

PPL Electric Utilities Annual Report to the Pennsylvania Public Utility Commission

**PHASE III OF ACT 129 PY12 ANNUAL REPORT
(JUNE 1, 2020 – MAY 31, 2021)**

**FOR PENNSYLVANIA ACT 129 OF 2008
ENERGY EFFICIENCY AND CONSERVATION PLAN**



Prepared by:
Cadmus

Prepared for:
PPL Electric Utilities

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Acronyms

AHRI	Air Conditioning, Heating, and Refrigeration Institute
AMI	Advanced Metering Infrastructure
C&I	Commercial and Industrial
CDD	Cooling Degree Day
CEI	Continuous Energy Improvement
CF	Coincidence Factor
CHP	Combined Heat and Power
C.L.	Confidence Limit
CSP	Conservation Service Provider or Curtailment Service Provider
Cv	Coefficient of Variation
DLC	DesignLights Consortium
DR	Demand Response
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE&C	Energy Efficiency and Conservation
EFLH	Equivalent Fuel Load Hours
EM&V	Evaluation, Measurement, and Verification
EISA	Energy Independence and Security Act
EUL	Effective Useful Life
GNE	Government, Nonprofit, Educational
HDD	Heating Degree Day
HER	Home Energy Report
HIM	High-Impact Measure
HOU	Hours of Use
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
IMP	Interim Measure Protocol
IPMVP	International Performance Measurement and Verification Protocol
ISR	In-Service Rate
kW	Kilowatt
kWh	Kilowatt-hour
KPI	Key Performance Indicator
LED	Light-Emitting Diode
LIURP	Low-Income Usage Reduction Program
M&V	Measurement and Verification

MW	Megawatt
MWh	Megawatt-hour
NPV	Net Present Value
NTG	Net-to-Gross
N/A	Not Applicable
O&M	Operations and Maintenance
P3TD	Phase III to Date
PA PUC	Pennsylvania Public Utility Commission
PAC	Program Administrator Cost
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
SKU	Stock Keeping Unit
SWE	Statewide Evaluator
T&D	Transmission and Distribution
tLED	Tubular LED
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 electric distribution company (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).
- **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.



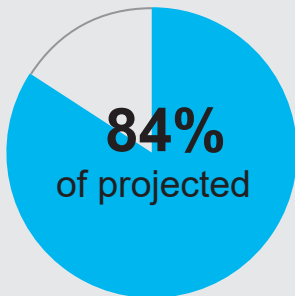
PORTFOLIO COMPLIANCE TARGETS

PPL Electric Utilities offers nine energy efficiency programs to non-residential, residential, and income-eligible customers.

VERIFIED ENERGY SAVINGS

Phase III
has saved
1,749,311 MWh/yr

121%
of the compliance
target

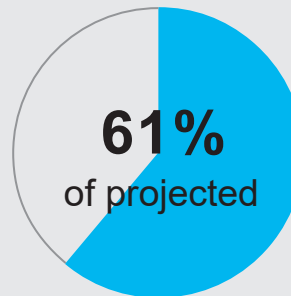


PY12
has saved
246,184 MWh/yr

LOW-INCOME VERIFIED ENERGY SAVINGS

Phase III
has saved
110,456 MWh/yr

139%
of the compliance
target

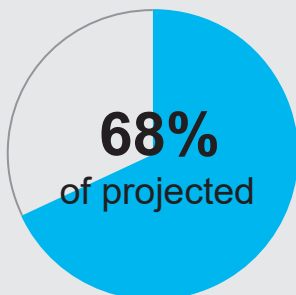


PY12
has saved
10,852 MWh/yr

GNE VERIFIED ENERGY SAVINGS

Phase III
has saved
225,541 MWh/yr

447%
of the compliance
target



PY12 saved
37,111 MWh/yr

DEMAND RESPONSE VERIFIED DEMAND REDUCTIONS

Phase III
has saved
113 MW/yr

123%
of the compliance
target



PY12 saved
97 MW/yr

PORTFOLIO SATISFACTION, PARTICIPATION, AND EXPENDITURES

PY12 PARTICIPATION

A total of **73,351** participants



118 Demand Response



32,975 Low-Income



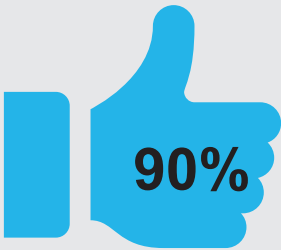
8,236 Non-Residential



32,022 Residential

Low-Income program total includes low-income sector participants in the Home Energy Education and Student Energy Efficient Education programs

PROGRAM SATISFACTION



Satisfied with overall program

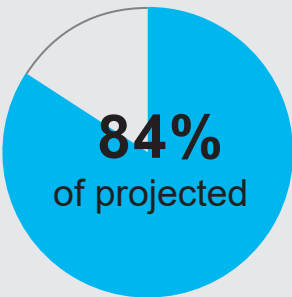
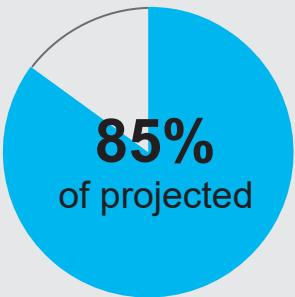
97% satisfied with Low-Income programs

91% satisfied with Non-Residential programs

88% satisfied with Residential programs

EXPENDITURES

Phase III
expenditures
\$264,827



PY12
expenditures
\$47,395

PARTICIPANT COMMENTS



"It was great for me. I really appreciated that my contractor knew how to maximize rebates and facilitated that for me."

"[They] helped us [with a] major efficiency improvement. [I] noticed [a] change in [energy] bills..."

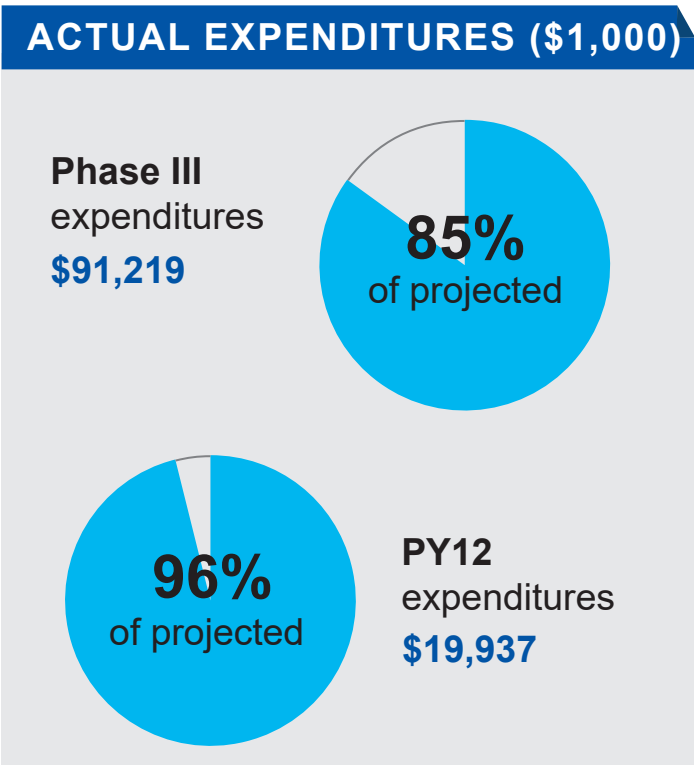
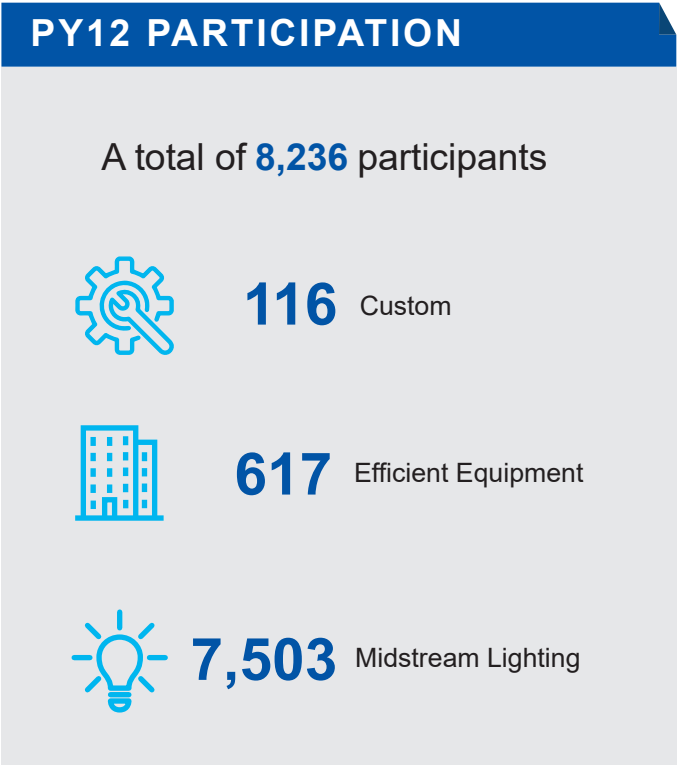
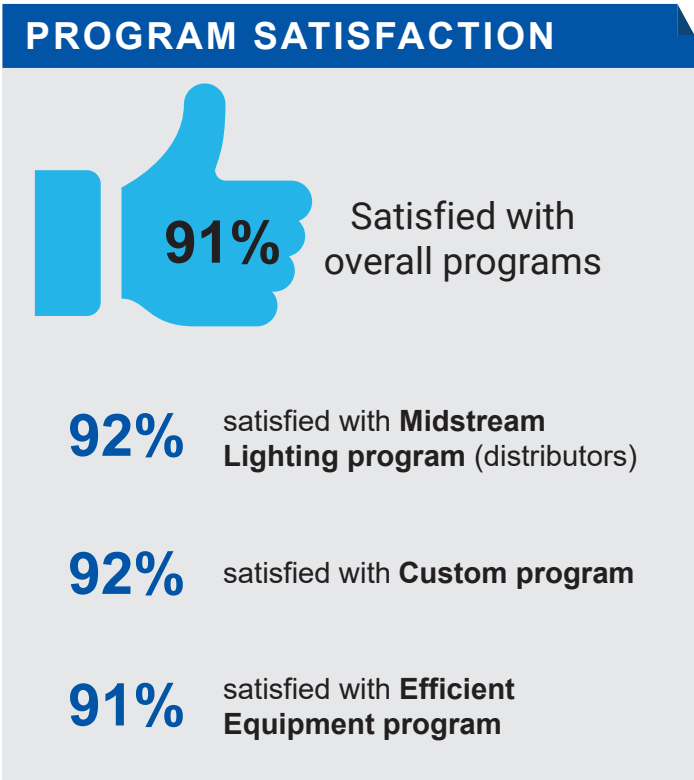
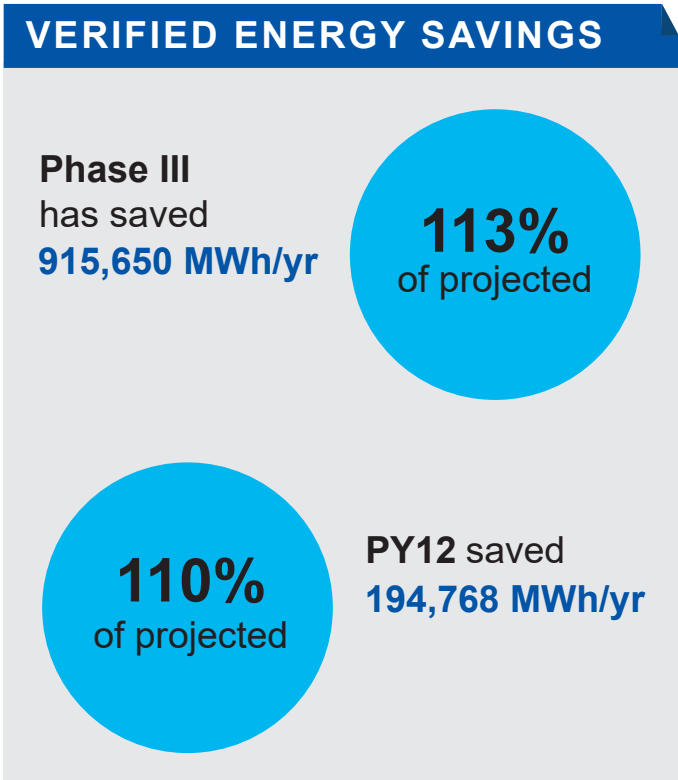


"[The] program was great. I had a couple of questions pertaining to submitted information. I called the number provided and my questions were answered. [There were] very helpful people on PPL [Electric Utilities] end."



