of the seven energy-saving behavioral practices listed in Figure G-45. For five out of these, Cadmus found no significant differences between treatment and control group respondents. For unplugging electronics/appliances when not in use and for keeping the air conditioner thermostat to 78 degrees or higher in summer, the control group respondents reported significantly higher adoption than did treatment group respondents.⁷⁰ Wave-level results varied and some significant differences were detected, but there were no consistent patterns to establish a clear finding.

⁷⁰ Difference is statistically significant, $p \leq 0.05$.

Figure G-45. Self-Reported Adoption of Energy-Saving Behavioral Practices

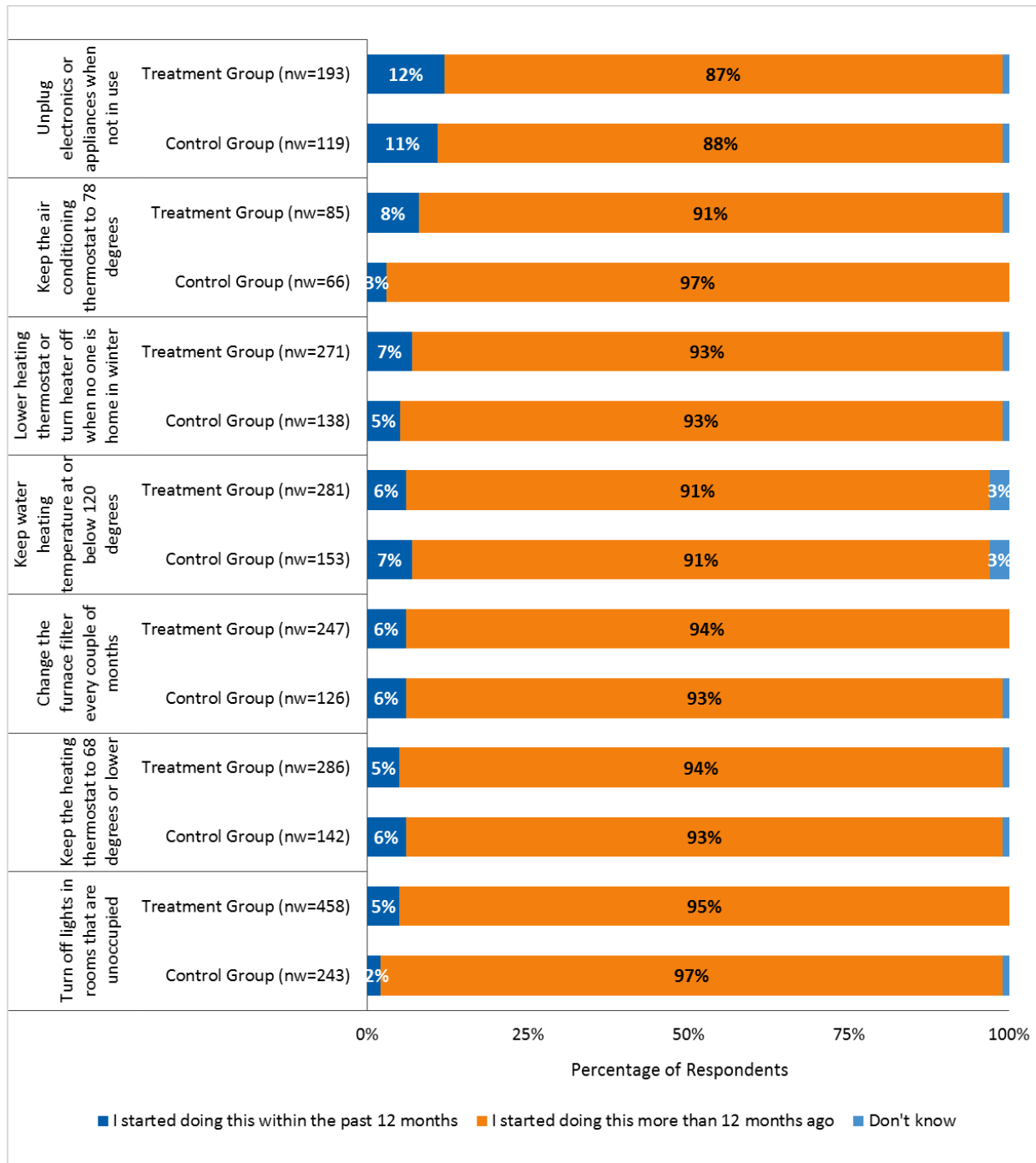


++ Difference is statistically significant, $p \leq 0.05$.

Source: Customer survey question, "I'd like to ask you about your everyday energy-using habits. I will read a list. For each item, please tell me yes if you do this or no if you do not do this." Respondents could skip questions.

For respondents who said "yes" to adopting the behavioral practices, the customer survey asked a follow-up question about when they started each practice—either within the past 12 months or more than 12 months ago. There were no significant differences between treatment and control group respondents. Figure G-46 shows that a large majority of treatment and control customers began engaging in these practices more than 12 months ago. Wave-level results varied and some significant differences were detected, but there were no consistent patterns to establish a clear finding.

Figure G-46. When Customers Started Practicing Energy-Saving Behaviors



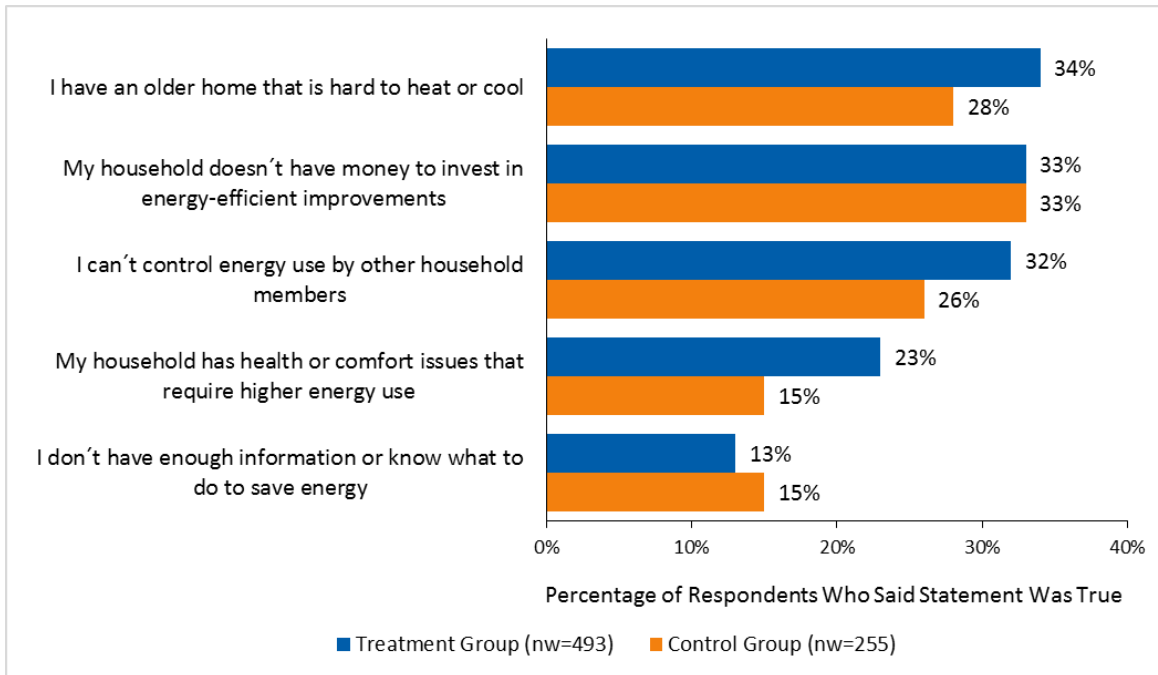
Source: Customer survey question, "I'm going to read you the habits you just said "yes" to. For each one, please tell me if you started doing this within the past 12 months or if you started doing this more than 12 months ago."

Attitudes Toward and Barriers to Saving Energy

To assess barriers to saving energy, the survey asked if each of the five statements shown in Figure G-47 resonated as true to the respondent. Treatment and control group respondents showed no significant

differences in four of the five statements, indicating that these customers largely face similar barriers. For the statement, “My household has health or comfort issues that require higher energy use,” more treatment group respondents (23%) than control group respondents (15%) said the statement was true.⁷¹

Figure G-47. PY8 Customer Attitudes Toward and Barriers to Saving Energy



Source: Customer survey 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 answer yes if this is true for you or no if it is not." Respondents could skip questions.

There were significant differences detected at the wave level where a higher proportion of Phase III treatment wave respondents said the following statements were true compared to the other waves:

- “My household doesn't have money to invest in energy-efficient improvements” (Phase III treatment wave 41%, $n_w=98$; Phase II treatment wave 30%, $n_w=122$)⁷²
- “I have an older home that is hard to heat or cool” (Phase III treatment wave 37%, $n_w=98$; Phase I control wave 28%, $n_w=182$)⁷³
- “My household has health or comfort issues that require higher energy use” (Phase III treatment wave 23%, $n_w=98$; Phase I control wave 14%, $n_w=180$)⁷⁴

⁷¹ Difference is statistically significant, $p \leq 0.05$.

⁷² Difference is statistically significant, $p \leq 0.10$.

⁷³ Difference is statistically significant, $p \leq 0.10$.

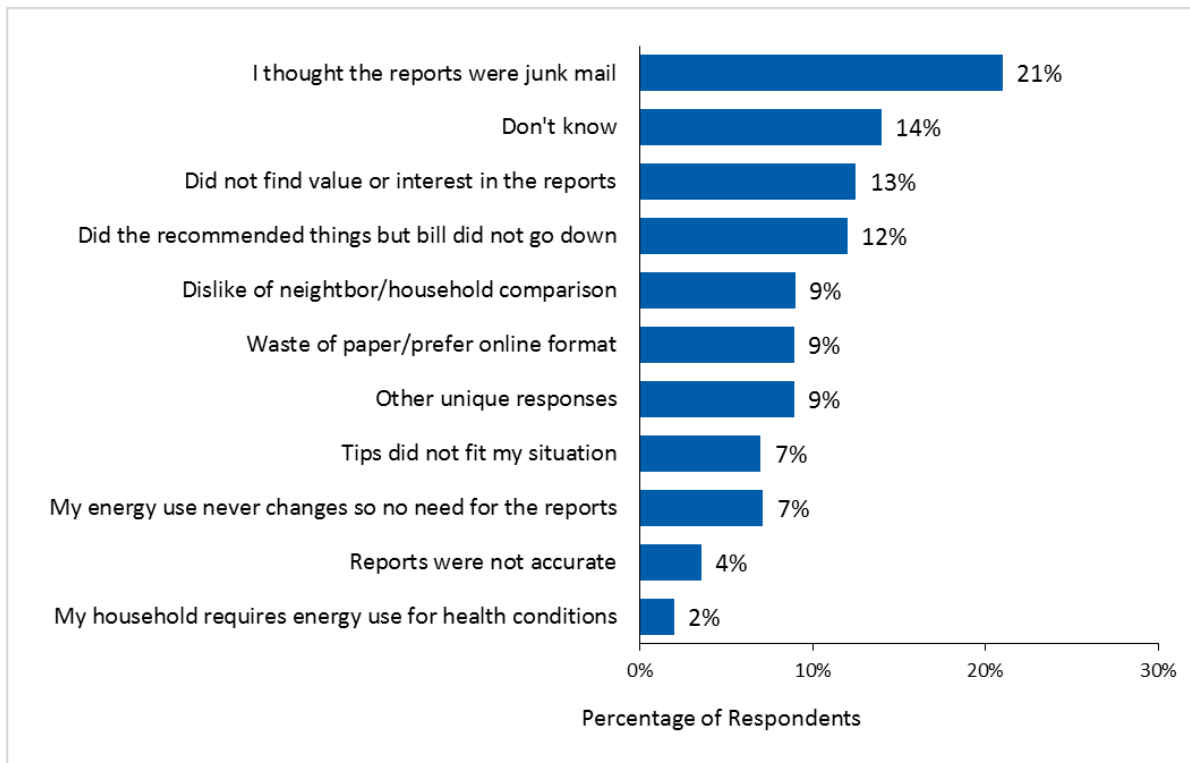
⁷⁴ Difference is statistically significant, $p \leq 0.05$.

Low-Propensity Customers and Reasons for Not Opting Back In

Low-propensity customers are those customers in the treatment group whom the home energy reports vendor identified as exhibiting low engagement with the program. The vendor sent these customers a notice letter that they would automatically stop receiving the home energy reports unless they opted back in by replying to a survey linked in the letter. A total of 181 low-propensity customers opted back in after receiving the notice letter, and 17,359 were removed from the program. The survey included a screening question for low-propensity customers who did not opt back in, and this question revealed that of the 474 low-propensity customers contacted for the survey, 55% did not remember seeing the notice letter.

The 45% of customers who did remember seeing the notice letter had various reasons for deciding to stop receiving the home energy reports. As shown in Figure G-48, 21% of low-propensity respondents thought the reports were junk mail and cited this as their reason for opting out. Fourteen percent did not know why they did not opt back in, and 13% said they did not find value or interest in the reports.

Figure G-48. Low-Propensity Customers' Reasons for Not Opting Back In



Source: Low-propensity survey question, "Could you tell me a little more about your decision to stop receiving the Home Energy Reports?" (multiple answers allowed) (n=56). Respondents could skip questions.

Identical to the customer survey for the treatment group, the low-propensity survey asked respondents to rate their likelihood to recommend the home energy reports on a 10-point scale (i.e., the net promoter score question). The low-propensity removed group had significantly more detractors (70%,

n=56) than the treatment group across all three waves (50% Phase I, $n_w=248$; 57% Phase II, $n_w=136$; 34% Phase III, $n_w=95$).⁷⁵

G.2.3 Sample Cleaning and Attrition for Surveys

Cadmus coordinated with PPL Electric Utilities' contractor to screen the sample and remove the records of any customers called in the past three months (whether for a Cadmus survey or a PPL Electric Utilities survey), had requested not to be contacted again, or had incomplete information.

Table F-78 and Table G-87 list total number of records submitted and the outcome (final disposition) of each record.

Table G-86. Treatment and Control Group Customer Survey Sample Attrition Table

Description of Call Outcomes	Number of Records	
	Treatment Group	Control Group
Population (Number of Unique Customers) ^[1]	142,360	74,124
Telephone		
Removed incomplete or bad phone number, inactive customer, completed survey in past 3 months, on "do not contact" list, opted out of survey, selected for a different survey, duplicate contact	5,449	2,587
Incomplete or bad phone number	1,683	852
Not Selected for Survey Sample Frame ^[2]	127,728	63,185
Survey Sample Frame (sent to subcontractor for telephone survey calls) ^[3]	7,500	7,500
Not Attempted ^[3]	45	116
Records Attempted	7,455	7,384
Nonworking number	1,105	908
Wrong number, business	136	96
No answer/answering machine/phone busy	4,490	4,930
Language barrier	24	23
Screener - PPL Electric Utilities or market research employee	73	63
Screener - Did not receive home energy report	140	--
Screener - Not involved in paying utility bills	--	9
Refusal	432	288
Terminated survey	41	14
Non-specific or specific callback scheduled	533	569
Partial complete (only included in satisfaction findings analysis)	106	109
Completed Surveys	375	375
Response Rate	5%	5%
^[1] Number of records available in ICSP's database at the time of the final survey effort. The count does not include the low-income waves.		
^[2] Not selected for sample because of more records than were needed for the telephone survey.		
^[3] Selected for sample but target was reached before attempted.		

⁷⁵ Difference is statistically significant, $p \leq 0.10$.

Table G-87. Low-Propensity Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Population (Number of Unique Customers) ^[1]	17,540
Telephone	
Removed incomplete or bad phone number, inactive customer, completed survey in past 3 months, on "do not contact" list, opted out of survey, selected for a different survey, duplicate contact	6,644
Incomplete or bad phone number	682
Not Selected for Survey Sample Frame ^[2]	0
Survey Sample Frame (sent to subcontractor for telephone survey calls) ^[2]	10,214
Not Attempted ^[3]	6,945
Records Attempted	3,269
Nonworking number	1,196
Wrong number, business	167
No answer/answering machine/phone busy	28
Language barrier	28
Screener - PPL Electric Utilities or market research employee	48
Screener - Did not recall receiving notice letter	260
Screener - Did not opt out of receiving home energy reports	70
Refusal	304
Terminated survey	72
Non-specific or specific callback scheduled	1,040
Partial complete (only included in satisfaction findings analysis)	28
Completed Surveys	56
Response Rate	2%
^[1] Number of records available in ICSP's database at the time of the final survey effort.	
^[2] Not selected for sample because of more records than were needed for telephone survey.	
^[3] Selected for sample but was not attempted due to low incidence rate.	

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Appendix H. Evaluation Detail – Energy Efficiency Kits and Education Program

H.1 Gross Impact Evaluation

H.1.1 Methodology

EM&V Sampling Approach

Table H-88 lists the Energy Efficiency Kits and Education Program sampling strategy for the impact evaluation. The impact evaluation activities produced program-level energy results with $\pm 1.41\%$ precision at 85% confidence. Note that Cadmus collected data from phone surveys in multiple waves. As a result, Cadmus did not include all the phone surveys into the *ex post* verified savings estimates. However, it did use all phone surveys to test for significant differences in ISRs between those who returned surveys and those who did not.

Table H-88. Energy Efficiency Kits and Education Program Impact Evaluation Sampling Strategy

Stratum	Population Size ^[1]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size ^[2]	Evaluation Activity
Agency	2,409	N/A ^[3]	All available	241	ICSP-collected paper survey included in the kit
		90/10	70	104 ^[4]	Non-responder phone survey (did not return the paper survey)
Direct Mail	9,649	N/A	All available	1,668	ICSP-collected paper survey included in the kit
		90/10	70	128 ^[4]	Non-responder phone survey (did not return the paper survey)
Program Total	12,058			2,141	

^[1] Number of unique kits not returned to the ICSP, not the unique records in PPL Electric Utilities' tracking database, which includes returned kits.

^[2] Number includes partially completed surveys. Respondents could skip questions.

^[3] Cadmus used survey responses collected by the ICSP from all participants who returned their surveys. Therefore, Cadmus did not have an assumed proportion of Cv.

^[4] Cadmus completed a greater number of phone surveys than targeted because of multiple waves of data collection. As a result, 34 phone surveys contributed to the agency savings estimate, and 62 phone surveys contributed to the direct mail savings estimate. Cadmus used additional phone surveys to test for significant differences in ISRs between those who returned paper surveys and those who did not.

Survey Methodology

Each kit distributed through the program included a paper survey for the participant to complete and mail back to the ICSP. These surveys, which were approved by PPL Electric Utilities, collected the necessary data to calculate installation rates and determine the participant actions taken because of the program. Cadmus also conducted a phone survey with a sample of participants who received a kit but did not return a paper survey.

Cadmus used these survey data to investigate the difference in ISRs between those who returned a paper survey and those who did not return the paper survey but did complete a phone survey. Data were used to calculate ISRs and *ex post* per-unit savings for each item in the energy-savings kit. The process of using survey data to calculate *ex post* savings is described in greater detail in *Section H.1.1 Methodology*. Cadmus also relied on survey responses in the process evaluation, which is described in more detail in *Section H.2.1 Agency Interviews*.

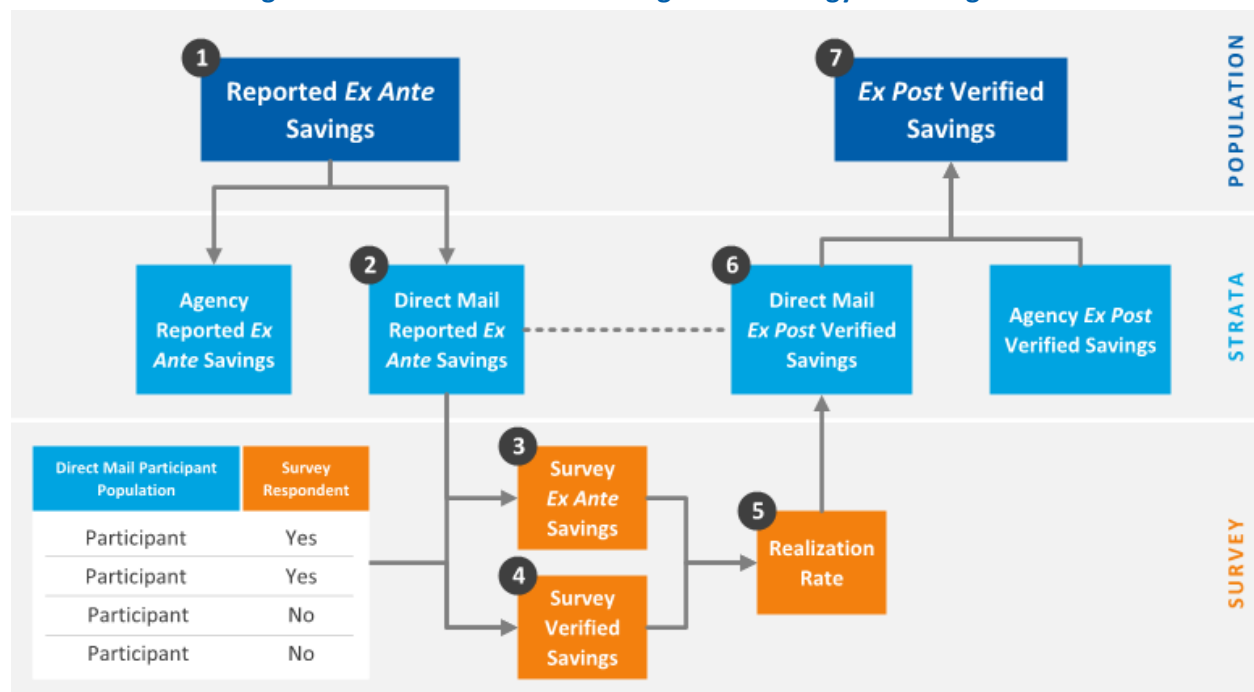
Potential sources of bias in the surveys include nonresponse, recall, and social desirability. Cadmus addressed these by applying best practices in survey design and survey data collection. Surveys did not include leading or ambiguous questions nor double-barreled questions. Cadmus provided clear interviewing and programming instructions so that they were implemented consistently. The SWE team and PPL Electric Utilities reviewed and approved surveys before fielding.

Cadmus conducted five interviews with agencies that deliver the program their clients. Cadmus randomly selected two low-distributing, two high-distributing, and one middle-distributing agencies for the interviews. The objectives of these interviews were to better understand how agencies deliver the program to their clients, their satisfaction with the ICSP, PPL Electric Utilities, and the program overall, and where they see areas of improvement.

Ex Post Verified Savings Methodology

Cadmus estimated *ex post* verified savings for the Energy Efficiency Kits and Education Program for each stratum and for the program overall using the ICSP-reported savings, paper and phone survey responses, and data from enrollment cards collected by the ICSP. Figure H-49 presents a flow diagram of the methodology. The rest of this section describes these items in the methodology in greater detail.

Figure H-49. Ex Post Verified Savings Methodology Flow Diagram



Reported *Ex Ante* Savings (Figure H-49, Items 1 & 2)

Cadmus collected reported savings recorded in PPL Electric Utilities' tracking database for each product and kit distributed to the population of program participants. Part of Cadmus' quality control process for evaluating this program involved understanding how the ICSP calculated reported savings, so Cadmus verified that the ICSP had calculated per-unit savings per the ISRs and the PA TRM inputs specified in PY8 plans and had made similar assumptions to Cadmus' in assigning savings to program participants.

Survey *Ex Ante* and Survey Verified Savings (Figure H-49, Items 3, 4 & 5)

Cadmus estimated stratum-level (agency or direct mail) realization rates using individual survey responses for the sample of program participants who returned a survey or responded to the phone survey. Cadmus assigned per-unit survey *ex ante* and survey verified savings to every participant, kit, and product in the survey data. Survey *ex ante* and survey verified savings are defined as follows:

- **Survey *ex ante* savings** are reported *ex ante* savings assigned to the subset of program participants who returned a survey and provided enough information to verify their savings for a particular product. Survey *ex ante* savings incorporate participants' information, such as water heater configuration and type of home, from the enrollment cards.
- **Survey verified *ex post* savings** are Cadmus' verification of savings assigned to the subset of program participants who returned a survey and provided enough information to verify their savings for a particular product. Survey verified savings incorporate data from both the enrollment cards and participants' responses to survey questions about product installations.

Assigning Survey *Ex Ante* and Survey Verified Savings

Cadmus assigned survey *ex ante* and survey verified savings to program participants based on the criteria listed in Table H-89.

Table H-89. Criteria for Assigning Survey *Ex Ante* and Survey Verified Savings

Criteria	Survey <i>Ex Ante</i> Savings ^[1]	Survey Verified Savings
Whether the respondent answered the product-specific question(s)	✓	✓
How the participant answered questions on the enrollment card about home characteristics	✓	✓
How the respondent answered the questions asking if products were installed		✓
How the respondent answered questions about actions taken that could result in behaviorally based energy savings		✓
^[1] Cadmus used the ICSP-reported <i>ex ante</i> savings for survey- <i>ex ante</i> savings based on the listed criteria. The ICSP incorporated information from the enrollment cards when calculating reported <i>ex ante</i> savings.		

Table H-90 shows how Cadmus assigned survey *ex ante* and survey verified savings to each program participant and product, a showerhead in this example. Cadmus included participants in the realization rate analysis if it could definitively verify whether the participant achieved savings for a particular product. In cases where it could not verify savings, because the participant either did not return a survey or did not respond to the necessary installation question, Cadmus did not include savings in the realization rate analysis for that particular product.

Table H-90. Example of Assigning Survey *Ex ante* and Survey Verified Savings

Program Participant (PPL Tracking Database)	Electric Water Heater (Enrollment Card)	Population Total <i>Ex Ante</i> kWh/yr (ICSP)	Survey Respondent (Survey Data)	Installed Product (Survey Data)	Survey <i>Ex ante</i> kWh/yr	Survey Verified kWh/yr	Savings Included in Realization Rate
Participant A	Yes	230.46	Yes	Yes	230.46	360.09	Yes
Participant B	Yes	230.46	Yes	No	230.46	0	Yes
Participant C	Yes	230.46	Yes	Yes	230.46	360.09	Yes
Participant D	No	0	Yes	Yes	0	0	Yes
Participant E	Yes	230.46	Yes	No Response	N/A	N/A	No
Participant F	No Response	230.46	Yes	No	230.46	0	Yes
Participant X	Yes	230.46	No	N/A	N/A	N/A	No
Participant Y	Yes	230.46	No	N/A	N/A	N/A	No
Participant Z	No	0	No	N/A	N/A	N/A	No

The example provides four distinct scenarios:

- **Participants A, B, C, & D.** Cadmus had enough information to verify showerhead savings for these participants. Their showerhead survey *ex ante* and survey verified savings were included in the realization rate.
- **Participant E.** Although Participant E returned a survey, Cadmus could not confirm if the showerhead from the kit had been installed because the participant did not answer that question. Therefore, Cadmus did not include this participant's showerhead survey *ex ante* and survey verified savings in the realization rate. However, Participant E's responses about other products could still be included in the realization rate analysis.
- **Participant F.** This participant responded to all the necessary survey questions for Cadmus to verify showerhead savings. Although this participant did not answer the question about the type of water heater in the home, Cadmus could verify showerhead savings because the participant did not install the showerhead. Therefore, Cadmus assigned 0 kWh/yr survey verified savings and included the showerhead savings in the realization rate analysis.
- **Participants X, Y, & Z.** These participants did not return a survey, so Cadmus could not verify savings for any of their products.

Cadmus assigned survey verified savings using information from the enrollment card, specifically water heater configuration, clothes washing location, type of home heating, type of home cooling, and type of home. The ICSP assigned reported savings based on the data uploaded to PPL Electric Utilities' tracking database. Although there should be no discrepancies between data in PPL Electric Utilities' tracking database and in the enrollment cards, Cadmus investigated both sources and confirmed the correct information with the ICSP when the two sources did not match. Cadmus found several differences between the database and the enrollment cards and verified with the ICSP that the enrollment cards reflected the most accurate information. Cadmus therefore used information from the enrollment card and not the database to assign survey verified savings.

Cadmus calculated realization rates for each stratum as the ratio of survey verified savings to survey *ex ante* savings. Because the kit contains one survey that asks questions about each item, survey responses for products may be correlated within customers. Cadmus accounted for these correlations by rolling savings up to the kit level prior to calculating realization rates and precision.

Calculating Survey Verified Savings

Cadmus independently calculated survey verified savings per the PA TRM and the associated algorithms.⁷⁶ These algorithms involve open variables for which the ICSP or Cadmus can use either the default or the option of “EDC data gathering.” Table H-91 lists the algorithm inputs and sources of the data collected.

Table H-91. 2016 PA TRM Open Variables

Product	Survey Data	Enrollment Card	Kit Specification Sheet
LED	ISR		Bulb wattage
LED Nightlight	ISR		Bulb wattage
Low Flow Showerhead	ISR	Water heater fuel type, type of home	Low flow GPM
Kitchen Faucet Aerator	ISR	Water heater fuel type, type of home	Low flow GPM
Tier 2 Advanced Power Strip	ISR, Equipment plugged into smart strip		
Furnace Whistle	ISR	Home heating fuel type, home cooling configuration	
Adjusting Thermostat for Cooling in the Summer	ISR	Home cooling configuration	
Adjusting Thermostat for Heating in the Winter	ISR	Home heating fuel type	
Water Heater Temperature Setback	ISR	Water heater fuel type, laundry location	

Ex Post Verified Savings (Items 6 & 7)

To calculate stratum-level *ex post* savings, Cadmus applied the stratum-level realization rates to stratum *ex ante* savings and took the sum of stratum-level *ex post* savings to estimate the program-level *ex post* savings. Cadmus calculated confidence and precision for the *ex post* savings and realization rate estimates in each stratum and for the program as a whole.

H.1.2 Database Review Findings

Cadmus reviewed PPL Electric Utilities’ program tracking database for all PY8 records for Energy Efficiency Kits and Education Program participants. It reviewed the PPL Electric Utilities account numbers, kit numbers, and home characteristics and compared these to information from the enrollment cards recorded in the ICSP’s electronic database to ensure that records were traceable between both databases.

⁷⁶ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016.

Prior to Cadmus' review of the database, PPL Electric Utilities' tracking database listed a total of 12,056 kits across 12,057 participants. Cadmus discovered several discrepancies and accounted for them as follows:

- Sixty-four kit numbers and account numbers appeared in both the direct mail electric and non-electric survey data. The ICSP confirmed that this occurred because of a glitch in its tracking application resulting from the two types of kits offered beginning in PY8. Cadmus removed all duplicate surveys under the incorrect kit type.
- In two cases, a kit number was associated with two different PPL Electric Utilities account numbers. Cadmus confirmed that the ICSP's subcontractor's enrollment data showed these kits belonged to two different accounts; this correction increased the overall count in PPL Electric Utilities' tracking database by two kits.
- One kit was present in PPL Electric Utilities' tracking database but not in the enrollment data. Cadmus confirmed with the ICSP that this kit was delivered to the participant and applied *ex post* savings to this kit.
- The enrollment data showed 13 kits had been returned but were not flagged in PPL Electric Utilities' tracking database; therefore, these kits received positive reported *ex ante* savings. Cadmus confirmed with the ICSP that these kits were returned and applied 0 *ex post* savings to these kits.

As a result of the review, Cadmus increased the total distribution to 12,058 program kits, representing 100% database accuracy for the program, as shown in Table H-92.

Table H-92. Accuracy of PY8 Data for Energy Efficiency Kits and Education Program

Sector	Product	PY8 Kits in PPL Electric Utilities' Tracking Database	Database Accuracy	PY8 Verified Kits
Low-Income	Energy-savings kit	12,056	100%	12,058

H.1.3 Survey Findings

In-Service Rates

Cadmus estimated ISRs for all products in the energy-savings kits. Table H-93 provides these ISRs and the ISRs the ICSP used for planning. Compared to the PY7 program (formerly the E-Power Wise Program),⁷⁷ the ISR for the LED bulbs dropped in PY8, most likely because the PY8 kits increased from two to six LED bulbs, and the first and second bulbs still achieved comparable ISRs. On average, participants in the agency stratum installed 4.96 of the LED bulbs provided in the kits, and participants in the direct mail stratum installed 4.83 of the six LED bulbs provided in the kits. The ISRs for furnace

⁷⁷ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

whistles also dropped—from 44% in PY7 to 32% in PY8 for the agency stratum and from 49% in PY7 to 38% in PY8 for the direct mail stratum.⁷⁸ Instead of the energy education ISR, Cadmus provided the average per-participant verified energy education savings and recommends that the ICSP apply the same savings to participants' *ex ante* savings in PY9.

Table H-93. PY8 Energy Efficiency Kits and Education Program Product-Level ISRs

Product	Agency		Direct Mail	
	Survey-Gathered ISR	ICSP Planning ISR	Survey-Gathered ISR	ICSP Planning ISR
LED Bulbs	84%	96%	82%	98%
First Bulb	97%	96%	98%	98%
Second Bulb	95%	96%	95%	98%
Third Bulb	92%	96%	91%	98%
Fourth Bulb	85%	96%	80%	98%
Fifth Bulb	71%	96%	66%	98%
Sixth Bulb	65%	96%	59%	98%
LED Nightlight	88%	87%	90%	92%
Low-Flow Showerhead	63%	64%	65%	72%
Kitchen Faucet Aerator	63%	63%	67%	75%
Tier 2 Advanced Power Strip	68%	77%	69%	83%
Furnace Whistle	32%	17%	38%	20%
Energy Education ^[1]	170.36 kWh/yr	253 kWh/yr	172.65 kWh/yr	253 kWh/yr

^[1] Cadmus suggests the ICSP use the average per-participant energy education savings for their *ex ante* energy education savings estimates.

Heating and Cooling Saturations

Cadmus estimated the saturation of electric heating, eligible cooling systems, and electric water heating among program participants using the enrollment card information provided by the ICSP, as shown in Table H-94. Eligible cooling systems included central air conditioners and air source heat pumps. As expected, the large majority of participants who received an electric kit had electric water heating, despite the glitch in the ICSP's tracking database that allowed electric kits to be sent to some non-electric customers. That glitch was corrected during PY8.

Note that few customers with non-electric water heaters had electric home heating in both the agency and direct mail strata. This may suggest that a separate energy education estimate should be used for reported *ex ante* savings for customers who receive a non-electric kit, because adjusting thermostats for heating in the winter, which relies on the customer having electric heat in the home, contributes a substantial amount to the overall energy education savings.

⁷⁸ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Table H-94. Electric Heating, Cooling, and Electric Water Heating Saturation

Stratum	Kit Type	Saturation ^[1]		
		Electric Heating	Eligible Cooling System	Electric Water Heating
Agency	Electric	58%	23%	100%
	Non-electric	6%	16%	0%
Direct Mail	Electric	50%	21%	95%
	Non-electric	17%	15%	0%

^[1] Does not include participants who did not respond to this question.

H.1.4 Behavior Savings Methodology

Cadmus estimated the impacts of electric consumption associated with behavior changes by participants in the Energy Efficiency Kits and Education Program using calculations derived from a combination of engineering estimates, secondary research, and survey data. These savings estimates were associated with the following behavior changes:

- Lowering the water heater temperature
- Washing more loads of laundry in cold water
- Adjusting the home thermostat per the heating or cooling season

The next sections provide details about the algorithms Cadmus used to estimate savings for these three behavior changes. Note that Cadmus applied the same energy education savings algorithms to participants of the Low-Income Winter Relief Assistance Program (WRAP) in PY8. See chapter 12 *Weatherization Relief Assistance Program* for details.

Water Heater Temperature Reduction

The Energy Efficiency Kits and Education program encourages participants to reduce the temperature setting of their electric water heater to save energy. Cadmus estimated savings for this action by following the PA TRM engineering calculation provided in Equation H-4.⁷⁹ The first term in this equation corresponds to the savings from tank losses, and the second term corresponds to savings from the clothes washer, as a result of changing the water heater setting. Equation H-5 is the algorithm Cadmus used to determine demand savings for reducing the water heater temperature.

Equation H-4

$$\Delta kWh/yr = \frac{A_{tank} \times (T_{hot\ i} - T_{hot\ f}) \times 8760 \frac{hrs}{yr}}{R_{tank} \times \eta_{elec} \times 3412 \frac{Btu}{kWh}} + \frac{V_{HW} \times \left(8.3 \frac{lb}{gal}\right) \times \left(365 \frac{days}{yr}\right) \times \left(1 \frac{Btu}{F \cdot lb}\right) \times (T_{hot\ i} - T_{hot\ f})}{\left(3412 \frac{Btu}{kWh}\right) \times EF_{WH}}$$

Equation H-5

$$\Delta kW_{peak} = E_{TDF} \times \Delta kWh/yr$$

⁷⁹ Pennsylvania Public Utility Commission. *Pennsylvania Technical Reference Manual*. June 2016.

Table H-95 provides a description of the variables in Equation H-4 and Equation H-5.

Table H-95. Protocol Inputs for Electric Water Heater Temperature Reduction Algorithm

Product	Input	Ex Post Savings Input		
		Source	Value	Notes
Electric Water Heater Temperature Reduction	Water heater fuel type ^[1]	Enrollment Card	Data gathering	Provided by the ICSP
	Washing machine located in home ^[1]	Enrollment Card	Data gathering	Provided by the ICSP
	Energy factor of water heater (EF_{WH})	TRM Default	0.904	Section 2.3.6; Table 2-64
	R value of electric water heater tank (R_{tank})	TRM Default	8.3	Section 2.3.6; Table 2-64
	Surface area of water heater tank (A_{tank})	TRM Default	24.99 sq. ft.	Section 2.3.6; Table 2-64
	Thermal efficiency of electric heater element (η_{elec})	TRM Default	0.98	Section 2.3.6; Table 2-64
	Volume of hot water used per day by clothes washer (V_{HW})	TRM Default	7.32 gallons/day	Section 2.3.6; Table 2-64
	Temperature setpoint of electric water heater initially (T_{hot_i})	TRM Default	130°F	Section 2.3.6; Table 2-64
	Temperature setpoint of electric water heater after setback (T_{hot_f})	TRM Default	119°F	Section 2.3.6; Table 2-64
	Energy to demand factor ($ETDF$)	TRM Default	0.00008047	Section 2.3.6; Table 2-64

^[1] Required to assign savings; not considered an open variable but ICSP is required to collect.

Cadmus applied Equation H-4 and Equation H-5 to survey respondents who indicated on the enrollment card that the home had an electric water heater. Respondents who indicated the home did not have an electric water heater received zero electric savings for water heater temperature setback.

Furthermore, Cadmus applied the clothes washer portion of savings (corresponding to the second term in the equation) only to participants who indicated on the enrollment card that they had a washing machine in their home or apartment. Respondents who wash their laundry at an on- or off-site public laundry facility were not eligible to receive the clothes washer portion of water heater temperature reduction savings.

Table H-96 provides the per-respondent savings applied to eligible participants.

Table H-96. Electric Water Heater Temperature Reduction Savings

Unit	Tank Loss	Clothes Washer	Total
kWh/yr	86.77	79.09	165.86
kW/yr	0.0070	0.0064	0.0134

Washing More Loads of Laundry in Cold Water

Cadmus estimated the savings associated with washing more loads of laundry in cold water, a behavior encouraged by the Energy Efficiency Kits and Education Program. Cadmus estimated these savings by following Equation H-6, in which the change in percentage of loads washed in cold water before and after the program is applied to the energy savings achieved when lowering the temperature of the water used by the clothes washer. Table H-97 provides a description of the variables in Equation H-6.

Equation H-6

$$\Delta kWh/yr = \frac{V_{HW} \times \left(8.3 \frac{lb}{gal}\right) \times \left(365 \frac{days}{yr}\right) \times \left(1 \frac{Btu}{F \cdot lb}\right) \times (T_{hot\ i} - T_{hot\ f})}{\left(3412 \frac{Btu}{kWh}\right) \times EF_{WH}} * (\Delta Loads\ Washed\ %)$$

Cadmus applied Equation H-5 to calculate the demand savings associated with this action.