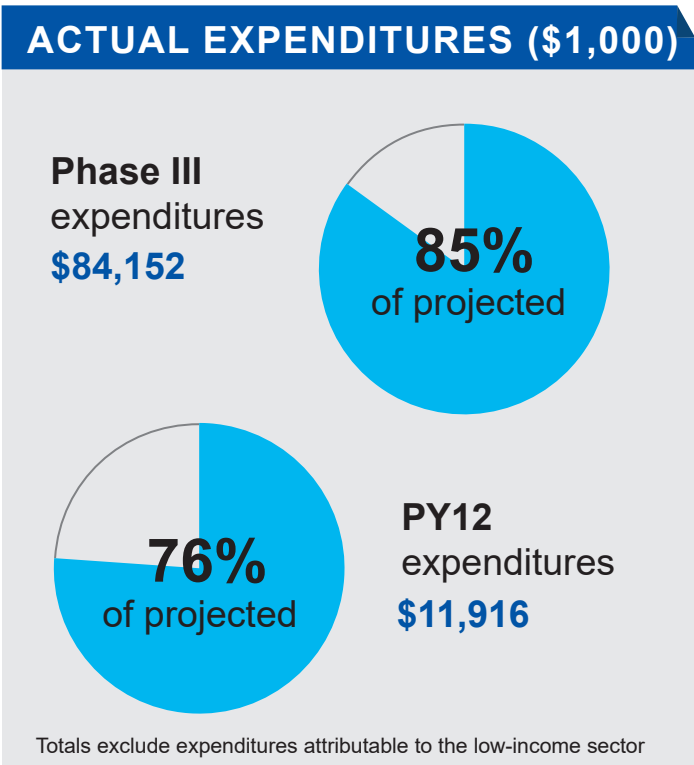
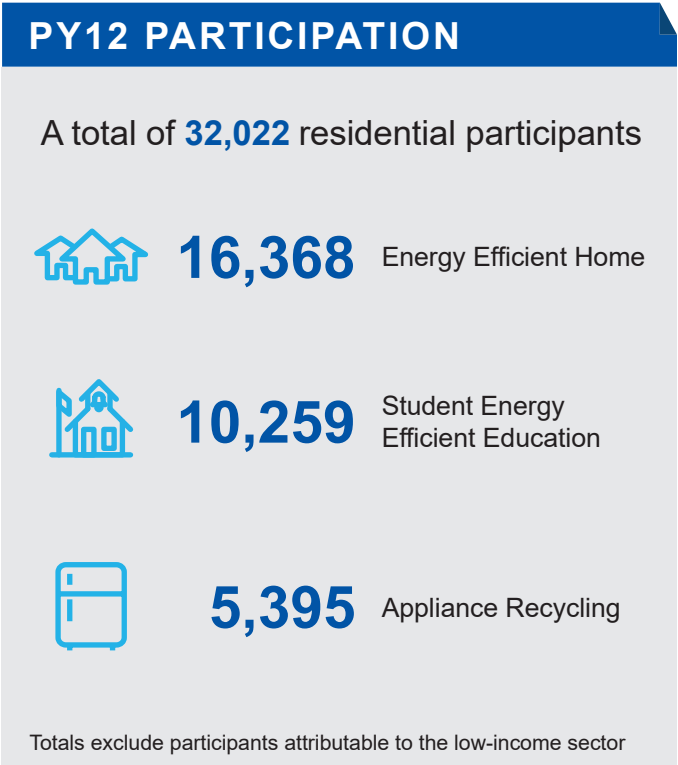
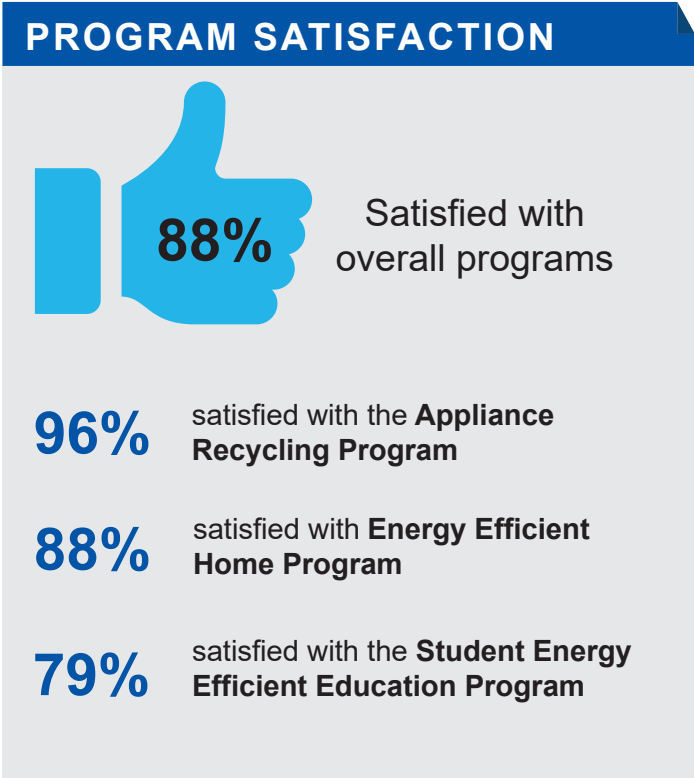
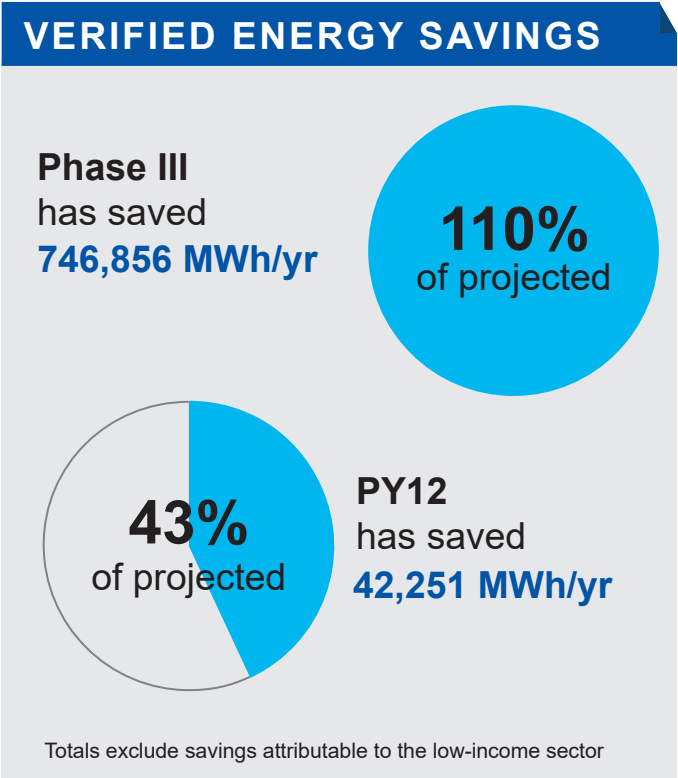
NON-RESIDENTIAL ENERGY EFFICIENCY PROGRAM

Three non-residential programs offer financial incentives to customers in a non-residential rate class.



RESIDENTIAL PROGRAMS

Residential customers participate in five programs to recycle inefficient appliances, purchase rebated efficient equipment and discounted lighting, receive home energy reports with tips to save energy, and to educate students about energy efficiency.



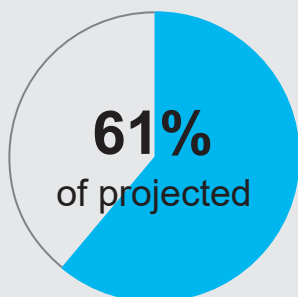
LOW-INCOME PROGRAMS

Low-income programs include two dedicated income-eligible programs that deliver energy education and energy-saving products and services and two additional programs that serve the income-eligible community.

VERIFIED ENERGY SAVINGS

Phase III
has saved
110,456 MWh/yr

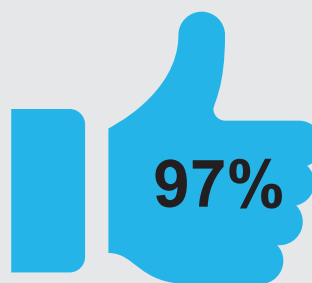
139%
of the compliance
target



PY12 saved
10,852 MWh/yr

Totals include low-income savings from Home Energy Education and Student Energy Efficient Education programs

PROGRAM SATISFACTION



Satisfied with
overall program

PY12 PARTICIPATION

A total of **32,975** participants



5,379 Winter Relief
Assistance Program



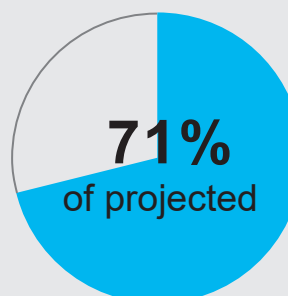
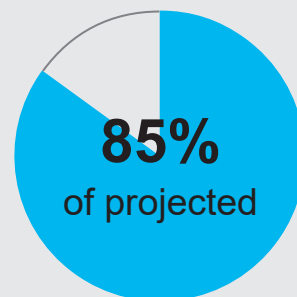
14,944 Home Energy Education
Income-Eligible Home
Energy Reports



12,652 Student Energy Efficient
Education
Income-Eligible Schools

ACTUAL EXPENDITURES (\$1,000)

Phase III
expenditures
\$43,406



PY12
expenditures
\$5,997

Total expenditures includes low-income expenditures for the Home Energy Education and Student Energy Efficient Education programs

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 ran until May 2021 (five program years—PY8 to PY12). This report documents the progress and effectiveness of the Phase III EE&C accomplishments for PPL Electric Utilities in the last program year of Phase III, Program Year 12 (PY12, June 2020–May 2021), as well as the cumulative accomplishments of the Phase III programs since inception (June 2016–May 2020).

This report details the participation, spending, reported gross savings, verified gross savings, and verified net savings impacts of the energy efficiency programs in PY12. 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 (TRC) test.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 limited process evaluation for selected programs 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 impact and process evaluations, and documents PPL Electric Utilities' consideration of recommendations.

1.1 Executive Summary

PPL Electric Utilities has continued to successfully implement the Phase III Act 129 programs in PY12. Programs are operating effectively and are meeting or surpassing program objectives. Cadmus does not suggest any major course corrections. Recommendations suggest minor fine tuning and possible areas of inquiry in future years.

PPL Electric Utilities exceeded the Phase III cumulative projected estimate of 1,587,984 MWh/yr, achieving 1,749,311 MWh/yr in verified savings, or 110% of projections for the phase shown in

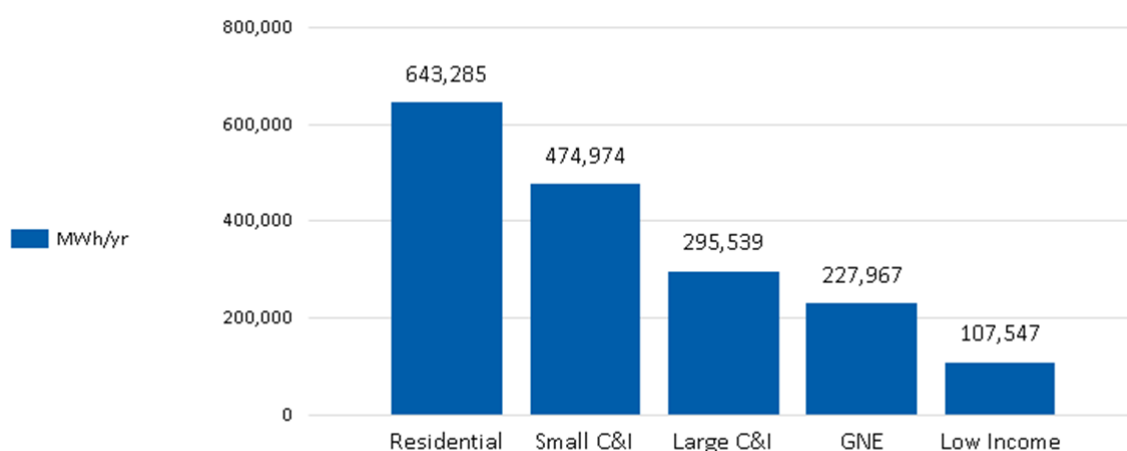
¹ The Pennsylvania TRC Test for Phase I was adopted by PUC order at Docket No. M-2009-2108601 on June 23, 2009 (2009 PA TRC Test Order). The TRC Test Order for Phase I was later refined in the same docket on August 2, 2011 (2011 PA TRC Test Order). The 2013 TRC Order for Phase II of Act 129 was issued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

PPL Electric Utilities' EE&C plan.² PPL Electric Utilities has also achieved 121% of the Phase III overall compliance target of 1,443,035 MWh/yr.

PPL Electric Utilities has exceeded the compliance target for the low-income and government, nonprofit, education (GNE) sectors. PPL Electric Utilities has achieved 139% of the Phase III low-income verified gross energy savings target of 79,367 MWh/yr. It has achieved 447% of the Phase III GNE verified gross energy savings target of 50,507 MWh/yr and began placing GNE projects on a waitlist in January 2018.

Figure 1-1 shows PPL Electric Utilities' Phase III verified savings by sector—residential, small commercial and industrial (C&I), large C&I, GNE, and low-income.

Figure 1-1. Phase III Verified Savings by Sector



Note: Total residential sector verified MWh/yr has been adjusted to account for Home Energy Education Program savings uplift. May not sum to total due to rounding.

PPL Electric Utilities delivered programs for 85% of the Phase III cumulative projected budget estimated in the EE&C Plan, expending \$264,827,482. The acquisition cost in PY12 and Phase III is \$0.19 and \$0.15 per annual kWh, respectively (EDC expenditures/first-year savings). The portfolio-level PY12 total cost of conserved energy (TRC costs/net present value [NPV] lifetime kWh, at generation) is \$0.047. The portfolio-level PY12 utility cost of conserved energy (program administrator cost [PAC]/NPV lifetime kWh, at generation) is \$0.026. The TRC includes PPL Electric Utilities' costs as well as the customers' costs. The PAC includes only PPL Electric Utilities' costs.

A portfolio is cost-effective when the TRC benefit-cost ratio exceeds 1.0. The PY12 and phase-to-date portfolio is cost-effective, with a portfolio-level TRC of 1.69 and 1.62, respectively.

The evaluated net-to-gross (NTG) ratio, including spillover attributable to some programs, is 0.68. Program offerings do not need modification to address free ridership.

² PPL Electric Utilities revised *Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642. November 2018.

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 sectors showed high levels of satisfaction with the programs. With the combined *very satisfied* and *somewhat satisfied* responses, portfolio satisfaction for PY12 is 90% (n=12,053), consistent with PY11 results of 93% (n=20,068).⁴

In PY12, the low-income programs achieved customer satisfaction of 97% (n=208), the Non-Residential Program achieved customer satisfaction of 91% (n=93), and the residential programs achieved satisfaction of 88% (n=11,752). All three sectors exceeded the customer satisfaction goal of 80%.

³ The customer satisfaction goal is listed in PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed November 2018.

⁴ PPL Electric Utilities. *Annual Report Program Year 11: June 1, 2018–May 31, 2019*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. February 15, 2021.

2 Summary of Achievements

2.1 Carryover Savings from Phase II of Act 129

The PA PUC's Phase III Implementation Order allowed the 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 any carryover savings for the portfolio, but it 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.

2.2 Phase III Energy Efficiency Achievements to Date

Table 2-1 shows the achievements to date since the beginning of PY12 on June 1, 2020. Table 2-2 shows the Phase III achievements to date.

Table 2-1. PY12 Energy Efficiency Achievements to Date

PYTD	Reported Gross Savings (PYRTD)	Verified Savings (PYVTD) ⁽¹⁾	Unverified (PYRTD)	Realization Rate ⁽¹⁾
Energy Savings (MWh/yr) ⁽²⁾	229,309	246,184	-	107%
Peak Demand Reductions (MW/yr) ⁽²⁾	35.20	37.54	-	107%
⁽¹⁾ The verified savings and realization rates in this table have been adjusted to account for energy-savings uplift (double-counting) in the Home Energy Education Program.				
⁽²⁾ Savings may not match other tables or figures due to rounding.				

Table 2-2. Phase III Energy Efficiency Achievements to Date

P3TD	Reported Gross Savings (P3RTD)	Verified Savings (P3VTD) ⁽¹⁾	Unverified (P3RTD)	Realization Rate ⁽¹⁾
Energy Savings (MWh/yr) ⁽²⁾	1,810,935	1,749,311	-	97%
Peak Demand Reductions (MW/yr) ⁽²⁾	304.05	247.66	-	81%
⁽¹⁾ The verified savings and realization rates in this table have been adjusted to account for energy-savings uplift (double-counting) in the Home Energy Education Program.				
⁽²⁾ Savings may not match other tables or figures due to rounding.				

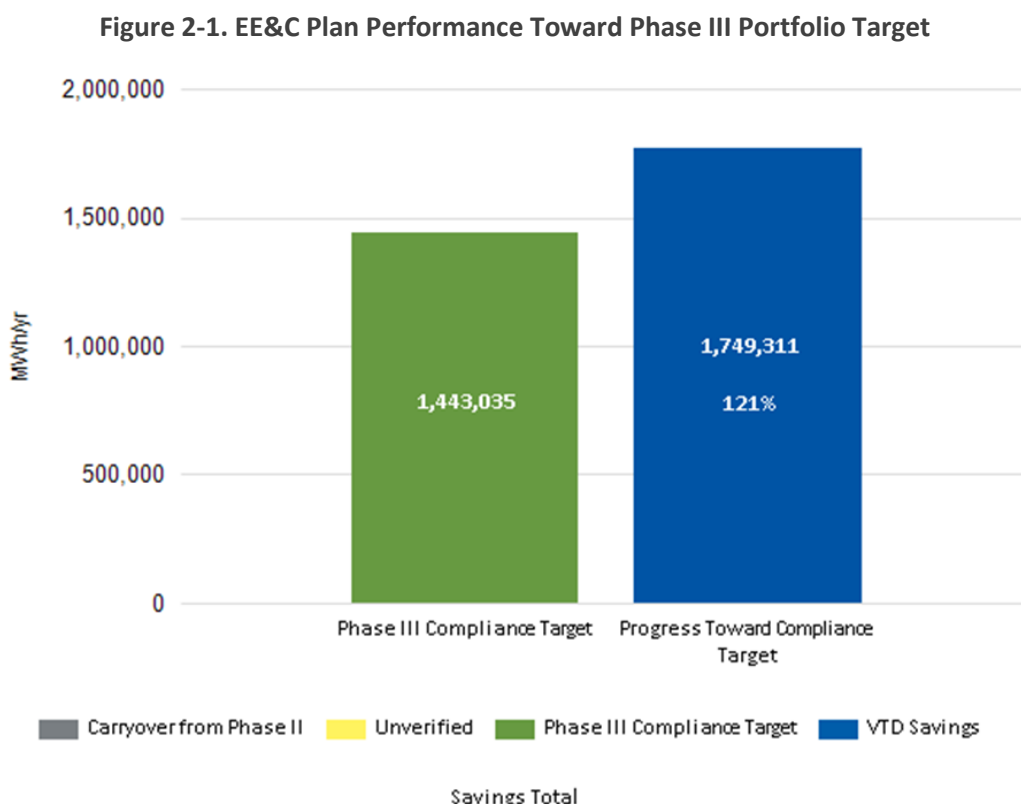
⁵ Pennsylvania Public Utility Commission. Energy Efficiency and Conservation Program Implementation Order, Docket No. M-2014-2424864 (*Phase III Implementation Order*). Entered June 11, 2015.

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.
http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/energy_efficiency_and_conservation_ee_c_program.aspx

Looking ahead to Phase IV, with 1,749,311 MWh/yr of verified-to-date (VTD) energy savings achieved during Phase III, PPL Electric Utilities has achieved an estimated 306,276 MWh/yr of carryover energy savings from Phase III to Phase IV. This represents 24.5% of the Phase IV portfolio savings target (1,250,157 MWh).⁸

Figure 2-1 summarizes PPL Electric Utilities' progress, verified to date (VTD), toward the Phase III portfolio compliance target.



The Phase III Implementation Order directed the EDCs to offer conservation measures to the low-income sector based on the proportion of electric sales attributable to low-income households. For PPL Electric Utilities, the proportionate number of measures targeted is 9.95%.⁹

PPL Electric Utilities offers a total of 132 EE&C measures (products and equipment) to its residential and nonresidential customer classes.¹⁰ It makes 25 measures available to the low-income sector at no cost to

⁸ Pennsylvania Public Utility Commission. *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2020-3015228 (*Phase IV Implementation Order*), entered June 18, 2020.

⁹ Pennsylvania Public Utility Commission. *Phase III Implementation Order*. Docket No. M-2014-242-2424864. June 11, 2015.

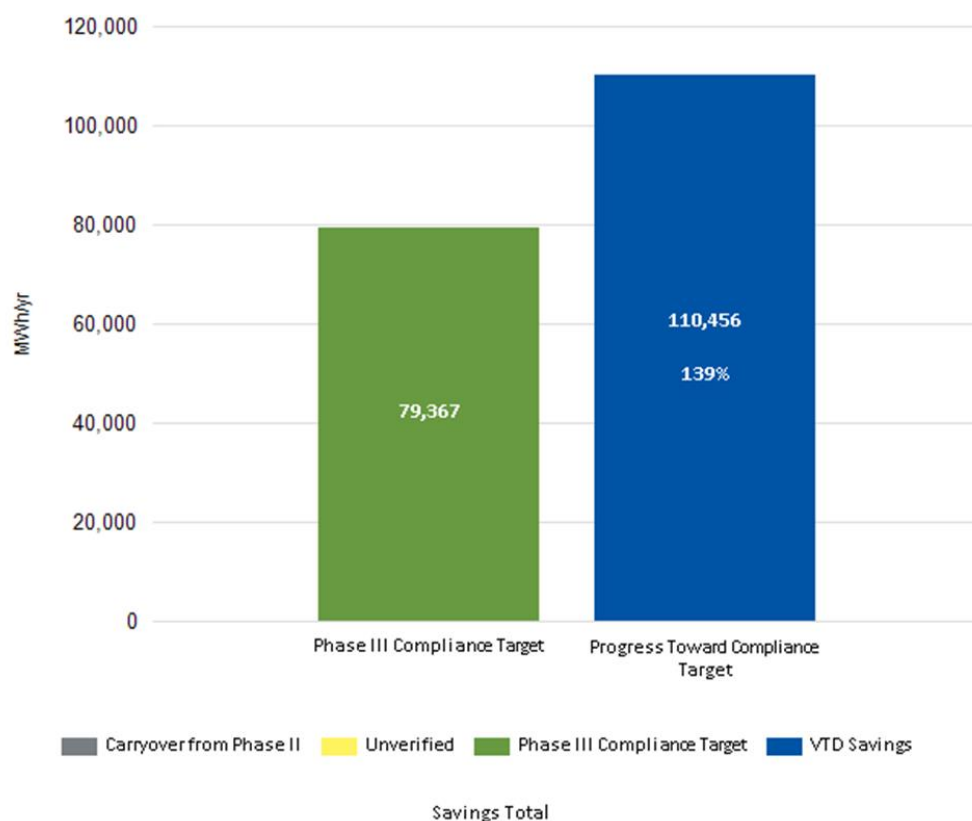
¹⁰ PPL Electric Utilities. *PPL Electric Utilities Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642. November 2018.

the customer, which is 19% of the total number of measures offered in the EE&C plan and exceeds the target of 9.95% for the proportionate number of measures.

The PA PUC also established a low-income energy savings target of 5.5% of the portfolio savings.¹¹ For PPL Electric Utilities, the Phase III low-income savings compliance target is 79,367 MWh/yr of verified gross energy savings. Figure 2-2 compares the VTD performance for the low-income customer sector to the Phase III savings target. Considering verified savings through PY12, PPL Electric Utilities has achieved 139% of the Phase III low-income energy-savings compliance target.

Looking ahead to Phase IV, with 110,456 MWh/yr of VTD low-income energy savings achieved during Phase III, PPL Electric Utilities has achieved an estimated 31,089 MWh/yr of low-income carryover energy savings from Phase III to Phase IV. This represents 42.9% of the Phase IV low-income carveout savings target (72,509 MWh).¹²

Figure 2-2. EE&C Plan Performance Toward Phase III Low-Income Compliance Target



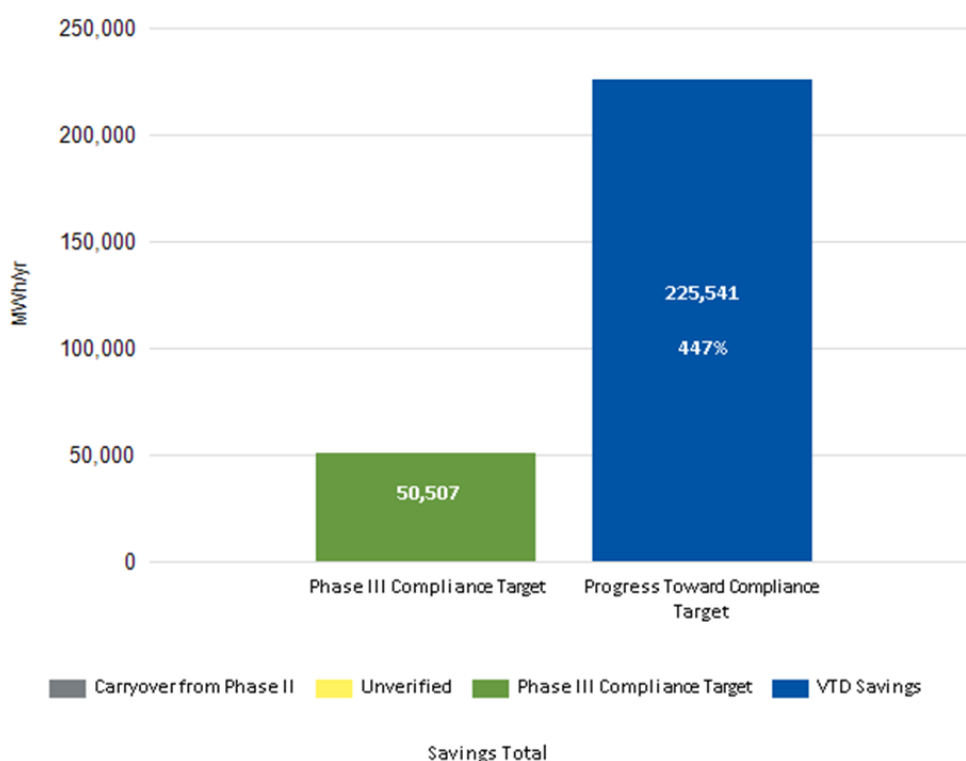
¹¹ Pennsylvania Public Utility Commission. *Phase III Implementation Order*. Docket No. M-2014-242-2424864. June 11, 2015.

¹² Pennsylvania Public Utility Commission. *Energy Efficiency and Conservation Program Implementation Order*, at Docket No. M-2020-3015228 (*Phase IV Implementation Order*), entered June 18, 2020.

The Winter Relief Assistance Program (WRAP) includes savings for multifamily projects that are allocated to the GNE and small C&I sectors based on the rate class of the buildings' meters. All savings from this component of the program are counted toward the low-income compliance target, as set forth in PPL Electric Utilities EE&C Plan. Therefore, the total savings shown in Figure 2-2 do not match the totals in Table 2-5 below. The additional savings counted toward the low-income compliance target total 2,909 MWh/yr (2,426 MWh/yr from GNE and 483 MWh/yr from small C&I).

The Phase III Implementation Order established a GNE energy savings compliance target of 3.5% of the portfolio savings.¹³ For PPL Electric Utilities, the GNE compliance target is 50,507 MWh/yr of verified gross energy savings. Figure 2-3 compares the VTD performance for the GNE customer sector to the Phase III GNE savings target. Of verified savings for Phase III, PPL Electric Utilities has achieved 447% of the Phase III GNE energy savings compliance target.

Figure 2-3. EE&C Plan Performance Against Phase III GNE Compliance Target



Again, WRAP includes savings for multifamily projects that are allocated to the GNE and small C&I sectors based on the rate class of the buildings' meters. All savings from WRAP are counted toward the low-income compliance target, as set forth in PPL Electric Utilities' EE&C Plan. Therefore, the VTD savings in Figure 2-3 do not include the 2,426 MWh/yr of GNE savings allocated to WRAP and do not match the GNE savings in Table 2-5 below.

¹³ Pennsylvania Public Utility Commission. *Phase III Implementation Order*. Docket No. M-2014-242-2424864. June 11, 2015.

2.3 Phase III Demand Response Achievements to Date

The Phase III demand response performance target for PPL Electric Utilities is 92 MW. Compliance targets for demand response programs are based on average performance across event hours and were established at the system level, which means the load reductions measured at the customer meter must be escalated to reflect transmission and distribution losses.

Compliance with Act 129 will not be based on performance in PY12 per the PA PUC's Phase III Modification Order that the Pennsylvania EDCs may operate the demand response programs in PY12 on a voluntary basis.¹⁴ The Commission modified the compliance requirements in response to disruptions to electric utility customer operations related to the COVID-19 pandemic. However, the Commission encouraged the utilities to operate their programs in PY12, and PPL Electric Utilities elected to continue operating the program for C&I customers and for GNE customers.

Act 129 demand response events are triggered by PJM's day-ahead load forecast. When the day-ahead forecast is above 96% of the peak load forecast for the year, a demand response event is initiated for the following day. In PY12, there were five voluntary demand response events called.

Table 2-3 lists the dates of the demand response events along with the verified gross demand reductions achieved by each sector. It also lists the average demand response performance for PY12 and for Phase III to date. The table also lists the average demand response performance for PY12, for the PY9-PY11 compliance period and for Phase III to date.

Table 2-3. PY12 Demand Response PYVTD Performance by Event

Event Date	Start Hour	End Hour	Small C&I Load Curtailment (MW)	Large C&I Load Curtailment (MW)	GNE Load Curtailment (MW)	Portfolio MW/Event Impact ⁽¹⁾
July 20, 2020	2 p.m.	6 p.m.	2.1	103.1	4.5	109.6
July 27, 2020	2 p.m.	6 p.m.	1.6	97.5	3.2	102.4
July 29, 2020	3 p.m.	7 p.m.	2.0	71.2	3.3	76.5
August 25, 2020	2 p.m.	6 p.m.	2.9	87.6	0.9	91.3
August 27, 2020	3 p.m.	7 p.m.	1.9	101.5	1.3	104.7
PYVTD - Average PY12 Demand Response Event Performance						96.9
VTD - Average Phase III Demand Response Event Performance ⁽²⁾						108.4
PY9-PY11 Compliance Period Average Demand Response Event Performance						112.8
⁽¹⁾ Portfolio MW/event may not equal the sum of customer segment MW/event because of rounding.						
⁽²⁾ VTD demand response impacts are the average performance across all Phase III demand response event hours. This is inclusive of PY12, which was voluntary and did not count toward Phase III compliance.						

¹⁴ Pennsylvania Public Utility Commission. *Phase III Modification Order*. Docket No. M-2014-2424864. June 3, 2020.
http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/energy_efficiency_and_conservation_ee_c_program.aspx

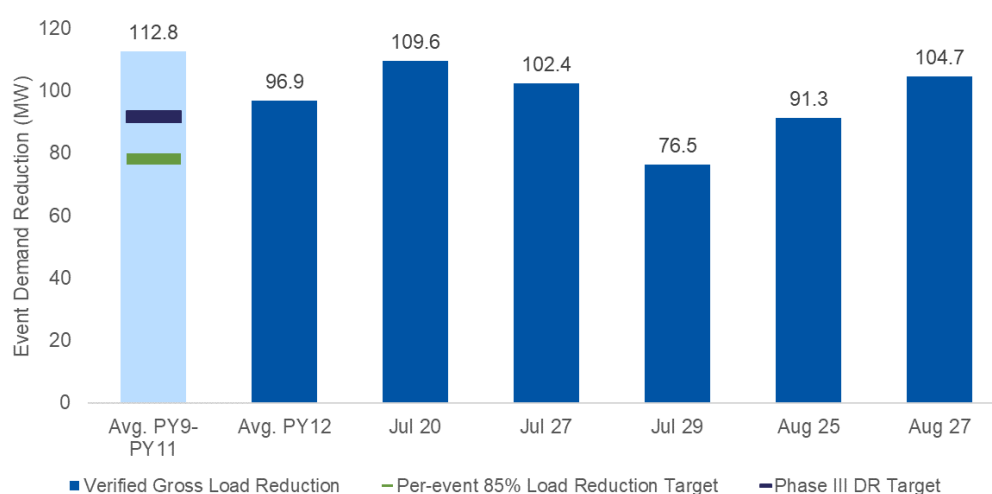
The PA PUC's Phase III Implementation Order also established a requirement that EDCs achieve at least 85% of the Phase III compliance reduction target in each demand response event. For PPL Electric Utilities, this translates to a 78.2 MW minimum for each demand response event.

Figure 2-4 shows the PY9-PY11 gross verified savings, which were the basis for determining Phase III compliance. For Phase III, the verified Act 129 event load reductions were 112.8 MW (the average load reduction over PY9, PY10, and PY11 event hours), which exceeds the Phase III compliance target of 92 MW. In addition, in PY9, PY10, and PY11, PPL Electric Utilities met its per-event compliance target of at least 78.2 MW (85% of the total compliance target) in each demand response event. The July 29, 2020, event did not meet the per-event 85% target; however, the PY12 demand response programs were voluntary, so the comparison of per-event performance to the 85% target is strictly informational.

Figure 2-4 also shows the gross verified savings for PY12 by event. In PY12, verified Act 129 event load reductions were 96.9 MW (equal to the average demand reduction over the five four-hour demand response events), a realization rate of 98.2% relative to the reported (*ex ante*) load reduction.

These verified load impacts are based on Cadmus analysis of participant advanced metering infrastructure (AMI) consumption data and have been grossed up to reflect transmission and distribution losses.

Figure 2-4. Event Performance Compared to 85% Per-Event Target



2.4 Phase III Performance by Customer Sector

Table 2-4 presents the participation, savings, and spending by customer sector for PY12. The residential, small C&I, and large C&I sectors are defined by EDC tariff, and the residential low-income and GNE sector are 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 in 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 2-4.