In PY8, the paper survey did not include a question appropriate for determining any behavior change related to program participation. To determine the change in the percentage of loads washed in cold water, Cadmus applied the average change estimated in the PY7 evaluation of the Energy Efficiency Kits and Education Program (formerly the E-Power Wise Program).⁸⁰ Because these respondents could indicate no change (by responding with the same pre- and post-percentage of loads washed in cold water), Cadmus could apply clothes washer savings to all survey respondents with an electric water heater and in-home laundry and could adjust the starting temperature of water ($T_{hot\ i}$) depending on whether the respondent had lowered the water heater setting and thereby not double-count savings from water heater temperature setback.

⁸⁰ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Table H-97. Protocol Inputs for Washing Clothes in Cold Water Algorithm

Product	Input	Ex Post Savings Input		
		Source	Value	Notes
Washing More Loads of Laundry in Cold Water	Water heater fuel type ^[1]	Enrollment Card	Data gathering	Provided by the ICSP
	Washing machine located in home ^[1]	Enrollment Card	Data gathering	Provided by the ICSP
	Energy factor of water heater (EF_{WH})	TRM Default	0.904	Section 2.3.6; Table 2-64
	Volume of hot water used per day by clothes washer (V_{HW})	TRM Default	7.32 gallons/day	Section 2.3.6; Table 2-64
	Temperature setpoint of electric water heater (T_{hot_i})	TRM Default	130°F (did not change water heater setpoint); 119°F (did change water heater setpoint)	Section 2.3.6; Table 2-64
	Temperature setpoint of water supply (T_{hot_f})	TRM Default	55°F	Section 2.3.1; Table 2-45
	Change in percentage of loads washed in cold water ($\Delta Loads\ Washed\%$)	PY7 E-Power Wise Survey Data	17.81%	Cadmus verified in PY7
	Energy to demand factor ($ETDF$)	TRM Default	0.00008047	Section 2.3.6; Table 2-64

^[1] Required to assign savings; not considered an open variable but ICSP is required to collect.

Table H-98 provides the per-respondent savings applied to eligible participants.

Table H-98. Washing More Loads of Laundry in Cold Water Savings

Unit	Lowered Water Heater Setpoint	Did Not Lower Water Heater Setpoint
kWh/yr	81.95	96.04
kW/yr	0.0066	0.0077

Adjusting Thermostat for Heating and Cooling Season

The Energy Efficiency Kits and Education Program recommends to participants that they save energy by raising their thermostat setpoint for cooling in the summer and lowering their thermostat setpoint for heating in the winter. Cadmus applied Equation H-7, Equation H-8, and Equation H-9 to calculate the cooling and heating savings.

Equation H-7

$$\Delta kWh_{cool} = \left[\frac{CAPY_{cool}}{1000 \frac{W}{kW}} \times \frac{1}{SEER \times Eff_{duct}} \times EFLH_{cool} \right] \times ESF_{tstat-cool}$$

Equation H-8

$$\Delta kWh_{heat} = \left[\frac{CAPY_{heat}}{1000 \frac{W}{kW}} \times \frac{1}{HSPF \times Eff_{duct}} \times EFLH_{heat} \right] \times ESF_{tstat-heat}$$

Equation H-9

$$\Delta kW_{peak} = ETDF \times \Delta kWh_{cool}$$

Equation H-7 and Equation H-8 first determine the average annual energy use of a residential electric HVAC system then apply a savings factor for the thermostat adjustment. The savings factors ($ESF_{tstat-cool}$ and $ESF_{tstat-heat}$) are based on the evaluation results of the Iowa 2011 through 2016 Energy Wise Program, which provided recent savings data.⁸¹ Table H-99 presents the results of the Iowa Energy Wise evaluations for reducing heating temperature, and Table H-100 presents the results for increasing cooling temperature. The changes in thermostat setpoint temperatures came from the survey responses of participants who either reduced their heating temperature or increased their cooling temperature. The percentage of savings per change in degrees comes from the U.S. Department of Energy.⁸²

Table H-99. Iowa Energy Wise Program Evaluations: Reducing Heating Temperature

Year	Change in Temp °F	% Savings/°F	Energy Savings Factor ^[1]
2011	-3.2	1%	3.2%
2012	-4.2	1%	4.2%
2013	-5.1	1%	5.1%
2014	-5.3	1%	5.3%
2015	-5.1	1%	5.1%
2016	-3.7	1%	3.7%
Average	-4.4	1%	4.4%

^[1] The energy savings factor is the absolute value of the change in temperature multiplied by the percent savings per degree; therefore, the energy savings factors are positive even though the temperature changes are negative.

⁸¹ Cadmus. *Iowa 2011 Energy Wise Program*. May 1, 2012. Prepared for Iowa Utility Association.
 Cadmus. *Iowa 2012 Energy Wise Program*. May 2013. Prepared for Iowa Utility Association.
 Cadmus. *Iowa 2013 Energy Wise Program*. June 24, 2014. Prepared for Iowa Utility Association.
 Cadmus. *Iowa 2014 Energy Wise Program*. January 31, 2015. Prepared for Iowa Utility Association.
 Cadmus. *Iowa 2015 Energy Wise Program*. January 30, 2016. Prepared for Iowa Utility Association.
 Cadmus. *Iowa 2016 Energy Wise Program*. February 22, 2017. Prepared for Iowa Utility Association.

⁸² This is 1% of the baseline savings per every one degree, per the U.S. Department of Energy's *Energy Saver* article "How Much Can You REALLY Save with Energy Efficiency Improvements?" Last updated October 7, 2016. Available online: <https://energy.gov/energysaver/articles/how-much-can-you-really-save-energy-efficient-improvements>

Table H-100. Iowa Energy Wise Program Evaluations: Increasing Cooling Temperature

Year	Change in Temp °F	Percentage Savings/°F	Energy Savings Factor
2011	3.1	1%	3.1%
2012	4.2	1%	4.2%
2013	5.0	1%	5.0%
2014	5.9	1%	5.9%
2015	4.8	1%	4.8%
2016	3.8	1%	3.8%
Average	4.5	1%	4.5%

Table H-101 provides a description of the variables in Equation H-7, Equation H-8, and Equation H-9. Respondents with electric heating and/or cooling systems were eligible for savings. Cadmus used the equivalent full load hours (EFLH) corresponding to the location of the participant's home (determined using zip code mapping).

Table H-101. Thermostat Setting Behavior Change Algorithm Inputs

Product	Input	Ex Post Savings Inputs		
		Source	Value	Notes
Adjusting Thermostat for Heating and Cooling	Presence of electric heating system (yes/no) ^[1]	Enrollment Card	Data Gathering	Provided by the ICSP
	Presence of electric cooling system (yes/no) ^[1]	Enrollment Card	Data Gathering	Provided by the ICSP
	Type of electric heating system	Enrollment Card	Data Gathering	Provided by the ICSP
	Type of electric cooling system	Enrollment Card	Data Gathering	Provided by the ICSP
	Capacity of cooling system ($CAPY_{cool}$)	TRM Default	32,000 Btu/hour	Section 2.2.8; Table 2-41
	Capacity of heating system ($CAPY_{heat}$)	TRM Default	32,000 Btu/hour	Section 2.2.8; Table 2-41
	Seasonal energy efficiency ratio ($SEER$)	TRM Default	11.9 Btu/Wh	Section 2.2.8; Table 2-41
	Heating seasonal performance factor ($HSPF$)	TRM Default	3.412 Btu/Wh	Section 2.2.8; Table 2-41
	Duct system efficiency (Ef_{duct})	TRM Default	0.8	Section 2.2.8; Table 2-41
	Equivalent full load hours for cooling ($EFLH_{cool}$)	TRM Default	Allentown = 487 Erie = 389 Harrisburg = 551 Philadelphia = 591 Pittsburgh = 432 Scranton = 417 Williamsport = 422	Section 2.2.8; Table 2-41; City to be determined through enrollment card zip codes
Equivalent full load hours for heating ($EFLH_{heat}$)	TRM Default	Allentown = 1,193 Erie = 1,349 Harrisburg = 1,103 Philadelphia = 1,060 Pittsburgh = 1,209 Scranton = 1,296 Williamsport = 1,251	Section 2.2.8; Table 2-41; City to be determined through enrollment card zip codes	
Energy to Demand Factor ($ETDF$): demand coincidence factor/ $EFLH_{cool}$	TRM Default; Enrollment Card	$0.647/EFLH_{cool}$	Section 2.2.1; Table 2-12. Section 2.2.8; Table 2-41; City to be determined through enrollment card zip codes	
Energy savings factor for the thermostat adjustment during the cooling season ($ESF_{tstat-cool}$)	Iowa 2011-2016 Energy Wise Program Evaluations; DOE Energy Saver article	4.4%	Average of savings across all evaluated years	
Energy savings factor for the thermostat adjustment during the heating season ($ESF_{tstat-heat}$)	Iowa 2011-2016 Energy Wise Program Evaluations; DOE Energy Saver article	4.5%	Average of savings across all evaluated years	

^[1] Required to assign savings; not considered an open variable but ICSP will be required to collect.

H.2 Process Evaluation

H.2.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In February through April of 2017, Cadmus conducted three interviews with the Energy Efficiency Kits and Education Program managers from PPL Electric Utilities and the ICSPs. The interviews focused on assessing the program's design versus its implementation, implementation changes, program marketing, and program uptake.

Agency Interviews

Cadmus conducted five interviews with agencies that deliver the program to their clients. Cadmus randomly selected two low-distributing, two high-distributing, and one middle-distributing agencies for the interviews. The objectives of these interviews was to better understand how agencies deliver the program to their clients, their satisfaction with the ICSP, PPL Electric Utilities, and the program overall, and where they see areas of improvement.

Participant Surveys

Cadmus collected most participant data from the paper surveys returned to the ICSP. Cadmus also conducted phone surveys with participants who did not return the paper survey. Both surveys asked identical questions to assess experience and satisfaction with the program and to verify product installation.

Cadmus excluded participants who completed the paper survey from the phone survey. Cadmus prepared the contact list of participants who had not returned a paper survey by removing the records of anyone who had completed a PPL Electric Utilities or Cadmus survey in the past three months, had opted out of a survey, or had asked not to be contacted again. Cadmus included all remaining participant records in the contact list and attempted 46% of the records before reaching the survey target.

Of 12,058 kits distributed, 1,909 participants returned the paper survey, a response rate of 16%, and 232 responded to the telephone survey, a response rate of 6%. The response rate for returned paper surveys is consistent with PY7, which achieved a response rate of 15%.⁸³ Altogether, Cadmus collected 2,142 participant responses, which resulted in energy and demand *ex post* verified savings estimates that exceeded the 90% confidence and 10% precision (90/10) plans by stratum (agency and direct mail) and for the program overall.

See *Section H.2.3 Sample Cleaning and Attrition for Participant Surveys* for sampling cleaning and attrition.

⁸³ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016*

H.2.2 Additional Findings

This section includes survey and interview findings.

Program Delivery

Overall, Cadmus found that the ICSP had continued to deliver and manage the program very well. PPL Electric Utilities, the ICSP, and the agencies all reported that communication among the parties was strong and contributed to program success. This result is consistent with PY7 findings.⁸⁴ The ICSP and subcontractor ICSP met regularly to discuss program distribution, and both parties agreed this was working well for the program. The ICSP also had regular check in meetings with PPL Electric Utilities.

All agencies reported that the launch of the program this year met their expectations. Specifically, the agencies found the training at the beginning of the program year very comprehensive; one said that because the ICSP sent trial kits to the agency, the staff could better understand the kit's contents and educate their customers. Two agencies said the one-on-one attention the ICSP gave agency staff was very helpful. Two agencies said that enrolling customers using the online data entry/customer qualification process was very smooth.

In PY8, PPL Electric Utilities and the ICSP created two energy-savings kits, tailored to customers' water heater fuel types (electric or non-electric). Kits for customers with electric water heaters also contained faucet aerators and low-flow showerheads, because PPL Electric Utilities can claim savings only for these products if installed in a home with an electric water heater. The ICSP said these new kits helped improve awareness and promote the PPL Electric Utilities' brand. However, one agency said some customers did not understand why there was a difference. The ICSP suggested that agencies should not mention that two kits are offered and instead explain that the kit is customized to the client's home. One agency said that while it does not intend for this to happen, customers can often see the two boxes at the agency.

When asked about kit distribution, the ICSP and one agency reported some issues with tracking how many kits the agency gave out and where they went. Another agency said it started tracking the kits it distributes. Some non-electric customers mistakenly received electric kits; this also wasted the costs of products for which PPL Electric Utilities could not claim savings.

One agency said some clients were unable to get to its office to pick up the kits and that many clients come in only for programs that require them to be physically present. Many of the clients who showed interest in the kit had no other reason to come so did not show up. This agency is examining ways to conduct better outreach to serve these clients.

⁸⁴ PPL Electric Utilities. Annual Report Program Year 7: June 1, 2015–May 31, 2016. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016

Key Performance Indicators

PPL Electric Utilities and the ICSP defined plans for energy savings for the Energy Efficiency Kits and Education Program and set levels for two other metrics they monitor—participation and customer satisfaction. The program’s performance plans for these metrics in PY8 is shown in Table F-72.

Although not official KPIs, PPL Electric Utilities also tracks the type of kits (electric or non-electric) and the delivery channel of the distributed kits (agency or direct mail). PPL Electric Utilities, as well as the ICSP and the agencies, also want to expand the program by recruiting additional agencies. This also is not a specific KPI for PY8.

The program delivered 4,058 more kits than the 8,000 projected for PY8 because PPL Electric Utilities and the ICSP want to reach the Phase III planned savings projections within four program years. Additionally, the extra kits contribute savings to the low-income sector, which helps to mitigate lower savings achieved in WRAP, which was because of its late launch at the start of PY8.

Table H-102. Energy Efficiency Kits and Education Program Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
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.	89% of customers were <i>very satisfied</i> and 10% were <i>somewhat satisfied</i> with the program.

Logic Model Review

Cadmus reviewed the logic model and determined that the Energy Efficiency Kits and Education Program is operating as expected. Table H-103Table F-73 lists the outcome of the logic model review.

Table H-103. Logic Model Review

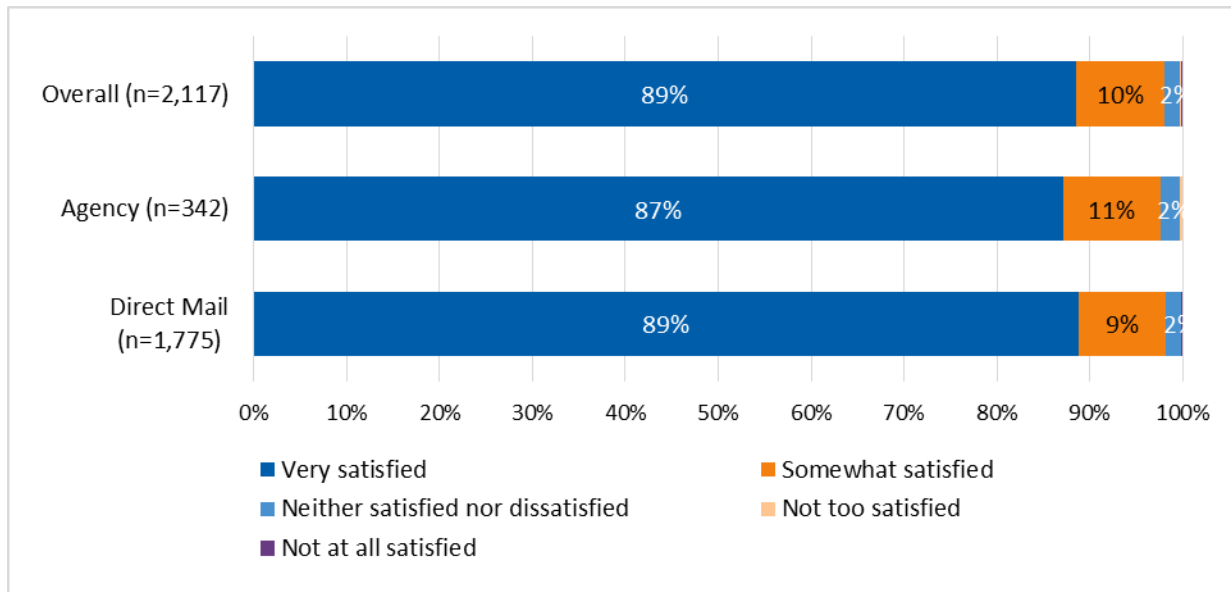
Expected PY8 Outcome	Topics	Actual PY8 Outcome
Identify potential income-qualifying participants, conduct education and outreach, provide training to trainers, provide workshops for low-income customers, and provide free energy-savings kits with energy efficiency products.	Program Activities	Delivered program activities as expected.
Free energy-savings kits distributed to customers, Workshops and one-on-one sessions conducted, Trainers trained, and low-income consumers educated.	Outputs Produced by Program Activities	Delivered outputs as expected.
Training and energy-savings workshops educate low-income customers about energy efficiency to help them reduce their energy consumption and energy costs. Items installed from the kit and behavior changes result in energy savings.	Short-term Outcomes	Produced short-term outcomes as expected.
Low-income customer base becomes more knowledgeable and continues to make informed and effective decisions about their energy use. This will result in additional energy savings, customer satisfaction, and environmental benefits.	Intermediate Outcomes	Program on track to meet intermediate outcomes.
Items installed from the kit and behavioral changes learned from the program continue to produce energy savings.	Long-term Outcomes	Program on track to meet long term outcomes; to be assessed at the end of Phase III.

Participant Satisfaction

In the paper and phone surveys, Cadmus asked a question about participants' satisfaction with the program. Results are reported in this section and broken out by delivery method. Because respondents could skip questions if they did not want to answer them, not all respondents provided an answer to every question. The number of participants responding is indicated with the question.

Overall, participants were *very satisfied* with the Energy Efficiency Kits and Education Program, as shown in Figure H-50. Eighty-nine percent of customers (n=2,117) were *very satisfied*, and an additional 10% were *somewhat satisfied*. These results are consistent across delivery method. All program stakeholders—PPL Electric Utilities, the ICSP, and agencies—said that the free products offered through the kit were the primary driver of satisfaction.

Figure H-50. Customer Satisfaction by Delivery Method



Source: Survey question, "Thinking about your overall experience with the Energy Efficiency Kit, how would you rate your satisfaction? Would you say you are..." (n=2,117) Due to rounding, overall customer satisfaction does not add to 100%.

Agency Satisfaction

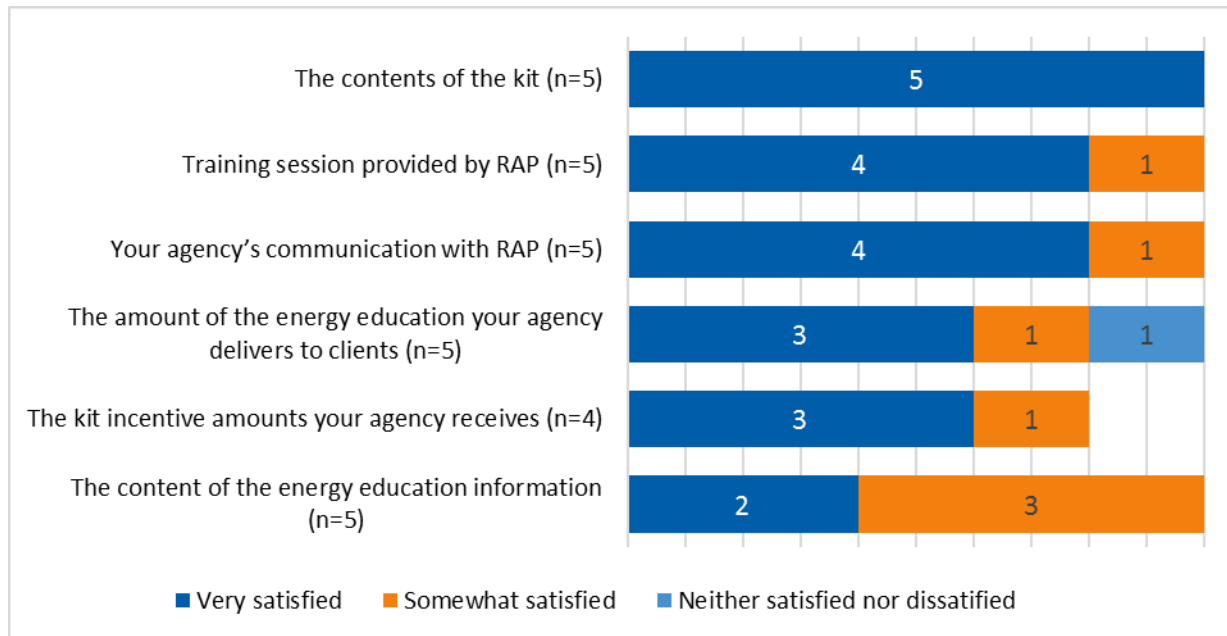
All five agencies interviewed for the Energy Efficiency Kits and Education Program reported a high level of satisfaction with the program—three were *very satisfied* and one was *somewhat satisfied*. Agency representatives answered questions about specific elements of the program, shown in Figure H-51.

The agencies reported high levels of satisfaction with these program components:

- Contents of the kit
- Training provided by the ICSP
- Communication with the ICSP

Agencies provided lower satisfaction ratings with the amount of energy education delivered (two were *very satisfied*), the kit incentive (two were *very satisfied*), and the content of the energy education information (one was *very satisfied*).

Figure H-51. Agency Satisfaction with Specific Elements



Source: Survey question, "I am going to ask you about your satisfaction with several features of the Energy Efficiency Kits and Education program. Please tell me whether you are very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, not too satisfied, or not at all satisfied with the following statements." (n=5)

Suggested Program Improvements

Most agencies were very satisfied and did not suggest major changes to the program. Two agencies said energy education could be improved, both in the training given to the agencies and in the materials provided to customers. Specifically, they asked for better ways to educate clients about the more complex products, such as the filter alarm and Tier 2 advanced power strips.

Some agencies said the increased size of the kit in PY8 has become an issue for two reasons—transporting for the client and storage for the agency. One agency said the larger boxes were harder for clients to carry if they take public transportation, walk, or bike. Some clients have resorted to leaving the box at the agency and taking the contents home in their own bag or a plastic bag from the agency. The agency suggested adding a handle to the box or providing a bag. Kit size was also a storage problem for some agencies. Two reported they had run out of storage space and thought smaller but more frequent shipments would help them manage their storage and inventory.

Marketing and Outreach

Marketing responsibility for the program is primarily allocated to the ICSP. The ICSP has developed standardized marketing materials and distributes these to the agencies to use as they choose. However, three out of five agencies said they do their own marketing, consisting of putting up flyers at various places in the area, sending a newsletter, maintaining a social media presence, and educating their staff. These agencies said no one tactic stands out as the most useful, and they liked to use a variety of marketing channels. Additionally, two agencies thought word of mouth was the most powerful

marketing tactic. Four agencies said they did not have much trouble distributing the kits, so they did not believe that much additional marketing is needed.

The surveys asked participants how they learned about the program. Sixty-two percent of agency participants (n=335) found out about the program through an agency or community-based organization, and 15% learned through word of mouth. Of direct mail customers, 64% (n=1,771) found out about the program through a mailer, 10% through the PPL Electric Utilities website, and 7% through an agency or community-based organization. The survey also asked participants if they knew that PPL Electric Utilities provided funding for the energy-savings kits before their participation. Twenty-five percent of agency participants (n=339) and 20% of direct mail participants (n=1,767) said that, before participating, they knew PPL Electric Utilities was the program sponsor.

Cadmus asked the agencies, ICSPs, and PPL Electric Utilities about ways they would change future marketing efforts. Two agencies that did additional program marketing (outside of the marketing provided by the ICSP) said that they were not currently combining program marketing with other outreach efforts but were considering doing so in the future. Two other agencies said they wanted more marketing support—one wanted additional ideas on marketing tactics and the other wanted a wider variety of flyers to hand out to clients. One stakeholder was concerned about finding enough low-income residents in later program years to meet program plans and thought recruiting new agencies would help expand program reach.

Energy Education

All agencies reported providing some form of energy education to residents when delivering the kits. The clients they serve were typically most interested in learning about the kit products and how to use each one. Two agencies said this interest was because all their clients needed to save money and realized these products could help them do so. One agency also said that many clients had poor energy-use habits, so the education the agency provided was very important.

The surveys asked agency clients about the helpfulness of the information provided by the agency. Almost all said the information was helpful—96% said they had everything they needed to install the kit (n=326), 96% said the information helped them understand how much energy they could save (n=325), and 98% said the information answered their questions about the kit (n=325).

Attitudes Towards and Barriers to Saving Energy

The agencies said that the biggest barrier to saving energy was confusion about some products in the kit, particularly the Tier 2 advanced power strip and how it worked, especially when initially setting it up. Some clients got frustrated and removed the power strip. One agency said many of its elderly clients had difficulty with the self-install products; some called for assistance or even came back to the agency for help, which could be a long trip for some.

H.2.3 Sample Cleaning and Attrition for Participant Surveys

Before selecting a sample of participants who had not returned the paper survey, Cadmus coordinated with PPL Electric Utilities' contractor to screen the sample. Cadmus removed records of customers who

had been called in the past three months (for a PPL Electric Utilities survey or a Cadmus survey) or had requested not to be contacted again. Cadmus removed any records with incomplete information and excluded customers who had returned a paper survey to the ICSP. Cadmus used all remaining records in the telephone survey sample frame.

Cadmus contacted participants who did not return a kit survey by telephone, making up to five attempts over several days, at different times of the day, and scheduling callbacks whenever possible. It was not necessary to contact all records selected in the survey sample frame to reach the targeted number of completed surveys. Table H-104 lists the total number of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table H-104. Energy Efficiency Kits and Education Sample Attrition Table for Telephone Survey

Description of Outcomes	Number of Records
Telephone	
Population (number of participants) ^[1]	9,253
Removed: inactive customer, completed survey in past 3 months, on "do not contact" list, opted out of survey, selected for a different survey, duplicate contact	92
Removed: incomplete or bad phone number	273
Survey sample frame (sent to subcontractor for telephone survey calls)	8,888
Not attempted ^[2]	4,778
Records attempted	4,110
Non-working number	712
Wrong number, business	116
No answer/answering machine/phone busy	2,334
Language barrier	75
Cannot confirm equipment/not aware of participation	152
Refusal	100
Terminated survey	77
Non-specific or specific callback scheduled	312
Completed surveys	232
Response rate	6%
^[1] Number of participants in PPL Electric Utilities tracking database at the time of the final survey effort.	
^[2] Selected for sample but target was reached before attempted.	

Appendix I. Evaluation Detail—Appliance Recycling Program

I.1 Gross Impact Evaluation

I.1.1 Methodology

EM&V Sampling Approach

Cadmus calculated gross verified savings through a records review of the full program tracking data and an update of one input to the savings algorithm specified in the PA TRM.

Table I-105. Appliance Recycling Program Impact Evaluation Sampling Strategy

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Appliance Recycling	11,368	N/A ^[1]	11,368	Records Review
Program Total	11,368	N/A	11,368	

^[1] Because this program's evaluation did not include sampling, Cv, and target precision are not meaningful.

Ex Post Verified Savings Methodology

Savings are partially deemed in the PA TRM for recycled appliances. The ICSP reports the quantity of each recycled appliance (refrigerators, freezers, and window air conditioners) through information it uploads to its tracking database. In its tracking database, PPL Electric Utilities reports gross savings per refrigerator and per freezer using the default inputs for the regression equation provided in the PA TRM,⁸⁵ with the exception of the proportion of units manufactured prior to 1990, which were forecasted based on previous year program tracking data. Cadmus updated the pre-1990 inputs to reflect the actual proportion reported in PPL Electric Utilities' tracking database.

Survey Methodology

The participant survey was not used for gross savings. It was used for the process evaluation and net savings.

I.1.2 Database Review Findings

Cadmus reviewed the tracking data after the second quarter of PY8 and again at the end of the program year. This review consisted of reconciling the records and appliances reported in PPL Electric Utilities' tracking database with the ICSP program tracking data.

⁸⁵ Pennsylvania Public Utility Commission. *2016 Technical Reference Manual*. Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards. February 2017. Available online: http://www.puc.state.pa.us/Electric/docs/Act129/TRM-2016_Errata_Feb2017.docx

I.1.3 Realization Rate Findings

Although the default pre-1990 percentage input to the savings algorithm was close to the actual proportion, verified savings were lower than reported with a realization rate of 98% for the Appliance Recycling Program.

The following factors led to variation between the reported and verified savings and to the observed realization rates:

- The actual proportion of appliances that were manufactured prior to 1990 was slightly lower than the assumed proportion used to generate the reported savings in PPL Electric Utilities' tracking database.
- The actual proportion for refrigerators was 29% rather than the assumed 35%.
- The actual proportion for freezers was 57% rather than the assumed 60%.

I.1.4 Survey Findings (if applicable to Impact Analysis)

Cadmus did not use the participant surveys for gross savings. The surveys were used for the process evaluation and net savings.

I.2 Net Impact Evaluation

I.2.1 Net-to-Gross Ratio Methodology

In 2016, the SWE, along with input from the Pennsylvania EDCs and their evaluators, published the Common Methods for Appliance Recycling Programs, which was incorporated into Appendix B of the Phase III Evaluation Framework.⁸⁶ The SWE protocol is consistent with the UMP appliance recycling protocol to determine program net savings.⁸⁷

Cadmus used the following formula to estimate net savings for recycled refrigerators and freezers:

$$\text{Net savings} = \text{Gross Savings} - \text{Freeridership and Secondary Market Impacts} - \text{Induced Replacement} + \text{Spillover}$$

Where:

- Evaluated Gross Savings* = The evaluated *in situ* unit energy consumption (UEC) for the recycled unit, adjusted for part-use
- Free Ridership and Secondary Market Impacts* = Program savings that would have occurred in the program's absence

⁸⁶ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Energy Efficiency and Conservation Program & Act 213 Alternative Energy Portfolio Standards*. February 2017. Available online: http://www.puc.state.pa.us/Electric/pdf/Act129/SWE_PhaseIII-Evaluation_Framework082516.pdf

⁸⁷ National Renewable Energy Laboratory. *Uniform Methods Project (Chapter 7)*. Available online: <http://energy.gov/sites/prod/files/2013/11/f5/53827-7.pdf>

<i>Induced Replacement</i>	=	Average additional energy consumed by replacement units purchased due to the program
<i>Spillover</i>	=	Non-programmatic savings induced by the program

Secondary market impacts require a decision-tree approach to calculating and presenting net savings. The decision tree—populated by the responses of surveyed participants—presents savings under all possible scenarios concerning the participants’ actions regarding the recycled equipment. Through these scenarios, Cadmus used a weighted average of savings to calculate the net savings attributable to the program. This section presents specific portions of the decision tree to highlight each aspect of the net savings analysis. The complete decision trees are presented at the end of this section.

Self-Report Survey

Cadmus used self-report surveys to assess net savings for the Appliance Recycling Program, following the Evaluation Framework’s recommended common method for assessing free ridership.⁸⁸ The SWE team reviewed and approved the survey prior to fielding.

I.2.2 Net-to-Gross Ratio Sampling

Participant and Nonparticipant Surveys

Cadmus completed online participant surveys (n=409) and telephone participant surveys (n=140), as shown in Table I-106. These surveys asked identical questions to assess program satisfaction and gather data to estimate net savings. Cadmus administered the online survey between January and June 2017 and the telephone survey in June 2017. Cadmus administered the telephone nonparticipant survey (n=9) in April 2017 as part of the general population residential lighting survey. Participant surveys assessed participant satisfaction; the number of completed participant surveys produced a measurement of program satisfaction with $\pm 1\%$ precision at 90% confidence.

Table I-106. PY8 Participant Survey Sampling Strategy

Survey Mode and Audience	Population Size	Final Sample Population	Target Sample Size	Achieved Sample Size	Response Rate
Online Participant Survey - Freezers	1,719	777	All available	82	11%
Online Participant Survey - Refrigerators	6,562	3,133	All Available	327	10%
Telephone Participant Survey - Freezers	1,719	1,316	70	70	5%
Telephone Participant Survey - Refrigerators	6,562	4,760	70	70	1%
Telephone Nonparticipant Survey	1,202,758	8,998	Up to 70	9	0.1%
Total Surveys Completed	N/A	N/A	N/A	558	N/A

⁸⁸ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

Cadmus used a stratified random sampling method for the program-specific telephone 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, Cadmus did not generate a separate sample for them.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. Cadmus addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys did not include leading or ambiguous questions nor double-barreled questions. Cadmus provided clear interviewing and programming instructions so that these surveys were implemented consistently. The SWE team and PPL Electric Utilities reviewed and approved surveys before fielding.

Cadmus also tested for mode effects.⁸⁹ The analysis of participant survey data tested for significant differences between demographic characteristics of online respondents and telephone survey respondents to investigate whether customers with different population characteristics systematically responded via one survey mode or the other, potentially introducing bias into the results. Specifically, the analysis examined differences in age, education, and income. Cadmus found no significant differences between survey modes; therefore, the results of the surveys contained in this report are unweighted.

Social desirability biases are more often present in telephone surveys than in online surveys because of the verbal conversation with an interviewer. For that reason, Cadmus also tested for significant differences in program satisfaction between modes and again found no differences. Ninety-seven percent of online respondents reported they were *very satisfied* or *somewhat satisfied* with the program, and 96% of phone respondents reported the same.

Contact Instructions

PPL Electric Utilities provided survey contact instructions for conducting surveys. Cadmus did not contact customers for a survey if they had completed a PPL Electric Utilities or Cadmus survey in the past three months, had opted out of a survey, or had asked not to be contacted again. Cadmus also removed records of any participants in the Energy Efficient Home Online assessment and Energy Efficient Home in-home audit programs and any customer in the Home Energy Education Program control group because these programs had limited participation and their participants were in the program-specific sample. Finally, telephone survey calls did not take place on Sundays or national holidays. See *Section 1.3.3* for sampling cleaning and attrition.

⁸⁹ Cadmus used a Chi-squared test for the differences in distributions of age, education, and income categories between survey mode and a t-test for differences in proportions, if significant differences were found in the distributions.

I.2.3 Net-to-Gross Ratio Findings

Free Ridership

Cadmus used self-report surveys to assess net savings for the Appliance Recycling Program, following the Evaluation Framework's recommended common method for assessing free ridership. The first step the free ridership analysis was to ask participants through participant surveys if they had considered discarding the participating appliance prior to learning about the Appliance Recycling Program. Participants who indicated they had no previous plans to dispose of or discontinue using the appliance are categorized as a non-free rider.

Next, participants who had at least considered disposing of or discarding their existing appliance before learning about the program were asked a series of questions to determine the number of participating units that would have been kept or discarded absent the program. There are three possible scenarios for disposed or discarded units independent of program intervention:

- Unit is discarded and transferred to another household.
- Unit is discarded and destroyed.
- Unit is kept in the home.

To determine the percentage of participants in each of the three scenarios, Cadmus asked the surveyed participants the likely fate of the recycled appliance had it not been decommissioned through the program. Responses were sorted into these categories:

- Kept the appliance
- Sold or gave the appliance to a private party (either an acquaintance or through a posted advertisement)
- Sold or gave the appliance to a used appliance dealer
- Gave the appliance to a private party, such as a friend or neighbor
- Gave the appliance to a charity organization, such as Goodwill Industries or a church
- Left the appliance on the curb with a "free" sign
- Had the appliance removed by the dealer where the new or replacement refrigerator was obtained
- Hauled the appliance to a landfill or recycling center
- Had the appliance picked up by local waste management company

To ensure the most reliable responses possible, and to mitigate socially desirable response bias, Cadmus asked some respondents additional questions to clarify their responses. For example, Cadmus asked surveyed participants who had an appliance that was more than 10 years old and who indicated they would have sold it to a used appliance dealer what they would have done had they been unable to do

so.⁹⁰ Using responses to this subsequent question, Cadmus then assessed free ridership. This dynamic, market research-based approach to surveys improves the reliability of the hypothetical self-reported actions of participants.

After completing the final assessment of participants' actions independent of the program, Cadmus categorized participants' self-reported discard methods as kept, transferred, or discarded, with discarded indicating free ridership (i.e., their action would have led to removal of the appliance from the grid without program intervention).

To mitigate potential response bias, Cadmus also included questions in the general population survey to identify nonparticipants, defined as customers who disposed of a working, qualifying appliance outside of the program during PY8. However, only nine respondents fit this definition. Given the small sample size, nonparticipant responses were ultimately not included in the net savings analysis.

Table I-107 shows the percentage of units that would have been kept or discarded.

Table I-107. Final Distribution of Kept and Discarded Appliance

Stated Action Absent Program	Indicative of Free Ridership	Refrigerators (n=372)	Freezer (n=138)
Kept	No	35%	42%
Discarded	Varies by Discard Method	65%	58%
Total		100%	100%

As shown in Table I-107, 65% of respondents would not have kept their refrigerator. Of these, 35% would have discarded it by one of these actions:

- Taking their appliance to the landfill or recycling center
- Hiring someone to take the appliance to the landfill or recycling center
- Having a retailer pick up their appliance

Having the retailer pick up the appliance is not necessarily indicative of free ridership. This depends on the retailer's decision whether to resell the unit. Not all appliances would be viable for resale. According to the recommendation in the Evaluation Framework, Cadmus used age as a proxy for secondary market viability and assumed any appliance over 10 years old is unlikely to be resold by a retailer. All of the respondents who indicated that they would have had their appliance picked up by a retailer had recycled an appliance that was more than 10 years old.

⁹⁰ This question is asked in this way because used appliance dealers are unlikely to purchase an appliance over 10 years old. The 10-year cutoff is specified in the SWE's Common Approach, which is included in the Phase III Framework. Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by the Statewide Evaluation Team (NMR Group Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC). Contracted under the Pennsylvania Public Utility Commission's RFP 2015-3 for the Statewide Evaluator. Final version August 25, 2016.

Together these actions resulted in a reduction in gross savings due to free ridership—23% for refrigerators and 25% for freezers.

Secondary Market Impacts

If Cadmus determined that a participant would have transferred the unit they recycled to another customer on the grid in the absence of the program, it is important to account for what the would-be acquirer might have done after the participant recycled the unit. There are three possibilities:

- **None of the would-be acquirers would find another unit.** Program participation would result in a one-for-one reduction in the total number of refrigerators operating on the grid. In this case, the total energy consumption of avoided transfers (participating appliances that otherwise would have been used by another customer) should be credited as savings to the program. This position is consistent with prevailing program theory and assumes that participating appliances are essentially luxury goods for would-be acquirers (that is, a secondary refrigerator is not a necessity, but it is nice to have should it be available).
- **All would-be acquirers would find another unit.** Program participation has no effect on the total number of refrigerators operating on the grid. In this case, none of the energy consumption associated with avoided transfers should be credited to the program, because the total refrigerator load operating on the grid is essentially unchanged. This position assumes participating appliances are necessities and that customers will always seek alternative units when participating appliances are unavailable.
- **Some of the would-be acquirers would find another unit, while others would not.** In this case, some of these acquirers were in the market for a refrigerator and would acquire another unit, while others were not and therefore would only have taken the unit opportunistically.

Absent conducting a detailed accounting of all metrics in the appliance market (which are rarely available), secondary market impacts are extremely difficult to measure. Identifying the would-be acquirers is also problematic, because it is uncertain whether the units they acquired are of the same vintage and condition as participating appliances. Therefore, the UMP protocol recommends the third possibility listed above—to assume that half (0.5, the midpoint of possibilities 1 and 2) of the would-be acquirers of avoided transfers found another unit.⁹¹

After estimating the parameters of the free ridership and secondary market impacts, Cadmus used the decision tree to calculate the average per-unit program savings net of their combined effect. Figure I-52 shows how Cadmus integrated these values into a combined estimate of savings net of free ridership and secondary market impacts for refrigerators. The process for freezers is identical.

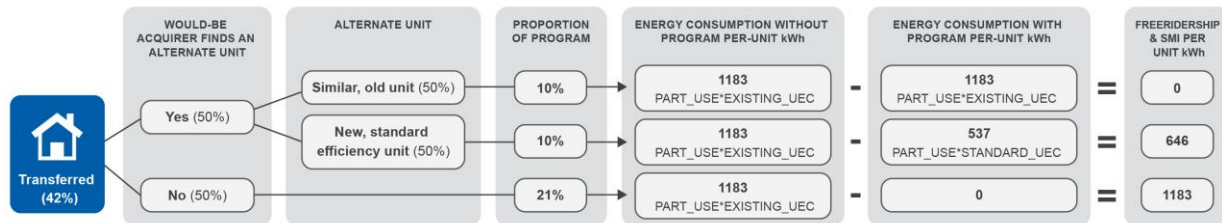
Figure I-52 details Cadmus' methodology for assessing the program's impact on the secondary refrigerator market and for applying the recommended midpoint assumptions when primary data were

⁹¹ National Renewable Energy Laboratory. *Uniform Methods Project (Chapter 7)*. Available online: <http://energy.gov/sites/prod/files/2013/11/f5/53827-7.pdf>

unavailable (Figure I-53 provides a freezer-specific diagram). As evident, accounting for market effects results in three savings scenarios:

- Full per-unit gross savings
- No savings
- Partial savings (i.e., the difference between energy consumption of the program unit and the new, standard-efficiency appliance acquired alternatively)

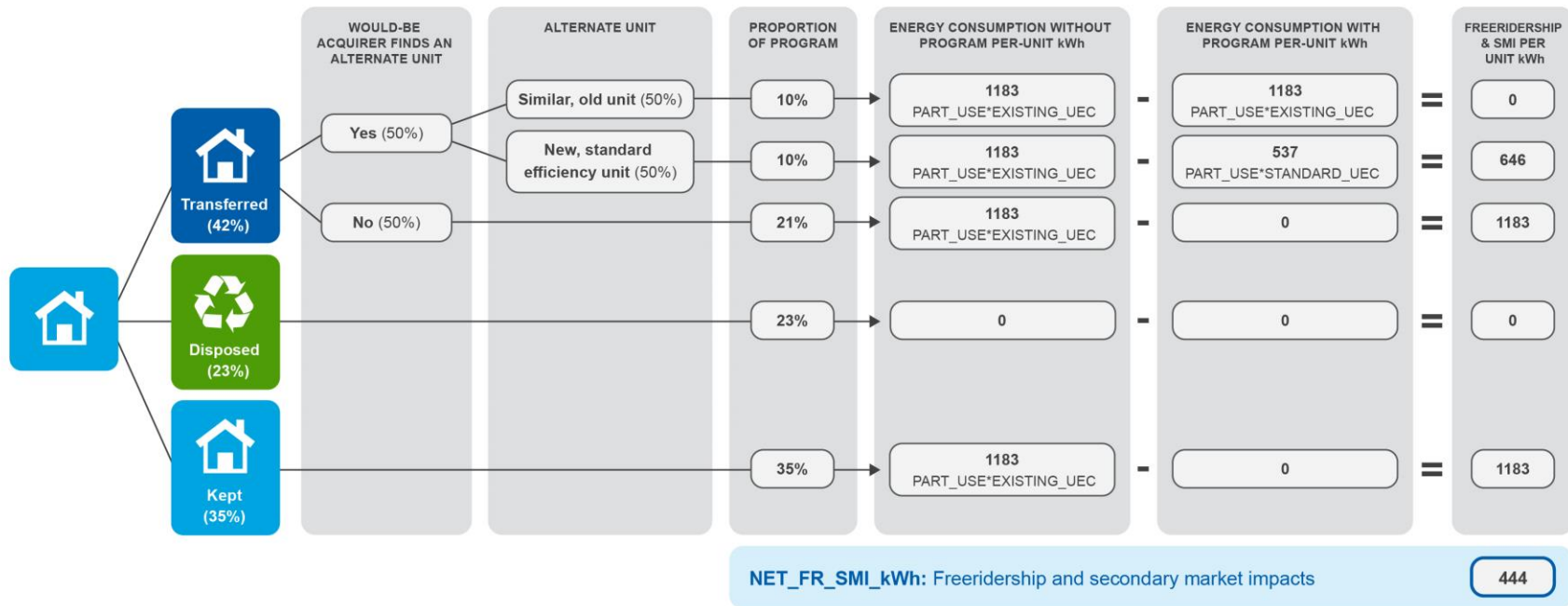
Figure I-52. Secondary Market Impacts—Refrigerators



The SWE protocol states that the consumption of a standard efficiency unit is assigned based on deemed values in the PA TRM. However, the 2016 PA TRM contains several tables with deemed consumption values that vary based on appliance characteristics, including configuration, capacity, manual or automatic defrost, and through-the-door features. This information for replacement units was not available to determine the distribution of values that apply at the time of this evaluation. Therefore, Cadmus applied the deemed values from the 2014 PA TRM, which were applied to the PY6 evaluation.⁹²

⁹² PPL Electric Utilities. *Annual Report Program Year 6: June 1, 2014–May 31, 2015*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

Figure I-53. Integrating Free Ridership and Secondary Market Impacts



Induced Replacement

The Evaluation Framework states that evaluators must account for the energy consumption of replacement units *only* when the program induced that replacement (i.e., when the participant would *not* have purchased the replacement refrigerator in the recycling program’s absence). For non-induced replacements, energy consumption of a replacement appliance is not germane to the savings analysis, as that appliance would have been purchased or acquired regardless of the program.

Cadmus used participant survey results to determine which replacement refrigerators and freezers were acquired by participants because of the program. Across both appliance types, a majority of participants replaced their recycled appliances—80% of refrigerators and 57% of freezers were replaced. Additionally, of respondents who replaced their appliances, 79% of refrigerator and 90% of freezer respondents reported replacing their appliance with an ENERGY STAR-rated appliance.

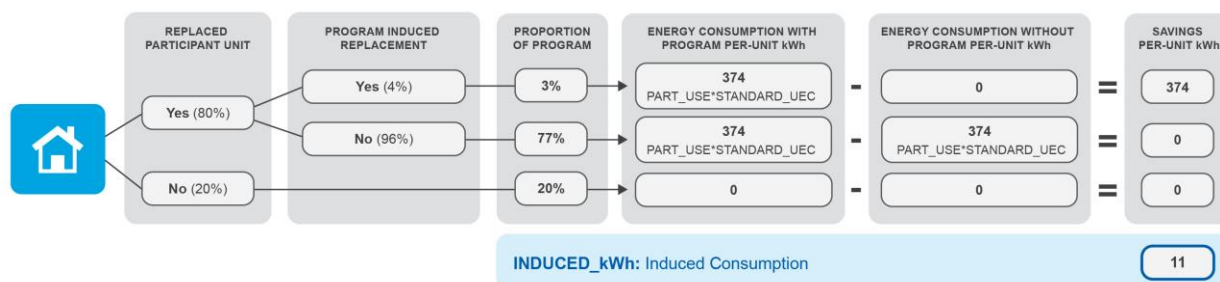
Cadmus then asked each participant who replaced the participating appliance: “Were you planning to replace your appliance before you decided to recycle your existing unit through the PPL Electric Utilities refrigerator and freezer recycling program?” Because it is unlikely the incentive would provide sufficient motivation for most participants to purchase an otherwise unplanned replacement unit (costing from \$500 to \$2,000), Cadmus asked a follow-up question of participants who responded “No.” This question was intended to confirm the participant’s assertion that the program alone caused them to replace their appliance: “Let me make sure I understand: if the PPL Electric Utilities refrigerator and freezer recycling program was not available, you would not have replaced your appliance? Is that correct?”

To further increase the reliability of these self-reported actions, induced replacement analysis considered the following:

- Whether the refrigerator was a primary unit
- The participant’s stated intentions in the program’s absence

For example, if a participant would have discarded his/her primary refrigerator independent of the program, the replacement unit could not be induced (i.e., the participant very likely would not forego use of a primary refrigerator). For all other use types and stated intention combinations, however, induced replacement offered a viable response. Figure I-54 shows induced replacement for refrigerators.

Figure I-54. PY8 Induced Replacement—Refrigerators



The final induced replacement rate is the product of the proportion of respondents who replaced their appliance and the proportion of those who were induced. As expected, only a portion of total replacements could be considered induced—the program induced 3% and 1% of refrigerator and freezer participants, respectively, to acquire a replacement unit, as shown in Table I-108.

Table I-108. PY8 Induced Replacement Rates

Appliance	Induced Replacement Rates
Refrigerator	3%
Freezer	1%

The induced replacement rates for refrigerators decreased between PY6, the most recent evaluation to estimate a NTG ratio, and PY8, down from 7%. Induced replacement rates for freezers also decreased, from 4% in PY6.

Spillover

To estimate spillover, surveys included questions to determine whether participants installed specific additional high-efficiency products and, if so, whether participation in the Appliance Recycling Program was important to their decision. Additional high-efficiency product purchases only counted toward spillover if the customer did not receive a rebate and the program had been important to the decision to purchase and install the products. Table I-109 shows the spillover measures, quantities, and source of savings results for the strata of the Appliance Recycling Program. The following is a list of the energy-efficient equipment types contributing spillover savings, attributed to PPL Electric Utilities, and the source of the estimated energy savings used in the spillover analysis.

Table I-109. Spillover Measures, Reported Quantities, and Savings Sources

Measure	Quantity	Per-Unit Savings kWh	Savings Source
Air conditioning equipment	10	208.4	PY8 PPL Gross Verified Savings
Attic or ceiling insulation (sq. ft.)	6,625	0.7	PY8 PPL Gross Verified Savings
Clothes washer	6	48.7	PPL TRM Feb 2017
Dishwasher	20	40.8	PPL TRM Feb 2017
Heat pump water heater	4	1,672.4	PY8 PPL Gross Verified Savings
Refrigerator	19	55.6	PY8 PPL Gross Verified Savings
Walls insulation (sq. ft.)	1,572	2.4	PY8 PPL Gross Verified Savings

Table I-110. Appliance Recycling Program Equipment Spillover by Equipment Category

Variable	Variable Description	Refrigerator	Freezer	Source
A	Online Survey Sample Size (n)	172 ^[1]	49 ^[1]	Survey Data
B	Total Online Survey Sample Spillover kWh/yr Savings	10,189	326	Survey Data/Engineering Estimates
A	Phone Survey Sample Size (n)	70	70	Survey Data
B	Total Online Survey Sample Spillover kWh/yr Savings	744	6,575	Survey Data/Engineering Estimates
C	Average SO kWh/yr Savings Per Survey Respondent	45	58	Variable B ÷ Variable A
D	Program Participant Population	6,562	1,719	Program Tracking Data
E	SO kWh/yr Savings Extrapolated to the Participant Population	296,466	99,684	Variable C × Variable D
F	Evaluated Program Population kWh/yr Savings	9,475,009	2,207,477	Evaluated Gross Impact Analysis
G	Spillover Percent Estimate	3%	5%	Variable E ÷ Variable F

^[1] Online survey respondents in Q3 were not asked all of the spillover questions so only respondents from Q1 and Q2 are included in the sample for spillover.

Final Net-to-Gross Ratio

As shown in Table I-111, Cadmus determined final net savings as evaluated gross per-unit savings less per-unit free ridership, secondary market impacts, induced replacement kWh/yr, plus spillover.

Table I-111. PY8 NTG Ratios

Appliance	Gross Verified Per-Unit Savings	Free ridership and Secondary Market Impacts (kWh/yr)	Induced Replacement kWh/yr	Induced Additional Savings (Spillover)	Net Per-Unit kWh/yr	NTG
Refrigerator	1,183	444	11	45	773	0.65
Freezer	1,060	391	3	58	724	0.68

The decision trees used to calculate the NTG ratio are shown in Figure I-55 for refrigerators and Figure I-56 for freezers.

Figure I-55. Refrigerator NTG Combined Decision Tree

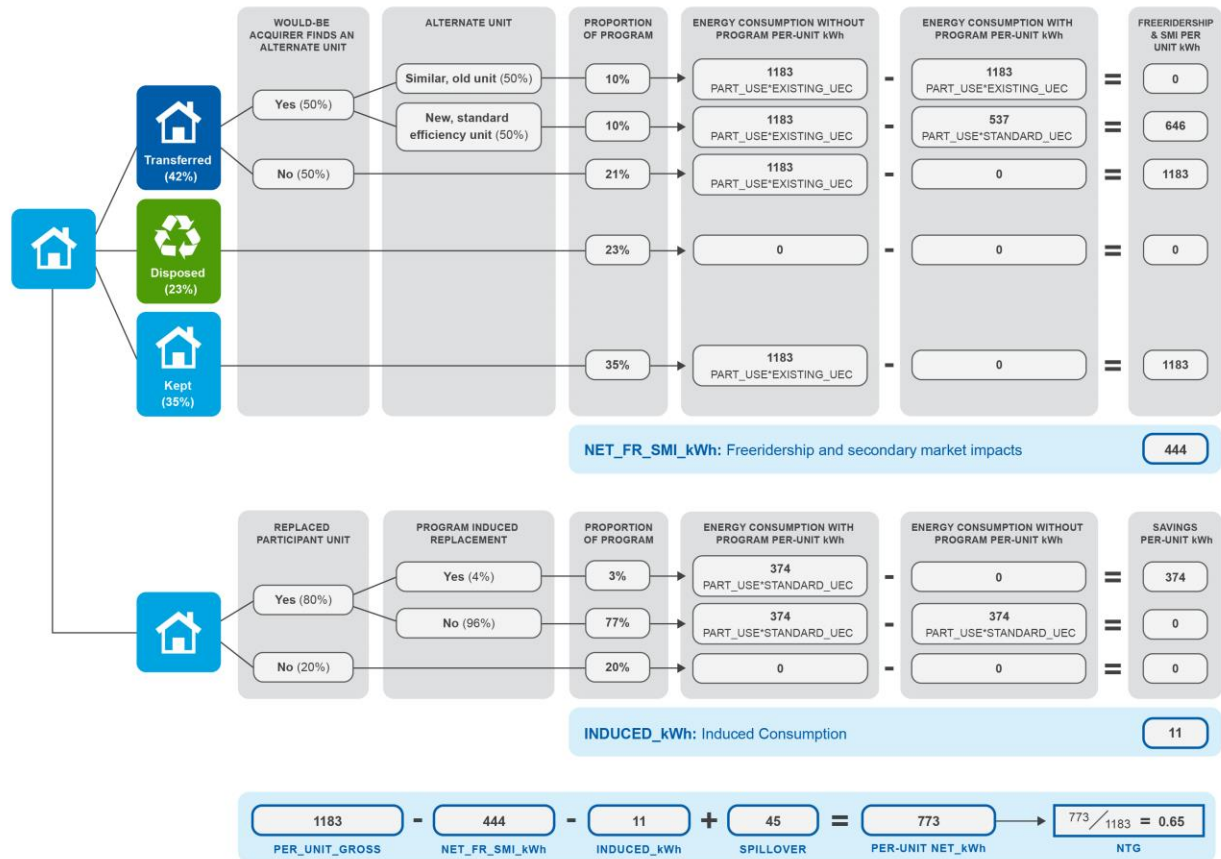
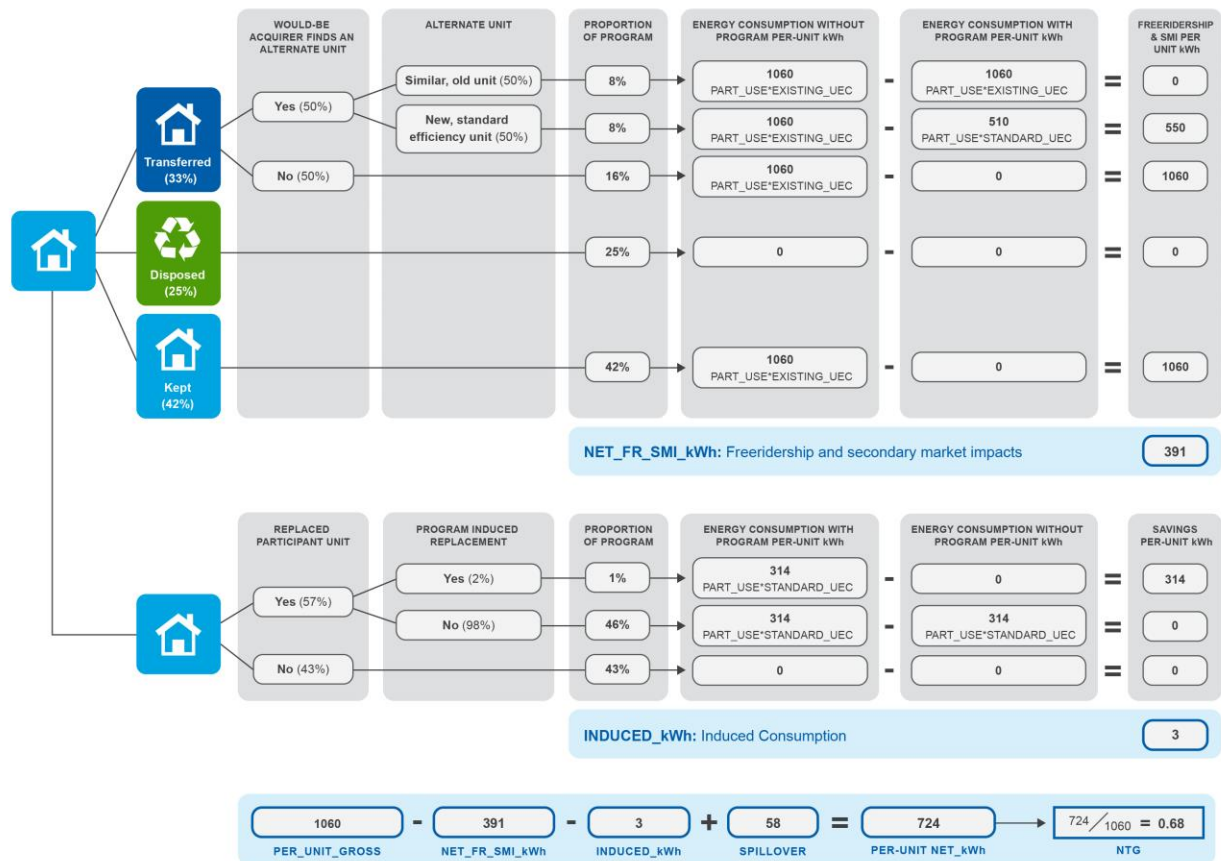


Figure I-56. Freezer NTG Combined Decision Tree



I.3 Process Evaluation

I.3.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In February and March of 2017, Cadmus conducted interviews with the program managers from PPL Electric Utilities (n=2), the ICSP (n=3), and the ICSP’s subcontractor (n=2). The interviews focused on identifying and assessing key progress indicators and program goals, gathering insights into program design and delivery to determine whether the program is being implemented as planned, and discussing the launch of program in Phase III and the transition to a new implementer.

Participant and Nonparticipant Surveys

The sample selection for participant and nonparticipant surveys is described in the *1.2.2 Net-to-Gross Ratio Sampling Section*.

I.3.2 Additional Findings

This section presents additional survey and interview findings. In this section, Cadmus presents survey data as follows: the report contains the percentage or frequency of responses, followed by the sample size for the particular question at hand. Sample size (denoted by “n”) refers to the number for

respondents who were *asked* the question, not the number of respondents who answered. Note that sample sizes vary according to each question, due to survey logic and skipped questions.

Program Delivery

In PY8, the ICSP and the ICSP's subcontractor successfully divided responsibility for the delivery of all program activities. The ICSP delivered the Appliance Recycling Program to customers, including marketing and managing the call center services, online and telephone scheduling of appliance pick-ups and processing applications and rebates, tracking program data, and providing customer and transaction information to PPL Electric Utilities. The ICSP's subcontractor managed the pick-up, decommissioning, and recycling of appliances. For any appointment changes within 48 hours of the scheduled pick-up, the customer was given the ICSP's subcontractor's number to reschedule, otherwise all scheduling was handled by the ICSP. Once an appointment was scheduled, the appliance was assigned an order number that followed the appliance from scheduling to disposal. Each week, the ICSP's subcontractor sent the ICSP a report of appliance order numbers that have been decommissioned the previous week and the ICSP issued rebates for those appliances.

Key Performance Indicators

PPL Electric Utilities set levels for customer satisfaction. The program's performance plans for this metric in PY8 is shown in Table I-112.

Table I-112. Appliance Recycling Program Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
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.	Surpassed goal; 87% of participants said they were <i>very satisfied</i> and 10% were <i>somewhat satisfied</i> with the program (n=559). ^[1]
^[1] Includes responses to the satisfaction question from completed surveys and partially completed surveys.			

PPL Electric Utilities met its PY8 customer satisfaction KPI and achieved 95% of its projected participation.

Although the program does not explicitly set goals, other items are tracked by the ICSP and ICSP's subcontractor based on their responsibilities. Items tracked include number of appliances scheduled, picked-up, and decommissioned; how customers hear about the program; the number of customer service calls received and their wait times; and the number of rebates processed.

Logic Model Review

A program logic model identifies the relationships between activities and expected results. The Phase II Appliance Recycling Program had a similar logic model to the Phase III Appliance Recycling Program. Cadmus reviewed the Appliance Recycling Program's logic model and determined that the program operated as expected in PY8. Table F-73 shows the program logic models expected versus actual outcomes.

Table I-113. Logic Model Review

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
Verify customer eligibility, process applications, pick up and recycle appliances, and process rebate payments.	Program Activities	Delivered program activities as expected; the ICSP and the ICSP's subcontractor have successfully divided the delivery of all program activities.
Produce marketing materials that link recycling an appliance and saving energy; pick up targeted numbers of appliances.	Outputs Produced by Program Activities	Delivered outputs as expected with exception of reaching participation targets.
Retire secondary/inefficient appliances; decommission appliances on site to prevent resale on secondary market.	Short-term Outcomes	Produced short-term outcomes as expected.
Program grows because of marketing and customer familiarity.	Intermediate Outcomes	On track to produce intermediate outcomes.
Fewer operating secondary/inefficient appliances in the market; environmentally responsible disposal.	Long-Term Outcomes (end of Phase III)	To be determined at end of Phase III.

Participant Profile

According to results from Cadmus' survey, participants most often lived in single-family detached homes (84%, n=542). The highest education level that participants most commonly reported were high school or diploma equivalent at 28% and technical or business school certificate/two-year college degree/some college at 27% (n=535). Over half of the participants earned under \$75,000 per year (58%, n=414).

As part of the participant survey, Cadmus collected the age of participants, shown in Table I-114.

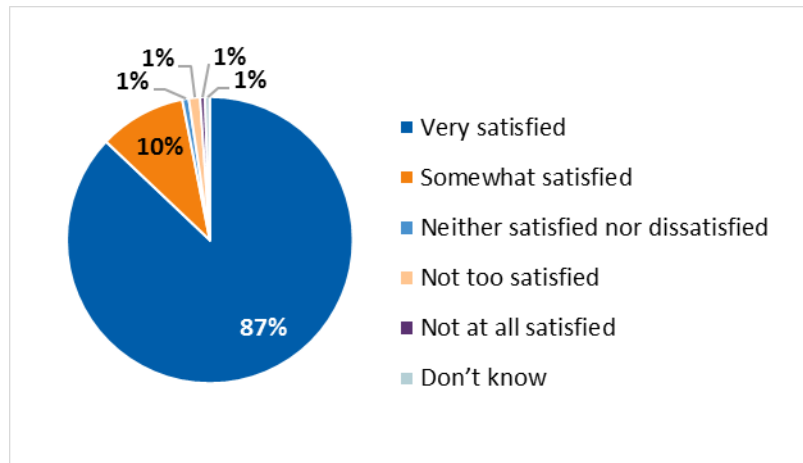
Table I-114. Appliance Recycling Program Customer Survey Demographics

What year were you born?	Total (n=507)
1920-1929	1%
1930-1939	6%
1940-1949	22%
1950-1959	34%
1960-1969	21%
1970-1979	12%
1980-1989	4%
1990-1999	1%

Participant Satisfaction

Program satisfaction remains very high and did not change much from PY6.⁹³ Nearly all participant survey respondents (97%, n=549) reported that they were satisfied with the program overall compared to 99% in PY6 (n=226). Figure I-57 shows program satisfaction.

Figure I-57. Appliance Recycling Program Satisfaction



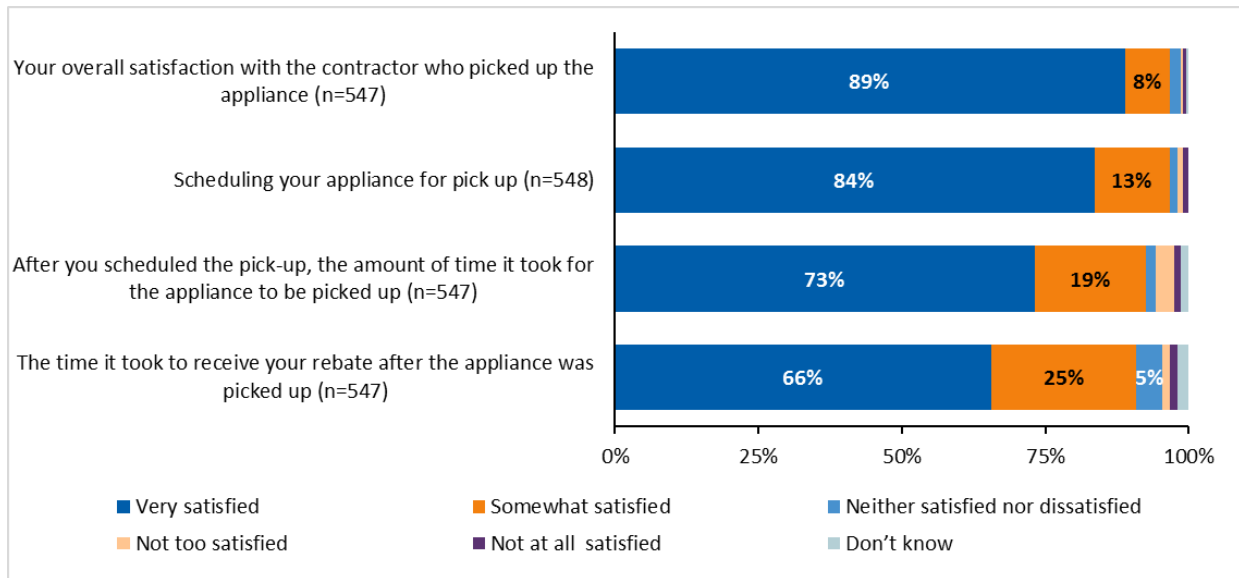
Source: Participant survey question, “Now, thinking about your overall experience with the PPL Electric Utilities residential rebate program, how would you rate your satisfaction?” (n=559) Includes responses from completed surveys and partially completed surveys. Total may exceed 100% due to rounding.

Most survey respondents said they were *very satisfied* with each component of the program (Figure I-58). The highest level of satisfaction was with the contractor who picked up their appliance, with 89% reporting *very satisfied* (n=547). Participants were less satisfied with the time it took to receive their rebate once the appliance was picked up.

Most respondents (83%, n=547) said there was nothing more the contractor could have done to improve their experience with the program. Of the remaining respondents, 7% said the contractor could have provided information about other energy efficiency programs offered by PPL Electric Utilities, 4% said the contractor could have been more professional during the visit, 2% said the contractor could have provided more tips on ways to save energy, and 1% said the contractor could have been more punctual.

⁹³ Cadmus did not conduct a process evaluation in PY7. Where applicable, Cadmus compared PY8 results to PY6 results.

Figure I-58. Participant Satisfaction with Appliance Recycling Program Components



Source: Participant survey question, “How satisfied are you with... [INSERT EACH STATEMENT]? Would you say very satisfied, somewhat satisfied, neither satisfied nor dissatisfied, not too satisfied, or not at all satisfied?”

The survey also assessed the importance of these aspects, shown in Figure I-58:

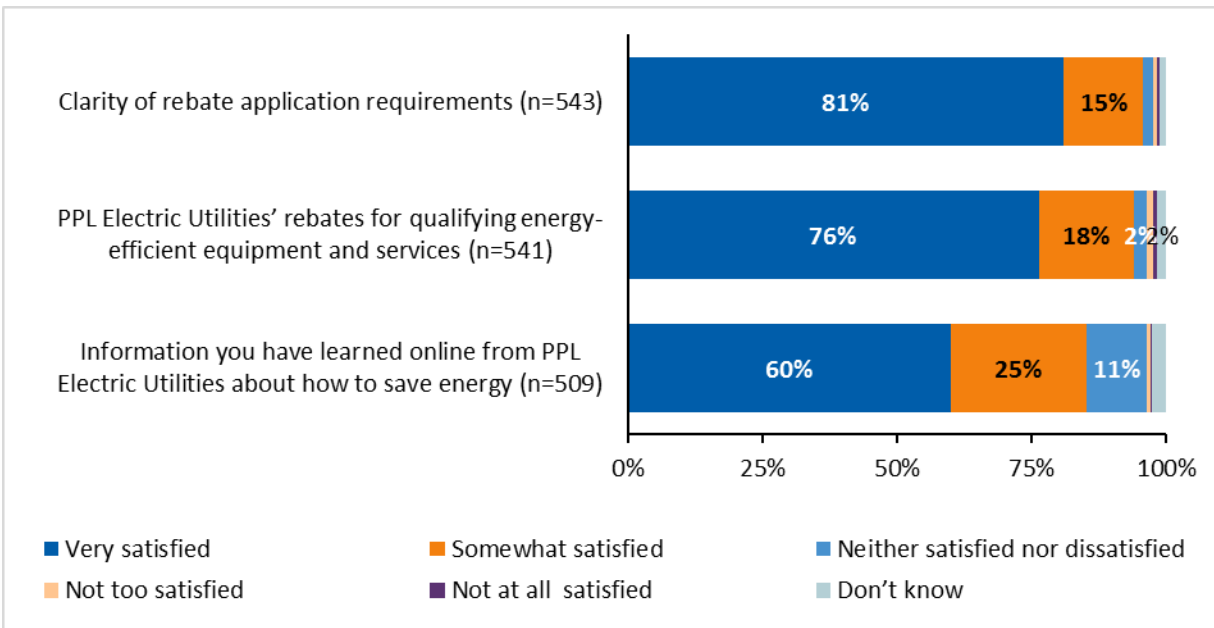
- Clarity of rebate application requirements
- Availability of PPL Electric Utilities’ online information, tips, and tools to save energy
- Availability of PPL Electric Utilities’ rebates for helping me save energy at home

Of these delivery aspects, 72% (n=544) of respondents said the availability of PPL Electric Utilities’ rebates was *very important* to helping them save energy at home; 70% (n=540) said the clarity of rebate application requirements was *very important*; and 52% (n=541) said the availability of PPL Electric Utilities’ online information, tips, and tools was *very important* to saving energy.

Most of survey respondents reported that they were *very satisfied* with each component of the program (Figure I-59), with 81% (n=543) of respondents reporting that they were *very satisfied* with the clarity of rebate application requirements and 76% (n=541) with PPL Electric Utilities’ rebates for qualifying energy-efficient equipment and services.

The program delivery aspects that respondents were most satisfied with coincided with the program delivery aspects respondents said were most important. Clarity of rebate application requirements is both an important program delivery aspect and was the program delivery aspect with the highest level of participant satisfaction. Respondents were least satisfied with information they learned online from PPL Electric Utilities about how to save energy, and this program delivery aspect was also considered the least important.

Figure I-59. Participant Satisfaction with Program Delivery Aspects



Source: Participant survey question, “Thinking about the same items, please indicate how satisfied you are with each one.”

Net Promoter Score

The net promoter score (NPS) is a metric of brand loyalty specifically measuring how likely customers are to recommend the program to others. Respondents rate their likelihood to recommend the program on a 10-point scale where 0 means “not at all likely” and 10 means “extremely likely.” Respondents giving a rating of 9 or 10 are known as promoters, respondents giving a rating of 7 or 8 are known as passives, and respondents giving a 0 to 6 rating are known as detractors. The NPS is expressed as a number between -100 and +100 that represents the difference between the percentage of promoters and detractors. As shown in Table F-77, the Appliance Recycling Program achieved an NPS of +87, indicating there are more promoters than detractors among the respondents

Table I-115. Net Promoter Score Likelihood to Recommend the Program

Rating Classification	Percentage of Respondents (n=548)
Promoters (9-10)	90%
Passives (7-8)	7%
Detractors (0-6)	3%
NPS	+87

Cadmus divided the suggestions for program changes given by survey respondents by NPS classification. A potential way to convert customers to promoters would be to improve the speed of program delivery—rebates and pick up times—a common theme across NPS classifications.

The most common suggestions from detractors were to speed up rebate processing times (44%, n=9), improve customer service (33%), have sooner pick-up times (11%), and have shorter time windows for pick-up (11%).

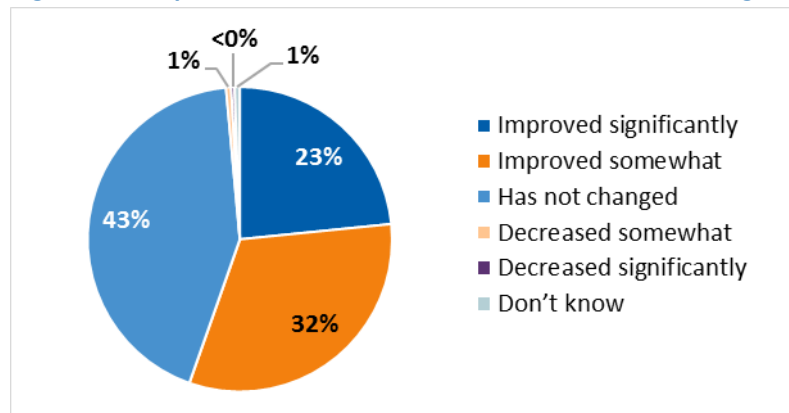
The most common suggestions for program improvement from promoters were to add other appliances to the program (16%, n=134), increase the rebate amount (13%), and have faster appliance pick-up times (13%).

The most common suggestions from passive customers were to add other appliances to the program (21%, n=19), increase the rebate amount (21%), and expand available appointments during scheduling (16%).

Opinion of PPL Electric Utilities

Most survey respondents (55%, n=547) said the program improved their opinion of PPL Electric Utilities (Figure I-60), and 43% did not change their opinion. In comparison, in PY6, the majority of respondents participating in the program did not change their opinion of PPL Electric Utilities (59%, n=226).

Figure I-60. Opinion Shifts of PPL Electric Utilities Due to Program



Source: Participant survey question, "After participating in PPL Electric Utilities' refrigerator and freezer recycling program, has your opinion of PPL Electric Utilities..." (n=547)

Of the few customers who said their opinion of PPL Electric Utilities had decreased since participating in the program, most did not provide a reason. Of the four customers who responded to this question, two said they had never received their rebate check.⁹⁴ Another said that the rebate amount was too low and that the refrigerator sat in front of the house for a month because of a long wait time before pick-up. The fourth customer gave an inapplicable response to the question.

⁹⁴ Cadmus provided information to PPL Electric Utilities for follow up.

Suggested Program Improvements

Most respondents (89%, n=549) did not have suggestions for ways to change the program. A common theme across suggestions is to improve the speed of program delivery—rebates and pick-up times—as discussed earlier in the *Net Promoter Score Section*.

Marketing and Outreach

The Appliance Recycling Program is marketed through the PPL Electric Utilities website, emails to customers, social media advertising, bill inserts, articles in the PPL Electric Utilities' newsletter, and point-of-purchase information provided to appliance retailers. The marketing materials are designed and produced by the ICSP and approved by PPL Electric Utilities before launch.

The main goals of marketing and outreach for this program were to increase customer awareness and ensure the marketing material illustrated the link between recycling an appliance and saving energy. PPL Electric Utilities reported that marketing was effective in PY8. After sending out a bill insert advertising the Appliance Recycling Program, staff reported a spike in customer interest.

Program Discovery

The most common ways that customers learned about the program were through bill inserts from PPL Electric Utilities, followed by word of mouth and email. This corresponds to the top three ways participants said they wanted to hear about the program, namely, email from PPL Electric Utilities (48%, n=546), bill insert or newsletter (38%), and to a lesser degree, through PPL Electric Utilities' website (8%).

Traditionally, the Appliance Recycling Program has been well communicated through bill inserts, and this remained an important marketing channel in PY8 (Table I-116). The top three most common ways respondents learned about the program remained the same in PY6 and PY8. In PY8, 43% of customers (n=541) reported learning about the program from bill inserts, an increase from PY6 (33%, n=140). Eighteen percent of customers reported learning about the program through word of mouth, a slight increase from PY6 (16%), and 13% reported learning about the program through email, another sizable increase from PY6 (5%).

Table I-116. Ways Customer Learned About the Appliance Recycling Program: PY8 vs. PY6

Ways Customers Learn About the Program	PY8 ^[1]	PY6 ^[2]
PPL Bill Insert	43%	33%
Word of Mouth	18%	16%
Email	13%	5%
Other	7%	9%
Internet Search	7%	N/A
PPL Website	5%	14%
In-Store Salesperson	2%	17%
Newspaper	1%	N/A
Television	1%	N/A
Radio	1%	N/A
Mail	1%	N/A
Contractor Trade All	<1%	N/A
Social Media	<1%	N/A

^[1] PY8 Source: ICSP's Tracking Data, "How did you hear?" (n=541).
^[2] PY6 Source: Question C1, "How did you learn about the Appliance Recycling Program? [Multiple responses allowed] (n=140).

Awareness of Other Energy Efficiency Programs

Appliance Recycling Program participants may learn about other PPL Electric Utilities programs when they schedule an appliance pick-up online. The scheduling web page advertises PPL Electric Utilities rebates. Most respondents (70%, n=546) said they were aware of PPL Electric Utilities' energy efficiency programs. Of these respondents, 47% (n=382) were aware of instant savings on LED bulbs sold at retailers; 46% were aware of energy-efficient appliances such as heating or cooling equipment, water heaters, pools pumps or refrigerators; and 40% were aware of home energy audits.

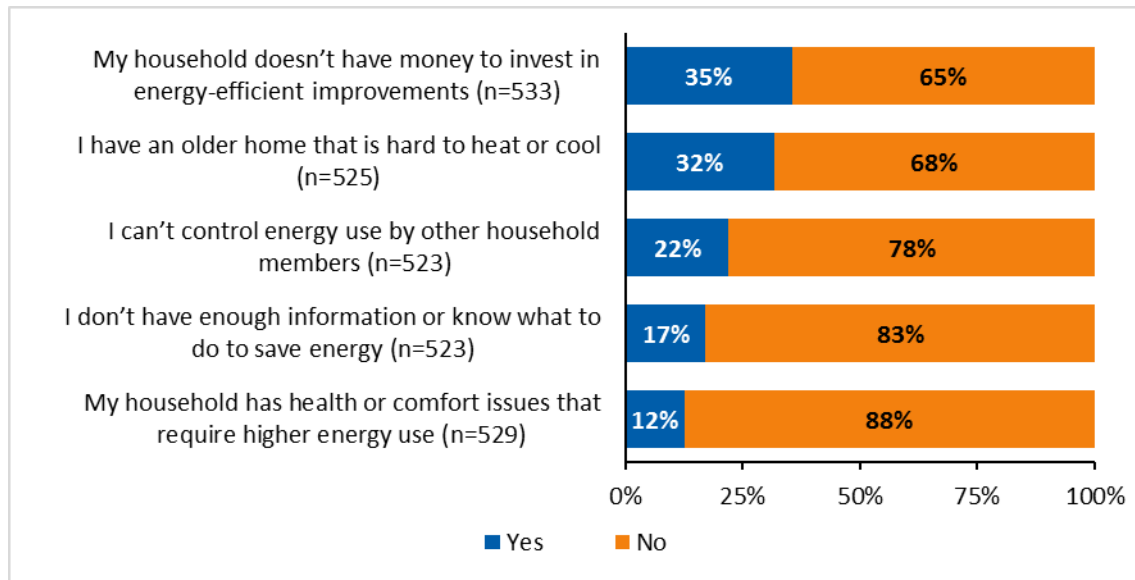
Online Engagement

Over half of the survey respondents (61%, n=546) said they had visited PPL Electric Utilities' website within the past six months compared to 38% who said they had not.