Table 2-4. PY12 Summary Statistics by Customer Sector

Parameter	Residential	Low-Income	Small C&I	Large C&I	GNE	Total ⁽¹⁾
Reported Number of Participants ⁽²⁾	30,112	34,846	4,729	1,445	2,227	73,359
PY12 Energy Realization Rate ⁽³⁾	157%	83%	103%	103%	102%	108%
PYVTD MWh/yr ⁽³⁾	42,620	10,852	110,634	46,654	37,111	247,871
PY12 Demand Realization Rate ⁽³⁾	191%	86%	95%	97%	100%	101%
PY12 Demand Realization Rate (Energy Efficiency) ⁽³⁾	191%	86%	90%	96%	98%	108%
PY12 Demand Realization Rate (Demand Response)			153%	97%	108%	98%
PYVTD MW/yr (Energy Efficiency) ⁽³⁾	10.38	1.14	13.71	6.02	6.85	38.09
PYVTD MW/yr (Demand Response)	-	-	2.10	92.18	2.63	96.91
PY12 Incentives (\$1000) ⁽⁴⁾	\$3,732	\$0	\$8,099	\$3,672	\$2,407	\$17,910

⁽¹⁾ Total may not sum due to rounding.

⁽²⁾ Verified participation totals discussed in each chapter and shown in the infographics may differ from the reported participation in this table.

⁽³⁾ The residential verified savings and realization rates 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 as an incentive cost.

Table 2-5 summarizes plan performance by sector since the beginning of Phase III.

Table 2-5. Phase III Summary Statistics by Customer Sector

Parameter	Residential	Low-Income	Small C&I	Large C&I	GNE	Total ⁽¹⁾
Reported Number of Participants	1,393,905	149,824	67,329	4,536	9,678	1,625,272
P3TD Energy Realization Rate ⁽²⁾	102%	89%	93%	99%	99%	98%
VTD MWh/yr ⁽²⁾	666,937	107,547	474,974	295,539	227,967	1,772,963
P3TD Demand Realization Rate ⁽²⁾	69%	104%	88%	100%	102%	87%
P3TD Demand Realization Rate (Energy Efficiency) ⁽²⁾	69%	104%	87%	101%	100%	82%
PY3TD Demand Realization Rate (Demand Response)			167%	100%	132%	102%
VTD MW/yr (Energy Efficiency) ⁽²⁾	96.90	11.20	70.54	37.48	34.54	250.65
VTD MW/yr (Demand Response)	-	-	1.70	102.41	4.26	108.37 ⁽³⁾
P3TD Incentives (\$1000) ⁽⁴⁾	\$36,636	\$0	\$33,289	\$21,310	\$11,450	\$102,685

⁽¹⁾ Total may not match sum of columns due to rounding.

⁽²⁾ The residential verified savings and realization rates have not been adjusted to account for energy savings uplift (double-counting) in the Home Energy Education Program.

⁽³⁾ The total does not match the totals in Table 2-3 and Table 2-13 because those averages exclude PY12.

⁽⁴⁾ The cost of measures provided to low-income participants at no cost is treated as an administrative cost, not as an incentive cost. The incentives differ from those in Table 2-15. Summary of Portfolio Finances – Gross Verified, presented later in this chapter, because incentives are discounted in that table.

2.5 Summary of Participation by Program

Participation is defined differently for certain programs depending on the program delivery channel and data tracking practices. These distinctions are summarized by program in Table 2-6, which also provides the reported participation totals for PY12 and Phase III. PPL Electric Utilities' tracking database assigns

unique job identifiers to rebated projects, and these correspond to participants as noted in this table. Verified participation totals discussed in each chapter and shown in the infographics may differ from the reported participation in this table.

Table 2-6. EE&C Portfolio Participation by Program

Program	Participant Definition	PY12 TD Participation	P3TD Participation
Appliance Recycling	Unique job number; corresponds with each unique appliance decommissioned through the program during the program year.	5,395	56,942
Demand Response	Unique account number; corresponds to a customer who enrolled in the program and is not the number of customers who participated in at least one event as shows in Table 14-1. The number reported in the PY12 Demand Response infographic reflects the number of unique customers (43). The number reported in the PY12 Portfolio infographic represents the number of participants who participated in at least one event (118).	126	353
Efficient Lighting	Person or business purchasing discounted bulbs. See the Efficient Lighting Chapter, section 9.1.1 <i>Definition of a Participant</i> , in the PY11 report, ⁽¹⁾ which describes the approach to computing number of participants.	-	1,003,843
Energy-Efficiency Kits and Education	Unique job number; corresponds to an energy-savings kit delivered to an income-eligible customer through the agency or the direct-mail delivery channel. 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.	-	55,137
Energy Efficient Home	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	16,368	100,603
Home Energy Education	Unique bill account number (household) that receives a home energy report in any program year (a household is counted once, even if it received reports in more than one year). Includes participants from all sectors.	14,944	208,096
Non-Residential Energy Efficiency	<i>Custom</i> : Unique job number; commercially operable job that received an incentive payment during the reporting period. <i>Midstream Lighting Program</i> : Unique job number; corresponds to each purchase of discounted products. <i>Prescriptive Lighting and Equipment</i> : Unique job number; corresponds to each unique job that received a rebate.	8,236	33,780
Student Energy Efficient Education	Number of participants is the number of energy conservation kits delivered. Includes participants from all sectors and will not match the participant count in the infographic.	22,911	119,292
WRAP	Unique bill account number; corresponds to an income-eligible household that receives an audit and program services. In PY8 ⁽²⁾ , a participant was defined as a unique job, but the PY9 ⁽³⁾ updated definition is applied retroactively here. Therefore, the P3TD total will not match the PY8 total plus PY9TD + PY10TD + PY11TD + PY12TD. In PY10 ⁽⁴⁾ and PY11 ⁽¹⁾ , an LED giveaway component was added to the program. The participant count for this component is equal to the number of bulbs given away.	5,379	47,226
Portfolio Total ⁽⁴⁾		73,359	1,625,272

⁽¹⁾ PPL Electric Utilities. *Annual Report Program Year 11: June 1, 2019–May 31, 2020*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. February 15, 2021

⁽²⁾ PPL Electric Utilities. *Annual Report Program Year 8: June 1, 2016–May 31, 2017*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2017.

⁽³⁾ PPL Electric Utilities. *Annual Report Program Year 9: June 1, 2017–May 31, 2018*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2018.

⁽⁴⁾ PPL Electric Utilities. *Annual Report Program Year 10: June 1, 2018–May 31, 2019*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2019.

2.6 Summary of Impact Evaluation Results

During PY12, Cadmus completed impact evaluations for all of the energy efficiency programs in the portfolio and a net savings analysis for some. Table 2-7 summarizes the realization rates and NTG ratios by program.

Table 2-7. PY12 Impact Evaluation Results Summary

Program	Energy Realization Rate	Demand Realization Rate	Net-to-Gross Ratio	Percentage of Total Portfolio Verified Gross	
				Verified MWh/yr	Verified MW/yr
Appliance Recycling	105%	104%	0.66 ⁽¹⁾	2%	1%
Demand Response	-	98%	1.0 ⁽²⁾	0%	72%
Energy Efficient Home	108%	90%	0.46 ⁽³⁾	9%	3%
Home Energy Education	964%	2099%	1.0 ⁽⁴⁾	6%	4%
Non-Residential Energy Efficiency	103%	93%	0.66 ⁽⁵⁾	79%	20%
Student Energy Efficient Education	93%	110%	1.0 ⁽²⁾	2%	0%
WRAP	80%	81%	1.0 ⁽²⁾	3%	1%
Total	108% ⁽⁶⁾	101% ⁽⁶⁾	0.68 ⁽⁷⁾	100% ⁽⁸⁾	100% ⁽⁸⁾

⁽¹⁾ PY10 evaluated NTG ratio.

⁽²⁾ No free ridership is expected, nor measured, per the evaluation plan. Therefore, the NTG ratio is 1.0.

⁽³⁾ PY12 evaluated NTG ratios used for ductless heat pump, air source heat pump, heat pump water heater and smart thermostat measures. PY11 evaluated NTG ratios used for new home and online marketplace program components. PY9 evaluated NTG ratios used for refrigerator and dehumidifier measures. PY8 evaluated NTG ratios used for all other measures. The 0.46 NTG ratio for the overall program is the verified gross population energy savings weighted average of the NTG ratios applied to each measure.

⁽⁴⁾ Savings are determined using a randomized control trial and the NTG ratio is irrelevant.

⁽⁵⁾ PY12 evaluated NTG ratios used for Custom program and Efficient Equipment program components. PY11 evaluated NTG ratio used for Midstream Lighting component.

⁽⁶⁾ The realization rates have not been adjusted to account for energy savings uplift (double-counting) in the Home Energy Education Program

⁽⁷⁾ Weighted by PY12 program verified gross energy savings.

⁽⁸⁾ Total may not match sum of rows due to rounding.

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 2-8 presents findings for PY12 high-impact measures.

Table 2-8. PY12 High-Impact Measure Net-to-Gross

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Efficient Equipment Commercial Lighting ⁽¹⁾	28% ⁽²⁾	0%	0.72
Custom ⁽¹⁾	39% ⁽²⁾	0%	0.61
Combined Heating and Power (CHP) ⁽³⁾	N/A	N/A	N/A
Energy Efficient Home Ductless Heat Pump ⁽¹⁾	62% ⁽²⁾	1%	0.39
Energy Efficient Home Air Source Heat Pump ⁽¹⁾	54% ⁽²⁾	1%	0.47
Energy Efficient Home Heat Pump Water Heater ⁽¹⁾	23% ⁽²⁾	1%	0.78
Energy Efficient Home Smart Thermostat ⁽¹⁾	43% ⁽²⁾	1%	0.58
Total	35% ⁽⁴⁾	0%	0.65
⁽¹⁾ Estimated from PY12 survey data.			
⁽²⁾ Weighted by the survey sample-verified program kWh/yr savings.			
⁽³⁾ CHP projects are included in the Custom Program. The one CHP participant in PY12 did not complete a survey.			
⁽⁴⁾ Weighted by verified gross energy savings of high-impact measure population.			

All projects in the Custom Program are unique and considered as high-impact measures, including combined heat and power (CHP) projects. Commercial lighting contributes more than 5% to the sector and portfolio and is considered a high-impact measure. Energy Efficient Home Program ductless heat pump, air source heat pump, heat pump water heater and smart thermostat measures were considered high-impact measures. Overall, the NTG research for high-impact measures represents 62% of the total portfolio verified gross energy savings in PY12.

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 are added to an EDC’s progress toward compliance. Incremental annual savings estimates are presented in the next section, *2.6.1 Incremental Annual Energy Savings by Program*. 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 2.6.2 *Lifetime Energy Savings by Program* presents the lifetime energy savings by program.

2.6.1 Incremental Annual Energy Savings by Program

Figure 2-5 presents a summary of the program year-to-date (PYTD) energy savings by program for PY12. The energy impacts in this report are presented at the meter 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 2-5. PY12 PYTD Energy Savings by Energy Efficiency Programs

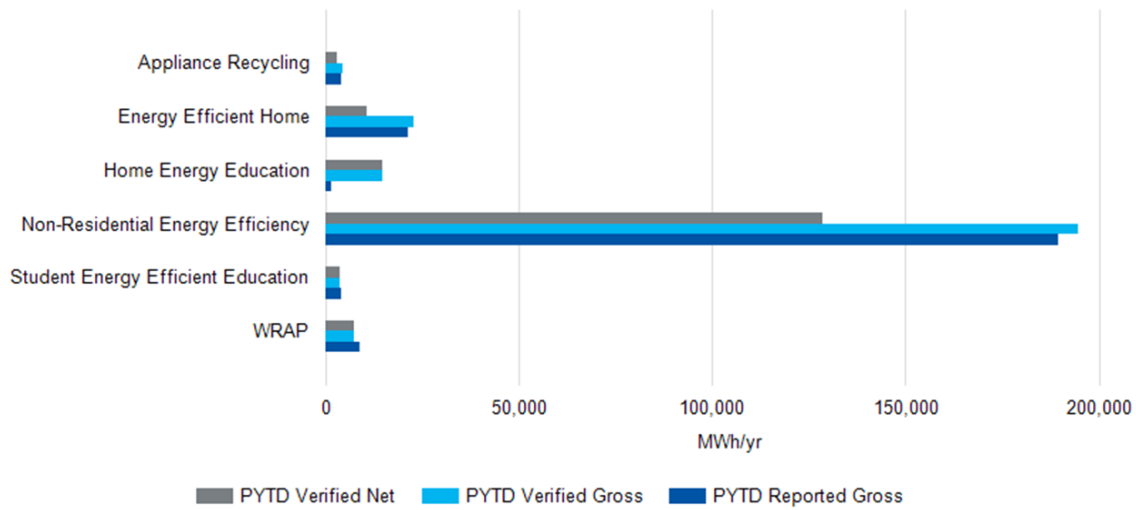
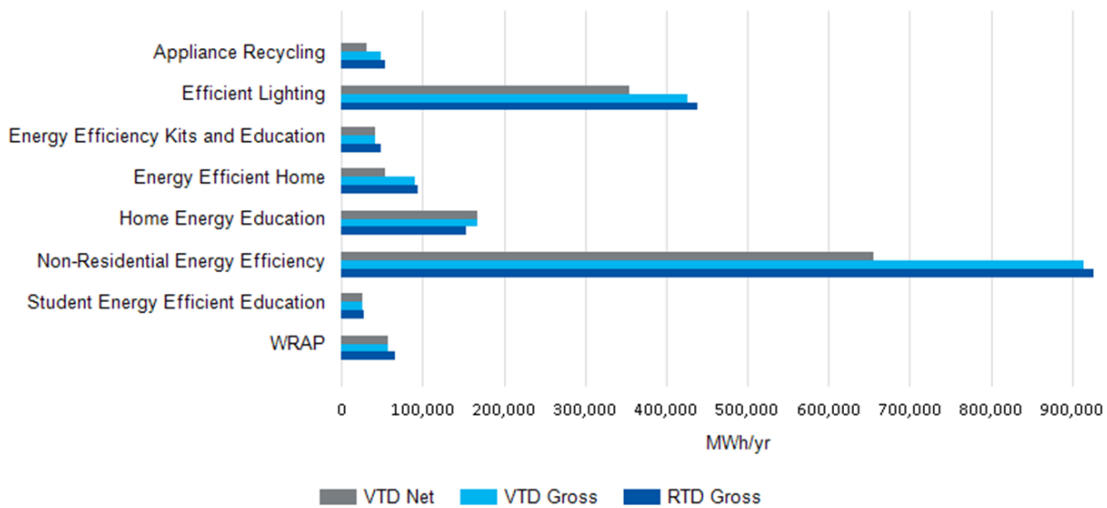


Figure 2-6 presents a summary of the energy savings by program for Phase III of Act 129.

Figure 2-6. P3TD Energy Savings by Energy Efficiency Programs



A summary of energy impacts by program through PY12 is presented in Table 2-9. Demand response is excluded from Figure 2-5 and Figure 2-6 and from this table because it does not produce energy savings.

Table 2-9. Incremental Annual Energy Savings by Program (MWh/Year)

Program	PYRTD	PYVTD	PY Unverified (1)	PYVTD Net	RTD	VTD	Unverified (1)	VTD Net
Appliance Recycling	4,111	4,332	0	2,859	54,014	48,215	0	31,822
Efficient Lighting	-	-	-	-	438,501	426,752	-	354,204
Energy Efficiency Kits and Education	-	-	-	-	48,719	41,240	-	41,240
Energy Efficient Home	21,199	22,967	0	10,579	94,220	90,460	0	54,248
Home Energy Education	1,534	14,784	0	14,784	154,101	166,958	0	166,958
Non-Residential Energy Efficiency	189,359	194,768	0	128,521	927,856	915,650	0	656,297
Student Energy Efficient Education	4,075	3,806	0	3,806	27,125	26,536	0	26,536
WRAP	9,031	7,215	0	7,215	66,399	57,152	0	57,152
Total^{(1) (2)}	229,309	247,871	0	167,763	1,810,935	1,772,963	0	1,388,457
Adjustment for Home Energy Education Double-Counted Savings		(1,687)	-	-	-	(23,651)	-	-
Adjusted Portfolio Savings^{(2) (3)}		246,184	0	-	-	1,749,311	0	-
⁽¹⁾ There are no unverified savings.								
⁽²⁾ Total may not match sum of rows due to rounding.								
⁽³⁾ The adjusted verified savings in this table account for energy-savings uplift (double-counting) in the Home Energy Education Program.								