Attitudes Towards and Barriers to Saving Energy

Cadmus asked respondents if they had experienced any of six specific barriers to saving energy. Figure I-61 shows the percentage of survey respondents who experienced these possible barriers to saving energy. Most survey respondents said they did not experience any of the six barriers. Respondents in both PY6 and PY8 said that insufficient finances was a barrier to investing in energy efficiency.

Figure I-61. Barriers to Saving Energy



Source: Participant survey question, "Of the scenarios listed below that people might face when purchasing new appliances or considering energy-efficient improvements to their home, please answer Yes if this is true for you or No if it is not."

I.3.3 Sample Cleaning and Attrition for Participant Surveys

Cadmus coordinated with PPL Electric Utilities' survey contractor to screen the sample and remove records of any customers who had been called in the past three months (whether for a Cadmus survey or a PPL Electric Utilities survey) and who had requested not to be contacted. Cadmus removed duplicate records and records with incomplete or invalid contact information. Cadmus also excluded inactive customers, customers who had recycled only an air conditioner or who were in the large commercial and industrial (C&I) sector, or customers who were selected for another survey.

This cleaning and survey sample preparation process reduced the available sample. Table I-117 lists total numbers of records submitted to the survey subcontractor and the outcome (final disposition) of each record. Cadmus sent email invitations to the remaining contacts with email addresses and followed up with two reminder email invitations. If the contact did not respond to an online survey, Cadmus attempted to contact the participant by telephone up to five times over several days, at different times of the day, and scheduled callbacks whenever possible.

Table I-117. ARP Survey Attrition

Description of Outcomes	Number of Records	
	Participant	Nonparticipant
Online Survey		
Population (number of unique jobs) ^[1]	8,281	N/A
Removed: incomplete, inactive customer, completed survey in past 3 months, on "opt out" list, selected for a different survey, duplicate contact, on "do not contact" list	679	N/A
Email was incomplete or invalid	3,692	N/A
Survey Sample Frame (email invitations sent)	3,910	N/A
Email was returned (bounce back)	277	N/A
Did not respond	3,100	N/A
Opt out	20	N/A
PPL Electric Utilities or market research employee	41	N/A
Cannot confirm equipment/not aware of participation	5	N/A
Did not complete survey	58	N/A
Completed Surveys	409	N/A
Online Response rate	10%	N/A
Telephone		
Population (number of unique jobs for participants; number of PPL residential customers for nonparticipants) ^[1]	8,281	1,202,758
Removed: inactive customer, completed survey in past 3 months, on "do not contact" list, opted out of survey, selected for a different survey, duplicate contact, recycled A/C only, large C&I sector	1,762	92,748
Incomplete or bad phone number,	443	24,376
Survey Sample Frame (sent to subcontractor for telephone survey calls)	6,076	1,085,634
Sampled	N/A	9,000 ^[2]
Not attempted ^[3]	3,288	2
Records attempted	2,788	8,998
Non-working number	260	1,227
Wrong number, business	29	73
No answer/answering machine/phone busy	1,957	5,851
Language barrier	2	58
PPL Electric Utilities or market research employee	11	40
Cannot confirm equipment/not aware of participation	15	0
Refusal	43	363
Terminated survey	29	110
Non-specific or specific callback scheduled	292	976
Did not discard a refrigerator or freezer	N/A	291
Partially completed survey	10	0
Completed Surveys	140	9
Telephone Response rate	2%	0.1%
Total Completed Surveys (total for all modes)	549	9
^[1] Number of rebates for refrigerators and freezers available in PPL Electric Utilities' tracking database through the third quarter of the year, at the time of the final survey effort.		
^[2] Stratified random sample		
^[3] Not selected for sample; PPL Electric Utilities' tracking database had more records than needed for telephone survey.		

Appendix J. Evaluation Detail—Energy Efficient Home Program

This appendix details the methodologies and results for the Energy Efficient Home Program evaluation activities.

J.1 Gross Impact Evaluation

J.1.1 Methodology

Evaluation Sampling Approach

As stated in PPL Electric Utilities' Phase III EE&C Plan, the Energy Efficient Home Program contributes 4.64% to PPL Electric Utilities' estimated portfolio MWh/yr savings.⁹⁵ Because of its small contribution to PPL Electric Utilities' overall estimated MWh/yr savings, most program components' sampling strategies and evaluation activities, as described in this appendix, met basic levels of rigor.

Cadmus evaluated the online assessment, in-home audit and kits, weatherization, and efficient equipment components with basic levels of rigor. For the efficient equipment component, Cadmus oversampled HVAC records because this equipment category is considered high-impact, meaning it contributes a large proportion of energy savings to the program. For all of the components, Cadmus used simple random sampling to select records for the records reviews.

For the new homes component, Cadmus applied an enhanced level of rigor by conducting site visits.

Table J-118 presents the gross impact evaluation sampling plan for PY8. The gross impact evaluation activities produced results with $\pm 2.70\%$ precision at 85% confidence.

⁹⁵ PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

Table J-118. Energy Efficient Home Program Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
New Homes	339	85/15	20	20	Site visits
		8/15	40	40	REM/Rate modeling reviews
Audit and Kit ^[2]	3,550	90/10	Census	54	Verification online survey ^[1]
		90/10	140	78	Verification phone survey ^[3]
		85/15	80	80	Records review ^[4]
Weatherization	482	85/15	25	25	Verification phone survey
		85/15	40	48	Records review
Efficient Equipment	7,030	90/10	135	135	Verification phone survey ^[5]
		85/15	350	350	Records review ^[6]
Program Total	11,401				

^[1] Cadmus attempted to reach a census of in-home audit and online assessment participants via online surveys and achieved 51 online assessment completes and three in-home audit completes.

^[2] Includes online assessment and in-home audit components. Both channels delivered energy efficiency kits to customers.

^[3] Phone surveys for this stratum were completed with eight in-home audit and 70 online assessment participants. The in-home audit population was 88.

^[4] Cadmus sampled 40 online assessment projects and 40 in-home audit projects.

^[5] This survey achieved 45 completes with this high-impact equipment: ductless heat pumps, central air conditioners, and air-source heat pumps. This survey also achieved 90 completes for these equipment types: heat pump water heaters, pool pumps, refrigerators, smart thermostats, and fuel switching.

^[6] Cadmus sampled 40 projects for each of these equipment types: air source heat pump, central air conditioner, fuel switching, heat pump water heater, pool pump, refrigerator, and smart thermostat, for a total of 280. Cadmus also sampled 70 projects for ductless heat pumps.

Ex Post Verified Savings Methodology

Cadmus used stratified random sampling to select a sample of projects for the records review. Strata were defined as these four program components—new homes, audit and kit, weatherization, and efficient equipment. Cadmus assessed savings for the sampled units, calculated stratum-level realization rates, then applied the realization rates to the population total *ex ante* savings within each stratum to estimate the stratum total *ex post* savings. Next, Cadmus summed the stratum total *ex post* savings to derive the program total *ex post* savings and calculated the program realization rate by dividing the program total *ex post* savings by the program total *ex ante* savings.

Cadmus calculated realization rates, standard errors, and precision for the total *ex post* savings estimates using formulas provided in the Uniform Methods Project’s sampling chapter using sampling weights (w_i) proportional to the sampling probability of each unit.⁹⁶ In stratified sampling, the weights

⁹⁶ National Renewable Energy Laboratory. “Chapter 11: Sample Design Cross-Cutting Protocols.” *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. Prepared by Cadmus. April 2013. <http://energy.gov/sites/prod/files/2013/11/f5/53827-11.pdf>

are equal to the stratum population size (N_h) divided by the stratum sample size (n_h), that is, $w_{hi} = N_h/n_h$, for stratum h and unit i .

Cadmus calculated the relative precision of program's total *ex post* savings and realization rate estimates at a minimum of 85% confidence. It designed the sample with a 15% precision target for the program's total energy savings to achieve PPL Electric Utilities' 85/15 program target for confidence and precision, as stipulated in the Phase III Evaluation Framework.⁹⁷

New Homes

Cadmus calculated the *ex post* evaluated gross savings by summing the *ex post* weather-sensitive and non-weather-sensitive savings. First, Cadmus calculated *ex post* energy savings and demand reductions for the non-weather-sensitive equipment (heat pump water heaters, refrigerators, dishwashers, and lighting) in accordance with the individual appliance and lighting algorithms in the PA TRM. For these equipment types, Cadmus used data collected during its verification site visits and data collected by the ICSP's subcontractor.

For weather-sensitive products, Cadmus examined the REM/Rate files and *ex ante* savings provided by the ICSP's subcontractor to determine whether the inputs to the simulations and savings were reasonable. Of 20 evaluated sites, two were units in a multifamily building; the ICSP's subcontractor modeled them as single-family homes and each unit met the same efficiency requirements. Cadmus also modeled these units as single-family homes (with adiabatic walls and other inputs as needed). Cadmus then determined *ex post* energy savings and demand reductions for envelope and HVAC equipment using output from the REM/Rate simulations that calculated heating and cooling energy savings. During this analysis, Cadmus used REM/Rate version 15.4.1 and incorporated the built-in baseline designed by RESNET specifically for PPL Electric Utilities' New Home Program. Cadmus also compared the input data for the ICSP's subcontractor's REM/Rate files (pertaining to mechanical equipment, lighting, and building envelope) against data collected during the site visits for 20 homes.

Two multifamily buildings also installed photovoltaic (PV) panels on the roofs of their buildings to provide power to 88 participating units. Because the ICSP's software calculated savings, the ICSP reported production for the PV system as energy savings to PPL Electric Utilities. However, the PA TRM does not address PV systems installed on new homes.

The next sections discuss Cadmus' approach to verifying energy savings and demand reduction.

⁹⁷ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by the Statewide Evaluation Team (NMR Group Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC). Contracted under the Pennsylvania Public Utility Commission's RFP 2015-3 for the Statewide Evaluator. Final version August 25, 2016.

Method to Verify PV Energy Savings

In Pennsylvania, PV systems are not required to meet the IECC 2009 residential energy code or a national standard.⁹⁸ Cadmus proposes that the baseline for a PV system installed on a new home should be the same as for a new home with no PV system. The ICSP used the method from REM/Rate software to determine energy and demand savings. Cadmus used the PVWatts tool to verify these energy savings.⁹⁹ For the purposes of the Energy Efficient Home Program, annual energy production from the PV system equaled the energy savings attributed to the PV system, as shown here:

$$\Delta kWh_{PV} = \text{annual energy production from PV system}$$

Method to Verify PV Demand Savings

Demand reduction for PV systems is equal to the power production of the PV systems output similar to the avoided demand of a typical energy-efficient product. PV system power production is not constant and the timing of the system output is dependent on the orientation and size of the PV system; therefore, a custom analysis approach was needed to determine demand savings. Cadmus calculated demand savings for verified PV systems using hourly estimated energy production from PVWatts and the PA TRM definition of peak period for coincident peak demand savings, as shown in Table J-119.

Table J-119. Period for Energy Savings and Coincident Peak Demand Savings

Period	Energy Savings	Coincident Peak Demand Savings
Summer	May through September	June through August (excluding weekends and holidays)
Winter	October through April	N/A
Peak	8:00 a.m. to 8:00 p.m. Mon.-Fri.	2:00 p.m. to 6:00 p.m.
Off-Peak	8:00 p.m. to 8:00 a.m. Mon.-Fri., 12 a.m. to 12 a.m. Sat/Sun & holidays	N/A

Source: PA TRM Section 1.10 Electric Resource Savings

Hourly energy production of the PV system was estimated using PVWatts and the typical meteorological year 3 (TMY3) weather dataset, using the coincident peak demand savings period of hours ending 15:00 through hours ending 18:00 from June 1 through August 31 inclusive. The PA TRM specifies that peak days are weekday/non-holidays; however, Cadmus included all days in peak demand calculations because power production of PV systems is weather-dependent and not dependent on user behavior. Demand savings for PV systems will therefore equal the average power production of the PV system across the coincident peak period.

⁹⁸ PA TRM Section 1.7 Baseline Estimates states that the typical baseline for new construction should be code or national standard.

⁹⁹ PVWatts, developed by the National Renewable Energy Laboratory (NREL), uses hourly solar data from the TMY3 dataset to determine energy production and normal time of day output.

Cadmus developed the following equation for coincident peak demand savings for PV systems:

$$\Delta kW_{PV} = \frac{1}{n} \sum_{i=peak\ hour}^n kW\ production_{peak\ hour}$$

Where:

$$\begin{aligned} n &= \text{number of peak period hours in TMY3 dataset} \\ kW\ production_{peak\ hour} &= \text{kW production at each peak hour} \end{aligned}$$

Method to Determine LED Savings Coefficient

Cadmus asked builders where they purchased lightbulbs. Three builders reported purchasing all of their LED bulbs from participating retail stores—two specified Lowe’s and the third said “retail” but did not specify the chain. Because the vast majority of home improvement retailers participate in the upstream lighting program, for purposes of this adjustment, Cadmus assumed it was a participating retailer. These builders accounted for just four homes in the New Homes Program. To avoid double counting savings from the Efficient Lighting Program, Cadmus created a savings coefficient to apply to those four building sites using average savings from LEDs per home. Cadmus did not include CFLs in the savings coefficient because CFLs are not discounted through the Efficient Lighting Program.

Cadmus derived the LED Savings Coefficient from the 20 REM/Rate Models, using the following formula to determine the coefficient:

$$LED\ Savings\ Coefficient = 1 - (E_s * E_x)$$

Where:

$$E_s = \frac{\sum LED\ Savings\ per\ Home}{\sum Total\ lighting\ savings\ per\ home \cdot 20}$$

$$E_x = \frac{\sum Ex\ Post\ Lighting\ Savings\ per\ Home}{\sum Total\ Ex\ Post\ Savings\ per\ home \cdot 20^{100}}$$

Audit and Kit

During the database review and records review, Cadmus calculated *ex post* savings for the energy efficiency products in the kit by reviewing the ICSP’s assumptions and calculations. For products in which the ICSP used TRM deemed inputs, Cadmus confirmed that the ICSP used the correct TRM deemed per-unit savings. For calculated products, Cadmus recalculated and verified savings using the TRM algorithm.

Cadmus calculated the *ex post* evaluated per-unit savings for products included in the energy-savings kit using the evaluated ISRs developed from responses to the online assessment telephone and online

¹⁰⁰ The total number of evaluated homes.

surveys. The process of using survey data to calculate ISRs for the in-home audit and online assessment components' kits is described below under *Section J.1.5 Installation Verification Methodology*.

Weatherization and Efficient Equipment

For weatherization and efficient equipment products, Cadmus verified customer-rebated installations for a sample of records by conducting records reviews and through online and telephone surveys. The records review involved verifying information recorded in PPL Electric Utilities' tracking database by comparing the tracking database data to the original rebate application forms, AHRI certificates, invoices, and ENERGY STAR-qualified product lists. Cadmus verified that rebated products qualified for the program and that the ICSP used the correct model-specific inputs in the TRM algorithm. Cadmus also reviewed PPL Electric Utilities' tracking database to confirm that all products met TRM requirements and that savings were calculated correctly using the applicable TRM algorithms.

Database Review Findings

Cadmus conducted a database review of each component to ensure that appropriate data were collected and confirmed that *ex ante* savings were properly calculated using the appropriate PA TRM algorithms. During this review, Cadmus discovered some discrepancies across components, including incorrect entry of inputs, improper assignment of savings for products that did not qualify for a rebate, and erroneous application of factors affecting savings. These are summarized in Table J-120.

Table J-120. PY8 Energy Efficient Home Program Database Review Findings Summary

Product	Number of Instances	Type of <i>Ex Ante</i> Reporting Difference
Heat Pump Water Heater	81	Incorrect heating type and de-rate factor; interactive effects not calculated for some electric space heat homes where heat type was initially incorrectly assigned
In-Home Audit and Kit	1	Customer with electric hot water heater mistakenly sent gas hot water kit
Insulation	112	Incorrect existing R-value of R-5, regardless of the previous recorded inches of insulation; attic insulation records did not meet TRM requirements of efficient R-value of R-38
Air Source Heat Pump	1	EER of less than 12.5 and a heating seasonal performance factor (HSPF) of less than 8.5; did not meet TRM ENERGY STAR Version 5.0 requirements
Central Air Conditioning	2	EER of less than 12.5; did not meet TRM ENERGY STAR Version 5.0 requirements
Fuel Switching	5	Annual fuel utilization efficiency (AFUE) value of 82, lower than the TRM minimum of 85; EEMIS applied fuel furnace equivalent full load hours (EFLH) instead of the corresponding fuel boiler EFLH

J.1.2 Records Review Findings

Cadmus reviewed a sample of records to evaluate the savings impacts of these program components—audit and kits, weatherization, and efficient equipment. The records reviews accomplished the following:

- Verified that product types were correctly categorized based on the verified installed products
- Verified reported equipment data used for PA TRM energy savings calculations through rebate applications, AHRI certificates, invoices, and other supporting documentation
- Calculated *ex post* savings using the TRM algorithms and verified equipment data

A summary of records review findings is in Table J-121.

Table J-121. PY8 Energy Efficient Home Program Records Review Findings Summary

Program Component	Records Reviewed	Discrepancies	Type of Error or Discrepancy
In-Home Audit and Kits	40	38	Incorrect water heater setback, rebate forms did not record if the contractor conducted the setback, contractor setback not conducted and therefore savings reduced, wrong kit for fuel type, quantity of LED bulbs not applied
Online Assessment	40	0	Lower than anticipated ISRs for kit products, ranging from 42% to 89%
Weatherization	48	25	Incorrectly entered: previous inches of insulation, added R-Value, square feet of insulation, previous R-Value, cooling system installation date, heating system type; attic insulation records did not meet TRM requirements of efficient R-value of R-38; incorrect entry for post-CFM50 value
Air Source Heat Pump	40	2	Incorrect heating capacity and HSPF
Central Air Conditioner	40	3	Records with EER of 12, not meeting TRM ENERGY STAR Version 5.0 requirements; incorrect SEER
Ductless Heat Pump	70	123	Records with EER of 12, not meeting TRM ENERGY STAR Version 5.0 requirements; incorrect entries for zip code, room type, existing heating and cooling type, cooling capacity, SEER, heating capacity at 47° F, and HSPF; missing information for room type, existing heating, and existing cooling
Fuel Switching	40	5	Incorrect heating type or EFLH
Heat Pump Water Heater	40	4	Incorrect water heater location, heating type for water heater location, cooling type for water heater location, or de-rate factor
Pool Pump	40	0	None
Refrigerator	40	0	None
Smart Thermostat	40	2	Equipment recorded as contractor-installed instead of self-installed when contractor invoices not present

J.1.3 New Construction REM/Rate Modeling Findings

Cadmus selected a sample using simple random sampling and reviewed 40 records for the PY8 new construction component of this program and found four sites that overclaimed savings by 30%. The ICSP's subcontractor had used modeling results to calculate *ex ante* savings that led to overestimating savings. Cadmus used the PA TRM methodology to determine savings for new construction.

J.1.4 New Construction Site Visit Findings

Cadmus selected a sample using simple random sampling and visited 20 new construction sites rebated by the program to verify installed equipment, including lighting, refrigerators, dishwashers, and heat pump water heaters. Cadmus also gathered data on mechanical systems to verify the ICSP's subcontractor's inputs into REM/Rate for these homes.

Lighting

Cadmus verified all installed lighting and compared the actual installed lights to the reported installed lighting. One site did not meet the minimum code requirements of the 2009 IECC for high-efficacy lights. In accordance with Section 404.1 Lighting Equipment in the 2009 IECC, a minimum of 50% of the lamps in permanently installed lighting fixtures must be high-efficacy. In one of the observed sites, only 13% of the installed lamps were high-efficacy.

Table J-122 shows the distribution of the observed lighting equipment in the homes in the sample.

Table J-122. PY8 Energy Efficient Home Program Distribution of Observed Lighting Technology

Technology	Number of Lamps by Technology	Percentage of Lamps by Technology
CFL	531	45%
LED	271	23%
Incandescent	245	21%
Linear Fluorescent	83	7%
Halogen	50	4%
Other	2	<1%

Solar PV

Of the 339 homes or tenant units in multifamily buildings that received a rebate through the program, 88 (26%) utilized PV. All were tenant units in two large multifamily projects that had solar PV incorporated into the energy design of the buildings. Cadmus inspected two tenant units at one of the multifamily sites, verified the energy and demand savings using the PVWatts software, and determined a realization rate of 100% for those units.

J.1.5 Installation Verification Methodology

As discussed in *Evaluation Sampling Approach* in Section J.1.1, Cadmus conducted participant surveys to calculate ISRs for the audit and kits component and confirm installation for the weatherization and equipment component.

Audit and Kits

Cadmus calculated ISRs for the audit and kits stratum's energy-savings kit products from a participant survey fielded with 121 online assessment recipients. The population size of the in-home audit and kits component was small, so it was difficult to reach enough survey respondents to derive ISRs. Because the online assessment component and the in-home audit and kits component were delivered the same way,

by mailing the kit to the customer, Cadmus calculated ISRs only from the online assessment component participant survey responses. Cadmus then applied these ISRs to the entire audit and kits stratum.

Cadmus calculated each product's ISR by dividing the total number of survey respondents who received the product by the number who installed the product. For water heating products, Cadmus calculated the ISRs only for customers who indicated they had electric water heat. This methodology was consistent with how ISRs have been calculated for other PPL Electric Utilities programs that distribute energy-savings kits.

Because of the manufacturer's recall of the electroluminescent nightlights and their replacement with LED nightlights (see *Program Delivery* in Section J.3.2), there was uncertainty in how respondents interpreted the question "Is the energy-efficient night light you received in your kit currently installed in your home?" Some respondents said they had not installed the nightlight because it was recalled. For these respondents, Cadmus could not verify if they had installed the replacement nightlight, so Cadmus manually removed any responses that indicated the nightlight was not installed because of the recall.

The ISRs are presented in Table J-123.

Table J-123. PY8 Energy Efficient Home Program Online Assessment Energy-Saving Kit ISRs

Kit Product	ISR
LED Light Bulbs	89%
Kitchen Faucet Aerators	61%
Bathroom Faucet Aerators	53%
Low Flow Showerheads	42%
Nightlight	76%
Pipe Insulation	56%

For the Energy Efficient Home Program, showerheads exhibited the lowest ISR of all products at 42%. Of the 41 respondents who answered a follow-up question asking why they did not install their showerheads, five said the water pressure was inadequate, two said they did not like the design of the showerhead, 21 said they already had a high-efficiency showerhead installed in all their showers, and 13 said "other." The most frequently cited "other" responses were that respondents had not tried to install it yet (three respondents), gave it to someone else (two respondents), or simply did not need it (two respondents). Respondents were also asked follow-up questions regarding their decision not to install the products for all of the other products. Table J-124 summarizes the reasons given by respondents.

**Table J-124. PY8 Energy Efficient Home Program Online Assessment
Reasons for Not Installing Kit Products**

Kit Product	Answered Follow-Up Question	Reasons for Not Installing
LED Light Bulbs	33	Waiting for a bulb to burn out (n=15), already had LEDs/CFLs installed everywhere they wanted (n=11), quality of light did not meet needs (n=1), "other" (n=4), "don't know" (n=2)
Kitchen Faucet Aerators	35	Already had aerator installed in kitchen faucet (n=10), found difficult to install (n=8), did not like design (n=3), "other" (n=13), "don't know" (n=1)
Bathroom Faucet Aerators	29	Already had aerator installed in bathroom faucet (n=13), did not like design (n=1), water pressure inadequate (n=1), "other" (n=13), "don't know" (n=1)
Pipe Insulation	32	Already had pipe insulation installed where it was needed (n=15), found difficult to install (n=6), water pressure inadequate (n=1), "other" (n=10)

Cadmus compared the ISRs from PPL Electric Utilities' Energy Efficient Home Program to ISRs from two other Midwestern utilities' programs that mailed energy-saving kits to gauge the similarity of ISRs (Table J-125).

**Table J-125. PY8 Energy Efficient Home Program Online Assessment
Energy-Saving Kit ISRs and Benchmarking**

Kit Product	PPL Electric Utilities	Dayton Power and Light ^[1]	Wisconsin Focus on Energy ^[2]
LED Light Bulbs	89%	90%	82%
Kitchen Faucet Aerators	61%	53%	43%
Bathroom Faucet Aerators	53%	52%	49%
Low Flow Showerheads	42%	51%	57%
Nightlight	76%	N/A	N/A
Pipe Insulation	56%	N/A	N/A

^[1] Cadmus. *Dayton Power and Light 2016 Evaluation, Measurement, and Verification Final Report*. May 5, 2017. Available online: <http://dis.puc.state.oh.us/TiffToPdf/A1001001A17E15B45137E01772.pdf>

^[2] Cadmus. *Focus on Energy Calendar Year 2016 Evaluation Report Volume II*. May 19, 2017. Prepared for Public Service Commission of Wisconsin. Available online: <https://www.focusonenergy.com/sites/default/files/WI%20FOE%20CY%202016%20Volume%20II%20-%20%28Low%20Res%29.pdf>

Weatherization and Efficient Equipment

For weatherization and efficient equipment participants, Cadmus confirmed that rebated products were installed by asking "Is the [PRODUCT] currently installed?" during the phone surveys. All weatherization respondents (n=25) and all efficient equipment respondents (n=135) responded with "Yes," the equipment was still installed.

J.2 Net Impact Evaluation

J.2.1 Net-to-Gross Ratio Methodology

Cadmus used self-report surveys to assess net savings for the Energy Efficient Home Program, following the Evaluation Framework's recommended common method for assessing NTG.¹⁰¹ The SWE team reviewed and approved the surveys prior to fielding.

New Homes

For the new home component, home builders receive the rebate, so they could be considered free riders if they were planning to install all of the rebated equipment or build homes that met PPL Electric Utilities' program requirements to build homes that exceeded the minimum building efficiency codes in the absence of the program. Cadmus assessed free ridership using participant builder interviews.

Audit and Kits, Weatherization and Efficient Equipment

For the audit and kits, weatherization, and efficient equipment program components, Cadmus calculated NTG ratios using participant surveys, because the customer either received the financial incentive or the free products in the energy-savings kits. For these program components, Cadmus calculated the free ridership scores using participant survey responses and the common methods for downstream rebate programs, including influence and intention questions.¹⁰²

For the efficient-equipment component, Cadmus oversampled HVAC products because they are high-impact products for the net savings analysis.

Participant spillover in the program's audit and kit component refers to participants' installation of products in addition to the free products which the participant receives in the energy-saving kits and where the program was important to the participant's decision to install these additional products.

To estimate spillover, surveys included questions to determine whether participants installed specific additional high-efficiency products and, if so, whether participation in the Energy Efficient Home Program was important to their decision. Additional high-efficiency product purchases only counted toward spillover if the customer did not receive a rebate and the program had been important to the decision to purchase and install the products.

Self-Report Surveys

The assessment includes two components of free ridership—the intention to implement an energy-efficient project without a rebate and the influence of the program in the decision to implement the

¹⁰¹ Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC October 21, 2016.

¹⁰² Ibid.

energy-efficient project. When scored, each component has a value ranging from zero to 50 and a combined total free ridership score ranging from zero to 100.

Net-to-Gross Ratio Sampling

Table J-126 shows the sampling plan for Energy Efficient Home net impact activities. Cadmus used a stratified random sample to contact participants across the four strata, which were defined by program component.

Table J-126. Energy Efficient Home Program Sampling Strategy

Stratum	Population Size ^[1]	Target Sample Size	Achieved Sample Size	Evaluation Activity
New Homes	17	10	10	Builder self-report phone interviews
Audit and Kit ^[2]	3,550	All available records	54	Participant self-report online survey
		140	78 ^[3]	Participant self-report phone survey
Weatherization	482	25	25	Participant self-report phone survey
Efficient Equipment	7,030	135	135	Participant self-report phone survey ^[4]
Program Total	11,078		302	

^[1] Population refers to unique projects, with exception of New Homes, which refers to the population of builders. The sample frame after cleaning and removing duplicate customer accounts is contained in Table F-78.

^[2] Includes online assessment and in-home audit components. Both channels delivered energy efficiency kits to customers.

^[3] Phone surveys for this stratum were completed with 8 in-home audit and 70 online assessment participants. The in-home audit population was 88.

^[4] Cadmus selected a sample of 45 participants or surveys for these high-impact products: ductless heat pumps, central air conditioners, and air-source heat pumps. The sample size was 90 for these products: heat pump water heaters, pool pumps, refrigerators, smart thermostats, and fuel switching.

J.2.2 Net-to-Gross Ratio Findings

Table J-127 shows the NTG ratio results for the stratum of the Energy Efficient Home Program.

Table J-127. Energy Efficient Home Program NTG Findings Summary

Stratum	PYVTD	Free Ridership (%) ^[1]	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.
New Homes	10	51%	0%	0.49	35%
Online Assessment Kit	114 ^[2]	7%	9%	1.02	8%
Audit – In-Home	11	4%	1%	0.97	5%
Weatherization	25	49%	7%	0.58	14%
Efficient Equipment	135	41%	7%	0.66	25%
High Impact Measures ^[3]	45	44%	7%	0.63	11%

^[1] These estimates were weighted by the survey sample-verified program kWh/yr savings. This method ensures that respondents who achieved higher energy savings through the program products have a greater influence on the measure-level free ridership estimate than do the respondents who achieved lower energy savings.

^[2] Seven respondents reported not installing any of the kit products and were not included in the NTG analysis.

^[3] HVAC equipment was a high impact measure in PY8 and was sampled at 85/15 confidence and precision by completing 45 self-report surveys. The HVAC equipment high impact measure research is a subset of the overall Efficient Equipment stratum NTG research effort. The NTG estimates for the Efficient Equipment stratum measure categories (HVAC equipment, HPWH, and Other) were weighted by the measure categories verified kWh/yr program population savings to arrive at the final Efficient Equipment stratum NTG ratio of 0.66.

Intention Free Ridership

Under the intention/influence method, Cadmus used the following key question to determine how participant’s purchasing decisions would have differed in the absence of the program:

“Which of the following would have happened if you had not received the \$[REBATE] [MEASURE] rebate from PPL Electric Utilities?”

Cadmus used the responses to determine each participant’s final intention score, then weighted these individual scores by their respective total survey sample *ex post* gross kWh/yr savings to arrive at savings-weighted average intention scores.

Influence Free Ridership

Influence is assessed by asking about how much influence—from 1 (no influence) to 5 (extremely influential)— various program elements had on the purchase decision making.

The survey asked the following influence question:

“Please rate the following items on how much influence each item had on your decision to purchase the [MEASURE]. Please use a scale from 1 to 5, 1 meaning no influence, and 5 meaning the item was extremely influential in your decision.”

From responses to this question, Cadmus obtained data about the influence of PPL Electric Utilities rebates and information about energy efficiency from PPL Electric Utilities as well as the influence of any

information about the type of equipment to install from the participant’s installer or contractor. Cadmus assessed influence from participants’ ratings about how important various program elements were in their decision to purchase energy-efficient products. Cadmus used the responses to determine each participant’s final influence score, then weighted these individual influence scores by their respective total survey sample *ex post* gross kWh/yr savings to arrive at savings-weighted average influence scores.

Cadmus then summed the intention and influence components to estimate the total intention and influence method’s free ridership average by stratum, weighted by *ex post* gross kWh/yr savings. Table J-128 summarizes the intention, influence, and free ridership scores for each stratum.

**Table J-128. Energy Efficient Home Program
Intention, Influence, and Free Ridership Score by Stratum**

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
New Homes	10	33%	18%	51%
Online Assessment Kit	114	7%	0%	7%
Audit – In-Home	11	3%	1%	4%
Weatherization	25	41%	8%	49%
Efficient Equipment ^[1]	135	35%	6%	41%

^[1]The intention, influence and free ridership scores for the Efficient Equipment stratum measure categories (HVAC equipment, HPWH, and Other) were weighted by the measure categories verified kWh/yr program population savings to arrive at the final Efficient Equipment stratum estimates.

Spillover Findings

Table J-129 lists the quantity of energy-efficient spillover equipment types attributed to PPL Electric Utilities along with the per-unit energy savings and source of the estimated energy savings used in the spillover analysis.

Table J-129. Energy Efficient Home Program Spillover Products and Savings

Spillover Product	Quantity	Per-Unit Savings kWh	Savings Source
Air Conditioning Equipment	13	236.2	PY8 PPL Gross Verified Savings
Clothes Washer	12	48.7	PPL TRM Feb 2017
Dehumidifier	1	183.0	PPL TRM Feb 2017
Dishwasher	11	40.8	PPL TRM Feb 2017
Freezer	2	22.0	PPL TRM Feb 2017
Insulation - Ceiling	9,780 square feet	0.7	PY8 PPL Gross Verified Savings
Insulation - Wall	939 square feet	2.4	PY8 PPL Gross Verified Savings
Refrigerator	22	55.6	PY8 PPL Gross Verified Savings
Windows	96 windows	13.0	PPL TRM Feb 2017

Table J-130 shows the spillover results for the strata of the Energy Efficient Home Program.¹⁰³

Table J-130. Energy Efficient Home Program Spillover Calculations by Stratum

Variable	Variable Description	Online Assessment Kit	Audit – In-Home	Weatherization	Efficient Equipment	Source
A	Survey Sample Size (n)	114	11	25	135	Survey Data
B	Total Survey Sample Spillover kWh/yr Savings	2,841	44	1,855	9,574	Survey Data/Engineering Estimates
C	Average SO kWh/yr Savings Per Survey Respondent	25	4	74	71	Variable B ÷ Variable A
D	Program Participant Population	3,462	88	482	7,030	Program Tracking Data
E	SO kWh/yr Savings Extrapolated to the Participant Population	86,264	349	35,774	523,143	Variable C × Variable D
F	Evaluated Program Population kWh/yr Savings	997,284	30,313	534,699	7,487,966	Evaluated Gross Impact Analysis
G	Spillover Percentage Estimate	9%	1%	7%	7%	Variable E ÷ Variable F

J.3 Process Evaluation

J.3.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In February of 2017, Cadmus conducted five interviews with the program managers from PPL Electric Utilities and the ICSP. The interviews focused on program goals and offerings, the delivery and marketing strategies, and their perceptions of the successes and challenges.

Participant Surveys

Cadmus conducted online and telephone surveys. These surveys asked identical questions to assess program satisfaction and net savings. Cadmus used a stratified random sample (see Table J-126 in Section J.2.2).

Cadmus administered the online surveys between April and August 2017 and the telephone surveys between July and August 2017. Participants who completed the online survey were excluded from the telephone survey. To prepare the contact list, Cadmus removed records of anyone who had completed a PPL Electric Utilities or Cadmus survey in the past three months. The surveys assessed participant satisfaction; the number of completed surveys produced a measurement of program satisfaction with ± 3% precision at 90% confidence.

¹⁰³ No data collected for the New Homes stratum indicated spillover activity attributable to PPL Electric Utilities.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. Cadmus addressed these potential sources of bias by applying survey design and survey data collection best practices. Surveys did not include leading or ambiguous questions or double-barreled questions. Cadmus provided clear interviewing and programming instructions so that they were implemented consistently. The SWE team and PPL Electric Utilities reviewed and approved surveys before fielding.

Cadmus also tested for mode effects in the online assessment component. The analysis tested for significant differences in demographic characteristics between online respondents and telephone survey respondents to investigate whether differences in population characteristics may affect responses. Specifically, the analysis examined differences in age, education, and income and found no significant differences between modes. Therefore, the results of the surveys contained in this report are unweighted. Social desirability biases are often more present in telephone surveys than in online surveys because of the verbal conversation with an interviewer. For that reason, Cadmus tested for any significant differences between free ridership scores for online and phone survey respondents and found that online respondents scored lower than phone respondents, as discussed in *Section J.2.2*.

Respondents in the online assessment survey were originally not asked about their overall satisfaction with the program. Because overall satisfaction with the program is a central metric, Cadmus fielded an additional online survey to online assessment participants (n=222) in August 2017. These respondents were asked only about their overall satisfaction with the online home energy assessment program.

See *Section J.3.3* for sampling cleaning and attrition.

Trade Ally Interviews

In July of 2017, Cadmus interviewed 30 trade allies who provided services for one of these program components: in-home audits, efficient equipment (heat pump water heater and HVAC), and new homes. Table J-131 shows the population size and the number of interviews completed by component, and the proportion of program rebates (i.e., jobs) that the interviewed sample represents.

Table J-131. Trade Ally Sample Information

Trade Ally Component	Population Size ^[1]	Target Sample Size	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample ^[2]	Percent of Projects Interviews Covered ^[3]
In-Home Auditor	8	5	5	100%	81%
Heat Pump Water Heater Retailer	267 ^[4]	5	5	6%	10% ^[5]
HVAC Contractor	380	10	10	5%	20%
New Home Builder	17	10	10	100%	73%
Program Total	671	30	30		

^[1] The source of the population was PPL Electric Utilities' tracking database.

^[2] Percent contacted means the percentage of the sample frame called to complete interviews.

^[3] Percent of projects interviews covered refers to the percentage of jobs that the interviewed respondents covered out of the total number of rebates for that component.

^[4] Not all heat pump water heater rebates listed a retailer, so this number may be excluding retailers.

^[5] This percentage may be underestimated, as many heat pump water heater rebates did not list the retailer.

The sampling methods varied slightly among components. For HVAC contractors, home builders, and heat pump water heater retailers, Cadmus prioritized completing interviews with the most active trade allies (i.e., those who had completed the highest number of jobs for PPL Electric Utilities, as reported in its tracking database). Additionally, for the heat pump water heater retailers, Cadmus completed interviews with a mix of big-box companies (e.g., Lowe’s and Home Depot) and local retailers. Cadmus contacted a census of in-home energy auditors and new home builders.

Cadmus collected the interview data for several purposes. All interviews assessed general program awareness and examined customer and trade ally satisfaction. Cadmus also used these interviews to explore the marketing and outreach strategies used by trade allies, key market indicators, and how the rebate program influenced business practices. For HVAC contractors, Cadmus added questions to assess the incremental cost of air source heat pumps and ductless mini-split heat pumps. For home builders, Cadmus gathered information on free ridership to inform the program’s NTG ratio.

J.3.2 Additional Findings

This section contains the findings from the process evaluation activities for the Energy Efficient Home Program.

Program Delivery

In PY8, the ICSP delivered the audit and kits, weatherization, and efficient equipment portions of the program to customers, which involved maintaining a call and rebate processing center, conducting in-home audits, completing quality assurance inspections for 5% of the participant population, recruiting and educating trade allies, and marketing the program to achieve sufficient participation. The ICSP’s subcontractor for the program’s new homes component managed the builder and rater network, completed quality assurance inspections for 5% of new homes, conducted marketing and outreach, and provided training and support to builders and HERS raters about how to meet program requirements to build homes to at least 15% above code. HERS raters are energy inspectors that are certified through RESNET’s Home Energy Rating System.¹⁰⁴

Program Changes

There were several large changes to program delivery from Phase II to Phase III. One change was that the ICSP took over management of the entire residential portfolio, including the Energy Efficient Home Program, so the ICSP could easily cross-promote residential programs and provide a more seamless experience to customers.

PPL Electric Utilities re-designed the in-home audit component so that when a customer scheduled an audit the ICSP mailed the customer a kit of energy products. The customer then could choose to install the energy products or wait for the auditor to complete the audit and request assistance to install the products.

¹⁰⁴ HERS raters are regulated through the Mortgage Industry National Home Energy Rating Systems Standards.

PPL Electric Utilities and the ICSP launched an online portal in PY8 so trade allies could manage their work related to PPL Electric Utilities. Trade allies could submit rebate applications on behalf of their customers, see all of the jobs they submitted and review their status, and create multiple accounts for each company.

Program Delivery Challenges

On the whole, and given the changes from PY7 to PY8, this complex program is operating smoothly. In PY8, the program reached 11,078 participants. However, challenges during program implementation in PY8 may have influenced program performance.

Efficient Equipment

Of the 16 heat pump water heater retailers Cadmus contacted, two had previously sold program-eligible equipment but said they no longer carried this equipment because General Electric dropped its heat pump water heater line at the end of 2016 (just over halfway through PY8).¹⁰⁵ Of the 522 heat pump water heaters purchased through December, 2016, 74% of those purchased were the General Electric brand. The other major brands purchased through December, 2016—A.O. Smith and Rheem—were sold less frequently (12% and 10% of purchases, respectively). Of the 180 heat pump water heaters purchased after January 1, 2017 (after the General Electric line was discontinued), 43% were the General Electric brand, whereas 24% were A.O. Smith and 27% were Rheem.¹⁰⁶ Although A.O. Smith and Rheem purchases increased after the General Electric line was discontinued, the fact that the discontinued General Electric brand continued to outperform other brands suggests that retailers are selling stock on hand. This change in the market may have impacted the PPL Electric Utilities program; Cadmus expects to see the shares of Rheem and A.O. Smith brand rebates continue to increase as the General Electric stock is sold.

For the first four months of PY8, the rebate forms for air source heat pumps, central air conditioners, and ductless heat pumps did not include minimum EER requirements. PPL Electric Utilities honored these customers' rebate applications. The ICSP revised the rebate form in September 2016 to include the minimum EER requirements needed to qualify for the rebate.

In-Home Audit and Online Assessment Kits

The program encountered an unexpected challenge when the manufacturer of electroluminescent nightlights, which were included in the kits, recalled the lights because of safety concerns. The ICSP contacted all kit recipients (n=3,550) by phone to instruct them to cease using the electroluminescent nightlights and successfully issued replacement LED nightlights.

The in-home audit component also experienced challenges with the kit-ordering system because kits often had not arrived at the home before the auditor's visit. According to the program design,

¹⁰⁵ GE Appliances. "Geospring Heat Pump Water Heater – Discontinuing Manufacture Statement." Accessed September 2017: <http://products.geappliances.com/appliance/gea-support-search-content?contentId=34296>

¹⁰⁶ Retailers may have continued to sell their existing stock of General Electric heat pump water heaters even after the line was discontinued.

contractors were to contact the ICSP at least two weeks before the audit so the ICSP had time to verify customer eligibility and mail the kit. However, four out of five in-home energy auditors interviewed said the kits had not arrived in time for their visits so they were unable to help customers install the products (see *Suggested Program Improvements* in Section J.3.2). Additionally, one contractor said the kits were difficult to order.

Key Performance Indicators

PPL Electric Utilities and the ICSP defined plans for participation for the Energy Efficient Home Program to meet estimated energy savings and set levels for customer satisfaction. The Energy Efficient Home Program performance plans for these metrics are shown in Table J-132.

Table J-132. Energy Efficient Home Program Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
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	Surpassed target; 65% of participants said <i>very satisfied</i> and 22% said <i>somewhat satisfied</i> with the program (n=409) ^[1]
Rebate Processing Time	Average rebate processing time (time completed rebate is received until check is mailed)	Contract goal is to have an average processing time of 6 weeks or less. (4 weeks is internal goal)	Surpassed target; average processing time was 18.5 days (just under 3 weeks)

^[1] Includes responses from completed surveys and partially completed surveys.

Logic Model Review

A program logic model identifies the relationships between activities and expected results. The Phase III PY8 Energy Efficient Home Program had a similar logic model to the Phase II program. Cadmus reviewed the program's logic model and determined the program operated as expected in PY8, with one exception. Low-cost products were often not installed during audits because the kits had not arrived in time (see *Program Delivery* in Section J.3.2 *Additional Findings*). Table J-133 shows the program logic model's expected and actual outcomes.

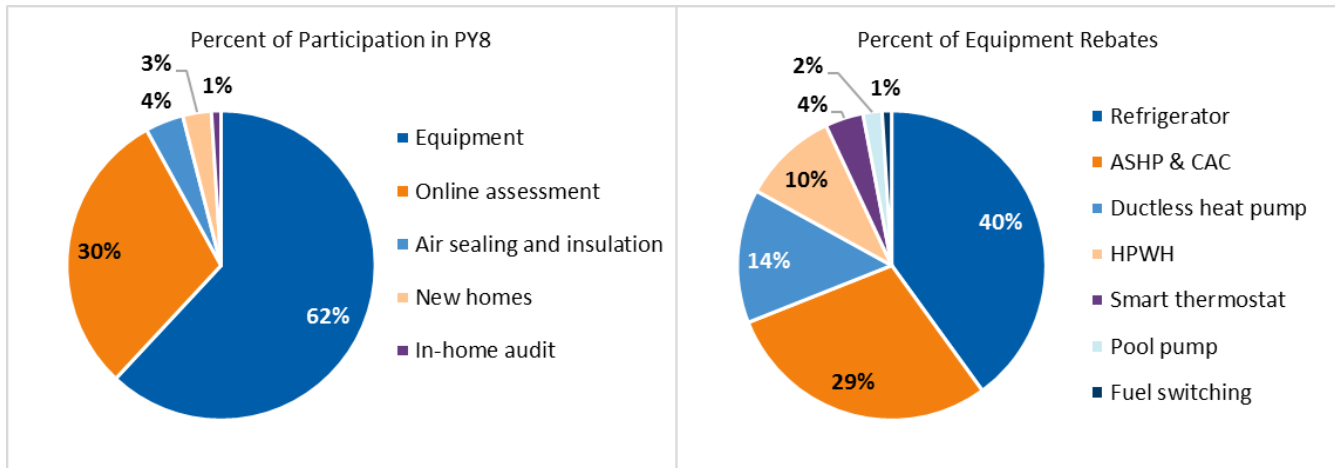
Table J-133. Energy Efficient Home Program Logic Model Review

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
Develop marketing and educational materials, conduct audits, install low-cost products during audits, mail energy efficiency kits, install major products, provide rebates to customers and builders	Program Activities	Delivered program activities as expected except for installing low-cost products during audits
Marketing activities; number of participants and builders; products installed; quality of installations; compensation paid	Outputs Produced by Program Activities	Delivered outputs as expected
Residential customers are more aware and knowledgeable of programs and energy efficiency; installation of energy-saving products in homes	Short-term Outcomes	Produced short-term outcomes as expected
Residential customers reduce energy use through products and/or behavior change	Intermediate Outcomes (end of PY10)	On track to produce intermediate outcomes as expected
Residential customers continue to save energy from upgrades and conservation behavior, as well as through changes in building practices	Long-term Outcomes (end of phase III)	To be determined at end of Phase III

Participant Profile

In PY8, the components with the highest participation levels were equipment and online assessment (see Figure J-62). Of equipment rebates, refrigerators comprised the highest volume, but HVAC equipment (air source heat pump, central air conditioner, and ductless mini-split heat pump) contributed most to the program’s savings.

Figure J-62. Energy Efficient Home Participation in PY8

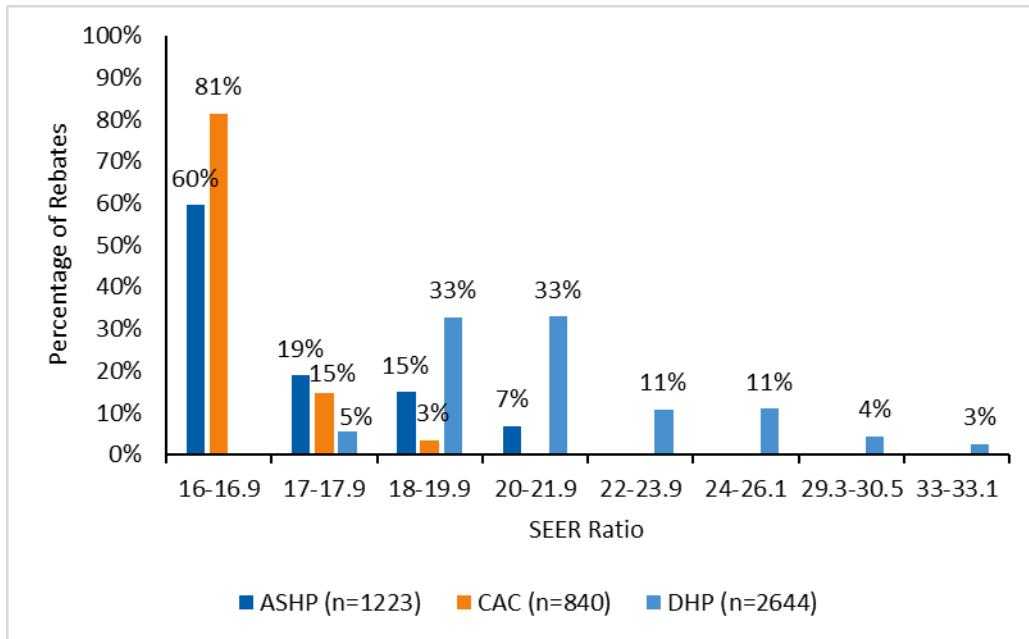


Percent of rebates for the equipment, online assessment, weatherization (i.e., air sealing and insulation), new homes, and in-home audit components (left figure). Percent of rebates for the equipment subcomponents (right figure).

HVAC equipment – SEER level. The percentage of rebates by SEER level for air source heat pumps, central air conditioners, and ductless heat pumps is shown in Figure J-63. A large percentage of participants purchased air source heat pumps and central air conditioners that just met the eligibility

requirements, whereas purchases of ductless mini-split heat pumps were more evenly distributed across the higher-efficiency tiers.

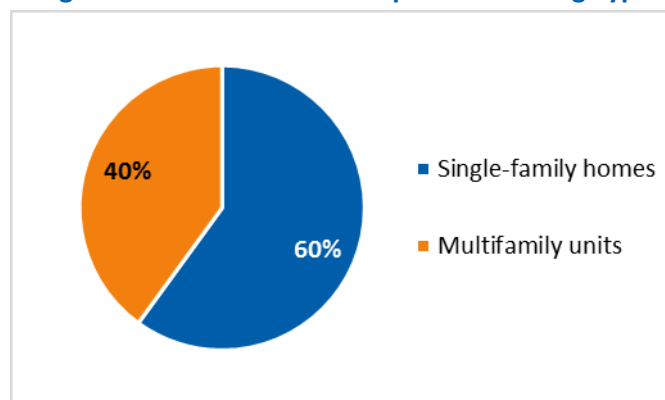
Figure J-63. Percentage of HVAC Rebates by SEER Level



Source: PPL Electric Utilities’ tracking database

New homes component – home type. Cadmus determined that 60% of participating new homes were single-family residences and 40% were multifamily units (where each unit is considered a home) (Figure J-64). Additionally, 98% of new home builders built to the Tier 1 standard and the remaining 2% built their program homes to the Tier 2 requirements.¹⁰⁷

Figure J-64. New Homes Component Housing Type



Source: PPL Electric Utilities’ tracking database

¹⁰⁷ Tier 1 requires builders to achieve 15% more energy efficiency than the 2009 IECC and Tier 2 requires builders to additionally meet the ENERGY STAR 3.1 requirements.

Participant Demographics. According to survey responses, customers who took advantage of the Energy Efficient Home rebates offerings are educated, middle- to high-income earners (Table J-134). The program’s online assessment component reached lower income households, with about 44% of the survey respondents reporting an income of less than \$50,000.

Table J-134. PY8 Participant Demographic Summary

Component	Sample Size	M Age (SD)	Percent Living in Single-Family Detached Home	Percent with Income Above \$50,000 Annually	Percent with a 2-Year College Degree or More
Equipment ^[1]	135	52.66 (15.82)	87%	73%	81%
Weatherization	25	50.57 (15.68)	83%	90%	79%
In-Home Audit	11	51.27 (18.28)	100%	91%	100%
Online Assessment	121	48.18 (16.72)	69%	56%	79%

^[1] Of the 135 equipment surveys Cadmus completed, 45 were for HVAC equipment, 30 were for HPWHs, 12 were for pool pumps, 27 were for refrigerators, 18 were for smart thermostats, and 3 were for fuel-switching.

Participant Satisfaction

Cadmus assessed participant satisfaction via 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. The number of participants responding is indicated in the following discussion.

Participants (n=409) were, overall, satisfied with the PPL Electric Utilities Energy Efficient Home Program; 65% reported they were *very satisfied* and 22% reported they were *somewhat satisfied* (Figure J-65). Four percent (20 respondents) reported dissatisfaction with the program. Overall satisfaction decreased from PY7, when 81% of respondents were *very satisfied* and 17% were *somewhat satisfied* (n=286).¹⁰⁸

Overall satisfaction in PY8 differed significantly only between the equipment and online assessment components—respondents who received rebates for equipment were significantly more satisfied with the program than were respondents who received an online assessment and energy-savings kits through the mail. Eighty-one percent of equipment respondents stated they were *very satisfied* (n=135) compared to 54% of online assessment respondents (n=222).¹⁰⁹

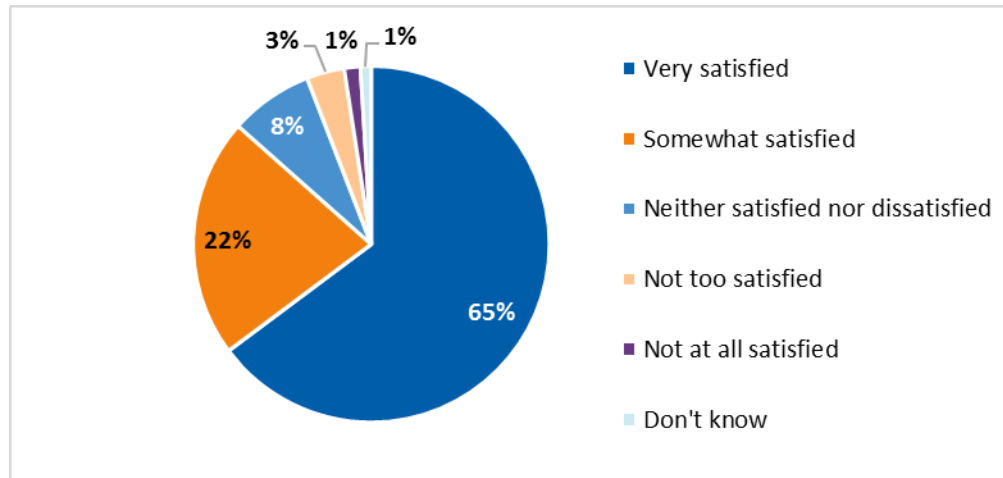
It is notable that most of the dissatisfied respondents in the program as a whole were online assessment participants (17 out of 20). When asked if they had any other comments, these respondents offered little useful feedback about the program. Three respondents said there was a problem with kit delivery,

¹⁰⁸ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

¹⁰⁹ $p < .10$. Significance tested using a one-way ANOVA with a post-hoc comparison.

one said LED lights burned out fast and broke, one said the nightlight did not work, and one said First Energy Corporation offered better kits.¹¹⁰

Figure J-65. PY8 Overall Participant Satisfaction with the Energy Efficient Home Program



Participant Survey Questions J1 (Equipment; Weatherization) and I1 (In-Home Audit). Separate satisfaction survey was conducted for Online Assessment participants: “Now, thinking about your overall experience with the PPL Electric Utilities [program] rebate program, how would you rate your satisfaction?” Responses include completed and partially completed surveys (Equipment n=146, Weatherization n=28, In-Home Audit n=13, Online Assessment n=222).

Participants were also asked about their satisfaction with various program delivery components. The survey first investigated how important the following were to respondents:

- Availability of PPL Electric Utilities’ rebates for helping me save energy at home
- Clear rebate application requirements
- Availability of PPL Electric Utilities’ online information, tips, and tools to save energy

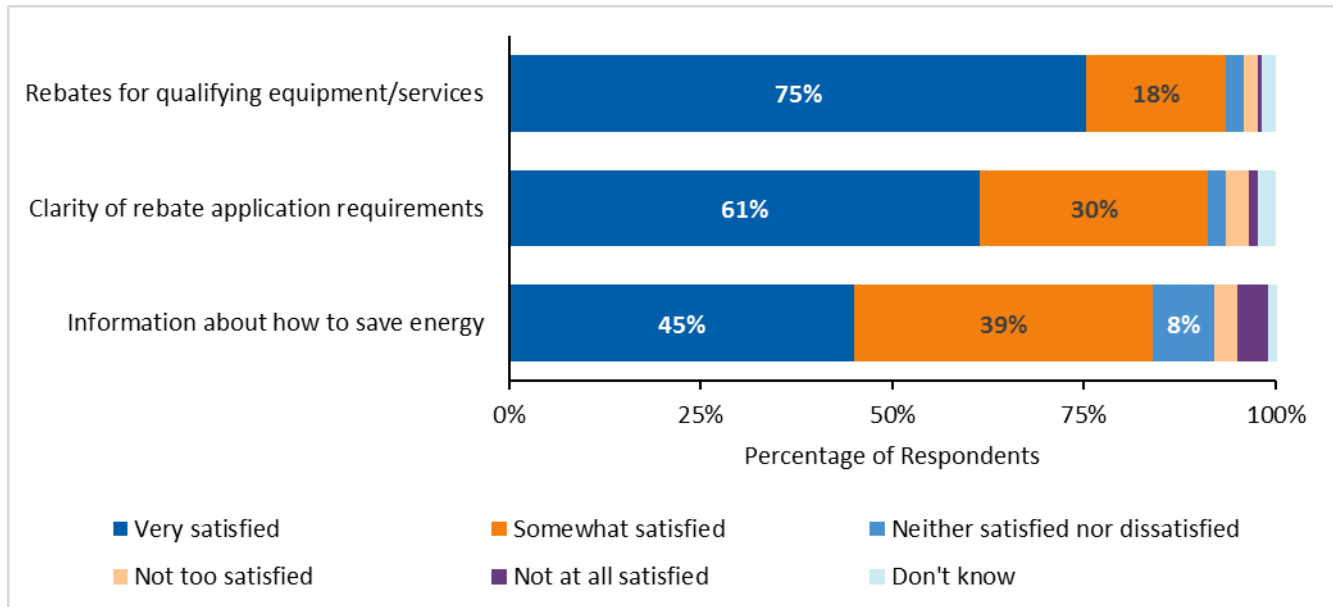
Respondents were most likely to rate rebates as the most important aspect of program delivery, with 75% reporting this was *very important* (n=169). When asked how satisfied they were with the rebates offered by PPL Electric Utilities, 75% were *very satisfied* and 18% were *somewhat satisfied*. Cadmus determined that the rebate component was not only important to participants but was also working well.

PPL Electric Utilities’ online information about saving energy was the least important component, with just under half (45%) of respondents reporting this was *very important*. Respondents were also least satisfied with this program component, offering potential room for improvement. Fifteen percent of respondents reported being less than *somewhat satisfied* with the available online information to save energy from PPL Electric Utilities.

¹¹⁰ The First Energy Corporation kit includes LED light bulbs in various wattages, one three-way compact fluorescent light bulb, a furnace filter whistle, and two LED night lights.

Satisfaction with various delivery components for all Energy Efficient Home respondents is shown in Figure J-66.

Figure J-66. PY8 Participant Satisfaction with Energy Efficient Home Program Components



Component Satisfaction Questions I1 (Equipment; Weatherization) and H1 (In-Home Audit): “Thinking about the same items, please rate how satisfied you are with each one...” (Equipment ns=83-133, Weatherization ns=19-25, In-Home Audit ns=11)

Net Promoter Score

The net promoter score (NPS) is a metric of brand loyalty by specifically measuring how likely customers are to recommend the program to others. Respondents rate their likelihood to recommend the program on a 10-point scale where 0 means *not at all likely* and 10 means *extremely likely*. Respondents giving a rating of 9 or 10 are known as promoters, respondents giving a rating of 7 or 8 are known as passives, and respondents giving a 0 to 6 rating are known as detractors. The NPS is expressed as a number between -100 and +100 that represents the difference between the percentage of promoters and detractors.

As shown in Table J-135, the Energy Efficient Home Program achieved a NPS of +71, indicating more promoters than detractors among the respondents and further supporting the satisfaction findings. NPS rating classification did not impact overall satisfaction with the Energy Efficient Home Program nor did classification impact whether a respondent suggested program improvements. However, detractors were significantly more likely to be participants in the in-home audit component (relative to the equipment or weatherization components).^{111, 112}

¹¹¹ $p < .10$. Significance tested using a chi-square analysis.

¹¹² This finding may be due to the low sample size (n=11) of the in-home audit component.

Of the 10 respondents who were classified as detractors (5.9%), seven suggested program improvements—three suggested increasing the rebate amount, two suggested increasing the speed of the rebate process, and two suggested increasing advertising of the program and how to obtain the rebates. Of the 29 respondents who were classified as passives (17.1%), 12 suggested program improvements—10 suggested increasing advertising of the program and making program communication clearer (e.g., changes to rebate program), one suggested increasing the rebate amount, and one suggested not giving contractors a rebate.

Table J-135. Net Promoter Score. Likelihood to Recommend the Program

Rating Classification	Percentage of Respondents (n=171)
Promoters (9-10)	77%
Passives (7-8)	17%
Detractors (0-6)	6%
NPS	71

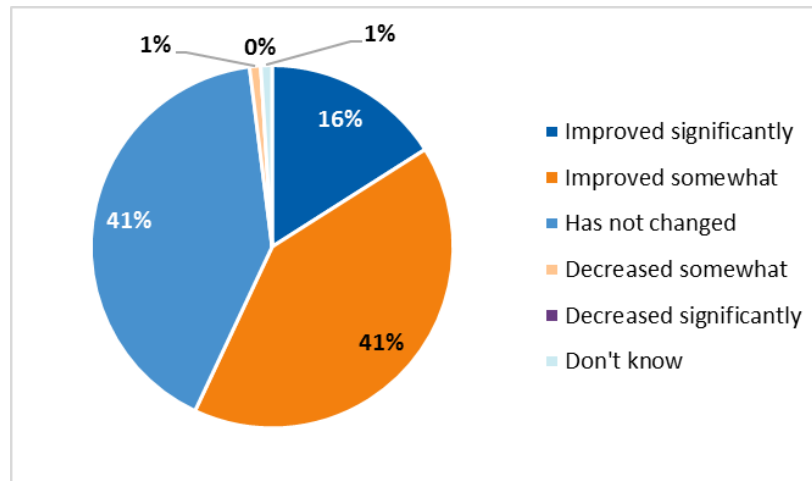
Opinion of PPL Electric Utilities

Of all survey respondents (n=290), 57% indicated that their opinion of PPL Electric Utilities had at least improved somewhat after participating in the rebate program (16% said it had *improved significantly* and 41% said it had *improved somewhat*) (see Figure J-67). Opinion of PPL Electric Utilities did not differ between program components nor did it differ by equipment type (within the equipment component).

Three respondents (two equipment and one online assessment) who said that their opinion of PPL Electric Utilities had *decreased somewhat* did not offer actionable recommendations for program improvement.¹¹³

¹¹³ One equipment respondent had to apply to the rebate program twice because the old program had expired, which led to the decrease in satisfaction. The other equipment respondent, who may have misunderstood the question or accidentally answered incorrectly, said he or she used less electricity now as the reason for the decrease in satisfaction. The online assessment respondent was still waiting to see if home energy use dropped, which was the reason for the decrease in opinion.

Figure J-67. Opinion Shifts of PPL Electric Utilities Due to Program

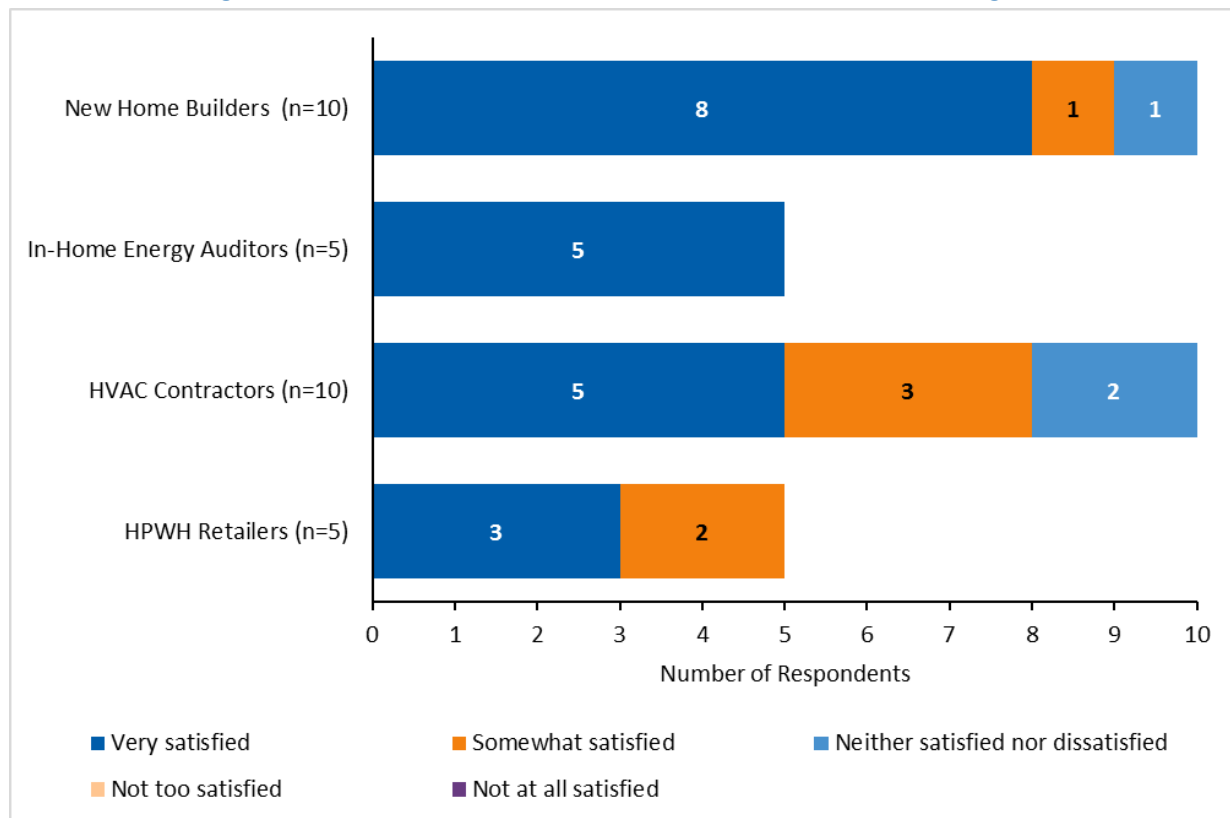


Program Influence Questions K1 (Equipment; Weatherization), J1 (In-Home Audit), and G1 (Online Assessment): "After participating in the PPL Electric Utilities [program], has your opinion of PPL Electric Utilities..." (Equipment n=135, Weatherization n=25, In-Home Audit n=1)

Trade Ally Satisfaction

Overall, the trade allies were satisfied with their respective program components (new homes, in-home energy audit, HVAC, and heat pump water heater). Although there was some variation in overall satisfaction, no trade ally indicated being dissatisfied with the program. The new home builders and in-home energy auditors were the most satisfied of the trade allies. These overall satisfaction findings are shown in Figure J-68.

Figure J-68. Trade Allies: Overall Satisfaction with the Rebate Program



Trade Ally Interview Questions G5 (in-home audit), F1 (HPWH), F3 (HVAC; New Homes): “Thinking about your overall experience with the [component] rebate program, how would you rate your satisfaction? Would you say you are...”

Cadmus also asked about use and awareness of the new online portal. The contractor-facing online portal can be used to submit rebates on behalf of customers. The portal also allows contractors to view the jobs they have submitted as well as the current status of their jobs. Two of five auditors used the portal, and just three of 10 HVAC contractors used the portal; many were unaware of it. There is opportunity for further education about this program benefit for trade allies.

Suggested Program Improvements

Participants and trade allies made several suggestions for PPL Electric Utilities to improve the Energy Efficient Home Program—most of these suggestions were consistent across program components. Participants most frequently suggested that PPL Electric Utilities advertise the rebates more, increase the rebate amounts, increase the speed of the rebate process, and increase or reevaluate program-eligible equipment. Trade allies suggested similar improvements and also asked for changes in the kit delivery system and to broaden the list of eligible equipment.

Although participants suggested that PPL Electric Utilities increase advertising and increase the rebate amount, the process evaluation suggested that these two program features do not need to be modified. Trade allies frequently market the program to their customers (see *Section Marketing and Outreach*) and participants are very satisfied with the rebates (see *Section Participant Satisfaction*).

All program improvement suggestions provided by participants and trade allies are listed in Table J-136.

Table J-136. Participant and Trade Ally Suggestions for Program Improvements

Suggested Improvement	Frequency	Audience
Advertise program more	27 of 98	Participants
	4 of 19	Trade Allies
Increase rebate amount	12 of 87	Participants
	13 of 29	Trade Allies
Increase speed of rebate process/make rebates instantaneous (move to upstream or midstream program)	9 of 98	Participants
	2 of 15	Trade Allies
Increase or reevaluate the rebate-eligible equipment	8 of 87	Participants
Make entire rebate system online	7 of 87	Participants
Change how the kit system works	4 of 4	Trade Allies
Program communication should be clearer and more frequent	3 of 11	Participants
	2 of 10	Trade Allies
Make website more user-friendly	3 of 76	Participants
Remove requirement of paid-in-full invoice	2 of 15	Trade Allies
Increase accuracy of quoted prices	1 of 76	Participants
Improve customer service	1 of 76	Participants
Improve rebates for senior citizens	1 of 76	Participants
Ensure the contractor is knowledgeable	1 of 76	Participants
Educate consumers about in-home audits	1 of 4	Trade Allies
Allow electronic submission of program forms ^[1]	1 of 4	Trade Allies
Provide program training	1 of 10	Trade Allies
Provide marketing materials	1 of 10	Trade Allies
Have PPL Electric representatives contact builders to provide support	1 of 10	Trade Allies

^[1] It is already possible to submit forms through the portal, which suggests this trade ally lacked knowledge of the portal and its functions.

Marketing and Outreach

A key aspect of the ICSP's marketing strategy was that trade allies (retailers, contractors, auditors, and builders) engage customers and promote Energy Efficient Home Program rebates. Findings are presented in this section. For the new homes component, the ICSP offered educational webinars for builders and raters, attended home builder association events, and designed a printed marketing toolkit that raters used to market the program to potential builders.

Trade Ally Marketing and Outreach

Most trade allies (except for new home builders) promoted their products or services with the PPL Electric Utilities rebates in some form, and home energy auditors did so more prevalently than other trade allies. Almost all HVAC contractors, heat pump water heater retailers, and in-home energy auditors said they always tell customers about the rebates when discussing qualifying equipment and services.

Some companies opted not to advertise the rebates (instead focusing only on their products and services). Few contractors promoted their companies as PPL Electric Utilities trade ally businesses. Few new home builders marketed their company as a PPL Electric Utilities builder or promoted their PPL Electric Utilities new homes in some form.

Table J-137 shows the extent of trade ally marketing and outreach.

Table J-137. Trade Ally Marketing and Outreach

Trade Ally Interviewed	Include PPL rebate information in marketing	Verbally tell customers about rebates when discussing services	Promote their business as PPL trade ally
In-home energy auditors (n=5)	4	4	3
HVAC contractors (n=10)	6	10	2
HPWH retailers (n=5)	2	4	N/A
New home builders (n=10)	2	N/A	1

The trade allies said the primary challenge in promoting energy-efficient equipment was the upfront cost, especially for heat pump water heaters. All retailers cited cost as the main challenge. Half of the HVAC contractors cited the cost of high-efficiency heating and cooling equipment. One HVAC contractor said other challenges were the low cost of energy and people making last-second purchases (e.g., replacing equipment upon failure).

Consumer Demand and Market Outlook

All in-home energy auditors, heat pump water heater retailers, and HVAC contractors said that customer demand for energy-efficient equipment and services was rising because of various factors. Retailers of heat pump water heaters rated the rebate program as having the most influence on increased demand. However, HVAC contractors said the rebate program had the least influence on increased consumer demand for energy-efficient heating and cooling equipment—they said their own marketing and general customer awareness of energy use was more influential. The in-home energy auditors said factors such as customer frustration with their electric bills and greater overall market awareness (i.e., hearing about energy-efficient options from other people) contributed to the increased demand. There was no consensus among the 10 home builders about customer interest in energy-efficient homes and the extent to which energy efficiency influenced their decisions. Four builders said customers, particularly older customers, were interested in energy-efficient homes. But five builders said customers were not interested and were instead more concerned with the cost per square foot; energy efficiency was just a bonus but not a driving force in the decision to buy a home.

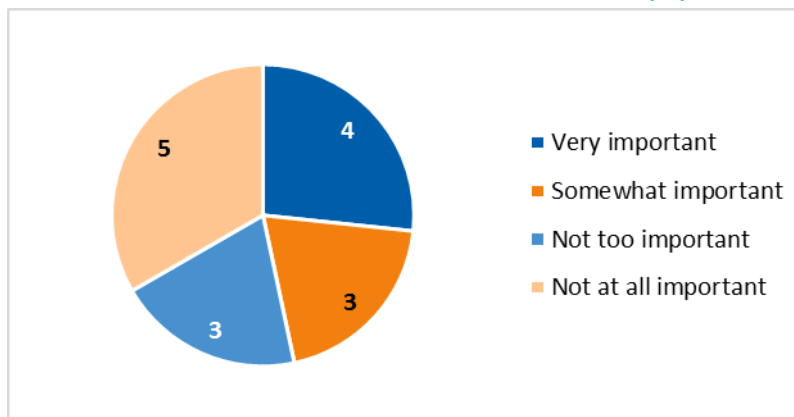
Standard Market Practice

HVAC contractors. The 10 HVAC contractors interviewed were asked how they defined a high-efficiency heat pump or air conditioner. Seven classified equipment as high-efficiency if it was rated 16 SEER and above. Five said equipment was highly efficient when it was rated 9 HSPF and above. Two contractors looked only at SEER and not HSPF when defining high-efficiency equipment. Two contractors did not use

SEER or HSPF to determine the efficiency of equipment; instead, they evaluated the technology and all factors regarding performance.

Eight HVAC contractors said the PPL Electric Utilities rebates did not have much impact on their revenue and sales. Nevertheless, two contractors said the rebates provided some credibility to their standard business practices. Only two said they saw an increase (of about 30%) in sales because of the rebates. Half of the HVAC contractors said the rebate program was important in their decision to stock, promote, or install high-efficiency HVAC equipment (see Figure J-69). This finding aligns with the free ridership score Cadmus derived for HVAC equipment from the participant surveys; this survey includes air source heat pumps, central air conditioners, and ductless mini-split heat pumps, and the combined free ridership score was 49%.

Figure J-69. HVAC Contractor and HPWH Retailers: Importance of Rebates in Decisions to Stock/Promote/Install Efficient Equipment



Trade Ally Interview Questions E3 (HVAC) and D5 (HPWH): “Overall, how important would you say the PPL program is in your company’s decision to stock, promote, and install high-efficiency equipment?” (n=15)

Heat pump water heater retailers. Similar to the HVAC contractors, the five heat pump water heater retailers said the rebate program had not significantly influenced their business or practices. All retailers said their stocking and promotion practices would not change if PPL Electric Utilities did not offer a rebate. When asked to rate how important the PPL Electric Utilities rebate program was in their decision to stock, promote, or install high-efficiency heat pump water heaters, three said *not too important* or *not at all important*.

In-home energy auditors. Two of the three in-home energy auditors said the rebate program had increased their revenue and sales, and the other auditor said the rebate program’s impact on the business was minimal. All three in-home energy auditors who were asked this question said the program had not influenced how they conduct business.

New home builders. The 10 new home builders said nearly all homes they built qualified for the PPL Electric Utilities rebate program. Six said that 100% of their homes qualified for the PPL Electric Utilities rebate, and four provided estimates between 75% and 90% of their homes. Two builders said they sometimes simply did not have time to submit the paperwork. One builder said the only difference

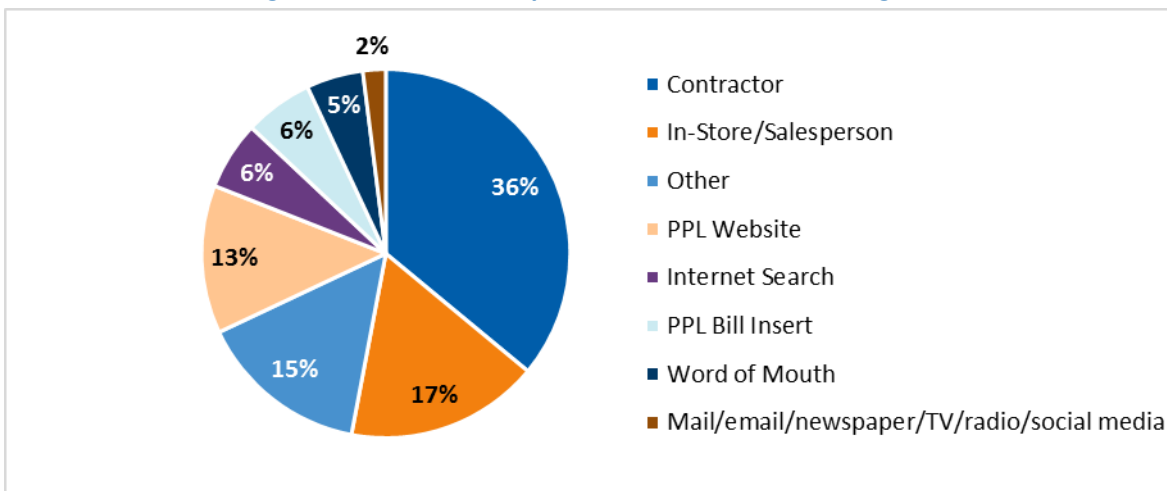
between qualifying and non-qualifying homes was to install ENERGY STAR equipment in the qualifying homes. Not surprisingly, nine builders said nothing would be different about their company's building practices if PPL Electric Utilities did not offer a rebate for energy-efficient new homes. These findings further support the free ridership score of 60% for home builders (see *Standard Market Practice* above).

Participant Program Discovery

The ICSP collected data on the rebate form about how participants learned about the Energy Efficient Home Program. Cadmus analyzed these data from PPL Electric Utilities' tracking database. Findings aligned with the program's delivery and outreach strategies in terms of variation across components such as contractor, salesperson, PPL Electric Utilities website, and so on. For example, equipment and weatherization participants were most likely to hear about the program from a contractor, more so than for other components. Figure J-70 shows the various ways participants learned about the program.

Across all components, 43% of respondents reported that the best way for PPL Electric Utilities to inform them of energy efficiency programs and rebates was through a bill insert or newsletter.

Figure J-70. How Participants Learned about the Program



How participants learned about the equipment, weatherization, and in-home audit programs. Acquired from PPL Electric Utilities' tracking database. Percentages exclude participants that did not provide a response (Equipment n=8548, Weatherization n=482, In-Home Audit n=581). Total may exceed 100% due to rounding.

In-Home Audit Reports

All 11 in-home audit and kit respondents said the auditor discussed actions they could take to improve the energy efficiency of their home. Notably, all respondents thought that the information they received in the in-home audit report was useful in helping them understand ways to save energy; seven said it was *very useful*. Two respondents thought it would be helpful to have more information about ways to save money and additional information on appliance options that would save energy.

The information provided during the in-home audit also appeared to have been effective at motivating energy-saving behaviors; nine of 11 respondents reported taking energy-saving actions or installing

products rebated by PPL Electric Utilities that were recommended by the auditor. Respondents reported taking the following steps to save energy: installing insulation or air sealing, replacing the old system or appliance with an energy-efficient model, replacing lightbulbs with LEDs, and several behavioral actions.