Table 2-10 shows the verified savings for each program, by year reported and verified.

Table 2-10. Savings by Reported and Verified Year

Program	Energy Savings (MWh/yr)									
	PY8		PY9		PY10		PY11		PY12	
Reporting Year	PY8		PY9		PY10		PY11		PY12	
Verified Year	PY8	PY9	PY9	PY10	PY10	PY11	PY11	PY12	PY12	Unverified
Appliance Recycling	11,844	-	10,731	-	11,362	-	9,945	-	4,332	-
Energy Efficiency Kits and Education	9,219	-	11,829	-	9,304	-	10,888	-	-	-
Energy Efficient Home	9,943	-	18,802	-	17,661	-	16,929	4,157	22,967	-
Efficient Lighting	145,929	-	128,036	-	104,448	-	48,339	-	-	-
Home Energy Education	34,326	-	36,232	-	42,829	-	38,787	-	14,784	-
Non-Residential: Custom ⁽¹⁾	46,368	24,372	30,467	-	64,487	-	77,068	-	69,132	-
Non-Residential: Efficient Equipment	70,917	-	115,994	-	96,197	-	125,081	-	87,440	-
Non-Residential: Midstream Lighting	-	1,917	15,915	-	24,306	-	27,794	-	38,196	-
Student Energy Efficient Education	4,539	-	6,024	-	6,011	-	6,158	-	3,806	-
WRAP	2,652	11	14,412	-	19,097	-	13,764	-	7,215	-
Total	335,739	26,299	388,442	-	395,702	-	374,752	4,157	247,871	-
⁽¹⁾ The Custom Program includes Continuous Energy Performance (CEI) Program savings.										

2.6.2 Lifetime Energy Savings by Program

Table 2-11 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.¹⁵

Table 2-11. Lifetime Energy Savings

Program	PY12		Phase III	
	PYVTD Gross Lifetime (MWh/yr)	PYVTD Net Lifetime (MWh/yr)	VTD Gross Lifetime (MWh/yr)	VTD Net Lifetime (MWh/yr)
Appliance Recycling	20,676	13,646	340,380	224,274
Efficient Lighting	-	-	3,161,616	2,624,143
Energy Efficiency Kits and Education	-	-	211,798	211,798
Energy Efficient Home	328,299	149,085	1,099,369	660,671
Home Energy Education	14,784	14,784	158,532	158,532
Student Energy Efficient Education	30,709	30,709	173,123	173,123
Non-Residential Energy Efficiency	2,883,627	1,903,974	12,956,035	9,360,218
WRAP	44,274	44,274	311,933	311,933
Total⁽¹⁾	3,322,368	2,156,472	18,412,788	13,724,693
Adjustment for Home Energy Education Double-Counted Savings	(1,687)	(1,687)	(22,382)	(22,382)
Portfolio Total ^{(1) (2)}	3,320,681	2,154,785	18,390,406	13,702,312
⁽¹⁾ Total may not match sum of rows due to rounding.				
⁽²⁾ The adjusted verified savings in this table account for energy-savings uplift (double-counting) in the Home Energy Education Program.				

2.7 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 reductions are also treated differently for reporting purposes. Peak demand reductions from energy efficiency are generally additive across program years, meaning the P3TD savings reflect the sum of the first-year savings in each program year. Demand reductions

¹⁵ 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.

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 demand response event 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.

2.7.1 Energy Efficiency

Act 129 defines peak demand reductions 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 and do not reflect adjustments for transmission and distribution losses. Figure 2-7 presents a summary of the PYTD demand savings by energy efficiency program for PY12.

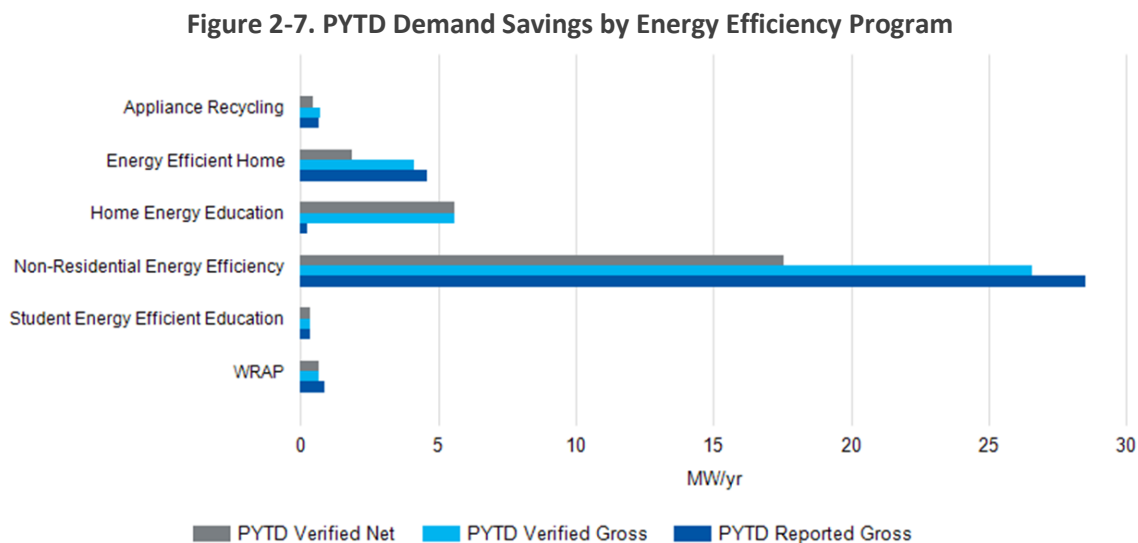
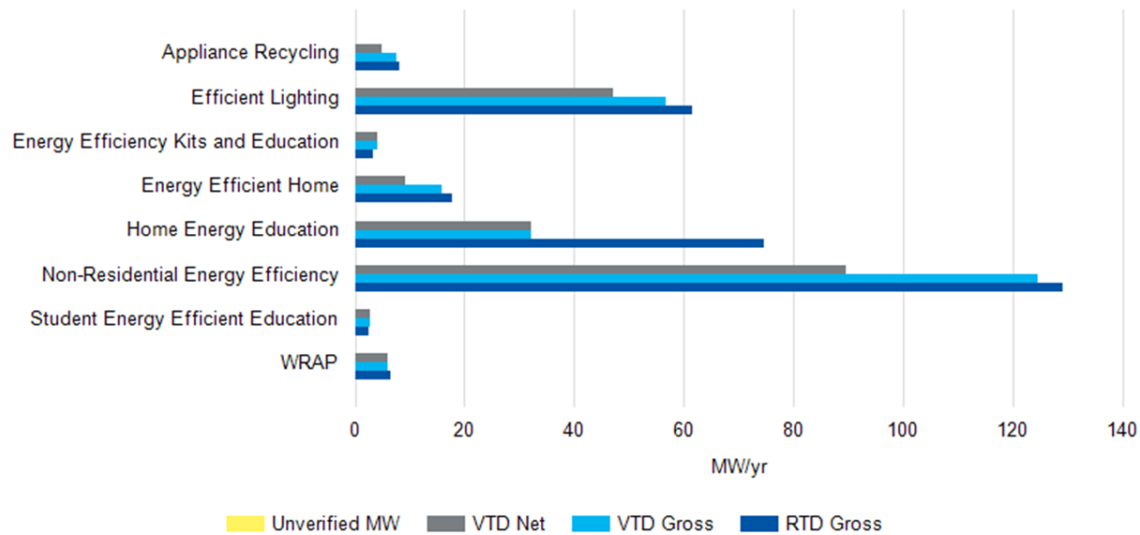


Figure 2-8 presents a summary of the P3TD demand savings by energy efficiency program for Phase III of Act 129.

Figure 2-8. P3TD Demand Savings by Energy Efficiency Program



Reported demand reductions for the Home Energy Education Program in PY8 were based on demand reductions reported in PY7, which were unreasonably high, skewing the demand realization rate for this program and for the portfolio overall. PY9 reported demand reduction for this program use PY8 evaluated demand reductions.

A summary of the peak demand impacts by energy efficiency program through the current reporting period is presented in Table 2-12.

Table 2-12. Peak Demand Savings by Energy Efficiency Program (MW/Year)

Program	PYRTD	PYVTD	PY Unverified (1)	PYVTD Net	RTD	VTD	Unverified (1)	VTD Net
Appliance Recycling	0.67	0.70	0	0.46	8.22	7.57	0	5.00
Efficient Lighting	-	-	-	-	61.68	56.83	-	47.17
Energy Efficiency Kits and Education	-	-	-	-	3.43	4.13	-	4.13
Energy Efficient Home	4.60	4.14	0	1.85	17.77	15.91	0	9.12
Home Energy Education	0.27	5.61	0	5.61	74.72	32.26	0	32.26
Non-Residential Energy Efficiency	28.49	26.59	0	17.55	129.19	125.31	0	90.20
Student Energy Efficient Education	0.33	0.36	0	0.36	2.56	2.73	0	2.73
WRAP	0.85	0.69	0	0.69	6.47	5.91	0	5.91
Total^{(1) (2)}	35.20	38.09	0	26.52	304.05	250.65	0	196.51
Adjustment for Home Energy Education Double-Counted Savings	-	(0.54)	-	-	-	(2.99)	-	-
Adjusted Portfolio Savings^{(2) (3)}	-	37.54	0	-	-	247.66	0	-

(1) There are no unverified savings.

(2) Total may not match sum of rows due to rounding.

(3) The adjusted verified savings in this table account for energy-savings uplift (double-counting) in the Home Energy Education Program.

2.7.2 Demand Response

Act 129 defines peak demand reductions from demand response as the average reduction in electric demand during the hours when a demand response event is initiated. Phase III demand response events are initiated according to the following guidelines:

- Curtailment events shall be limited to the months of June through September.
- Curtailment events shall be called for the first six days of each program year in which the peak hour of PJM's day-ahead forecast is greater than 96% of its summer peak demand forecast for the months of June through September.
- Each curtailment event shall last four hours.
- Each curtailment event shall be called such that it will occur during the day's forecasted peak hour(s) above 96% of the PJM summer peak demand forecast.
- Once six curtailment events have been called in a program year, the peak demand reduction program shall be suspended for that program year.

The peak demand impacts from demand response in this report are presented at the system level and reflect adjustments to account for transmission and distribution losses. PPL Electric Utilities uses the following line loss percentages/multipliers by sector:

- Residential = [8.75% or 1.0875]
- Small C&I = [8.75% or 1.0875]
- Large C&I = [4.20% or 1.042]

Table 2-13 summarizes the PYVTD and VTD demand reductions for the Demand Response Program in the EE&C plan and for the demand response portfolio as a whole. VTD demand reductions are the average performance across all Phase III demand response events independent of how many events occurred in a given program year. The relative precision columns indicate the margin of error (at the 90% confidence interval) around the PYVTD and VTD demand reductions.

Compliance with Act 129 will not be based on performance in PY12 per the PA PUC's Phase III Modification Order that the Pennsylvania EDCs may operate the demand response programs in PY12 on a voluntary basis.¹⁶ The Commission modified the compliance requirements in response to disruptions to electric utility customer operations related to the COVID-19 pandemic. However, the Commission encouraged the utilities to operate their programs in PY12, and PPL Electric Utilities elected to continue operating the program for C&I customers and for GNE customers.

¹⁶ Pennsylvania Public Utility Commission. *Phase III Modification Order*. Docket No. M-2014-2424864. June 3, 2020.
http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/energy_efficiency_and_conservation_ee_c_program.aspx

Table 2-13. Verified Gross Demand Response Impacts by Program

Program	PYVTD		VTD	
	Gross MW	Relative Precision (90%)	Gross MW	Relative Precision (90%)
Demand Response	96.9	3.1%	112.8	1.8%
Portfolio Total	96.9	3.1%	112.8	1.8%

2.8 Summary of Fuel Switching Impacts

Act 129 allows EDCs to achieve electric savings by converting electric equipment to non-electric equipment. Table 2-14 summarizes key fuel switching metrics in PY12 and to date in Phase III.

Table 2-14. Phase III Fuel Switching Summary

Metric	PY12	P3TD
Fuel Switching Measures Offered	Electric to Fossil Fuel Central Heating Electric to Fossil Fuel Water Heating Custom Commercial Combined Heat and Power (CHP) Custom Other Commercial Projects	Electric to Fossil Fuel Central Heating Electric to Fossil Fuel Water Heating Custom Commercial Combined Heat and Power (CHP) Custom Other Commercial Projects
Fuel Switching Measures Implemented	Electric to Fossil Fuel Central Heating Electric to Fossil Fuel Water Heating Custom Commercial Combined Heat and Power (CHP) Custom Other Commercial Projects	Electric to Fossil Fuel Central Heating – 245 projects Custom Commercial Combined Heat and Power (CHP) - 7 projects Custom Other Commercial Projects – 5 projects
Verified Energy Savings Achieved via Fuel Switching (MWh/yr)	10,607	120,856
Increased Fossil Fuel Consumption Due to Fuel Switching Measures (MMBTU/yr)	57,775	530,331
Incentive Payments for Fuel Switching Measures (\$1000)	\$323	\$2,924

2.9 Summary of Cost-Effectiveness Results

A detailed breakdown of portfolio finances and cost-effectiveness is presented in Table 2-15. TRC benefits were calculated using gross verified impacts. Net present value (NPV) PY12 costs and benefits are expressed in PY12 dollars (PY12 includes months in both 2020 and 2021). NPV costs and benefits for P3TD financials are expressed in 2016 dollars.

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.

PPL Electric Utilities incorporates the cost of kits into the TRC as program delivery costs rather than as incentives to participants. Because PPL Electric Utilities' tracking and internal reporting systems are in place to catalog these costs as a program delivery cost, it would be cost-prohibitive for PPL Electric Utilities to change its processes and reporting procedures for Phase III. PPL Electric Utilities will change its approach in Phase IV, as required in the final TRC Order.

Table 2-15. Summary of Portfolio Finances – Gross Verified

Row #	Cost Category	PY12 (\$1,000)		P3TD (\$1,000) ⁽¹⁰⁾	
1	EDC Incentives to Participants ⁽¹⁾	\$17,910		\$89,559	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$56,377		\$287,030	
4	Incremental Measure Costs (Sum of rows 1 through 3) ⁽⁹⁾	\$74,287		\$376,589	
		EDC	CSP	EDC	CSP
5	Design & Development ⁽²⁾	-	-	\$449	\$476
6	Administration, Management, and Technical Assistance ⁽³⁾	\$1,294	\$921	\$9,254	\$3,626
7	Marketing ⁽⁴⁾	\$2,638	\$1,585	\$6,850	\$10,715
8	Program Delivery ⁽⁵⁾	-	\$20,238	-	\$95,979
9	EDC Evaluation Costs	\$2,509		\$11,397	
10	SWE Audit Costs	\$300		\$1,962	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽⁹⁾	\$29,485		\$140,707	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$3,130		\$21,140	
13	Total NPV TRC Costs ^{(6) (9)} (Net present value of sum of rows 4, 11, and 12)	\$106,902		\$538,436	
14	Total NPV Lifetime Electric Energy Benefits	\$140,252		\$643,826	
15	Total NPV Lifetime Electric Capacity Benefits	\$26,057		\$122,052	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$6,684		\$82,808	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	\$7,633		\$24,914	
18	Total NPV TRC Benefits ⁽⁷⁾ (Sum of rows 14 through 17) ^{(9) (11)}	\$180,625		\$873,601	
19	TRC Benefit-Cost Ratio ^{(8) (9)}	1.69		1.62	

⁽¹⁾ PPL Electric Utilities incorporates the cost of kits into the TRC as program delivery costs rather than incentives to participants.
⁽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.
⁽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.
⁽⁴⁾ Includes the marketing CSP and marketing costs by program CSPs.
⁽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.
⁽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.
⁽⁹⁾ Total may not sum due to rounding.
⁽¹⁰⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.
⁽¹¹⁾ Portfolio TRC Benefits account for energy-savings uplift (double-counting) adjustments from the Home Energy Education Program. Program-level cost-effectiveness tables do not include energy-saving uplift (double-counting) adjustments.