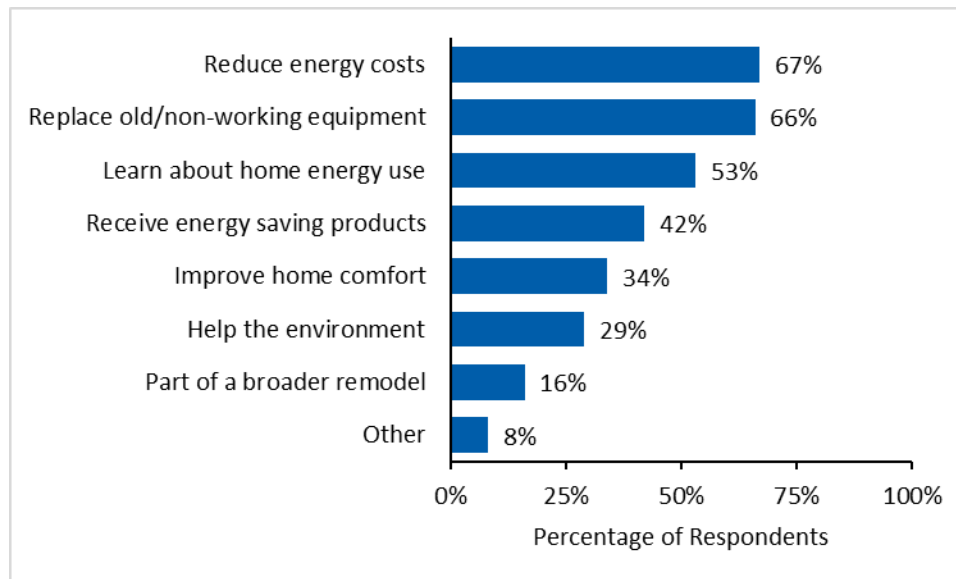
Drivers and Barriers to Saving Energy

Cadmus tested for significant differences between program components in what motivated customers to make energy-saving purchases. The analysis found the following:

- Weatherization, in-home audit and kit, and online assessment respondents said reducing energy costs was a driver significantly more frequently than equipment respondents.
- Home comfort was a significantly larger motivator for weatherization participants than for other components, which was unsurprising because a key selling point was that air sealing and insulation help made indoor home temperatures more comfortable during hot and cold months.
- Helping the environment was a bigger factor for the decision to conduct an in-home and an online assessment than it was for other components; therefore, it is important to emphasize the environmental benefits of these offerings to prospective participants.¹¹⁴

Drivers for participating in the program are presented in Figure J-71.

Figure J-71. Participant Reasons for Purchasing the Equipment or Service



Participant Surveys Questions O1 (Equipment; Weatherization), Q1 (In-Home Audit), and L1 (Online Assessment): “What were the main reasons you decided to purchase and install the [measure]?” (Multiple responses allowed; Equipment n=135, Weatherization n=25, In-Home Audit n=11, Online Assessment n=121). Some response options were not provided to respondents of certain components (e.g., only equipment participants were asked about replacing equipment).

¹¹⁴ $p < .10$. Significance tested using a one-way ANOVA with a post-hoc comparison.

Participant barriers to saving energy. Respondents (n=292) most frequently cited owning an older home that was hard to heat and cool (30%) and not having enough money to invest in efficient improvements (26%) as barriers to making energy-efficient improvements to their home.

Consistent with the participant surveys, of the 30 trade allies, 20 said finances were the biggest barrier to selling and promoting energy-efficient equipment and services. They also reported several additional challenges in the marketplace. These included installation challenges for energy-efficient equipment (e.g., equipment requires specific household conditions), homeowners' lack of understanding about the long-term savings of heat pump technologies, and long payback periods that make it unattractive for homeowners to invest in expensive, efficient equipment if they do not plan to be in their home for the long-term.

Although participant surveys indicated that knowledge barriers among customers were not an issue, trade allies thought there were opportunities to educate customers about the long-term financial savings of air source heat pumps and ductless heat pumps.

The fact that homeowners did not want to invest in costly upgrades if they did not plan to live in the home long enough see the financial benefits underscores a bigger market failure: that energy efficiency is not currently, and formally, valued in the residential real estate market. PPL Electric Utilities' new homes component to construct highly efficient homes partially addresses this barrier.

J.3.3 Sample Cleaning and Attrition for Participant Surveys

Cadmus coordinated with PPL Electric Utilities' survey subcontractor to screen the sample and remove any records of customers who had been called in the past three months (whether for a PPL Electric Utilities survey or a Cadmus survey), requested not to be contacted again, or had incomplete information.

This cleaning and survey sample preparation process reduced the available sample. For surveys using both survey modes, Cadmus sent initial email invitations to the remaining contacts with email addresses and followed up with two reminder email invitations. If the contact did not complete an online survey or was not invited to complete an online survey, Cadmus attempted to reach the contact by telephone up to five times over several days, at different times of the day, and scheduled callbacks whenever possible. Table J-138 lists total numbers of records submitted to the survey subcontractor or contacted via online survey and the outcome (final disposition) of each record. This table does not contain interviews with new home builders, as those were conducted in-house by Cadmus staff.

Table J-138. Energy Efficient Home Sample Attrition Table

Description of Call Outcomes	Number of Records			
	In-Home Audit	Online Assessment	Weatherization	Equipment
Population (number of unique jobs) ^[1]	88	3,462	482	7,030
Online Survey				
Removed: inactive customer, completed survey in past 3 months, on “opt out” list, selected for a different survey, duplicate contact, on “do not contact” list	77	3,462	N/A	N/A
Incomplete or invalid email address	11	0	N/A	N/A
Survey Sample Frame (email invitations sent)	73	3,137	N/A	N/A
Email was returned (bounce back)	3	27	N/A	N/A
Did not respond	62	2,754	N/A	N/A
Opt out	1	12	N/A	N/A
PPL Electric Utilities or market research employee	0	20	N/A	N/A
Cannot confirm equipment/not aware of participation	1	271	N/A	N/A
Did not complete survey	3	2	N/A	N/A
Completed Surveys	3	51	N/A	N/A
Online Response Rate	4%	2%	N/A	N/A
Telephone				
Removed: inactive customer, completed survey in past 3 months, on “do not call” list, opted out of survey, selected for a different survey, duplicate contact, recycled A/C only, large C&I sector	32	690	182	1,271
Incomplete or bad phone number	0	70	5	111
Survey Sample Frame ^[2]	56	2,702	295	5,648
Final Sample (sent to subcontractor for telephone survey calls)	56	2,702	295	2,331 ^[3]
Not attempted ^[4]	0	955	29	14
Records Attempted	56	1,747	266	2,317
Non-working number	4	139	14	186
Wrong number, business	2	15	2	16
No answer/answering machine/phone busy	29	1,248	187	1,660
Language barrier	0	2	0	4
PPL Electric Utilities or market research employee	3	5	2	15
Cannot confirm equipment/not aware of participation	2	3	0	11
Refusal	3	36	0	67
Terminated survey or partially completed survey	2	22	3	33
Non-specific or specific callback scheduled	3	207	33	190
Completed Surveys	8	70	25	135
Telephone Response Rate	14%	4%	9%	6%
Total Completed Surveys (total for all modes)	11	121	25	135

Description of Call Outcomes	Number of Records			
	In-Home Audit	Online Assessment	Weatherization	Equipment
EEH Online Assessment Follow Up Satisfaction Survey				
Population (number of unique jobs) ^[5]	N/A	3,137	N/A	N/A
Removed those on the “do not call” list	N/A	17	N/A	N/A
Incomplete or invalid email address		1		
Survey Sample Frame (email invitations sent)	N/A	3,119	N/A	N/A
Email was returned (bounce back)	N/A	31	N/A	N/A
Did not respond	N/A	2,781	N/A	N/A
Opt out	N/A	4	N/A	N/A
Did not complete survey after starting	N/A	81	N/A	N/A
Completed Surveys	N/A	222	N/A	N/A
Online Response Rate	N/A	7%	N/A	N/A
<p>^[1] Number of rebates available in PPL Electric Utilities’ tracking database at the time of the final survey effort.</p> <p>^[2] Not selected for sample because more records in PPL Electric Utilities’ tracking database than were needed for telephone survey.</p> <p>^[3] Cadmus selected a stratified random sample for the telephone survey.</p> <p>^[4] Selected for sample but target was reached before attempted.</p> <p>^[5] Participants were included even if they already responded to first online assessment survey</p>				

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Appendix K. Evaluation Detail—Student Energy Efficiency Education

K.1 Gross Impact Evaluation

K.1.1 Methodology

EM&V Sampling Approach

Table K-139 lists the program sampling strategy for the impact evaluation. The impact evaluation activities produced results with $\pm 1.18\%$ precision at 85% confidence.

Table K-139. SEEE Program Impact Evaluation Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Bright Kids, Take Action, Innovation	24,145 ^[1]	N/A ^[2]	All available	24,145 ^[1]	Records review
Bright Kids	5,065	N/A	All available	3,517	Online and paper HEWs
Take Action	14,049	N/A	All available	10,556	Online and paper HEWs
Innovation	5,031	N/A	All available	3,526	Online and paper HEWs
Program Total	24,145			17,599	

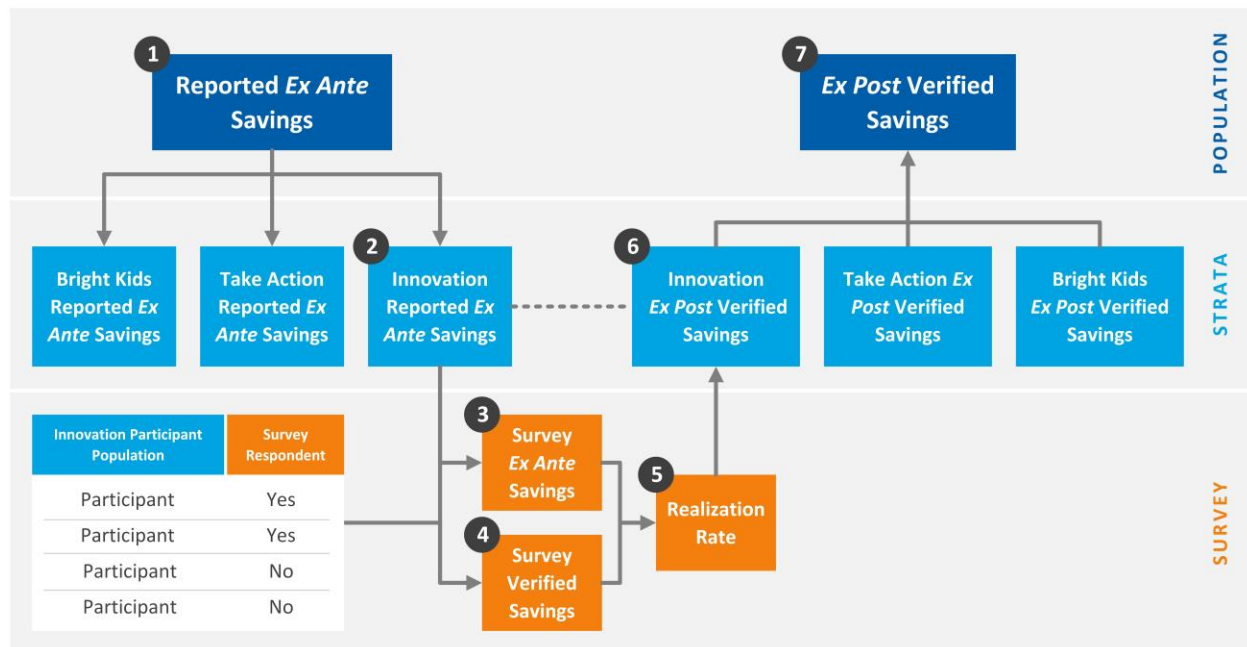
^[1] Not counted in the program total calculation; counting the population in the records review would double-count records.

^[2] Because this program's evaluation did not include sampling, Cv and target precision are not meaningful.

Ex Post Verified Savings Methodology

Cadmus estimated *ex post* verified savings for the SEEE Program for each student cohort and for the program overall using the ICSP-reported savings and paper and online Home Energy Worksheets (HEWs). Figure K-72 presents a flow diagram of the methodology. The rest of this section describes the methodology in greater detail.

Figure K-72. Ex Post Verified Savings Methodology Flow Diagram



Reported Ex Ante Savings (Items 1 & 2)

Cadmus collected reported savings for each product and kit distributed to the population of program participants through PPL Electric Utilities' tracking database. Part of Cadmus' quality control process for evaluating the SEEE Program involved understanding how the ICSP calculated reported savings. To do this, Cadmus verified that the ICSP calculated per-unit savings according to the planning ISRs and PA TRM inputs specified in the planning documentation Cadmus received during PY8. This process ensured that Cadmus and the ICSP were not making drastically different assumptions in assigning savings to program participants.

Survey Ex Ante and Survey Verified Savings (Items 3, 4, & 5)

Cadmus estimated stratum-level realization rates using individual survey responses for the sample of program participants who returned a HEW. Cadmus assigned per-unit survey *ex ante* and survey verified savings to every participant, kit, and product in the survey data. Survey *ex ante* and survey verified savings are defined as follows:

- **Survey ex ante savings** are reported *ex ante* savings assigned to the subset of program participants who returned an HEW and provided enough information on the HEW to verify their savings for a particular product.
- **Survey verified savings** are savings verified by Cadmus and assigned to the subset of program participants who returned a survey. Survey verified savings incorporate data from responses to HEW questions about product installations, home characteristics, and heating and water heating fuel saturations.

Cadmus assigned survey *ex ante* and survey verified savings to program participants based on the criteria listed in Table K-140. A discussion on the PA TRM inputs that Cadmus collected through survey data are provided in the *Survey Verified Savings Inputs Section*.

Table K-140. Criteria for Assigning Survey *Ex Ante* and Survey Verified Savings

Criteria	Survey <i>Ex Ante</i> Savings ^[1]	Survey Verified Savings
Whether the respondent answered the product-specific question(s)	✓	✓
How the respondent answered questions about home characteristics		✓
How the respondent answered the questions asking if products were installed		✓

^[1] Cadmus used the ICSP-reported *ex ante* savings for survey *ex ante* savings based on the listed criteria.

Table K-141 provides an example of how Cadmus assigned survey *ex ante* and survey verified savings to each program participant and kit product, which, in this example, is a showerhead from the Take Action cohort. Cadmus included participants in the realization rate analysis if it could definitively verify whether the participant achieved savings for a particular product. In cases where it could not verify savings, because either the participant did not return an HEW or did not respond to the necessary installation question, it did not include them in the realization rate analysis.

In the example, Cadmus had enough information from program participants A through E to verify their showerhead savings:

- Although Participant D did not respond to the installation question, they indicated they did not have electric heat so they are ineligible to receive savings regardless of whether they installed the product. Therefore, Cadmus assigned this participant 0 kWh/yr savings.
- Similarly, although Participant E did not indicate water heat fuel type, they indicated they did not install the product, so Cadmus assigned this participant 0 kWh/yr savings.
- Participant F's showerhead savings were not included in the realization rate because Cadmus could not confirm whether the participant installed the showerhead from the kit, based on the participant's response to the installation question in the survey.
- Participant G's showerhead savings were not included in the realization rate because Cadmus could not confirm whether the participant had electric water heat based on the participant's response to the water heating fuel type question in the survey.
- Participants X, Y, and Z did not return a survey, so Cadmus could not verify savings for any of their products.

Table K-141. Example of Assigning Survey *Ex Ante* and Survey Verified Savings

Program Participant (PPL EU)	Reported <i>Ex Ante</i> kWh/yr (ICSP)	Survey Respondent (Survey Data)	Installed Product (Survey Data)	Electric Water Heat (Survey Data)	Survey <i>Ex Ante</i> kWh/yr	Survey Verified kWh/yr	Savings Included in Realization Rate
Participant A	121.42	Yes	Yes	Yes	121.42	390.09 ^[1]	Yes
Participant B	121.42	Yes	No	Yes	121.42	0	Yes
Participant C	121.42	Yes	Yes	No	121.42	0	Yes
Participant D	121.42	Yes	No Response	No	121.42	0	Yes
Participant E	121.42	Yes	No	No Response	121.42	0	Yes
Participant F	121.42	Yes	No Response	Yes	N/A	N/A	No
Participant G	121.42	Yes	Yes	No Response	N/A	N/A	No
Participant X	121.42	No	N/A	Yes	N/A	N/A	No
Participant Y	121.42	No	N/A	Yes	N/A	N/A	No
Participant Z	121.42	No	N/A	No	N/A	N/A	No

^[1] Survey verified savings calculated for this example assuming respondent indicated four people in the home and two showers.

Ex Post Verified Savings (6 & 7)

To calculate cohort-level *ex post* savings, Cadmus applied the cohort-level realization rates to cohort reported *ex ante* savings. Taking the sum of cohort-level *ex post* savings estimated the program-level *ex post* savings.

Cadmus calculated confidence and precision for the *ex post* savings and realization rate estimates in each cohort and for the program as a whole.

Survey Verified Savings Inputs

Cadmus independently calculated verified savings according to the PA TRM and the associated algorithms.¹¹⁵ These algorithms include open variables for which the ICSP or Cadmus can use either the default or the option of “EDC data gathering.” Table K-142 lists the algorithm inputs, method of data collection, and source of the data collected.

¹¹⁵ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016. Available online: http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

Table K-142. PA TRM Algorithm Open Variables

Product	Open Variable	Data Collection Method	Data Collector
LED	In-service rate (ISR)	HEW ISR	ICSP's Subcontractor
LED	Wattage of installed bulb	Spec sheet	ICSP
Electroluminescent Night Light	ISR	HEW ISR	ICSP's Subcontractor
Electroluminescent Night Light	Wattage of installed night light	Spec sheet	ICSP
Showerhead	ISR	HEW ISR	ICSP's Subcontractor
Showerhead	GPM of installed	Spec sheet	ICSP
Showerhead	Number of persons in household	HEW	ICSP's Subcontractor
Showerhead	Number of showers in household	HEW	ICSP's Subcontractor
Showerhead	Water heater fuel	HEW	ICSP's Subcontractor
Kitchen Faucet Aerator	ISR	HEW ISR	ICSP's Subcontractor
Kitchen Faucet Aerator	Water heater fuel	HEW	ICSP's Subcontractor
Kitchen Faucet Aerator	Housing type	HEW	ICSP's Subcontractor
Kitchen Faucet Aerator	Number of persons in household	HEW	ICSP's Subcontractor
Smart Power Strip	ISR	HEW ISR	ICSP's Subcontractor
Smart Power Strip	Use (entertainment, computer, unspecified)	HEW ISR	ICSP's Subcontractor

K.1.2 Database Review Findings

Cadmus reviewed both PPL Electric Utilities' and the ICSP's databases as well as the sources for the records in the databases. Cadmus compared the number of HEWs the ICSP collected and the number of HEWs reported in PPL Electric Utilities' tracking database. The database the ICSP provided to Cadmus contained 17,599 HEWs (which Cadmus used for its savings analysis), while PPL Electric Utilities' tracking database contained 17,660 HEWs, a discrepancy of 61 HEWs missing from the ICSP's database. Cadmus confirmed with the ICSP and the ICSP's subcontractor that additional kits were delivered in the spring of 2017, and these additional HEWs were collected after delivering the database to Cadmus. The ICSP provided an updated database, which Cadmus then compared to PPL Electric Utilities' tracking database and found 100% accuracy between the databases.

Within the ICSP records, Cadmus found two additional minimal discrepancies:

- Cadmus identified five classrooms in the ICSP records where teachers returned more HEWs than the number of kits they distributed. Cadmus included all surveys in the savings analysis but adjusted the standard error calculations for these classrooms to reflect the total quantity of kits distributed.
- One respondent returned the HEW survey with invalid survey responses (i.e., response options not available on the HEW). Cadmus removed this respondent from the survey analysis (but retained this participant in the population).

K.2 Process Evaluation

K.2.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In February and March of 2017, Cadmus conducted interviews with program managers from PPL Electric Utilities, the ICSP, and the ICSP's subcontractor. The interviews focused on the following:

- Gathering insights into program design and delivery
- Assessing major differences between the Phase II and Phase III program
- Identifying areas that worked well and others that could be improved
- Evaluating KPIs and goals
- Assessing student and teacher participant satisfaction
- Reviewing communication, marketing, and outreach processes
- Identifying evaluation topics of greatest interest

Participant Surveys

Student participants completed HEWs, which were developed and administered by the ICSP's subcontractor, either online or via paper forms included in the energy-saving kits. The HEWs asked questions to provide data for the impact evaluation as well as the process evaluation, including whether student participants installed each kit product, their household characteristics, and their satisfaction with the program.

The ICSP's subcontractor delivered a program evaluation paper survey to teachers in their program materials during the fall of 2016. Cadmus also administered an online survey to participating teachers in May 2017. These surveys asked questions to assess program satisfaction and the importance of program elements, determine an NPS, and solicit recommendations for improvement. The surveys were not mutually exclusive, as respondents could have responded to both surveys, but each survey asked distinctly different questions to avoid overlap and double-counting.

Table K-143 lists the participant sampling for the process evaluation. The HEW survey assessed student participant satisfaction; the number of completed surveys produced a measurement of program satisfaction with $\pm 0.42\%$ precision at 90% confidence.

Table K-143. Participant Survey Sampling Strategy

Survey Mode and Audience	Population Size	Target Sample Size	Achieved Sample Size
Online teacher survey (Cadmus)	886	70	158
Paper teacher survey (ICSP's subcontractor)	886	All Available	238
Paper and online HEWs (ICSP's subcontractor)	24,145	All Available	17,599
Bright Kids (2 nd – 3 rd grades)	5,065	All Available	3,517
Take Action (5 th – 7 th grades)	14,049	All Available	10,556
Innovation (9 th – 12 th)	5,031	All Available	3,526
Total Surveys Completed			17,995

^[1] The sample frame after cleaning and removing duplicate contacts or invalid email addresses is contained in Table F-78.

Potential sources of bias in all surveys include nonresponse, recall, and social desirability biases. Cadmus addressed these potential sources of bias by applying survey design and survey data collection best practices where possible or by advising the ICSP. Cadmus reviewed the HEW survey template developed by the ICSP for completeness but did not review the teacher survey administered by the ICSP's subcontractor. Surveys did not include leading or ambiguous questions or double-barreled questions. For the online teacher survey, Cadmus provided clear interviewing and programming instructions so that they were implemented consistently. The SWE team and PPL Electric Utilities reviewed and approved the online teacher survey before fielding. Completed HEWs totaled 17,599 and provided data for a robust analysis of student actions and satisfaction with the program.

In this report, Cadmus presents survey data as follows: the report contains the percentage or frequency of responses, followed by the sample size for the particular question at hand. Sample size (denoted by "n") refers to the number for respondents who were *asked* the question, not the number of respondents who answered. Note that sample sizes vary according to each question, due to survey logic and skipped questions.

Contact Instructions

Teachers were not included in Cadmus' online survey if they opted out of the survey.

See *Section K.2.2 Sample Cleaning and Attrition for Participant Surveys*, which includes the attrition table.

Additional Findings

This section includes additional process evaluation findings.

Program Delivery

The SEEE Program is delivered through distribution of energy kits to students in three grade-level cohorts: Bright Kids (2nd – 3rd grades), Take Action (5th – 7th grades), and Innovation (9th – 12th grades). The energy-saving 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 ICSP's subcontractor markets the program to schools and teachers. Once the program reached capacity, applicants were placed on a waitlist, as was done in previous program years.

The program provided teachers with THINK! ENERGY packets that contained program curricula, instructions, activities, and posters. Staff from the ICSP's subcontractor also conducted THINK! ENERGY presentations at participating schools.

The ICSP's subcontractor included paper HEWs within the kits and managed an online HEW portal for students and parents to record the energy-saving products they installed in their homes. To provide an incentive for teachers to encourage their students to fill out their HEWs, the ICSP's subcontractor offered \$50 mini-grants in the form of prepaid gift cards to classrooms that achieved 80% HEW completion rates. The HEWs collected data—such as installation rates, participant demographics, and participant satisfaction—needed for the process and impact evaluations. The ICSP collected 17,599 HEWs, totaling 73% of kits distributed, down from 81% returned in PY7.¹¹⁶

The same firm administered the program in Phase II and Phase III, and the program changed slightly from Phase II to Phase III. The ICSP's subcontractor said the planned participation per cohort changed from PY7 to PY8 as follows:

- The Bright Kids cohort reduced its planned participation from 8,000 to 5,000.
- The Take Action cohort increased its planned participation from 10,800 to 14,000.
- The Innovation cohort reduced its planned participation slightly from 5,200 to 5,000.
- The overall planned participation of 24,000 did not change from PY7 to PY8.

Other notable program changes included the removal of furnace whistles from all kits, kitchen faucet aerators from Innovation kits, and smart power strips for participating teachers. The program also reduced the total funding for classroom mini-grants that the ICSP's subcontractor offered to encourage HEW completion from \$100 for Bright Kids and Take Action and \$150 for Innovation in PY7 to \$50 for Bright Kids and Take Action and \$75 for Innovation in PY8. The program discontinued teacher training and low-income parent workshops. In terms of participation targets, the program no longer attempted to achieve a specified participation rate among schools with a large low-income population.¹¹⁷

Additions to the program included the introduction of the first Innovation Challenge for high school students. The competition asked students to create a video or website promoting energy efficiency, and the winners and runners-up were awarded solar-powered backpacks and branded USB drives, respectively. The ICSP's also subcontractor expanded the online HEW portal to include all three cohorts, not just the Innovation cohort.

¹¹⁶ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

¹¹⁷ Defined as schools in which at least 40% of students qualify for free or reduced hot lunch.

Key Performance Indicators

PPL Electric Utilities and the ICSP defined plans for energy savings for the SEEE Program and set levels for customer satisfaction. The SEEE Program performance on these metrics in PY8 is shown in Table K-144.

Table K-144. SEEE Program Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
Customer Satisfaction	Percentage of satisfied customers	80% or more of surveyed student participants report they are very or somewhat satisfied with their experience.	87% of student participants were very satisfied (68%) or somewhat satisfied (19%) with the program.

Logic Model Development and Review

A program logic model identifies the relationships between activities and expected results. The Phase III PY8 SEEE Program had a similar logic model to the Phase II SEEE Program with one exception: the PY8 SEEE Program removed an outcome from its program activities by discontinuing teacher training and low-income parent workshops. Cadmus reviewed the SEEE Program's logic model and determined the program operated as expected in PY8 with one exception: it did not achieve its planned savings because of the nightlight recall. Table K-145 shows the program logic model's expected versus actual outcomes.

Table K-145. SEEE Program Logic Model Review

Expected PY8 Outcome	Logic Model Element	Actual PY8 Outcome
Conduct energy efficiency education in classrooms, conduct outreach, train teachers, and provide free energy-saving kits for all participants	Program Activities	Delivered program activities as expected
Energy-saving kits are disseminated and teachers trained	Outputs Produced by Program Activities	Delivered outputs as expected
Help customers reduce energy consumption and costs, and achieve savings for installed kit products	Short-term Outcomes	Did not achieve planned savings (due to nightlight recall)
Develop more knowledgeable students, households, and teachers, increase energy savings, uphold customer satisfaction, and obtain environmental benefits	Intermediate Outcomes	On track to produce intermediate outcomes as expected
Energy savings accrue from installed devices and through behaviors of energy-literate customers	Long-term Outcomes	To be determined at the end of Phase III

Participant Profile

Cadmus considered a participant a distributed kit, which equates to any student household that received a THINK! ENERGY kit through the SEEE Program. Students were segmented into three cohorts by grade level:

- Bright Kids: 2nd – 3rd grades (n=5,000)
- Take Action: 5th – 7th grades (n=14,000)
- Innovation: 9th – 12th grades (n=5,000)

Each kit contained an HEW that solicited limited demographic information along with self-reported installation information. Student participant respondents most often lived in single-family homes (78%) and most commonly reported household sizes of four residents. Teacher surveys did not solicit demographic information.

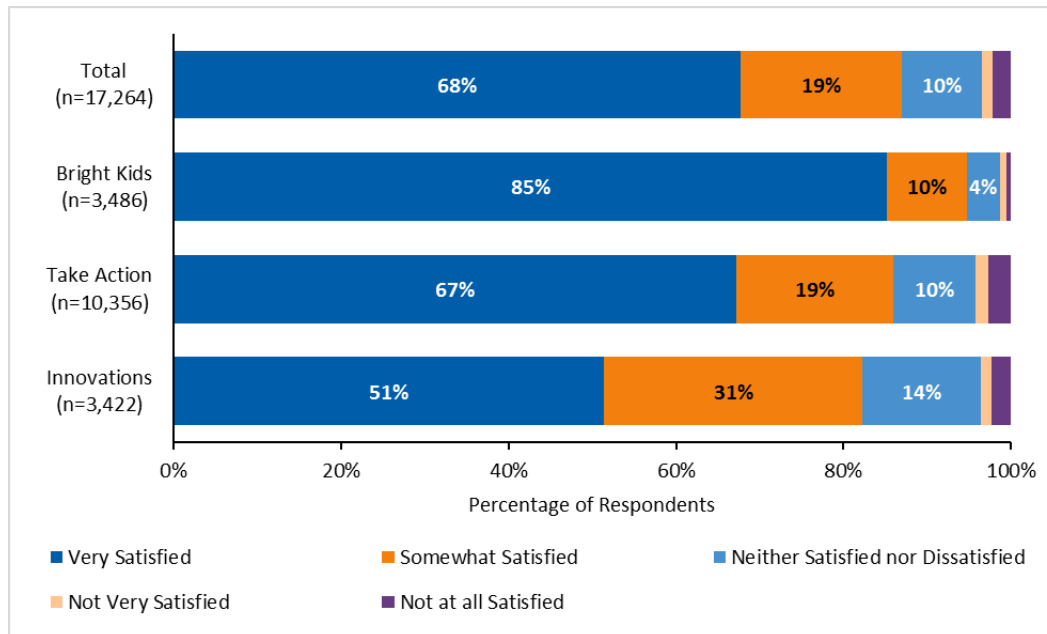
The ICSP tracked which participating schools qualified as low-income, although the program did not specifically target low-income schools as it did in prior program years. PPL Electric Utilities staff reported that low-income schools comprised roughly 37% of participating schools.

Participant Satisfaction

The ICSP's subcontractor asked students questions about their satisfaction with the SEEE Program and its elements via online and paper HEWs. After obtaining completed HEWs, Cadmus analyzed the results, which are reported in this section. Respondents were permitted to skip questions they did not want to answer, so not all respondents answered every question. The number of respondents to each question is indicated.

Figure K-73 shows student satisfaction with the program overall. Overall, most respondents were satisfied--Eighty-seven percent (n=15,020 of 17,264 respondents) said they were *very satisfied* (68%) or *somewhat satisfied* (19%) with the program. The Bright Kids cohort most frequently reported being *very satisfied* (85%) whereas the Innovation cohort least frequently reported being *very satisfied* (51%).

Figure K-73. Participant Satisfaction with SEEE Program Overall by Cohort



Home Energy Worksheet Q11 (Bright Kids), Q24 (Take Action), Q25 (Innovation): "Please rate your overall satisfaction with the Think! Energy program."

Teacher Satisfaction

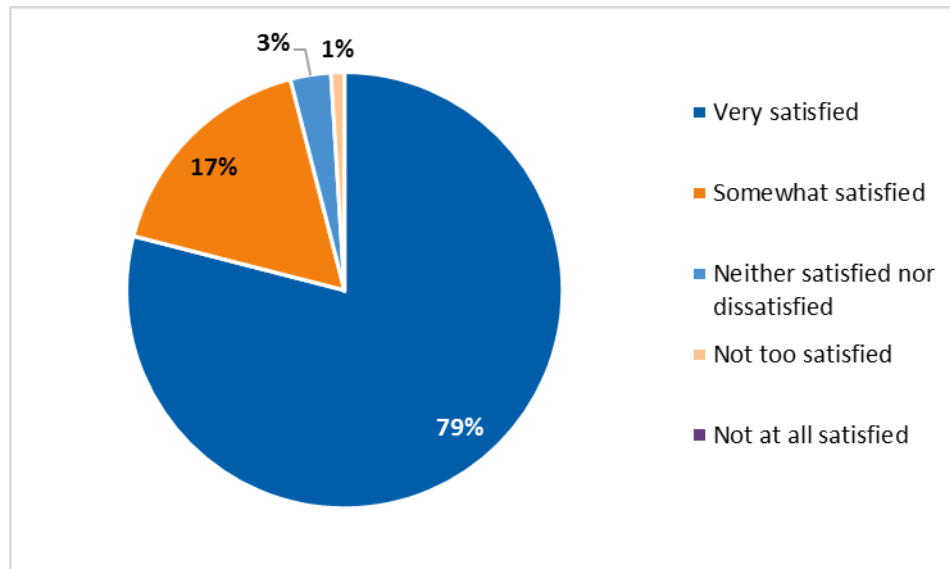
Cadmus administered an online survey to teachers to measure their satisfaction as well as assess behaviors during and opinions about the program and its components, such as the THINK! ENERGY teachers' packets and online HEW portal. The survey achieved 158 completed responses.

The ICSP's subcontractor conducted separate paper surveys, included in teachers' program materials, that assessed teachers' impressions of the program and its elements and solicited open-ended feedback. The number of teachers who responded to the ICSP's survey fell more than 60% from PY7 (634 respondents) to PY8 (238 respondents).

The results of these surveys are reported in this section. Respondents were permitted to skip questions they did not want to answer, so not all respondents answered every question. The number of respondents to each question is indicated.

Ninety-six percent of teacher respondents (n=151) to Cadmus' survey said they were *very satisfied* (79%) or *somewhat satisfied* (17%) with the program overall, as shown in Figure K-74. These results align with results from the ICSP subcontractor's survey: 99% of teacher respondents said their impressions of the program were *excellent* (87%) or *good* (12%), remaining consistent with PY7's results. Because of the relatively small sample sizes of respondents in each cohort (including only 22 responses from Innovation teachers), statistically valid comparisons cannot be made between cohorts; therefore, Cadmus reported results at the program level.

Figure K-74. Teacher Satisfaction with SEEE Program Overall

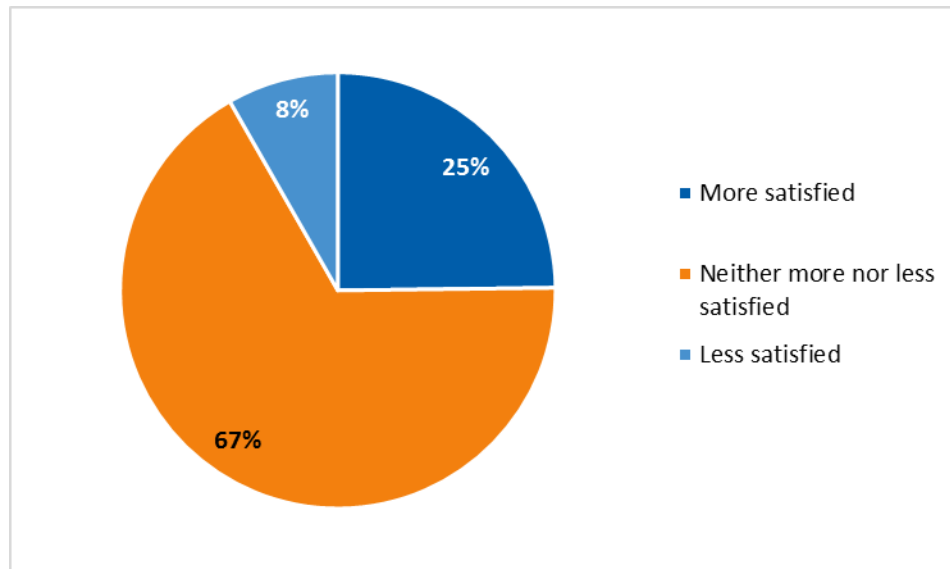


Cadmus-administered teacher survey: “How satisfied were you overall with THINK! ENERGY?”
(n=151)

Each survey asked open-ended questions that prompted teacher respondents for feedback for PPL Electric Utilities and the SEEE Program. Like the results shown in Figure K-74, the overwhelming majority of comments—sample of which Cadmus transcribed here verbatim from survey data—were positive:

- “I teach in a school which has the highest poverty level in all of our elementary schools. Programs like this are very important so students can experience more science-based information.”
- “I love this program and look forward to it every year! It brings to "light" the importance of energy conservation, explains where electricity comes from, and gives the students a sense of responsibility to conserve.”
- “Thank you for sponsoring the program. My students enjoyed learning and interacting with the presenters during the presentation. It is a fun way for them to learn about energy!”

Eighty-nine percent of teacher respondents to Cadmus’ online survey (n=156) said they had participated in the SEEE Program in a previous school year. Figure K-75 shows how teacher satisfaction with the program overall has changed for the 89% of respondents who had previously participated in the program and provided valid responses (n=133). Twenty-five percent of teacher respondents who previously participated in the program reported being *more satisfied* when participating this year than in previous years while 8% said they were *less satisfied*. Roughly two-thirds (67%) said they were *neither more nor less satisfied* than they were before.

Figure K-75. Changes in Teacher Satisfaction with SEEE Program Overall

Cadmus-administered teacher survey: “You mentioned you previously participated in THINK! ENERGY. How has your satisfaction with the program changed since the last time you participated?” (n=133)

Teacher respondents who were *less satisfied* (8%, n=11) than in previous years cited the following reasons why:

- Presentation “too crowded,” “did not grab students’ attention”
- Less grant money or did not receive grant
- Presenters did not start presentation on time
- Concepts “a little watered down”

PPL Electric Utilities staff could not offer the program to all teachers who applied to participate because of funding limitations and noted it received complaints from those who could not participate.

Teacher Net Promoter Score

The Net Promoter Score (NPS) is a brand loyalty metric that measures how likely customers are to recommend the program to others. Respondents rated their likelihood to recommend the program on a 10-point scale where 0 means *not at all likely* and 10 means *extremely likely* via questions Cadmus asked in its online teacher survey.¹¹⁸ Respondents who give a rating of 9 or 10 are considered promoters; a rating of 7 or 8 are considered passives; and a rating of 0 to 6 are considered detractors. The NPS is calculated as the difference between the percentage of promoters and detractors and expressed as a number from -100 and +100. As shown in Table K-146, the SEEE Program achieved an overall NPS of +69, indicating there are more promoters than detractors among the respondents.

¹¹⁸ Cadmus-administered teacher survey: “How likely is it that you would recommend this program to another teacher? Use a 0 to 10 scale where 0 means “not at all likely” and 10 means “extremely likely.” (n=151)

Table K-146. Net Promoter Score

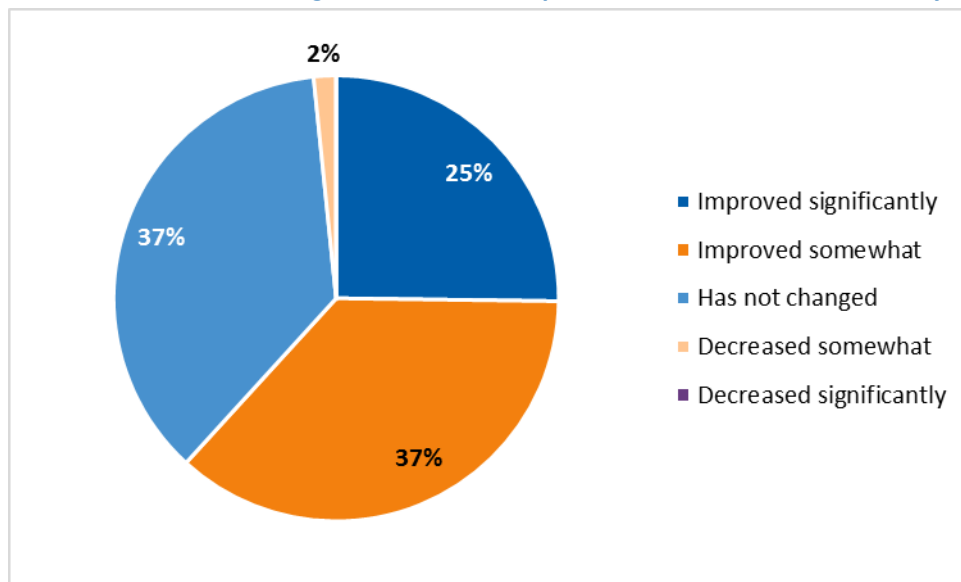
Rating Classification	Percentage of Respondents (n=152)
Promoters (9-10)	74%
Passives (7-8)	21%
Detractors (0-6)	5%
NPS	+69

NPS correlated strongly with a respondent's reported satisfaction with the program overall: 94% of Promoters (n=133) said they were *very satisfied* compared to 39% of Passives and 14% of Detractors. Only Detractors said they were *not too satisfied* with the program overall (29%, compared to 0% of Promoters and Passives).

Program Effect on Opinion of PPL Electric Utilities

Cadmus' online teacher survey results indicated that 62% of teacher respondents (n=125) said their opinions of PPL Electric Utilities *improved significantly* (25%) or *improved somewhat* (37%) after participating in the SEEE Program. Figure K-76 demonstrates these results.

Figure K-76. Effect of SEEE Program on Teacher Opinions of PPL Electric Utilities by Cohort



Cadmus-administered teacher survey: "After participating in THINK! ENERGY, has your opinion of PPL Electric Utilities..." (n=125)

Teachers whose opinions of PPL Electric Utilities had *improved significantly* or *improved somewhat* offered the following:

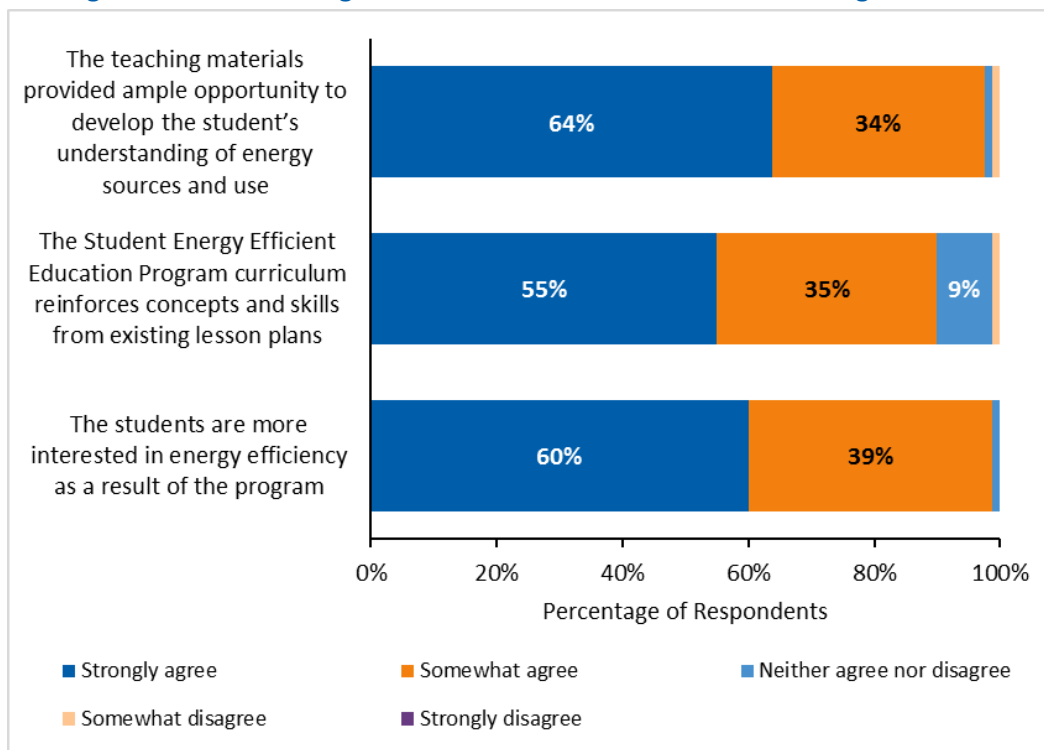
- "I think both the NEF and PPL are doing a great job in supporting instruction and deeper level thinking for students in my school. Three light bulbs go a long way in helping students understand the impact that their energy use has on the larger world."

- “I appreciate the willingness of PPL to participate in a student education program which donates usable equipment/tools/knowledge to help educate families about energy. Love the idea that the family is incorporated into the home analysis.”
- “Thanks for sponsoring the program. We have solar panels at our school so the program fits nicely with highly visible renewable options. I give PPL credit for educating children and families about ways to use energy wisely.”

Two respondents across all cohorts said their opinions *decreased somewhat* (2%; n=125). Both teachers were disappointed with the reduction of mini-grants as incentives for their students completing HEWs, something that PPL Electric Utilities staff had anticipated as a source of dissatisfaction. One thought the quality of the programming had slipped from previous years, and the other thought PPL Electric Utilities poorly conveyed information to parents about recalling the defective nightlights.

The online survey administered by Cadmus also asked teachers about the extent to which they agreed with statements about the program’s intentions, based on a five-point word scale from *strongly disagree* to *strongly agree*. As shown in Figure K-77, most teachers *strongly agreed* with each statement about the program performing as intended. More than a third of respondents (n=80) said they only *somewhat agreed* with each statement, indicating room for improvement. However, few teacher respondents (less than 1%) *somewhat disagreed* with any of the statements, and none *strongly disagreed*.

Figure K-77. Teacher Agreement with Statements about SEEE Program Intent



Cadmus-administered teacher survey: “Please read the following statements regarding the THINK! ENERGY curriculum and indicate whether you strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, or strongly disagree with each” (n=80).

Suggested Program Improvements

The paper survey administered by the ICSP's subcontractor asked teachers how PPL Electric Utilities can improve the program. Respondents most frequently recommended making THINK! ENERGY presentations more interactive—by asking for student volunteers to participate in activities that demonstrate energy-saving behavior, for example—to improve student engagement. Respondents also suggested improvements to the presentations such as adding to or changing the content, making the presentation longer, and using different presenters. PPL Electric Utilities staff thought it could improve presentations by offering prizes (to encourage student engagement and interaction) as well as scheduling follow-up presentations or classroom visits (to sustain student engagement). Staff also said they had received teacher feedback about reinstating the poster contest from PY7.

Respondents to Cadmus' online survey made similar statements about the presentation and made recommendations such as to slow it down, make it “more hands-on,” and conduct it in smaller groups. Five teachers (3%, n=168) expressed concerns about faulty nightlights.

The ICSP's subcontractor is developing a smart device application that students can use at home to encourage their engagement and improve installation rates of the kit products. The app is meant to encourage the installation of kit products through gamification and to deliver tips and resources in an online format accessible through a phone or tablet.

Marketing and Outreach

The ICSP's subcontractor handled marketing duties for the SEEE Program. The ICSP oversees collateral design, including the design of the boxes that house the THINK! ENERGY kits, kit inserts, HEWs, and press releases that promote PPL Electric Utilities' stewardship of the program. The ICSP staff reviewed its subcontractor's THINK! ENERGY presentations to ensure teachers and students know the program is sponsored by PPL Electric Utilities.

The program is available to all schools in PPL Electric Utilities' service territory. The ICSP subcontractor staff said it sends out promotional emails to let teachers know that registration for the program has opened.

PPL Electric Utilities staff said, “It's so well known that some schools sign up without us having to market it.” The ICSP subcontractor's staff agreed, confirming that marketing and outreach for the program was minimal, and that word of mouth is a strong contributor to program participation.

The ICSP's subcontractor tracked schools that qualified as low-income, which it estimated comprised roughly 37% of all participating schools.

Online Engagement

In PY7, the SEEE Program allowed the Innovation students to complete their HEWs online. The ICSP's subcontractor made this option available to the Take Action and Bright Kids cohorts as well in PY8. Results from Cadmus' online teacher survey did not indicate clear preferences between paper or online HEWs. Teachers who taught classrooms with older students (such as the Innovation and Take Action cohorts) more frequently reported that students used the online portal.

Roughly two-thirds of teacher respondents who said their students used the online portal (n=43) reported the online portal made it *significantly easier* (44%) or *somewhat easier* (23%) for students to complete HEWs. Teachers who said it made the process *somewhat more difficult* (7%) or *extremely more difficult* (2%) mentioned it was harder to track which students had submitted HEWs, and it was difficult for younger students to use.

Energy Education

Seventy-one percent of teacher respondents (n=153) said they incorporated energy education in their classroom curriculum prior to participating in the program. When asked if they would teach the THINK! ENERGY curriculum if the program did not provide kits, just 5% said *yes* (n=152). Another 9% said *it depends*, 77% said *no*, and 9% said *I don't know*. Teacher respondents who thought it was not *very likely* (n=62) most frequently thought energy efficiency topics would take too much time away from other topics.

K.2.2 Sample Cleaning and Attrition for Participant Surveys

Cadmus included the entire teacher population in its' online teacher survey, but the cleaning and survey sample preparation process reduced the available sample. Cadmus sent email invitations to the remaining contacts with email addresses. All respondents with email addresses received an initial survey invitation and two reminder email invitations. Table K-147 lists total numbers of emails and the outcome (final disposition) of each record.

Table K-147. SEEE Program Sample Attrition Table

Description of Outcomes	Number of Records
Online Survey	
Population (number of unique records) ^[1]	886
Duplicate contact	33
Incomplete or invalid email address	1
Survey Sample Frame (email invitations sent)	852
Email was returned (bounce back)	26
Did not respond	643
PPL Electric Utilities or market research employee	2
Did not participate in program	1
Did not complete survey after starting	22
Completed Surveys	158
Response Rate	19%
^[1] Number of teachers available in PPL Electric Utilities' tracking database at the time of the survey effort.	

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Appendix L. Evaluation Detail—Winter Relief Assistance Program

L.1 Gross Impact Evaluation

L.1.1 Methodology

EM&V Sampling Approach

Cadmus stratified the population in to five strata—one for each job type (baseload, low-cost, and full-cost), one specifically for master-metered multifamily units, and one for targeted manufactured home parks—to allow for a detailed examination of savings in each stratum. Cadmus reviewed records for all completed site visits as shown in Table L-148.

Table L-148. Winter Relief Assistance Program Sampling Strategy

Stratum	Population Size	Target Levels of Confidence & Precision ^[1]	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Baseload	1,451	90/10	65	89	Records review
		85/15	24	24	Site visit
Low-cost	968	90/10	64	92	Records review
		85/15	24	24	Site visit
Full-cost	7	90/10	7	7	Records review
		85/15	6	2	Site visit
Manufactured Home Initiative (all job types)	57	90/10	32	39	Records review
		85/15	17	17	Site visit
Master-Metered Multifamily (tenant units, all job types)	235	90/10	53	76	Records review
		85/15	22	22	Site visit
Program Total ^[2]	2,718	90/10	221	303	Records review
		85/15	93	89	Site visit ^[3]

^[1] By setting the target confidence and precision to 90/10 for records review and 85/15 for site visits, sample sizes were sufficient to estimate energy savings for the program with confidence and precision of 85/15 using the combined records review and site visit samples.

^[2] May not match due to rounding.

^[3] Cadmus did not visit participants' dwellings that were already inspected by the ICSP.

To verify savings, Cadmus used a double sampling approach using records review in the first sample and site visits in the second sample.¹¹⁹ Cadmus determined sample sizes for the records review evaluation activity based on 90% confidence and 10% precision targets, and for site visit sample based on 85% confidence and 15% precision targets. For both the records review and site visit evaluation activities, the number of individual records needed to reach the sample targets depended on the number of participants in each stratum which Cadmus accounted for using the finite population correction to

¹¹⁹ Thompson, Steven K. (2012) *Sampling Third Edition*. Joh Wiley & Sons, Inc., Hoboken, New Jersey.

reduce sample sizes when strata population sizes are small. For each stratum and sample, Cadmus used simple random sampling to select records for the records reviews as well as for the samples for site visits.

The gross impact evaluation activities produced program total gross energy savings and realization rate results with $\pm 6.3\%$ precision at 85% confidence.

ICSP Site Inspections

The ICSP field technicians inspected about 5% of all jobs associated with program participation to ensure project quality and to verify that products were installed as documented. Cadmus reviewed a sample of the ICSP's inspection records. (See *Inspection Records Review Findings Section* in *L.1.4 Ex Post Verification Findings*.) Cadmus did not use the ICSP's verification data to adjust the ISR for *ex post* verified savings because the data uploaded into PPL Electric Utilities' tracking database contained the final savings after the ICSP took any remedial actions.

L.1.2 Ex Post Verified Savings Methodology

Verification Activities

Cadmus conducted independent verification of WRAP energy savings' impact by job type based on the summary of methods described in Table L-149.

Table L-149. Impact Evaluation Methods for WRAP

Job Type ^[1]	Impact Evaluation Methods Conducted
Baseload Jobs	Conducted a records review for a sample of homes. Conducted engineering analysis by measure using the PA TRM. Estimated savings for energy education. Visited a sample of sites to verify installed measures.
Low-Cost Jobs	Conducted a records review for a sample of homes. Conducted engineering analysis by measure using the PA TRM. Estimated savings for energy education. Visited a sample of sites to verify installed measures.
Full-Cost Jobs	Did not verify savings for full-cost jobs because there were not enough post-treatment data for a billing analysis. There were only seven full-cost jobs; so few participants introduces a considerable amount of uncertainty. In PY10 Q2, Cadmus will conduct a single billing analysis for PY8 and PY9 full-cost jobs to have sufficient post-treatment usage data.
Manufactured Home Park Initiative	Conducted a records review for a sample of homes. Conducted engineering analysis by measure for the baseload and low-cost jobs using the PA TRM. Estimated savings for energy education. Visited a sample of sites to verify installed measures. For the limited air sealing products, used the workbook Cadmus developed to calculate limited air sealing savings estimates for the PY7 Wise Home Pilot Program as a basis for the savings in PY8. Did not conduct billing analysis for participants who received limited air sealing because only 21 manufactured home park initiative jobs received these products and nine of these jobs received only door corner pads.
^[1] The master-metered multifamily stratum only includes baseload and low-cost measures. Thus, the multifamily jobs are included in the baseload or low-cost job strata.	

An overview of the products and services installed in the WRAP and offered in each of the five strata along with the PA TRM entries Cadmus used to determine verified energy savings are discussed in the following sections.

Baseload Job Type

Baseload jobs require no additional qualifications beyond the general WRAP requirements. However, baseload customers generally have non-electric heating and a non-electric water heater.¹²⁰ Table L-150 shows the energy-saving items in the baseload stratum and the PA TRM entries Cadmus used to determine verified energy savings. Customers are eligible for all items offered by the job type, but most customers do not receive all of these items.¹²¹

Table L-150. Baseload Items

Items Offered	PA TRM References
LED Nightlight	LED Nightlight - Section 2.1.4
ENERGY STAR LED Lighting	ENERGY STAR Lighting - Section 2.1.1
Tier 2 Smart Strips	Smart Strip Plug Outlets - Section 2.5.3
Energy Education	Programmable Thermostats – Section 2.2.8 Water Heater Temperature Setback – Section 2.3.6 Low Flow Showerheads – Section 2.3.9 WRAP Participant Survey Energy Efficiency Kits PY7 and PY8 Participant Survey
Refrigerator Recycle with Replace	Final IMP - EDC Direct Install Refrigerator/Freezer Recycling with Replacement
Refrigerator Recycle without Replace	
Freezer Recycle with Replace	
Freezer Recycle without Replace	
Furnace Whistle ^[1]	Furnace Whistle – Section 2.2.7
^[1] Cooling only; a furnace whistle with electric heating is a full-cost item.	

Low-Cost Job Type

Homes with electrically heated water qualify for low-cost jobs. Low-cost jobs are eligible for the items in Table L-151 and all items offered to baseload job types.

Table L-151. Low Cost Items

Items offered	PA TRM References
Low-Flow Faucet Aerator	Low-Flow Faucet Aerators – Section 2.3.8
Low-Flow Showerhead	Low-Flow Showerheads – Section 2.3.9
Water Heater Temperature Setback	Water Heater Temperature Setback – Section 2.3.6
Water Heater Pipe Insulation	Water Heater Pipe Insulation – Section 2.3.7
Water Heater Tank Wrap	Water Heater Tank Wrap – Section 2.3.5
Thermostatic Restriction Valve	Thermostatic Shower Restriction Valve–Section 2.3.10
Heat Pump Water Heater	Heat Pump Water Heater – Section 2.3.1

¹²⁰ If a customer had an electric water heater but refused water heater measures, the customer was categorized as a baseload customer. This rarely happened.

¹²¹ Customers do not receive all items for a variety of reasons. For example, customers refused some items or were not eligible (the customer already had the item in place, their freezer did not need to be recycled, etc.).

Full-Cost Job Type

Homes with electric space heat qualify for full-cost jobs, which include all baseload and low-cost items (if electric water heating is present). Cadmus will conduct a billing analysis to verify the PY8 and PY9 full cost jobs in PY10, after a year of post-treatment data are available. The additional energy-saving products included in the full-cost stratum are these:

- Air sealing
- Attic insulation
- Residential advanced smart thermostat
- Residential programmable thermostat

Master-Metered Multifamily Buildings

In Phase III, PPL Electric Utilities provided WRAP at no cost in the tenant units of master-metered multifamily buildings (in a nonresidential rate class) with income-qualified low-income occupants, subject to landlord approval. PPL Electric Utilities treated the single-tenant units in master-metered multifamily buildings; however, energy efficiency improvements for common areas (e.g., vestibule, basement, hallways, exterior) were not covered under WRAP. Single-tenant units in master-metered multifamily buildings qualified only for baseload and low-cost measures; see the measures listed in Table L-150 and Table L-151.

Manufactured Homes Park Initiative

Manufactured homes with electrically heated water qualified for low-cost jobs. If the home did not have electrically heated water, it qualified for baseload jobs. In addition, some manufactured homes were eligible for the minor air sealing measures—door caddies, door corner pads, closed cell foam weatherstripping, and window kits—based on the auditor’s recommendations.¹²² The exact combination of products delivered along with minor air sealing depended on the conditions of the individual home.

Cadmus initially planned to conduct a billing analysis if at least 20 manufactured homes received limited air sealing. Although 21 customers received limited air sealing measures, Cadmus did not conduct a billing analysis because it found low ISRs during the site visits and nine customers installed only door corner pads, which provide very small savings and would not be detectable in a billing analysis. Cadmus estimated savings for air sealing using an engineering analysis, which drew on several sources, and made adjustments for Pennsylvania climate wherever necessary.

Ex Post Methodology to Determine Total Savings, Realization Rates, and Precision

Cadmus estimated the total program verified savings, realization rate, and precision based on the reported and evaluated savings, as well as estimated realization rates, based on the double sampling approach described in Thompson’s book on sampling.¹²³ Using double sampling, Cadmus evaluated the first sample using records review verification and estimated this realization rate as the sum of the

¹²² Usually these homes had electric heat. All homes had either cooling, electric heat, or both.

¹²³ Thompson, Steven K. *Sampling*. Third Edition. 2012. John Wiley & Sons, Inc. Hoboken, New Jersey.

records review evaluated savings divided by the sum of reported savings among sampled homes using the following equation.

$$\text{Records Review } RR_{\text{Stratum } h} = \frac{\sum_{i=1}^{n'_h} \text{Records Review Evaluated Savings}_i}{\sum_{i=1}^{n'_h} \text{Reported Savings}_i}$$

Cadmus evaluated the second sample using site visit verification and estimated this realization rate as the sum of the site visit evaluated savings divided by the sum of records review savings among sampled homes using the following equation.

$$\text{Site Visit } RR_{\text{Stratum } h} = \frac{\sum_{i=1}^{n_h} \text{Site Visit Evaluated Savings}_i}{\sum_{i=1}^{n_h} \text{Records Review Savings}_i}$$

Cadmus estimated the stratum total verified savings using a combined stratum realization rate, calculated as the product of the records review realization rate and the site visit realization rate, and multiplying the overall realization rate to the reported savings, using the following equations.

$$\text{Overall } RR_{\text{Stratum } h} = \text{Records Review } RR_{\text{Stratum } h} \times \text{Site Visit } RR_{\text{Stratum } h}$$

$$\text{Total Verified Savings}_{\text{Stratum } h} = \text{Overall } RR_{\text{Stratum } h} \sum_{i=1}^{N_h} \text{Reported Savings}_i$$

Cadmus estimated the precision within each stratum and for the program total realization rate based on the standard errors of each stratum's total verified savings estimate, where Cadmus calculated the standard error based on the estimated variance of the total verified savings, according to Thompson using the following equation.

$$\widehat{\text{var}}(\text{Total Verified Savings}_{\text{Stratum } h}) = N_h(N_h - n'_h) \frac{S_{\text{records review}}^2}{n'_h} + N_h^2 \frac{n'_h - n_h}{n'_h n_h} S_{\text{site visit}}^2$$

Where:

N_h = population size in stratum h

n'_h = records review sample size in stratum h

n_h = site visit subsample size in stratum h

$S_{\text{records review}}^2$

$$= \frac{\sum_{i=1}^{n'_h} (\text{Records Review Evaluated Savings}_i - \text{Records Review } RR_{\text{Stratum } h} \times \text{Reported Savings}_i)^2}{n'_h - 1}$$

$S_{\text{site visit}}^2$

$$= \frac{\sum_{i=1}^{n_h} (\text{Site Visit Evaluated Savings}_i - \text{Site Visit } RR_{\text{Stratum } h} \times \text{Records Review Savings}_i)^2}{n_h - 1}$$

Ex Post Savings Calculation Methodology for Energy Education

To estimate energy education savings in PY8, Cadmus used a combination of WRAP participant survey data and algorithms from the PA TRM.¹²⁴ Cadmus selected three behavioral recommendations—adjusting thermostats, washing clothes in cold water, and taking shorter or fewer showers—that reasonably corresponded to energy saving measures in the PA TRM.¹²⁵ The next sections discuss these behavioral suggestions in detail.

Adjusting Thermostats

Cadmus assumed that participants who adjusted their thermostats saved energy similar to savings from a programmable thermostat and applied the PA TRM’s algorithms for programmable thermostat (see Section 2.2.8). Table L-152 shows the inputs used to calculate these savings (along with different weightings).

$$\Delta kWh/yr = (\Delta kWh_{cool} \times \%CAC + \Delta kWh_{heat} \times \%ElectricHeat) \times \%Adjusted$$

$$\Delta kWh_{cool} = \frac{CAPY_{cool}}{1000 \frac{W}{kW}} \times \frac{1}{SEER \times Eff_{duct}} \times EFLH_{cool} \times ESF_{cool}$$

$$\Delta kWh_{heat} = \frac{CAPY_{heat}}{1000 \frac{W}{kW}} \times \frac{1}{HSPF \times Eff_{duct}} \times EFLH_{heat} \times ESF_{heat}$$

$$\Delta kW_{peak} = 0$$

Cadmus assumed that participants who indicated they adjusted their thermostat adjusted it both in the winter and summer. This represents a ceiling for savings (because not every customer may have done so).

¹²⁴ WRAP used results from the PY6 Energy Efficiency Kits and Education Program as a proxy for the *ex ante* reported savings.

¹²⁵ For washing clothes in cold water, Cadmus used the PA TRM to estimate the energy consumption of a washing machine and used survey data to adjust the usage.

Table L-152. Inputs for Adjusting Thermostats

Variable	Value	Reference/Notes
$CAPY_{cool}$	32,000	PA TRM default (Btuh)
$SEER$	11.9	PA TRM default
Eff_{duct}	0.8	PA TRM default
$EFLH_{cool}$	490	Weighted based on WRAP PY8 participant data
ESF_{cool}	0.02	PA TRM default
$CAPY_{heat}$	32,000	PA TRM default (Btuh)
$HSPF$	3.412	PA TRM default
$EFLH_{heat}$	1,185	Weighted based on WRAP PY8 participant data
ESF_{heat}	0.036	PA TRM default
%CAC	22%	Weighted based on WRAP PY8 participant data (and adjusted for those who already received a programmable thermostat) ^[1]
%ElectricHeat	33%	Weighted based on WRAP PY8 participant data (and adjusted for those who already received a programmable thermostat)
%Adjusted	16%	Survey data

^[1] Cadmus determined the central air conditioner saturation from the sample of audit records weighted by stratum, because the ICSP did not consistently report on cooling type in PPL Electric Utilities' tracking database.

Wash Clothes in Cold Water

Cadmus estimated the energy savings from participants washing clothes in cold water in two steps:

- Estimated the energy usage of a clothes washer (using algorithms from the PA TRM)¹²⁶
- Weighted the results based on survey questions from the PY8 Energy Efficiency Kits and Education Program and from WRAP's survey results

Cadmus did not assume that participants who said they washed their clothes in cold water did so every time and used the survey results of the percentage increase in loads from the Energy Efficiency Kits and Education Program instead. Cadmus also used the Energy Efficiency Kits and Education Program results for weighting the percentage of homes with a clothes washer. Table L-153 shows the inputs used to calculate these savings.

$$\Delta kWh/yr = \frac{V_{HW} \times \left(8.3 \frac{lb}{gal}\right) \times \left(365 \frac{days}{yr}\right) \times \left(1 \frac{Btu}{F \cdot lb}\right) \times (T_{hot} - T_{cold})}{\left(3412 \frac{Btu}{kWh}\right) \times EF_{WH}} \times \%ElectricDHW$$

$$\times \%ColdWashIncrease \times \%HomesWithClothesWasher$$

$$\Delta kW_{peak} = ETDF \times \Delta kWh/yr$$

¹²⁶ Section 2.3.6 of the PA TRM concerns the water heater temperature setback. One component in the algorithm estimates savings from the clothes washer. Cadmus used these savings to estimate consumption of a clothes washer.

Table L-153. Inputs for Washing Clothes in Cold Water

Variable	Value	Reference/Notes
V_{HW}	7.32	PA TRM default
T_{hot}	129.31	PA TRM default weighted by the percentage of WRAP participants that received a temperature setback
T_{cold}	55	PA TRM default for the input temperature of the water (see PA TRM section 2.3.10)
EF_{WH}	0.912	Weighted by number of heat pump water heaters installed in WRAP and number of storage water heaters
%ElectricDHW	59%	Percentage of participants in WRAP population with electric water heaters
%ColdWashIncrease	43%	The percent increase in loads washed in cold water for participants who took energy saving steps based on the recommendations in the PY7 Energy Efficiency Kits and Education program ^[1]
%HomesWithClothesWasher	73%	The distribution of homes with a clothes washer in their unit from the PY8 Energy Efficiency Kits evaluation described in this annual report
ETDF	0.00008047	PA TRM default

^[1] PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

Taking Shorter Showers

Cadmus assumed that participants who said they take shorter or fewer showers take a five-minute shower every time. Cadmus estimated shower energy use using section 2.3.9 in the PA TRM, which concerns low-flow showerheads but was a good proxy after adjusting the flow rate to be constant (technically, the weighted flow rate of WRAP participants) and added a term to subtract the energy education recommendation for shower length from the default.¹²⁷ Table L-154 shows the inputs used to calculate these savings.

$$\begin{aligned} & \Delta kWh/yr \\ & = ELEC \\ & \times \left[\frac{GPM \times (T_{person/day} - T_{person/day,EE}) \times N_{persons} \times N_{showers/day} \times 365 \frac{days}{yr} \times (T_{out} - T_{in}) \times 8.3 \frac{Btu}{gal \cdot ^\circ F}}{\#_{showers} \times 3412 \frac{Btu}{kWh} \times RE} \right] \\ & \Delta kW_{peak} = \Delta kWh/yr \times ETDF \end{aligned}$$

Where:

$$\begin{aligned} ETDF &= \frac{CF}{HOU} \\ CF &= \frac{\%_{shower\ use, peak} \times T_{person/day, EE} \times N_{persons} \times N_{showers/day}}{\#_{showers} \times 240 \frac{minutes}{daily\ peak}} \\ HOU &= \frac{T_{person/day, EE} \times N_{persons} \times N_{showers/day} \times 365 \frac{days}{yr}}{\#_{showers} \times 60 \frac{minutes}{hour}} \end{aligned}$$

¹²⁷ The PA TRM groups like terms and takes the difference of the variables that are changed. In this instance, Cadmus set the flow rate to be constant and changed the time of the showers.

Table L-154. Inputs for Taking Shorter Showers

Variable	Value	Reference/Notes
<i>ELEC</i>	59%	Actual electric water heater saturation from WRAP data
GPM	2.0	Weighted GPM based on PA TRM defaults and PY8 WRAP tracking data
$T_{person/day}$	7.8	PA TRM default (minutes)
$T_{person/day,EE}$	5.0	Energy education suggestion (minutes)
$N_{persons}$	2.2	PA TRM defaults weighted by distribution of home types
$N_{showers/day}$	0.6	PA TRM default
T_{hot}	101	PA TRM default (degrees Fahrenheit)
T_{cold}	55	PA TRM default (degrees Fahrenheit)
$\#_{showers}$	1.2	PA TRM default weighted by distribution of home types
<i>RE</i>	0.98	PA TRM default
$\%_{shower\ use,peak}$	11.7%	PA TRM default
CF	0.0026	Calculated based on energy education recommendation
<i>HOU</i>	33	Calculated based on energy education recommendation
<i>ETDF</i>	8.0137E-05	Calculated

L.1.3 Ex Post Demand Reduction

For baseload and low-cost jobs, Cadmus calculated demand savings using the PA TRM. For savings components of the manufactured home park initiative jobs that were not found in the PA TRM, Cadmus calculated demand reductions as follows:

$$kW = kWh * ETDF$$

Where:

kWh = Deemed kWh per job type

ETDF = Energy to demand factor; 0.00011797¹²⁸

To calculate the kW reduction at the generator, Cadmus applied the residential line loss factor of 0.0833.

L.1.4 Ex Post Verification Findings

Database Review Findings

For both the impact and process evaluations, Cadmus reviewed the PPL Electric Utilities' tracking database extracts and ICSP's Energy Reduction Management System (ERMS) database extracts for the census of records for PY8 projects and WRAP components. The quality control review assessed the completeness of fields necessary to conduct the participant telephone surveys and verify that items

¹²⁸ The coincidence factor of 0.00011797 is the percentage of load occurring during a defined peak period using a residential single-family miscellaneous load shape.

recorded in the PPL Electric Utilities' tracking database for each job sampled matched the items installed from the ICSP's ERMS database.

Cadmus confirmed that there were no duplicate account numbers (or addresses) corresponding to different job numbers in PPL Electric Utilities' tracking database with the exception of a few multifamily buildings. Cadmus found only one WRAP job that was miscategorized as a baseload instead of a low-cost job in the tracking database. This affected the realization rate in the low-cost stratum but the effect was almost negligible considering the relative savings of one job.

Records Review Findings

Cadmus verified a sample of records comparing the ICSP's audit records to PPL Electric Utilities' tracking database. Cadmus found that the location of Tier 2 smart strips was consistently incorrectly listed in PPL Electric Utilities' tracking database compared to the ICSP's audit records. The location of smart strips was important because this input in the TRM algorithm determined the per-unit energy savings and could change it by 103 kWh per smart strip. Overall, Cadmus found that the reported savings for Tier 2 smart strips were underreported by 17%.

Cadmus determined Tier 2 smart strips energy savings in the sample for all strata, using the corrected locations. Cadmus then divided the reported savings by the corrected energy savings for each stratum and weighted each by strata population to determine the overall weighted average of the percentage of underreported smart strips.

In the selected sample, Cadmus found that contractors reported low-flow showerheads and low-flow faucet aerators in some homes that already had a low-flow showerhead or aerator.¹²⁹ This lowered savings for showerheads by 25% and aerators by 17%.

Cadmus' records review found that contractors reported installing LED nightlights in some participants' homes where no incandescent nightlight was installed (as a baseline). Cadmus calculated the overall effect of LED nightlights installed with no baseline and the ISR of LED nightlights by averaging the weighted averages from the record reviews and the site visits.

Site Visit Findings

Cadmus conducted 89 site visits for the PY8 evaluation and verified home type, heating fuel type, water heater fuel type, and the cooling conditions and, wherever possible, baseline conditions. Overall, Cadmus found that ISRs were high for items such as LEDs, showerheads, and aerators and lower for items such as Tier 2 smart strips and LED nightlights.

¹²⁹ The contractors reported the baseline GPM on the audit record. In one instance, the contractor indicated the existing low-flow showerhead in a participants' home was broken and gave the participant a new one. In this case, Cadmus assigned savings. Cadmus' field technicians note that GPM information is generally located on the showerhead or aerator.

Table L-155 shows the ISRs in descending order of the number of verified installations, weighted by strata using the population percentages.¹³⁰ Reported installations show the quantity of installations reported in PPL Electric Utilities' tracking database. Verified installations refers to the reported number of installations multiplied by the ISRs.

Table L-155. PY8 Installations for Products with ISR Input to PA TRM Algorithm

Item	Reported Installations	ISR	Verified Installations
ENERGY STAR LED Lighting	54,774	94%	51,299
LED Nightlight	5,121	69%	3,537
Energy Education ^[1]	2,718	100%	2,718
Water Heater Pipe Insulation (feet)	1,526 ^[2]	45%	686
Low-Flow Faucet Aerator	1,707	81%	1,377
Tier 2 Smart Strips	2,140	44%	937
Low-Flow Showerhead	865	88%	764
Thermostatic Restriction Valve	373	71%	266
Door Corner Pads ^[1]	32	0%	0
Furnace Whistle	22	47% ^[3]	10
Door Caddie ^[1]	12	67%	8
Window Kit ^[1]	3	50%	2
Closed Cell Foam ^[1]	3	0%	0

^[1] These measures are not in the PA TRM or available only in the Manufactured Homes Initiative. Cadmus calculated ISRs for these measures to decide if a billing analysis was necessary to estimate savings and concluded that, partly because of the low ISRs, it was not necessary.

^[2] This represents the length of all pipe wrap installed. There were 201 installations. Savings are calculated per foot. The measure is installed if 1 or more feet of pipe insulation is installed.

^[3] This is the default ISR in the PA TRM. During the site visits, Cadmus saw only one reported furnace whistle, which was not installed.

WRAP offered additional products, including for example, refrigerator recycling, freezer recycling, water heater pipe insulation, or water heater setback thermostat.¹³¹ Table L-156 shows the reported installations and the number of reported and verified installations in the sample of site visits.

WRAP also offered several health and safety products, such as CO₂ detectors (1,011 reported), smoke detectors (368), and battery replacements (422 reported).

¹³⁰ Cadmus analyzed each measure that each sampled participant received. Thus, there is a binary ISR applied to every measure in the sample—the measure was either there or it was not. This table shows the calculated program-level ISR for measures whose PA TRM algorithm require an ISR input.

¹³¹ The PA TRM algorithms assume these items are installed and the algorithms do not include an explicit ISR term.

Table L-156. PY8 WRAP Installations for Products without ISR Input to PA TRM Algorithm

Item	Reported Installations	Sample Reported Installations	Sample Verified Installations
Water Heater Temperature Setback	100	14	10
Refrigerator Recycle with Replacement	64	2	0
Heat Pump Water Heater	12	1	1
Freezer Recycle with Replacement	7	1	1
Water Heater Tank Wrap	7	2	0
Residential Programmable Thermostat	3	1	1
Air Sealing	2	0	0
Attic Insulation	2	0	0
Residential Advanced Smart Thermostat	2	2	0
Refrigerator Recycle without Replacement	2	0	0
Freezer Recycle without Replacement	1	0	0
HVAC Tune-Up	1	0	0

Table L-157 shows an example of the effect that ISR has on reported savings. The table shows how the quantity findings from the site visits contribute to the overall realization rate. With everything else being equal, these are the effects that the ISRs have on the program savings. (Note that the final realization rate includes results from the records reviews and other input variables as well site visit findings.)

Table L-157. Effect of ISR on Reported Savings

Measure	ISR	Total Reported kWh/yr	Effect of ISR on Reported Savings kWh/yr ^[1]
Tier 2 Smart Strips	44%	512,207	287,949 less
ENERGY STAR LED Lighting	94%	1,758,706	111,570 less
LED Nightlight	69%	145,709	45,068 less
Low-Flow Showerhead	88%	303,005	35,392 less
Low-Flow Faucet Aerator	81%	167,005	32,261 less
Thermostatic Restriction Valve	71%	26,247	7,499 less

^[1] The ISR values shown in this table are rounded. However, the effect of the ISR on reported savings use the actual weighted ISR.

As in its records review, Cadmus found that many participants did not have a baseline nightlight but were nevertheless given a LED nightlight. In some homes, participants had two baseline nightlights but received more than two LED nightlights. Cadmus averaged the weighted averages of the effect of LED nightlight installations for which there was no baseline nightlight to achieve a combined overall effect of “Verified/Reported” of 17%. Results are shown in Table L-158.

Table L-158. Summary of Baseline Nightlight and ISR Effect on Realization Rate

Measure	Total Reported Energy Savings (kWh/yr)	Average Weighted Verified to Reported Ratio from Records Reviews and Site Visits	Total Verified Savings (kWh/yr)	Savings Lowered by (kWh/yr)
LED Nightlights	145,709 ^[1]	17% ^[2]	25,409 ^[3]	120,300 ^[4]
^[1] This is the total reported savings for LED nightlights. ^[2] This is the average of the weighted averages of the verified to reported ratio. ^[3] This is the total reported savings multiplied the average of the weighted averages of the verified to reported ratio. ^[4] This is the difference of the total reported energy savings and the calculated total verified savings.				

Verifying the baseline conditions of showerheads and aerators in the site visits proved more difficult because participants were generally unaware of the flow rate of their shower or faucet before participating in WRAP. Therefore, Cadmus relied on the audit records to verify baseline showerheads and aerators.

Records Reviews and Site Visits Findings Comparison and Realization Rates

Cadmus found that results from the site visits were close to the results from the records review. For both energy and demand, the site visit realization rate was at least 80% for all strata, which indicates that the site visits verified 80% of the results from the records review in all strata. This section summarizes the site visit and records review results.

Table L-159 and Table L-160 summarize the factors that contributed to the difference between the reported and verified savings, a reduction of 822,558 kWh in verified savings.

Overall, six factors contributed 80% of the difference between the reported and verified energy savings and to the observed realization rates, as shown in Table L-159. These factors are relatively easy to correct to improve savings.

Tier 2 smart strips were the third largest contributor to reported savings, and this product's low ISR of 44%, decreasing reported savings by 287,949 kWh/yr (a 56% decrease). This reduction makes up 35% of the realization rate reduction.

For *ex ante* WRAP energy education savings, the ICSP assumed (and reported) the average PY6 *ex post* savings from the Energy Efficiency Kits and Education Program.¹³² Cadmus verified PY8 participants' uptake of energy efficiency suggestions through phone surveys and found that 39% of WRAP participants practiced at least one recommendation following the energy education they received. Cadmus used the Energy Efficiency Kits and Education Program's methodology to calculate energy education savings. This resulted in a reduction in energy savings by 252,401 kWh/yr. This reduction makes up 31% of the realization rate reduction.

¹³² PPL Electric Utilities. Annual Report Program Year 6: June 1, 2014–May 31, 2015. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 16, 2015.

Contractors often installed 1.5 GPM low-flow kitchen faucet aerators and showerheads when the existing aerator or showerhead was already 1.5 GPM, resulting in no energy savings.¹³³

Similarly, contractors installed many LED nightlights where there had previously been no nightlights, resulting in negative energy savings equal to the consumption of an LED nightlight. These installations lessened each product's reported savings by 25% for showerheads, 17% for aerators, and 83% for nightlights (or, at the program level 75,137 kWh/yr, 28,913 kWh/yr, and 120,283 kWh/yr respectively).¹³⁴ Respectively, these reductions make up 9%, 4%, and 15% of the realization rate reduction.

Cadmus found that the reported savings for Tier 2 smart strips were underreported by 13% because the database did not correctly report location (that is, reported savings should have been 103,942 kWh/yr greater). This, effectively, increased the realization rate and somewhat lessened the effects of the low ISR for this item.

Table L-159. Summary of Major Factors Driving the Realization Rate

Item	Reason	Percent Contribution to Realization Rate	Energy Savings Difference (kWh/yr)
Tier 2 Smart Strips	Low ISR	35%	287,949 less
Energy Education	Low participation compared to EE Kits	31%	252,401 less
Low-Flow Showerheads	Existing baseline GPM equal to item GPM	9%	75,137 less
Low-Flow Aerators	Existing baseline GPM equal to item GPM	4%	28,913 less
LED Nightlights	No baseline nightlight present (and ISR)	15%	120,283 less
Tier 2 Smart Strips	Location consistently wrong in tracking database	-13%	103,942 more
Subtotal (Only Major Factors) ^[1]		80%	660,741 less
^[1] May not match due to rounding.			