Table 2-16 shows the TRC ratios by program and for the portfolio. The benefits were calculated using gross verified impacts. PY12 benefits and costs are expressed in PY12 dollars as the analysis is completed, using program years that align the values for nominal calendar years to a program year. The Demand Response Program costs shown in Table 2-16 through Table 2-20 include those costs incurred for PY12 after the Semi-Annual Report to the PA PUC was filed on January 15, 2021.

Table 2-16. PY12 Gross TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$1,135	\$1,749	0.65	(\$614)
Efficient Lighting	\$0	\$177	0.00	(\$177)
Energy Efficiency Kits and Education	\$0	\$46	0.00	(\$46)
Energy Efficient Home	\$25,564	\$17,806	1.44	\$7,759
Home Energy Education	\$1,138	\$2,388	0.48	(\$1,249)
Student Energy Efficient Education	\$7,463	\$1,676	4.45	\$5,787
WRAP	\$3,530	\$5,106	0.69	(\$1,576)
Residential (Including Low-Income) Subtotal ^{(1) (2)}	\$38,830	\$28,948	1.34	\$9,883
Non-Residential Subtotal ⁽¹⁾	\$137,466	\$68,760	2.00	\$68,705
Demand Response	\$4,452	\$2,197	2.03	\$2,255
Common Portfolio Costs and Uplift	(\$123)	\$6,997	N/A	(\$7,120)
Portfolio Total ⁽¹⁾	\$180,625	\$106,902	1.69	\$73,723
⁽¹⁾ Total may not match sum of rows due to rounding.				
⁽²⁾ Low-income is shown as a subsector of residential in this table.				

Table 2-17 presents PY12 cost-effectiveness using net verified savings to calculate benefits. Net savings for each program are calculated by multiplying the NTG ratios determined for the program sample to the program verified energy savings. The adjustment for net savings impacts the total energy savings, secondary energy savings, participant measure costs (reducing measure costs by the NTG ratio), and operations and maintenance (O&M) benefits.

Table 2-17. PY12 Net TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$749	\$1,749	0.43	(\$1,000)
Efficient Lighting	\$0	\$177	0.00	(\$177)
Energy Efficiency Kits and Education	\$0	\$46	0.00	(\$46)
Energy Efficient Home	\$12,227	\$9,527	1.28	\$2,701
Home Energy Education	\$1,138	\$2,388	0.48	(\$1,249)
Student Energy Efficient Education	\$7,463	\$1,676	4.45	\$5,787
WRAP	\$3,530	\$5,106	0.69	(\$1,576)
Residential (Including Low-Income) Subtotal ^{(1) (2)}	\$25,107	\$20,668	1.21	\$4,439
Non-Residential Subtotal ⁽¹⁾	\$90,833	\$47,042	1.93	\$43,791
Demand Response	\$4,452	\$2,197	2.03	\$2,255
Common Portfolio Costs and Uplift	(\$123)	\$6,997	N/A	(\$7,120)
Portfolio Total ⁽¹⁾	\$120,270	\$76,905	1.56	\$43,365
⁽¹⁾ Total may not match sum of rows due to rounding.				
⁽²⁾ Low-income is shown as a subsector of residential in this table.				

Table 2-18 summarizes cost-effectiveness by program for Phase III of Act 129. Benefits and costs are expressed in PY8 dollars.

Table 2-18. P3TD Gross TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$15,088	\$8,698	1.73	\$6,390
Efficient Lighting	\$184,109	\$37,361	4.93	\$146,748
Energy Efficiency Kits and Education	\$19,341	\$6,021	3.21	\$13,319
Energy Efficient Home	\$75,815	\$74,111	1.02	\$1,704
Home Energy Education	\$8,129	\$6,942	1.17	\$1,188
Student Energy Efficient Education	\$21,687	\$5,500	3.94	\$16,187
WRAP	\$23,048	\$30,552	0.75	(\$7,504)
Residential (Including Low-Income) Subtotal ^{(1) (2)}	\$347,217	\$169,186	2.05	\$178,031
Non-Residential Subtotal ⁽¹⁾	\$510,661	\$330,392	1.55	\$180,270
Demand Response	\$16,792	\$6,983	2.40	\$9,808
Common Portfolio Costs and Uplift	(\$1,070)	\$31,875	N/A	(\$32,944)
Portfolio Total ⁽¹⁾	\$873,601	\$538,436	1.62	\$335,165
⁽¹⁾ Total may not match sum of rows due to rounding.				
⁽²⁾ Low-income is shown as a subsector of residential in this table.				

Table 2-19 presents P3TD cost-effectiveness results using net verified savings to calculate benefits. Benefits and cost are expressed in PY8 dollars. Net savings for each program are calculated by multiplying the NTG ratios determined for the program sample to the program verified energy savings. The adjustment for net savings impacts the total energy savings, secondary energy savings, participant measure costs, and O&M benefits. As noted in Table 2-7 above, NTG ratios determined in PY8, PY9, PY10, and PY11 were used for some programs.

Table 2-19. P3TD Net TRC Ratios by Program (\$1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	\$14,800	\$8,698	1.70	\$6,102
Efficient Lighting	\$184,109	\$37,361	4.93	\$146,748
Energy Efficiency Kits and Education	\$19,341	\$6,021	3.21	\$13,319
Energy Efficient Home	\$65,876	\$67,942	0.97	(\$2,066)
Home Energy Education	\$8,129	\$6,942	1.17	\$1,188
Student Energy Efficient Education	\$21,687	\$5,500	3.94	\$16,187
WRAP	\$23,048	\$30,552	0.75	(\$7,504)
Residential (Including Low-Income) Subtotal ^{(1) (2)}	\$336,991	\$163,016	2.07	\$173,974
Non-Residential Subtotal ⁽¹⁾	\$475,911	\$314,208	1.51	\$161,704
Demand Response	\$16,792	\$6,983	2.40	\$9,808
Common Portfolio Costs and Uplift	(\$1,070)	\$31,875	N/A	(\$32,944)
Portfolio Total ⁽¹⁾	\$828,624	\$516,082	1.61	\$312,542
⁽¹⁾ Total may not match sum of rows due to rounding.				
⁽²⁾ Low-income is shown as a subsector of residential in this table.				

2.10 Comparison of Performance to Approved EE&C Plan

Table 2-20 presents PY12 expenditures, by program, compared to the budget estimates set forth in the EE&C plan for PY12.¹⁷ All of the dollars in this table are presented in PY12 dollars.

Table 2-20. Comparison of PY12 Expenditures to Phase III EE&C Plan (\$1,000)

Program	PY12 Budget from EE&C Plan	PY12 Actual Expenditures ⁽¹⁾	Ratio (Actual/Plan)
Appliance Recycling	\$2,806	\$1,749	62%
Demand Response	\$3,144	\$2,549	81%
Efficient Lighting	\$120	\$182	152%
Energy Efficiency Kits and Education	\$1,133	\$46	4%
Energy Efficient Home	\$8,991	\$6,765	75%
Home Energy Education ⁽²⁾	\$2,376	\$2,388	100%
Non-Residential Energy Efficiency	\$20,772	\$19,937	96%
Student Energy Efficient Education ⁽²⁾	\$1,419	\$1,676	118%
WRAP ⁽²⁾	\$7,265	\$5,106	70%
Total Direct Program Costs ⁽³⁾	\$48,026	\$40,398	84%
Common Portfolio Costs ⁽⁴⁾	\$8,620	\$6,997	81%
Portfolio Total ⁽³⁾	\$56,646	\$47,395	84%
⁽¹⁾ Expenditures may not match the sum of incentives and program costs listed in the individual program cost-effectiveness tables due to rounding.			
⁽²⁾ The expenditures for the Home Energy Education Program, Student Energy Efficient Education Program and WRAP do not match the totals used for the infographics.			
⁽³⁾ Total may not match sum of rows due to rounding.			
⁽⁴⁾ Common costs include SWE costs.			

¹⁷ The EE&C Plan referenced in this section is PPL Electric Utilities revised *Energy Efficiency and Conservation Plan Act 129 Phase III*, EE&C plan (Docket No. M-2015-2515642), November 2018.

Table 2-21 presents P3TD expenditures, by program, compared to the projected budget estimates set forth in the EE&C plan through PY12. All dollars are presented in PY12 dollars.

Table 2-21. Comparison of P3TD Expenditures to Phase III EE&C Plan (\$1,000)

Program	Phase III Budget from EE&C Plan through PY12	Phase III Actual Expenditures through PY12 ⁽¹⁾	Ratio (Actual/Plan)
Appliance Recycling	\$11,802	\$10,002	85%
Demand Response	\$12,400	\$9,655	78%
Efficient Lighting	\$36,337	\$30,158	83%
Energy Efficiency Kits and Education	\$6,899	\$6,624	96%
Energy Efficient Home	\$34,734	\$30,726	88%
Home Energy Education ⁽²⁾	\$10,141	\$8,241	81%
Non-Residential Energy Efficiency	\$107,181	\$91,219	85%
Student Energy Efficient Education ⁽²⁾	\$5,662	\$6,490	115%
WRAP ⁽²⁾	\$44,223	\$35,317	80%
Total Direct Program Costs ⁽³⁾	\$269,379	\$228,432	85%
Common Portfolio Costs ⁽⁴⁾	\$43,100	\$36,396	84%
Portfolio Total ⁽³⁾	\$312,479	\$264,827	85%
⁽¹⁾ This may not match the sum of incentives and may not match program costs listed in the individual program cost-effectiveness tables due to rounding and discounting.			
⁽²⁾ The expenditures for the Home Energy Education Program, Student Energy Efficient Education Program and WRAP do not match the totals used for the infographics.			
⁽³⁾ Total may not match sum of rows due to rounding.			
⁽⁴⁾ Common costs include SWE costs.			

Table 2-22 compares PY12 verified gross program savings compared to the energy savings projections set forth in the EE&C plan.

Table 2-22. Comparison of PY12 Actual Program Savings to EE&C Plan Projections for PY12

Program	PY12 EE&C Plan (MWh/yr)	PY12 Gross Savings (MWh/yr) ⁽¹⁾	Ratio (Actual/Plan)
Appliance Recycling	15,316	4,332	28%
Energy Efficiency Kits and Education	6,506	-	0%
Energy Efficient Home	22,561	22,967	102%
Home Energy Education	57,406	14,784	26%
Non-Residential Energy Efficiency	176,809	194,768	110%
Student Energy Efficient Education	1,933	3,806	197%
WRAP	11,349	7,215	64%
Total⁽²⁾	285,374	247,871	87%
Adjustment for Home Energy Education Double-Counted Savings	-	(1,687)	-
Portfolio Total ^{(2) (3)}	291,880	246,184	84%
⁽¹⁾ Totals include savings from all sectors attributed to the program and may not match totals in the infographics.			
⁽²⁾ Total may not match sum of rows due to rounding.			
⁽³⁾ The adjusted verified savings in this table account for energy-savings uplift (double-counting) in the Home Energy Education Program.			

Table 2-23 compares Phase III verified gross program savings to the energy savings projections filed in the EE&C plan.

Table 2-23. Comparison of Phase III Actual Program Savings to EE&C Plan Projections for Phase III

Program	EE&C Plan through PY12 (MWh/yr)	VTD Gross MWh/Yr Savings through PY12 (MWh/yr) ⁽¹⁾	Ratio (Actual/Plan)
Appliance Recycling	65,522	48,215	74%
Efficient Lighting	292,853	426,752	146%
Energy Efficiency Kits and Education	37,601	41,240	110%
Energy Efficient Home	73,721	90,460	123%
Home Energy Education	226,268	166,958	74%
Non-Residential Energy Efficiency	810,810	915,650	113%
Student Energy Efficient Education	17,924	26,536	148%
WRAP	63,285	57,152	90%
Total ⁽²⁾	1,587,984	1,772,963	112%
Adjustment for Home Energy Education Double-Counted Savings	-	(23,651)	-
Portfolio Total ^{(2) (3)}	1,587,984	1,749,311	110%
⁽¹⁾ Totals include savings from all sectors attributed to the program and may not match totals in the infographics.			
⁽²⁾ Total may not match sum of rows due to rounding.			
⁽³⁾ The adjusted verified savings in this table account for energy-savings uplift (double-counting) in the Home Energy Education Program.			

The reasons program savings in PY12 varied from projections estimated in the EE&C Plan are summarized below. Additional details can be found in the individual program chapters.

- **Appliance Recycling (residential sector).** The Appliance Recycling Program achieved 28% of projected energy savings in PY12 and 74% of projected energy savings in Phase III. The program did not meet the projected savings for PY12 because PPL Electric Utilities suspended the program in March 2020 due to concerns about in-person appliance pick-up due to COVID-19. The program resumed in July 2020 but offered contactless pick-up. Overall, the number of units picked up in PY12 was down 62% from PY10 (the most recent program year not affected by COVID-19).
- **Demand Response.** In PY12, PPL Electric Utilities' Demand Response Program was conducted on a voluntary basis. During the PY9-PY11 compliance period, the program achieved 123% of the compliance target of 92 MW.
- **Energy Efficient Home (residential sector).** The Energy Efficient Home Program achieved 102% of projected energy savings in PY12 and 123% of projected energy savings in Phase III. In PY12, Cadmus was able to conduct site visits and verify the saturation rates of lighting and appliances for new homes, which meant PY11 savings could be verified in PY12.

- **Home Energy Education (residential sector).** The program achieved 72% of the estimated residential savings projections for Phase III and 23% of estimated residential projections for PY12.¹⁸ PPL Electric Utilities' EE&C Plan added a low-income Home Energy Education offering to its portfolio in PY11. In October 2019, PPL Electric Utilities ceased sending the home energy reports to residential customers for the remainder of Phase III but continued to send reports to low-income customers. The low-income savings achieved in PY11 and PY12 are attributed to WRAP.
- **Non-Residential.** The Non-Residential Energy Efficiency Program exceeded its projected energy savings, achieving 113% of the estimated projections for Phase III and 110% of projected energy savings for PY12. The following factors affected the program's progress toward the estimated savings projected for PY12:
 - The Lighting and Equipment components achieved verified savings of 45% of total program projected savings for PY12, at a realization rate of 98% for lighting and 101% for equipment.
 - The Custom component achieved verified energy savings that contributed 35% of projected savings for PY12, at a realization rate of 105%.
 - The Midstream Lighting component contributed verified savings of 20% to the program, at a realization rate of 113%.
 - The GNE sector rebates were put on a waitlist in January 2018 because participation rates were higher than expected in the first two years of Phase III.
- **Student Energy Efficient Education (residential sector).** The Student Energy Efficient Education Program achieved 98% of the estimated residential projections for Phase III.¹⁹ PPL Electric Utilities' EE&C Plan added a low-income Student Energy Efficient Education offering to its portfolio in PY10. In PY11 and PY12, the ICSP targeted schools with low-income students, increasing program participation in PY11 and PY12. Thirty-four percent of the program's savings in Phase III were attributed to the low-income sector, determined using Pennsylvania Department of Education data specifying the percentage of students receiving reduced-fee and free lunches. The low-income savings achieved in PY10, PY11, and PY12 are attributed to WRAP.
- **WRAP (residential low-income sector).** The program's verified savings met 109% of estimated savings projected for Phase III, better than projections, due to higher participation in WRAP and additional savings from low-income offerings in the Home Energy Education and Student Energy Efficient Education programs.²⁰

¹⁸ Excludes savings attributable to the low-income sectors and does not match Table 2-22 and Table 2-23.

¹⁹ Ibid.

²⁰ Includes low-income Phase III savings from the Home Energy Education (3,032 MWh/yr) and Student Energy Efficient Education (9,033 MWh/yr) programs and does not match Table 2-22.

Program Changes for PY13

PPL Electric Utilities has made the following program changes in Phase IV:

- **Non-Residential Program Components**
 - **Custom.** In Phase IV, this program component will continue to offer rebates to both large C&I and small C&I customers for projects not included in the Pennsylvania (PA) Phase III technical reference manual (TRM).
 - **Efficient Equipment.** In Phase IV, PPL Electric Utilities has added a midstream delivery channel for commercial kitchen projects, agricultural projects, and HVAC projects.
- **Residential Program Components**
 - **Appliance Recycling.** This component of the Residential Program will continue in Phase IV and will offer customers the choice to schedule a contactless or in-home appliance pick-up.
 - **Energy Efficient Home.** In Phase IV, PPL Electric Utilities has added a midstream delivery channel for HVAC projects. It will continue to offer downstream incentives through the new homes, in-home audit and weatherization, and efficient equipment components as well as continuing to offer efficient equipment through its online marketplace.
 - **Efficient Lighting.** In Phase IV, this program component will encourage customer to purchase and install specialty LED bulbs from local retail stores.
 - **Home Energy Education.** This program will not be offered in PY13 but may be re-introduced in future program years in Phase IV.
 - **Student Energy Efficient Education.** The program will continue to offer education and energy efficiency kits to students and teachers. The program is not planning any hands-on activities in PY13 but will reassess this in future program years.
- **Low-Income Program:**
 - **Low-Income.** The low-income component will continue in Phase IV by offering low- and no-cost energy-saving improvements and education to income-eligible customers residing in single-family homes, individually meter multifamily units, and manufactured homes. PPL Electric Utilities will continue to offer in-home and remote assessments. The program will also offer comprehensive measures through the in-home delivery channel.

2.11 Summary of Process Evaluation Results

This section summarizes program satisfaction results gathered from the participant surveys. Table 2-24 lists the programs for which Cadmus conducted participant surveys in PY12 and the number of respondents who answered the program satisfaction question. Details on each program's survey methodology are provided in the program chapters and their respective appendices.

Table 2-24. PY12 Participant Surveys and Program Satisfaction Response Counts

Sector and Program	Survey Mode	Targeted Number of Completed Surveys ⁽¹⁾	Number of Satisfaction Responses ⁽²⁾
Residential Sector			
Appliance Recycling	Online	All Records (1,325)	172
Energy Efficient Home In-home Audit	Online	All Records (107)	720
Energy Efficient Home Online Assessment	Online	All Records (2,196)	
Energy Efficient Home Equipment	Online	All Records (5,178)	
Energy Efficient Home Weatherization	Online	All Records (437)	
Energy Efficient Online Marketplace	Online	All Records (683)	
Student Energy Efficient Education	ICSP subcontractor-administered paper and online home energy worksheets (HEWs)	All Returned Surveys (10,860)	10,860
Non-Residential Sector			
Custom	Online and telephone	All Records (37)	12
Efficient Equipment	Online and telephone	All Records (278)	69
Midstream Lighting	Telephone: Participating Distributors	15	12
Low-Income Sector			
WRAP	Telephone (residential participants)	208	208
Portfolio			12,053
⁽¹⁾ All records include all participants with contact information who have a chance to complete the survey at the time of data collection. The final sample frame includes unique records in the PPL Electric Utilities tracking database for projects that generated savings. 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, opted out of the online survey, or did not have PY12 savings (incentive adjustments). ⁽²⁾ The total number of responses in this table includes completed and partially completed surveys. Not all survey respondents answered the program satisfaction question because respondents can refuse to answer. Because of these reasons, the total number of responses in this table and Table 3-3 in the next chapter, <i>Evaluation Results by Program</i> , may not match each other.			

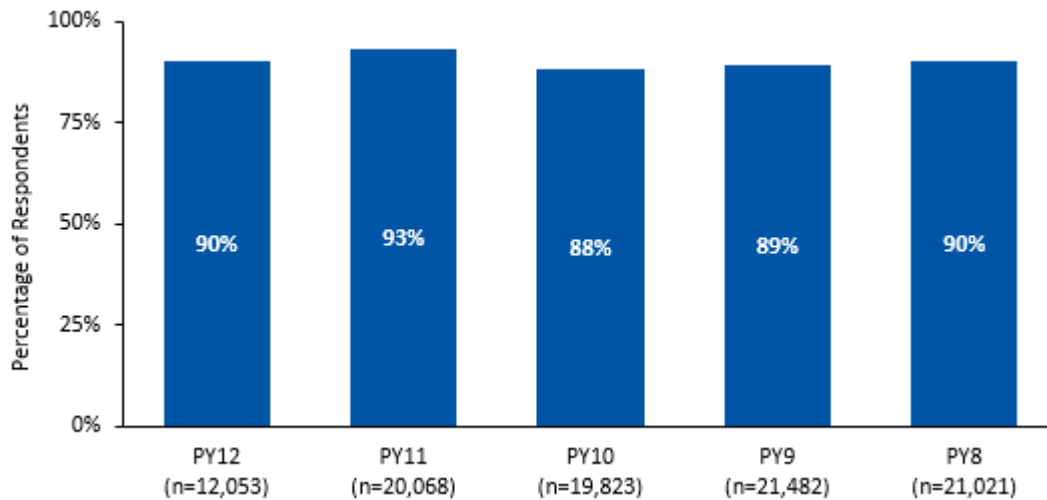
2.11.1 Portfolio-Level Program Satisfaction

Throughout this report, Cadmus refers to the PY8 through PY12 reports when comparing results. See Table 2-6 above for references to these reports.

Cadmus asked respondents how satisfied they were with the program overall, using a 5-point word scale from *very satisfied* to *not at all satisfied*, with a neutral midpoint. Cadmus combined the percentages of respondents who rated their satisfaction with the program as *very satisfied* or *somewhat satisfied* and computed a straight average of all programs to determine the portfolio-level and sector-level program satisfaction results.

Figure 2-9 shows that at a portfolio-level average, PY12 achieved high program satisfaction.

Figure 2-9. Portfolio-Level Program Satisfaction by Program Year
Very and Somewhat Satisfied Combined



Program satisfaction results include all responses to the satisfaction question, averaged to compute the portfolio-level satisfaction. Source: Participant survey question, "How would you rate your overall satisfaction with the program?"

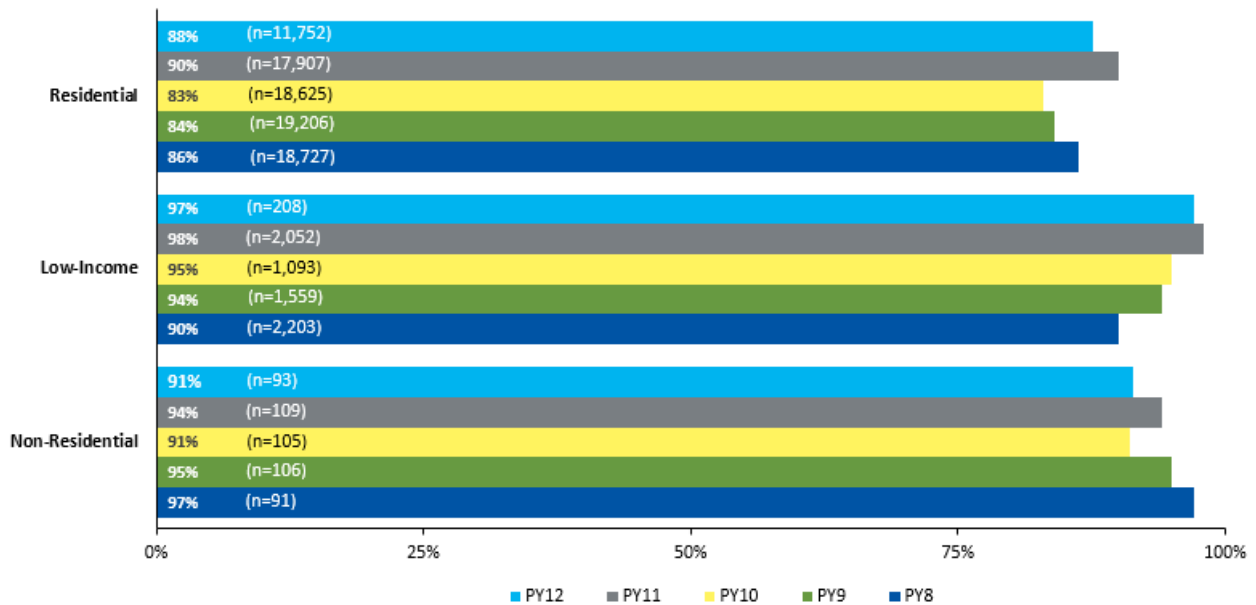
The PY9 Annual Report included satisfaction results for the Demand Response Program, but in this figure satisfaction results for this program are not included in any of the program years.

2.11.2 Program Satisfaction by Sector

For Phase III, PPL Electric Utilities established a sector-level satisfaction goal to achieve 80% or greater of *very satisfied* and *somewhat satisfied* customers.²¹ As shown in Figure 2-10, respondents across all three sectors showed high program satisfaction and exceeded the customer satisfaction goal of 80% or greater. The low-income sector achieved the highest percentage of satisfied respondents at 97% (n=208), compared to 91% for the nonresidential sector (n=93) and 88% for the residential sector (n=11,752).

²¹ The customer satisfaction goal is stipulated in PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the PA PUC, November 2018.

Figure 2-10. PY12 Program Satisfaction by Sector
Very and Somewhat Satisfied Combined



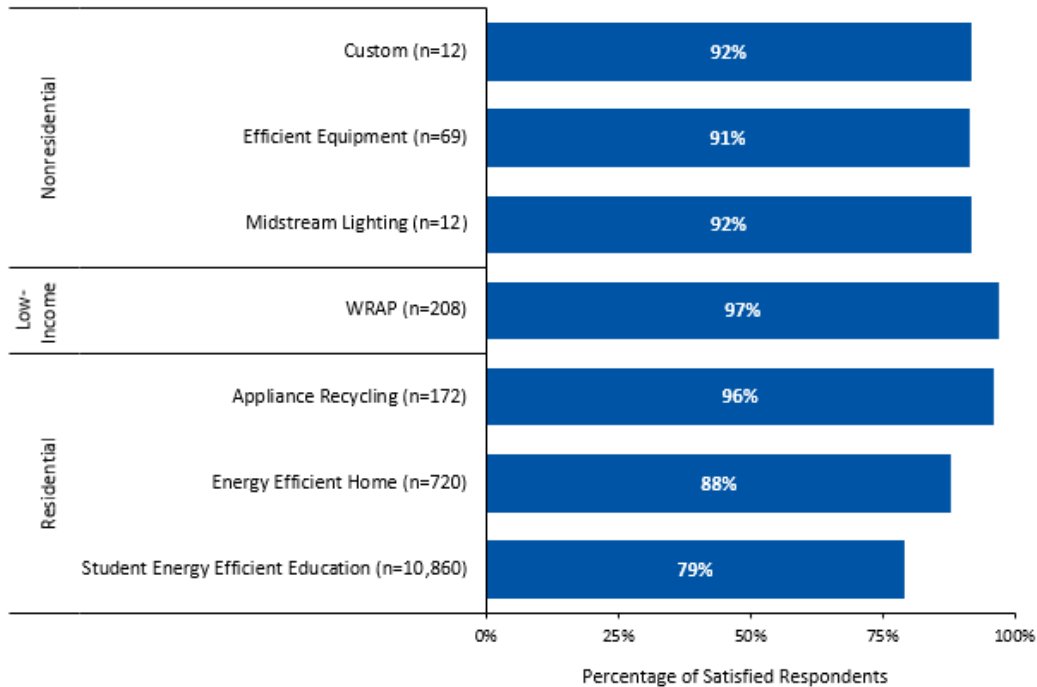
The program satisfaction results include all responses to the satisfaction question. Source: Participant survey question, “How would you rate your overall satisfaction with the program?”

2.11.3 Program Satisfaction by Individual Program

Figure 2-11 shows the satisfaction results for each program. WRAP achieved the highest satisfaction (97%, n=208). The Student Energy Efficient Education Program achieved the lowest satisfaction (79%, n=10,860).

Further details on each program’s satisfaction results are provided in the individual program chapters.

**Figure 2-11. PY12 Program Satisfaction by Individual Program
Very and Somewhat Satisfied Combined**



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?"

2.12 Findings and Recommendations

The impact and process evaluation activities completed by Cadmus led to recommendations for program improvement. Cadmus does not have any overarching recommendations that affect more than one program. Specific recommendations for each program are in the program chapters.

3 Evaluation Results by Program

This chapter documents the gross impact, net impact, and process evaluation activities conducted in PY12, along with the outcomes of those activities. The individual program chapters are organized by the largest contributor to PY12 portfolio savings to the smallest. Program information in portfolio-level tables are organized in alphabetical order.

Table 3-1 lists the activities for each program in PPL Electric Utilities' portfolio.

Table 3-1. PY12 Evaluation Activity Matrix

Program	Sector	Gross Impact	Net Impact	Process ⁽¹⁾
Appliance Recycling	Residential	✓		✓
Demand Response	Demand Response	✓		✓
Energy Efficient Home	Residential	✓	✓	✓
Home Energy Education	Residential	✓		✓
Non-Residential - Custom	Nonresidential	✓	✓	✓
Non-Residential - Efficient Equipment	Nonresidential	✓	✓	✓
Non-Residential - Midstream Lighting	Nonresidential	✓		✓
Student Energy Efficient Education	Residential	✓		✓
WRAP	Low-income	✓		✓

⁽¹⁾ Cadmus conducted a limited process evaluation in PY12.

3.1 Impact Evaluation

Impact evaluation activities varied by program in PY12. More detailed explanations of each program's impact evaluation methodology and analyses are contained in the program chapters and their respective appendices. Table 3-2 lists the impact evaluation activities conducted for each program in PY12 along with the number of site visits conducted for each program. In many cases, Cadmus converted to virtual site visits due to COVID-19.

The individual program chapters discuss the impact evaluation activities, methodology, findings, and any impact of COVID-19 on the evaluation.

Table 3-2. PY12 Impact Evaluation Activities by Program

Program	Impact Evaluation Activity						
	Database Review	Records Review	Desk Reviews	Site Visits ⁽¹⁾	Metering	Engineering Analysis	Billing Analysis
Appliance Recycling	✓					✓	
Demand Response	✓	✓					✓
Energy Efficient Home	✓	✓	✓	✓ ⁽²⁾		✓	
Home Energy Education	✓						✓
Non-Residential - Custom	✓	✓	✓	✓ ⁽³⁾	✓	✓	✓
Non-Residential - Efficient Equipment	✓	✓	✓	✓ ⁽⁴⁾		✓	
Non-Residential - Midstream Lighting	✓	✓	✓	✓ ⁽⁵⁾		✓	
Student Energy Efficient Education	✓					✓ ⁽⁶⁾	
WRAP	✓	✓				✓	
⁽¹⁾ Site visits completed by Cadmus either in person or virtually. ⁽²⁾ Includes nine in-person site visits conducted in unoccupied homes. ⁽³⁾ Includes 29 visits (19 virtual and 10 in-person). One project received both a virtual and in-person site visit. ⁽⁴⁾ Includes two equipment visits (all virtual) and six lighting visits (all virtual). ⁽⁵⁾ Includes four site visits (all virtual) to verify 23 jobs. ⁽⁶⁾ Engineering analysis uses paper and online home energy worksheets (HEWs) administered by the ICSP.							