As shown in Table L-160, the remaining 20% of the difference between reported and verified savings is the sum of all of the minor differences in inputs and quantities found from the records review and site visits in all the other measures. LED bulbs contribute a large portion of the energy and demand savings for the WRAP, and its site visit realization rates were around 100% across all four strata. Cadmus found that contractors were installing LED bulbs under the right circumstances, customers were leaving them in, and that PPL Electric Utilities was reporting them correctly in their tracking database. However, a relatively small percentage of uninstalled or not-in-service bulbs contributed to a relatively large reduction in energy savings.

¹³³ In the audit records sample, 50 out of 135 showerheads had a baseline GPM equal to the installed GPM. 62 out of 261 aerators had a baseline GPM equal to the installed GPM. The GPM is generally stamped on the aerator or showerhead.

¹³⁴ The percentage reduction to LED nightlights was also influenced by the ISR in a slightly positive way. That is, a participant given an LED nightlight with no baseline nightlight and later removed it, nothing would be added to the load. (Note that LED nightlights consume only about 2 kWh of energy per year.)

Table L-160. Summary of Minor Factors Driving the Realization Rate

Item	Reason	Percent Contribution to Realization Rate	Energy Savings Difference (kWh/yr)
LED Bulbs	94% ISR, but 1,758,706 kWh in reported savings yields relatively high impact on verified savings	14%	111,570 less
Thermostatic Restriction Valve	71% ISR, but low savings yields low impact on savings	1%	6,366 less
Pipe Wrap	Input changes	<1%	2,810 less
All Other Measures	Input/quantity changes and ISR	5%	41,071 less
Subtotal (Only Minor Factors) ^[1]		20%	161,817 less
^[1] May not match due to rounding.			

Table L-161 shows the energy realization rates from the records review and the site visits in each stratum. Cadmus calculated the realization rate by dividing the sample verified savings by the reported savings. Since the site visits were conducted for a sample of the homes where the records review were conducted, the reported savings in the site visits columns (column D) are the results of the records review for the sample of records. The overall realization rate for each stratum is computed by multiplying the records review realization rate (column C) by the site visit realization rate (column F).

Table L-161. Sample Records Review and Sample Site Visits Energy Realization Rates

Stratum	Records Review			Site Visits		
	Reported Savings ^[1] (MWh/yr)	Verified Savings (MWh/yr)	Realization Rate ^[2]	Reported Savings ^[3] (MWh/yr)	Verified Savings (MWh/yr)	Realization Rate ^[2]
	A	B	C	D	E	F
Baseload	91	75	83%	20	18	88%
Low-cost	139	126	91%	31	27	86%
Full-cost ^[4]	-	-	-	-	-	-
Manufactured Home Initiative (all job types)	34	32	94%	15	12	81%
Master-Metered Multifamily (all job types)	79	52	66%	14	20	139%
^[1] The reported savings in this column refer to the savings reported in PPL Electric Utilities' tracking database for the sample of records review.						
^[2] May not match due to rounding.						
^[3] The reported savings in this column refer to the results from the records review for each home that received a site visit.						
^[4] Cadmus did not verify the full-cost stratum.						

Evaluated energy savings for the strata populations are calculated by multiplying the overall strata realization rates shown in Table L-162, to the reported savings in the strata.

Table L-162. Overall Energy Savings Realization Rate Calculation

Stratum	Population Percent (Weight)	Energy Realization Rate		
		Records Review	Site Visit	Overall Stratum ^[1]
Baseload	54%	83%	88%	73%
Low-cost	36%	91%	86%	78%
Full-cost ^[2]	-	-	-	-
Manufactured Home Initiative (all job types)	2%	94%	81%	76%
Master-Metered Multifamily (all job types)	9%	66%	139%	91%
Program Total ^[3]				76% ^[4]

^[1] The overall realization for each stratum is found by multiplying the records review realization rate by the site visit realization rate.
^[2] Cadmus did not verify the full-cost stratum.
^[3] May not match due to rounding.
^[4] The program total realization is found by taking the weighted average of the stratum level overall realization rate and the population weight of the stratum.

Table L-163 shows the population and the weighting used to determine the program level savings. The program level realization rate is calculated using the total evaluated savings summed across strata for the entire population, divided by the total reported savings summed across strata for the entire population (similar to using a weighted average with stratum weights).

Table L-163. Low-Income WRAP Gross Impact Results for Energy with Population Weights

Stratum	Population	Population Percent (Weight)	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.
Baseload	1451	54%	1,700	73%	1.16	11.33%
Low-cost	968	36%	1,488	78%	0.89	8.62%
Full-cost (unverified)	7	-	16	N/A	N/A	N/A
Manufactured Home Initiative	57	2%	49	76%	0.57	8.01%
Master Metered Multifamily	235	9%	238	91%	0.43	4.56%
Program Total ^[1]	2718	-	3,491	76% ^[2]	N/A	6.34%

^[1] May not match due to rounding.
^[2] Realization rates exclude unverified energy savings. The program level realization rate is weighted by stratum.

Energy Education Savings Analysis Findings

Table L-164 shows the energy savings recommendations considered in estimating energy education savings, the behavioral element the education could change, PA TRM reference, the WRAP participant survey results, and the per-unit energy and demand savings. The survey results report the percentage of respondents who reported that they took this action. The verified energy education savings estimate average is 66.90 kWh/yr per household. The verified savings estimate is 42% of the reported savings assumption of 160 kWh/yr per household.

Table L-164. Verified Energy Education Savings and Assumptions Summary Table

Energy Savings Recommendation	Behavioral Assumption	PA TRM Reference	Survey Results	Energy Savings (kWh/yr)	Demand Savings (kW/yr)
Adjust Thermostats	Participants lower their thermostat in the winter and raise it in the summer	Programmable Thermostats – Section 2.2.8	16%	172.54	0.0000
Wash Clothes in Cold Water	Participants increase the number of loads of laundry they wash in cold water	Water Heater Temperature Setback – Section 2.3.6	19%	96.78	0.0078
Take Shorter Showers	Participants decrease the duration each shower	Low Flow Showerheads – Section 2.3.9	14%	149.30	0.0120
Total Savings (weighted with survey results) ^[1]				66.90 ^[2]	0.0032 ^[2]
^[1] May not match due to rounding.					
^[2] The weighted energy education results are found by summing the product of the survey results and the unit energy savings for each recommendation.					

The unit energy savings of each component of the energy education, when summed, are relatively high when compared to most other WRAP measures installed at each participant’s home. The energy education savings represented the third highest reported energy savings by measure (after LED bulbs and Tier 2 smart strips) in the WRAP. However, the low participation among WRAP participants drove down the total energy education savings.

Inspection Records Review Findings

The ICSP conducted field inspections for about 5% of WRAP jobs to check project quality and to verify that products were installed as documented. Cadmus reviewed a sample of 43 of the ICSP’s inspection records to determine whether there were systematic errors or areas that could be improved. The reviews found the following:

- 46% of the sampled inspection records did not have completed entries for the “# invoiced” and “# installed” fields, so Cadmus was unable to determine whether there were discrepancies.
- 36% of the sampled inspection records that did have completed information in the “# invoiced” and “# installed” fields had discrepancies.
- 71% of sampled inspection records did not have completed “pass/fail” fields and 78% did not have completed “in-person inspection required” fields. It is unclear if these fields were intended for use for all inspections or just a subset of inspections. Cadmus was unable to draw any further conclusions from these sparsely populated fields.
- 12% of customers from sampled inspection records either did not have energy education provided to them or did not remember if it was provided.

Cadmus reviewed inspection records for two of the seven full-cost jobs. The ICSP marked one of these as failed in the inspection “pass/fail” field because one customer did not receive the refrigerator. On the other inspection record, the ICSP invoiced an Ecobee smart thermostat, but the record indicates none was installed.

Table L-165 summarizes the inspections records review findings, grouped by job type, conducted by the ICSP. Where all data are available, the inspection form clearly documents the discrepancy and the resolution.

The data uploaded into PPL Electric Utilities' tracking database contained the final savings, confirmed by the ICSP after its verification site visits. Therefore, Cadmus used the data reported in PPL Electric Utilities' tracking database when calculating the *ex post* verified savings.

Table L-165. PY8 WRAP Sample Inspection Records Review Summary

Job Type	Inspection Records Reviewed	Inspection Records with Sufficient Data ^[1]	Sites with Discrepancies from Reports	Type of Discrepancies	Resolution of Discrepancies
Baseload	20	12	4	No LED bulbs installed	LED bulbs installed
				No LED nightlight installed	LED nightlight installed
				No aerator installed	Aerator installed
				No showerhead installed	Showerhead installed
Low-Cost	21	9	3	No LED bulbs installed	LED bulbs installed
				No aerator installed	Aerator installed
				No smoke detector installed	Smoke detector installed
				No smart strip installed	Smart strip installed
Full-Cost	2	1	1	No LED bulbs installed	LED bulbs installed
				No smart thermostat installed	None
				No pipe insulation invoiced or initially installed	Pipe insulation installed

^[1] Sufficient data indicates the record has complete information in # Invoiced, # Installed, and the ICSP's inspection general survey questions 1-9.

L.2 Process Evaluation

L.2.1 Process Evaluation Methodology

Program Staff and ICSP Interviews

In March through April of 2017, Cadmus conducted three interviews with the WRAP managers from PPL Electric Utilities and the ICSP. The interviews focused on assessing the program's implementation, implementation changes, program marketing, and program uptake.

Market Actor Interviews: Multifamily Building and Manufactured Home Park Property Managers

In PY8, Cadmus conducted interviews with all three property managers of master-metered multifamily buildings and one property manager of the only manufactured home park that participated in WRAP. The objectives of these interviews were to understand how PPL Electric Utilities delivered the program

to its clients; ascertain market actors' satisfaction with the ICSP, PPL Electric Utilities, and the program overall; and solicit any suggestions for improvement.

Trade Ally Interviews: Contractors Delivering WRAP services

Cadmus conducted interviews with all four contractors who support delivery of the WRAP. The objectives of these interviews were to understand how contractors assist in program implementation; their satisfaction with the ICSP, PPL Electric Utilities, and the program overall; and where they see areas for improvement.

Participant Surveys

Cadmus conducted telephone surveys with program participants to assess program satisfaction. Cadmus administered the telephone survey in July 2017 and achieved a 5% response rate among 1,650 phone records attempted. To prepare the contact list, Cadmus removed records of anyone who had completed a PPL Electric Utilities or Cadmus survey in the past three months and attempted to contact the remaining records.

Potential sources of bias in the surveys include nonresponse, recall, and social desirability biases. Cadmus 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.

PPL Electric Utilities provided survey contact instructions for conducting surveys. Customers could not be contacted for a survey if they had completed a PPL Electric Utilities or Cadmus survey in the past three months, had opted out of a survey, or had asked not to be contacted again. Telephone survey calls could not take place on Sundays or national holidays.

See *Section The master-metered multifamily property managers were asked why they chose to participate in the WRAP*. All three said they wanted to save energy and reduce operating costs. One wanted to replace old equipment, even though this is not part of the program, because of the quality of the product provided through the WRAP. They all said the main barrier to additional program participation was that tenants did not fully understand the program. They thought providing in-person education sessions to master-metered multifamily building tenants instead of seminars would be more productive since the attendance was very low for the seminars. (See *Section Suggested Program Improvements*.)

Sample Cleaning and Attrition for Participant Surveys for sampling cleaning and attrition.

L.2.2 Additional Findings

This section includes additional survey and interview findings.

Program Delivery

Overall, WRAP had a slow start, summarized in the issues mentioned in this section. However, as indicated by PPL Electric Utilities during in-depth interviews, changes in the implementation method in Phase III could result in positive long-term outcomes, and provide more WRAP jobs for a lower cost.

Transition from Phase II to Phase III. PPL Electric Utilities transferred program management from PPL Electric Utilities' internal administration to a new ICSP and changed the implementation methods. The program did have a slow start in PY8, getting organized with the transition. Phase III started with a wait list of customers who were not treated in Phase II (PY7). In PY8, WRAP achieved significant participation for all job types except full-cost. PY8 had only seven full-cost jobs; by contrast to PY7, which had 359 full-cost jobs or about 10% of Act 129 WRAP jobs. However, in moving to Phase III, the ICSP said that the PPL Electric Utilities internal system that assigned WRAP jobs to Act 129 and to PPL Electric Utilities' Low Income Usage Reduction Program (LIURP) was designed to assign electrically heated homes to LIURP for treatment.

During interviews, all four WRAP contractors said the transition from Phase II to Phase III WRAP caused some logistical issues during program launch and a delay in the start date by one or two months. One contractor said this made the program feel rushed while all parties were refining processes. Three contractors were concerned that some customers did not get necessary services and that the program missed some of the most vulnerable customers. The contractors said that, after the program began, the ICSP did get everything running as intended.

Low Participation. Low program participation was mentioned as a possible risk in the EE&C plan and PY8 ended with 2,718 completed jobs.¹³⁵ Although PY8 participation was not substantially lower than PY7 participation (3,585 completed jobs),¹³⁶ it was much lower than the 7,000 low-income WRAP participants needed each year to achieve approximately 35,000 participants during Phase III. However, there were 1501 jobs completed in PY8 contributing about 1800 MWh/yr that were not entered into the database in time to include in PY8 reports. These jobs will be included in PY9 reports.

Scheduling. In PY8, the ICSP said scheduling was the main challenge for the WRAP because of the high number of cancellations for its site visits. This is partially because the ICSP is required to schedule work during normal business hours. The ICSP said that scheduling site visits outside of normal business hours—with the approval of PPL Electric Utilities—could help to overcome some scheduling challenges in PY9.

Marketing. The marketing initiative also did not obtain a strong response in the beginning of PY8, so PPL Electric Utilities improved the design and language of marketing materials used for the rest of the program year. PPL Electric Utilities also increased the number of postcards sent to customers and

¹³⁵ PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016..

¹³⁶ PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016. Pg. 245

diversified the marketing methods to increase leads. It made the application process easier by accepting applications over the phone.

Multifamily and manufactured homes. Previously, WRAP applied only to individually metered homes. Starting with Phase III, WRAP includes master-metered multifamily buildings and the manufactured home park initiative. Property managers were asked who made the decision to participate in the WRAP. All three master-metered multifamily property managers said they made the decision along with the board of directors, showing that outreach to key individuals in property management can be an effective method to increase program participation. One property manager said there was some initial confusion as to what counted as master-metered versus individually metered. This property manager wanted more education at the beginning and more clear communication from PPL Electric Utilities.

In contrast, the single manufactured home park property manager said residents could choose to participate but that the property manager was still an important source of information for residents and should be kept as the program's primary point of contact. Of the roughly 300 residents at the park, 120 agreed to participate. The property manager said residents were generally interested in WRAP. There was some confusion when WRAP started in the park, however, because similar work had been done through PPL Electric Utilities or the county in the last few years so not all residents qualified for WRAP.

Data collection. Another change from PY7 to PY8 was to the data collection process employed by the ICSP. In PY8, data collected in the field for all Act 129 jobs were recorded in a tablet-based application. All four contractors said the application was well-suited to baseload jobs, specifically that it gave good directions to contractors, was easy to use, and flowed well. However, all contractors said the tablet application had some issues. After submitting data, they could not go back and review data. Because of this, two contractors made paper records so they would know what work had been done and could answer any questions if customers called back. One contractor said the application was not designed for full-cost jobs, for example, not having enough specifics for certain items, such as the R-value for attic insulation. Therefore, the contractor added as much detail as possible in the small notes section. Another contractor said data could only be saved locally, and sometimes the tablet lost data before it could be uploaded. Finally, contractors said invoice tracking needed improvement because they received no documentation after jobs were completed.

Communications. All four contractors said they had issues communicating with the ICSP, especially about overscheduling and, because of the ICSP's apparent lack of knowledge about the service area, not scheduling jobs in a logical geographically grounded order. One contractor reviewed the schedule weekly and provided suggestions but said schedulers were hard to reach and this feedback was not well received. Lastly, two contractors said it was hard to find the right person at the ICSP to address issues; one contractor eventually figured out the correct contacts but thought this should have been made clear from the beginning. Another said communication was adequate when speaking to higher-level staff but broke down at lower levels.

All four property managers interviewed also reported issues with communication and scheduling work. One said he had to call back multiple times before hearing from the ICSP. Property managers for master-

metered multifamily buildings said scheduling issues affected WRAP participants—some did not receive notices of schedule changes or receive follow-up calls. One property manager said some contractors cancelled or changed schedules within the 48-hour limit, which was not enough notice.

Customers and contractors were also affected by a lack of detail in communication protocol. Two of the four contractors interviewed said some customers were confused about what work was done through the WRAP and had different expectations about what the contractor would deliver.

Key Performance Indicators

PPL Electric Utilities and the ICSP defined plans for energy savings for the WRAP and set customer satisfaction metrics. The program’s performance plans for this metric in PY8 is shown in Table L-166.

Table L-166. PY8 WRAP Key Performance Indicators

Key Performance Indicator	Metric	Goal	PY8 Result
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.	Met KPI. 57% of participants said they were <i>very satisfied</i> and 23% said <i>somewhat satisfied</i> with the program.

Logic Model Review

Cadmus reviewed the logic model and determined that, overall, the WRAP is operating as expected. However, outputs produced by program activities were lower than anticipated, which is also discussed in the EE&C plan, projected as a possible risk for the WRAP.¹³⁷ Certain program activities, especially energy education, have potential for improvement. Table L-167 shows the program logic model’s expected and actual outcomes.

Table L-167. Winter Relief Assistance Program Logic Model Review

Topics	Planned Outcome	PY8 Outcome
Marketing and referrals from other low-income programs (Act 129 and Universal Services) identify participants, establish participants’ eligibility and conduct energy audits and measure-eligibility assessments, and include the installation of energy-efficient equipment, provide energy education, and generate referrals to other organizations for participant households.	Program Activities	Generally delivered program activities as expected.
ICSP enrolls income qualified participants, completes audits, installs energy saving products, and clients served.	Outputs Produced by Program Activities	Participant enrollment, installation of energy saving products, and number of clients served in PY8 was lower than anticipated.

¹³⁷ PPL Electric Utilities’ revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania PUC on December 5, 2016.

Topics	Planned Outcome	PY8 Outcome
Increase program awareness, install energy-efficient equipment in participant homes, increase participant knowledge of energy efficiency and conservation, and provide access to other needed services.	Short-Term Outcomes	Produced short-term outcomes, though at lower levels than anticipated.
Energy savings accrue from participant households through installation of efficient equipment.	Intermediate Outcomes	Program on track to meet intermediate outcomes.
Energy savings continue to result from energy-efficient equipment upgrades and conservation behaviors in the participating low-income population.	Long-Term Outcomes (end of Phase III)	Program on track to meet long-term outcomes; to be assessed at the end of Phase III.

Process Flow Map Review

Cadmus reviewed the process flow maps developed by the ICSP to determine whether the program was implemented as designed or evolved from the original plan. Cadmus concluded that the process flow maps reflected the WRAP and did not need an update.

Participant Satisfaction

Telephone surveys asked WRAP participants about their satisfaction with the program. Results are reported in this section, by job types. Because respondents could skip questions they did not want to answer, not all respondents provided an answer to every question. The number of participants responding is indicated.

When asked about their overall satisfaction with the WRAP, 57% of all survey respondents who replied to the question (n=86) said they were *very satisfied* with the WRAP. An additional 23% rated their satisfaction as *satisfied*. These relatively high levels of satisfaction were consistent with contractors' and property managers' statements about residents' reactions to the WRAP. The manufactured home park property manager said some customers were confused about why they did not receive the same measures as other customers, which led to some frustration with the program.

When asked how the WRAP could be improved, 22% of customers (n=81) suggested improving communication about program expectations and following up in a timely manner. Suggested program improvements are covered in detail in the *Suggested Program Improvements Section*.

Sixty-three percent of low-cost job recipients (n=41) were *very satisfied* with the WRAP, a 15% point decrease from PY7 (78% were *very satisfied*; the difference was not statistically significant).¹³⁸ Baseload job recipients (n=44) followed the same trend, with 52% *very satisfied* in PY8 compared to 63% in PY7,¹³⁹ a decrease of 11% points, but the difference was not statistically significant.¹⁴⁰ As discussed in the

¹³⁸ This difference was tested using a two-tailed z-test, and is not significantly different at the 90% confidence interval.

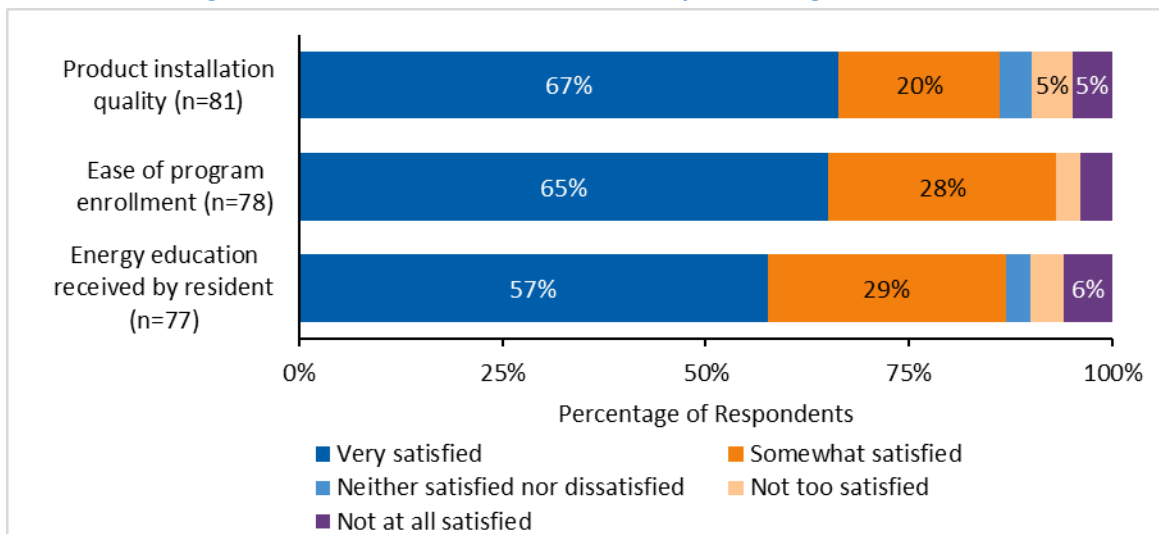
¹³⁹ PPL Electric Utilities. Annual Report Program Year 7: June 1, 2015–May 31, 2016. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016.

¹⁴⁰ This difference was tested using a two-tailed z-test, and is not significantly different at the 90% confidence interval.

Suggested Program Improvements Section, customers had issues with program expectations, which is consistent with PY7, and program communication, a more prominent issue for PY8. The single full-cost job recipient said the energy audit and new items were not helpful. PY8 results are shown in Figure L-78.

Participants were also asked about their satisfaction with specific program elements and how important they were, specifically the quality of products installed, ease of the enrollment process, and energy education received from the contractor. As discussed in the *Energy Education Section*, some improvements could be made to help customers better understand the program. Satisfaction results are consistent across job types, meaning PPL Electric Utilities could consider these improvements at the program level.

Figure L-78. Customer Satisfaction with Specific Program Elements



Source: Survey Question "Thinking about the same items, please indicate how satisfied you are with each one."

Net Promoter Score

The net promoter score (NPS) is a metric of brand loyalty by specifically measuring how likely customers are to recommend the program to others. Respondents rate their likelihood to recommend the program on a 10-point scale where 0 means "not at all likely" and 10 means "extremely likely." Respondents giving a rating of 9 or 10 are known as promoters, respondents giving a rating of 7 or 8 are known as passives, and respondents giving a 0 to 6 rating are known as detractors. The NPS is expressed as a number between -100 and +100 that represents the difference between the percentage of promoters and detractors.

As shown in Table L-168, the WRAP achieved a NPS of +48, indicating more promoters than detractors among the respondents. Addressing the issues described in the *Suggested Program Improvements Section* will help to move detractors and passives into the promoters category.

Table L-168. Customer Net Promoter Score. Likelihood to Recommend the Program

Rating Classification	Percentage of Respondents (n=81)
Promoters (9-10)	65%
Passives (7-8)	17%
Detractors (0-6)	17%
NPS	+48

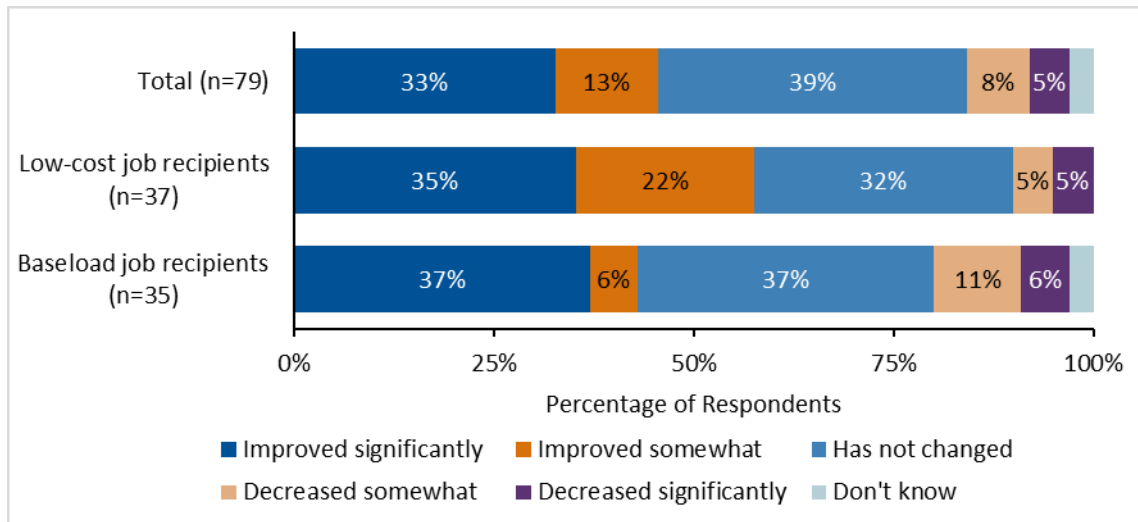
Multifamily property managers were also asked about their likelihood to recommend the program. All three property managers gave a rating of 10.

Opinion of PPL Electric Utilities

Participants were asked how participating in the WRAP affected their opinion of PPL Electric Utilities (Figure L-79). The percentage of participants who said their opinion had *improved significantly* increased from 26% in PY7 to 33% in PY8. The opinion of PPL Electric Utilities (in PY8) increased more among low-cost job recipients (57%, 21 out of 37) compared to baseload job recipients (43%, 15 out of 35).

Ten participants (13%, n=79) said their opinion of PPL Electric Utilities decreased (*somewhat* or *significantly*), with seven citing communication issues. Specifically, five of these customers cited the lack of follow-up with the program representatives and two cited a long lead time to get work done. The other three participants said they were not happy with the quality of the installed products. Fixing communication issues and improving education around the installed products would help to diminish these concerns.

Figure L-79. Change in Opinion of PPL Electric Utilities



Source: Survey Question “After participating in the PPL Electric Utilities WRAP Program, has your opinion of PPL Electric Utilities...”

Contractor Satisfaction

Of the four contractors interviewed, one was *very satisfied*, one was *somewhat satisfied*, and two were *neither satisfied nor dissatisfied*. As discussed in *Program Delivery Section*, the largest issue concerned data collection.

Property Manager Satisfaction

Overall, two property managers said they were *very satisfied* with the program and two said they were *somewhat satisfied*. Property managers were generally satisfied with the various program elements. Two elements received ratings of *very satisfied*: the contractors' interaction with their tenants (n=4) and the products installed in tenants' apartments (n=3). The quality of the contractor work received one rating of *very satisfied* and one of *somewhat satisfied*. The only element that received a rating lower than *somewhat satisfied* was the energy audits; one property manager did not find the energy audit particularly helpful and said it did not reveal many new ways to save energy.

Suggested Program Improvements

Participants (n=81) were asked what they would change about the program. Most had no suggestions for improvement but some mentioned communication, particularly the explanation of the WRAP and the work involved. Seven participants said program representatives did not accurately represent the work that would be done. Three had different expectations of what the program would cover from their initial conversation with program representatives to when the work was done.

One of the four interviewed contractors also said some customers had different expectations, and another suggested that PPL Electric Utilities could strive to explain more clearly what the program is, and what is offered. One property manager of four interviewed said residents did not fully understand the program's benefits until they talked with the contractor, suggesting that more personal contact would help clarify the intent of the program.

The second area for program improvement was scheduling. Ten participants said it took a long time to schedule a contractor visit. This is likely due to the Phase II backlog with which that the program started. Now that the backlog is caught up, PPL reports the time between scheduling to completed work is now about 36 days on average.

All four contractors said they had issues with scheduling, specifically that schedules were not optimally routed and were difficult to change. Noted by the ICSP, this may be due in part to cancellations and no-shows.

One customer and two property managers requested that the program representatives and/or contractors speak Spanish.

Participants were asked how the auditors could have improved their experience. Of 81 participants, 27% said that the auditors could have provided more information about other energy efficiency programs offered by PPL Electric Utilities, 22% said they could have provided more tips on ways to save energy, and 7% said they could have been more professional.

Marketing and Outreach

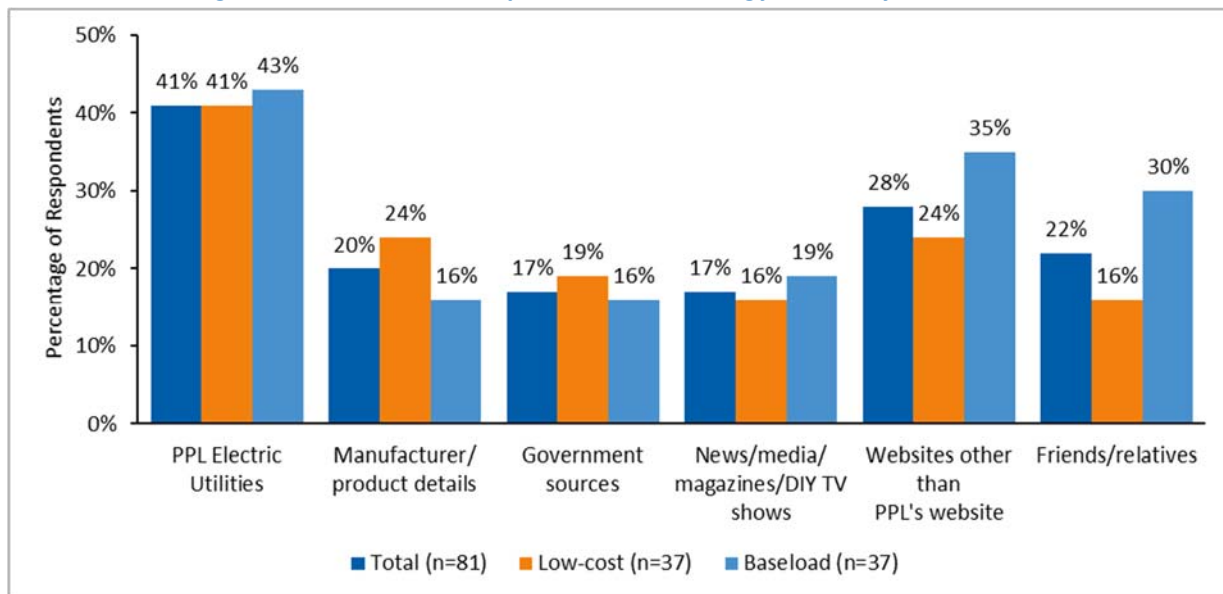
Of the four multifamily property managers, two found out about the WRAP from other building managers, one from Franklin Energy (the ICSP’s subcontractor), and one from a community-based organization. Property managers preferred to be informed about PPL Electric Utilities’ programs by word of mouth, email, and through community-based organizations. PPL Electric Utilities could take advantage of these communication channels in PY9 to increase program awareness.

All four multifamily property managers said tenants were notified of the WRAP by leaving a flyer on the door.

The manufactured home park property manager said they gave contractors permission to go door to door, but residents thought the contractors were trying to sell them something so they were wary of the program. The manufactured home park property manager thought the best way to notify residents was through management because the communication came from a trusted source.

Prior to receiving Cadmus’ survey, only 43% of participants (n=81) said they were aware that PPL Electric Utilities provided the funding for the WRAP. This was slightly higher among low-cost job participants (49%, n=37) than among baseload job participants (41%, n=37), but this difference is not statistically significant.¹⁴¹ Participants (n=81) were asked where they look for energy efficiency information (Figure L-80). Participants were also asked how they wanted to receive energy efficiency information; 59% said through a bill insert or newsletter and 19% said in an email from PPL Electric Utilities.

Figure L-80. Where Participants Look for Energy Efficiency Information



Source: Survey Question “Where do you look for information about energy efficiency or ways to save energy?”

¹⁴¹ Cadmus tested these proportions using a two-tailed t-test. It was not statistically significant at the 90% confidence level.

Energy Education

During the phone survey, WRAP participants of all job types answered questions about the energy-saving recommendations that the auditor provided during the in-home energy audit. Of 81 phone survey participants, 62% said the auditor discussed actions they could take to improve home efficiency; 41% found the energy education *very useful* and 26% found it *somewhat useful*. However, 16% reported they did not receive any energy education information as part of the WRAP.

Participants were also asked if the auditor could have provided anything additional. Of 17 who said they wished the auditor had provided more information, eight wanted the audit to be more informative in general, four wanted more information about appliances, four wanted to learn more about weatherization, and one wanted the audit conducted in Spanish.

Later in the call, participants answered questions about whether they took steps to save energy at home and, if so, what steps they took. About 39% of participants (n=81) said they had taken such steps. This is much lower than reported in PY7 (94%; n=141).¹⁴² Table L-169 shows the energy-saving actions the respondents took based on the recommendations they received from the auditor, along with the percentage of respondents who reported they took the action.

Table L-169. Energy-Saving Actions Taken by WRAP Participants

Energy Savings Recommendations	Percentage of Respondents
Turn off lights when not in use	22%
Unplug devices when not in use	17%
Wash clothes in cold water	15%
Adjust thermostats	13%
Take shorter or fewer showers	11%
Turn down the temperature on your water heater	10%
Other	4%
Source: Question K6. "Have you taken any energy-saving actions or installed any PPL Electric Utilities-rebated products recommended by the auditor or the Your Home Energy Report?" (n=81)	

The most popular energy-saving step was turning off the lights, followed by unplugging devices when not in use. Steps mentioned in the "Other" category were sealing windows and buying energy-efficient bulbs.

Cadmus asked the three master-metered multifamily building property managers their opinion of the energy education provided by the ICSP's subcontractors. All property managers organized a seminar for their building residents. One property had 100% attendance because the event was required, but at the other two properties only 15% to 20% of the residents attended. These property managers said this was

¹⁴² PPL Electric Utilities. *Annual Report Program Year 7: June 1, 2015–May 31, 2016*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2016. pg. 262

relatively normal and they did not offer ideas about how to improve attendance. All three property managers attended the event and said the explanation of the products and services to be installed was most helpful, especially, according to one, because their residents typically struggle with new things and needed to be introduced to new concepts.

Attitudes Towards and Barriers to Saving Energy

The master-metered multifamily property managers were asked why they chose to participate in the WRAP. All three said they wanted to save energy and reduce operating costs. One wanted to replace old equipment, even though this is not part of the program, because of the quality of the product provided through the WRAP. They all said the main barrier to additional program participation was that tenants did not fully understand the program. They thought providing in-person education sessions to master-metered multifamily building tenants instead of seminars would be more productive since the attendance was very low for the seminars. (See *Section Suggested Program Improvements*.)

Sample Cleaning and Attrition for Participant Surveys

Cadmus coordinated with PPL Electric Utilities' contractor to screen the survey sample and remove any records of customers called in the past three months (for a PPL Electric Utilities or Cadmus survey) or who requested not to be contacted again, any duplicate records, and any with incomplete or invalid information. Cadmus also excluded inactive customers or those who were selected for another survey.

This cleaning and survey sample preparation process reduced the available sample. Cadmus attempted to reach the contact by telephone up to five times over several days, at different times of the day, and scheduled callbacks whenever possible. Table L-170 lists total numbers of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

Table L-170. WRAP Sample Attrition Table for Participant Telephone Surveys

Description of Call Outcomes	Number of Records
Population (number of unique jobs) ^[1]	2,718
Removed: inactive customer, completed survey in past 3 months, on "do not contact" list, opted out of survey, selected for a different survey, duplicate contact, recycled A/C only, large C&I sector	700
Incomplete or bad phone number	368
Survey sample frame (sent to subcontractor for telephone survey calls)	1,650
Not attempted	0
Records attempted (telephone)	1,650
Non-working number	179
Wrong number, business	48
No answer/answering machine/phone busy	1,074
Language barrier	14
PPL Electric Utilities or market research employee	7
Cannot confirm equipment/not aware of participation	31
Refusal	28
Terminated survey	34
Non-specific or specific callback scheduled	154
Partially completed surveys	5
Completed surveys	81
Telephone response rate	5%
^[1] Number of unique jobs available in PPL Electric Utilities' tracking database at the time of the survey effort including base load, full cost, low cost jobs and manufactured home park jobs. PPL Electric Utilities' tracking database did not include contact information for tenants of multifamily properties so they were removed from this contact list.	

Appendix M. Rebate Levels – Energy Efficient Home

Because Cadmus made recommendations regarding rebate levels (see section 10.8.2 *Equipment Component*), rebates are discussed in this appendix. Cadmus found that a large percentage of participants purchased air source heat pumps (79% less than 17.9 SEER) and central air conditioners (96% less than 17.9 SEER) that just met the eligibility requirements, whereas purchases of ductless mini-split heat pumps were more evenly distributed because the program offered higher efficiency tiers.

For new homes, home builders could receive rebates by the amount of energy savings accrued above the 2009 IECC (adopted in Pennsylvania). The Energy Efficient Home Program has two tiers:

- Tier 1 requires the builder to construct homes that are 15% more efficient than the 2009 IECC, as calculated by the RESNET software REM/Rate. This tier offers \$0.30 for every kWh/yr saved.¹⁴³
- Tier 2 requires the builder to construct homes that are 15% more efficient than the 2009 IECC, as calculated by the RESNET software REM/Rate and the home must meet ENERGY STAR requirements. This tier offers \$0.35 for every kWh/yr saved.

For weatherization, participants could receive rebates for attic insulation (75% of cost; up to \$450 for electric heat and up to \$125 for air conditioners and non-electric heat), wall insulation (75% of cost; up to \$450 for electric heat and up to \$125 for air conditioners and non-electric heat), and air sealing (up to \$100, must have 10% minimum improvement).

For fuel switching, participants could receive rebates for natural gas or propane furnace (\$200; AFUE 95, switching from electric to non-electric), oil furnace (\$200; AFUE 85, switching from electric to non-electric), and fossil fuel boiler (\$200; AFUE 85, switching from electric to non-electric).

The rebates available for the equipment component are provided in Table M-171.

¹⁴³ Annual kWh savings are determined by comparing the newly constructed home against a code-minimum (2009 IECC) reference home using REM/Rate software.

Table M-171. PY8 Equipment Rebate Levels

Rebate	Type	Requirements ^[1]	Rebate Amount
Air Source Heat Pump	Single-level	Qualifying ENERGY STAR model, minimum 16 SEER	\$200
Ductless Mini-Split Heat Pump	Tiered	Qualifying ENERGY STAR model; Levels: (1) minimum 16 SEER; (2) minimum 17 SEER; (3) minimum 19 SEER	\$100, \$150, or \$200 per 12,000 BTU/hour
Air Conditioner	Single-level	Qualifying ENERGY STAR model, minimum 16 SEER	\$150
Heat Pump Water Heater	Tiered	Levels: (1) EF 2.3-2.74; (2) EF 2.75+	\$300 or \$400
Refrigerator	Single-level	ENERGY STAR certified model	\$35
Smart Thermostat – Self Installation	Single-level	ENERGY STAR certified model, homes must have electric heating as main heating source	\$50
Smart Thermostat – Contractor Installation	Single-level	ENERGY STAR certified model, homes must have electric heating as main heating source	\$100
Pool pump	Single-level	ENERGY STAR certified model, variable speed, must replace existing single-speed pool pump, must be for in-ground pool	\$350
^[1] Only SEER requirements are reported. Although there are also HSPF and EER minimum requirements for some equipment, that information was not included to avoid overcomplicating the table.			