3.2 Process Evaluation

This section summarizes the process evaluation of PPL Electric Utilities' PY12 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.

Each program assessment is discussed in more detail in the individual chapters of this report. The chapters discuss the findings from the program-specific evaluation activities and note any modifications to these activities from Cadmus' evaluation plans.

Table 3-3 lists the process evaluation activities conducted for each program in PY12, along with the total number of survey and interview respondents reached for each program. A more detailed explanation of each programs' survey methodology is in the program chapters and their respective appendices.

Table 3-3. PY12 Process Evaluation Activities by Program

Program	Completed Participant Survey ⁽¹⁾	Participant Satisfaction Analysis	Stakeholder Interviews /Feedback	Trade Ally Interview	Market Actor Interview
Appliance Recycling	166	✓	✓		
Demand Response	6	✓	✓		
Energy Efficient Home	714 ⁽²⁾	✓	✓		
Home Energy Education			✓ ⁽³⁾		
Non-Residential - Custom	12	✓	✓		
Non-Residential - Efficient Equipment	69 ⁽⁴⁾	✓	✓		
Non-Residential - Midstream Lighting	12 ⁽⁵⁾	✓	✓	8 ⁽⁶⁾	
Student Energy Efficient Education	10,860 ⁽⁷⁾	✓	✓		50 ⁽⁸⁾
WRAP	208	✓	✓		5 ⁽⁹⁾
Total	12,047	N/A	N/A	8	55
⁽¹⁾ Includes all survey modes: online, telephone, and paper. For additional detail, see program chapter and appendix. This may not match the totals used for program satisfaction, net-to-gross, or impact inputs. ⁽²⁾ Includes 449 equipment, 10 in-home audit, 154 online assessment, 38 weatherization, and 63 online marketplace surveys. ⁽³⁾ Program updates were gathered via email from program managers along with regular check-in calls. ⁽⁴⁾ Includes five equipment, 27 direct discount lighting, and 37 prescriptive lighting surveys. ⁽⁵⁾ These are participating distributors. ⁽⁶⁾ These are contractor purchasers. ⁽⁷⁾ Includes 10,860 paper and online home energy worksheets administered by the ICSP. ⁽⁸⁾ Includes 50 ICSP-administered online surveys with participating teachers. ⁽⁹⁾ Includes five interviews with home energy auditors and inspectors.					

4 Portfolio Finances and Cost Recovery

This section provides an overview of the expenditures associated with PPL Electric Utilities' portfolio and the recovery of those costs from ratepayers.

4.1 Program Finances

Program-specific and portfolio total finances for PY12 are shown in Table 4-1 and for Phase III in Table 4-2. Column headings in these tables are adapted from the Direct Program Cost categories in the PA PUC's template for the EE&C plan for Phase III.²² The column titled EDC Materials, Labor, and Administration includes costs associated with an EDC's own employees. The column headed ICSP Materials, Labor, and Administration includes both the program implementation contractor and the costs of any other outside vendors and EDCs employed to support program delivery. These dollar amounts are based on EDC tracking of expenditures with no adjustments to account for inflation.²³

Table 4-1. PY12 Program and Portfolio Total Finances (\$1,000)

Program	Incentives to Participants and Trade Allies	EDC Materials, Labor, and Administration	ICSP Materials, Labor, and Administration	EM&V	Total ⁽¹⁾
Appliance Recycling Program	\$177	\$75	\$1,497	-	\$1,749
Demand Response Program	\$1,407	\$36	\$1,105	-	\$2,549
Efficient Lighting Program	\$5	\$39	\$138	-	\$182
Energy Efficiency Kits & Education Program ⁽²⁾	\$0	\$16	\$30	-	\$46
Energy Efficient Home Program	\$3,537	\$77	\$3,151	-	\$6,765
Home Energy Education Program	\$0	\$42	\$2,345	-	\$2,388
Non-Residential Energy Efficiency	\$12,783	\$157	\$6,996	-	\$19,937
Student Energy Efficiency Education Program ⁽²⁾	\$0	\$54	\$1,622	-	\$1,676
WRAP ⁽²⁾	\$0	\$180	\$4,925	-	\$5,106
Common Portfolio Costs ⁽³⁾	\$0	\$3,267	\$921	\$2,509	\$6,697
Portfolio Total ^{(3) (4)}	\$17,910	\$3,945	\$22,731	\$2,509	\$47,095
SWE Costs ⁽⁵⁾	-	-	-	-	\$300
Total ⁽⁴⁾	\$17,910	\$3,945	\$22,731	\$2,509	\$47,395

⁽¹⁾ Total may not sum due to rounding and may not match costs listed in the individual program cost-effectiveness tables due to rounding.

⁽²⁾ Costs associated with program measures provided to customers at no cost are categorized as administrative costs.

⁽³⁾ Common Portfolio Costs are costs applicable to more than one customer class, to more than one program, or those that provide portfolio-wide benefits. These include PPL Electric Utilities labor and materials, costs related to PPL Electric Utilities' tracking system, EE&C plan development, etc.

⁽⁴⁾ Portfolio Total and Total may not equal total of column due to rounding.

⁽⁵⁾ SWE costs are outside of the 2% spending cap.

²² Pennsylvania Public Utility Commission. *Implementation of Act 129 of 2008—Phase III Energy Efficiency and Conservation Plan Template Docket No. M-2014-2424864*. Section 10. July 21, 2015.

²³ The cost recovery of program expenses through riders generally happens promptly so that costs are being recovered from ratepayers in the same dollars that they are incurred.

Program-specific and portfolio total finances since the inception of Phase III are shown in Table 4-2.

Table 4-2. P3TD Program and Portfolio Total Finances (\$1,000)

Program	Incentives to Participants and Trade Allies	EDC Materials, Labor, and Administration	ICSP Materials, Labor, and Administration	EM&V	Total ⁽¹⁾
Appliance Recycling Program	\$1,692	\$271	\$8,039	-	\$10,002
Demand Response Program	\$5,448	\$306	\$3,900	-	\$9,655
Efficient Lighting Program	\$23,410	\$283	\$6,465	-	\$30,158
Energy Efficiency Kits & Education Program ^[2]	\$0	\$208	\$6,415	-	\$6,624
Energy Efficient Home Program	\$14,076	\$311	\$16,339	-	\$30,726
Home Energy Education Program	\$0	\$202	\$8,039	-	\$8,241
Non-Residential Energy Efficiency	\$58,059	\$943	\$32,217	-	\$91,219
Student Energy Efficiency Education Program ^[2]	\$0	\$250	\$6,240	-	\$6,490
WRAP ^[2]	\$0	\$1,083	\$34,234	-	\$35,317
Common Portfolio Costs ^[3]	\$0	\$15,198	\$5,925	\$13,073	\$34,195
Portfolio Total ^{[3] [4]}	\$102,685	\$19,057	\$127,813	\$13,073	\$262,627
SWE Costs ^[5]	-	-	-	-	\$2,200
Total ^[4]	\$102,685	\$19,057	\$127,813	\$13,073	\$264,827

⁽¹⁾ Total may not sum due to rounding and may not match program costs listed in the individual program cost-effectiveness tables due to rounding and discounting.

⁽²⁾ Costs associated with program measures provided to customers at no cost are categorized as administrative costs.

⁽³⁾ Common Portfolio Costs are costs applicable to more than one customer class, to more than one program, or to those that provide portfolio-wide benefits. These include PPL Electric Utilities labor and materials, costs related to PPL Electric Utilities' tracking system, EE&C plan development, etc.

⁽⁴⁾ Portfolio Total and Total may not be equal due to rounding.

⁽⁵⁾ SWE costs are outside of the 2% spending cap.

4.2 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 4-3 shows PPL Electric Utilities' EE&C Plan Expenditures for PY12 and Phase III.

Table 4-3. EE&C Plan Expenditures by Cost-Recovery Category⁽¹⁾ (\$1,000)

Cost Recovery Customer Sector	Rate Schedules Included	PYTD Spending	P3TD Spending
Residential & Low-Income	Residential (primarily RS)	\$21,531	\$142,206
Small C&I	Small C&I (primarily GS1 & GS3)	\$13,612	\$57,537
Large C&I	Large C&I (primarily LP4 & LP5)	\$8,002	\$42,490
GNE	Residential, Small C&I, and Large C&I	\$4,250	\$22,594
Portfolio Total ^[2]	-	\$47,395	\$264,827
^[1] Includes SWE costs.			
^[2] Totals may not sum due to rounding.			

5 Non-Residential Energy Efficiency Program

PPL Electric Utilities' Non-Residential Energy Efficiency Program offers financial incentives to customers in a nonresidential rate class and for any building or business type. The program comprises four distinct components—Efficient Equipment, Midstream Lighting, Custom, and Continuous Energy Improvement (CEI). For this evaluation, Cadmus treated each of these components as an individual program offering and designed a distinct set of data collection activities, research, and evaluation methodologies.

The Non-Residential Energy Efficiency Program components and the evaluation methodology, findings, conclusions, and recommendations for each component are described in separate chapters. PPL Electric Utilities did not offer the CEI component in PY12, so there is no chapter addressing this program.

- **Chapter 6 Non-Residential Efficient Equipment** component offers prescriptive rebates and direct discounts to small businesses for lighting and equipment products.
- **Chapter 7 Non-Residential Midstream Lighting** component offers incentives to distributors of efficient lighting products for eligible products sold to PPL Electric Utilities' customers.
- **Chapter 8 Non-Residential Custom** component provides financial incentives to customers who install products or offer services that are not offered in PPL Electric Utilities' other programs.

Due to COVID-19 restrictions, Cadmus conducted fewer in-person site visits than in previous program years and instead, based on guidance from the SWE, collected data through either virtual site visits or desk reviews.²⁴ These details are included in the individual chapters.

These are the objectives of the Non-Residential Energy Efficiency Program:²⁵

- 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
- Encourage customers to take a comprehensive, whole-facility approach to energy efficiency by installing high-efficiency custom measures 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 energy-efficient equipment
- Support emerging technologies and nontypical efficiency solutions in cost-effective applications

²⁴ Pennsylvania Statewide Evaluation (SWE) Team. *PY11 EM&V and the Coronavirus Outbreak*. Memo to EDCs and EDC evaluation contractors. June 03, 2020.

²⁵ Program objectives are stipulated in 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. November 2018.

- Encourage advanced energy efficiency strategies required for certification by national market transformation programs such as Leadership in Energy and Environmental Design (LEED), Architecture 2030, or ENERGY STAR Buildings
- Engage trade allies to stock, promote, and provide high-efficiency technology options to customers
- Promote other PPL Electric Utilities energy efficiency programs
- Collect energy and operating data from customers, as required to confirm customer and measure eligibility, and to determine energy savings and cost-effectiveness
- Obtain participation necessary to achieve approximately 810,810 MWh/year gross verified savings
- Achieve high customer and trade ally satisfaction with the program

5.1 Gross Savings Impact Evaluation

Table 5-1 shows the Non-Residential Energy Efficiency Program's verified gross savings.

Table 5-1. Non-Residential Energy Efficiency Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	143,573	162,377	184,990	229,943	194,768	915,650 ⁽¹⁾
⁽¹⁾ Phase III verified savings may not match sum of program years due to rounding.						

The impact and process evaluation findings for each non-residential component are described in the component's individual chapter. Table 5-2 presents the participation counts, reported and verified energy savings and demand reductions, and incentive payments across all components of the Non-Residential Energy Efficiency Program in PY12 by customer segment.

Table 5-2. PY12 Non-Residential Energy Efficiency Program Participation and Reported Impacts

Parameter	Residential	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total ⁽¹⁾
PYTD # Participants	157	4,501	1,411	2,167	8,236
PYRTD MWh/yr	611	107,473	45,078	36,196	189,359
PYRTD MW/yr	0.09	15.15	6.25	6.99	28.49
PYVTD MWh/yr	684	110,374	46,654	37,057	194,768
PYVTD MW/yr	0.08	13.66	6.02	6.83	26.59
PY12 Incentives (\$1000)	\$47	\$8,040	\$2,329	\$2,368	\$12,783
⁽¹⁾ Total may not match sum of columns due to rounding. Total may not match sum of totals from individual Non-Residential Program components due to rounding.					

Cadmus calculated gross verified savings using data from the PPL Electric Utilities tracking database and from a combination of evaluation activities, including records review, desk review, engineering analyses, site visits, and billing analysis. Table 5-3 shows the gross energy savings and demand reductions realization rates for the components of the Non-Residential Energy Efficiency Program in PY12.

Table 5-3. PY12 Non-Residential Energy Efficiency Program Gross Energy Savings and Demand Reductions Realization Rates by Component

Component	PYRTD MWh/yr	PYRTD MW/yr	Energy Savings Realization Rate	Demand Reductions Realization Rate	PYVTD MWh/yr	PYVTD MW/yr
Efficient Equipment - Lighting	86,350	12.69	97.6%	92.1%	84,245	11.69
Efficient Equipment - Equipment	3,175	0.14	100.6%	97.8%	3,195	0.13
Midstream Lighting	33,769	5.89	113%	76%	38,196	4.49
Custom	66,065	9.76	105%	105%	69,132	10.28
Total ⁽¹⁾	189,359	28.49	103%	93%	194,768	26.59

⁽¹⁾ May not sum due to rounding.

Table 5-4 and Table 5-5 show the Non-Residential Energy Efficiency Program's PY12 total reported energy savings and demand reductions, respectively.

Table 5-4. PY12 Non-Residential Energy Efficiency Program Gross Impact Results for Energy

	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MWh/yr ⁽¹⁾
Program Total	189,359	103%	N/A	4.64%	194,768

⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.

Table 5-5. PY12 Non-Residential Energy Efficiency Program Gross Impact Results for Demand

	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MW/yr ⁽¹⁾
Program Total	28.49	93%	N/A	5.36%	26.59

⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.

5.2 Net Savings Impact Evaluation

Table 5-6 shows the NTG ratios for the Non-Residential Energy Efficiency Program components in PY12.

Table 5-6. PY12 Non-Residential Energy Efficiency Program NTG Ratios by Component

Component	NTG Ratio	Program Verified Gross MWh/yr	Percentage of Total Program Verified Gross MWh/yr	Program Verified Net MWh/yr
Efficient Equipment - Lighting	0.72	84,245	43%	60,656
Efficient Equipment - Equipment	0.63	3,195	2%	2,013
Midstream Lighting	0.62 ⁽¹⁾	38,196	20%	23,681
Custom	0.61	69,132	35%	42,171
Total ⁽²⁾	0.66	194,768	100%	128,521

⁽¹⁾ Cadmus applied the PY11 ratio in PY12.
⁽²⁾ May not sum due to rounding.

5.3 Verified Savings Estimates

Table 5-7 shows the reported energy savings (PYRTD) and verified gross and net energy savings estimates for the Non-Residential Energy Efficiency Program in PY12.

Table 5-7. PYTD and P3TD Non-Residential Energy Efficiency Program Savings Summary

Savings Type	Energy (MWh/yr) ⁽¹⁾	Total Demand (MW/yr) ⁽¹⁾
PYRTD	189,359	28.49
PYVTD Gross	194,768	26.59
PYVTD Net ⁽²⁾	128,521	17.55
P3RTD	927,856	129.19
P3VTD Gross	915,650	125.31
P3VTD Net ⁽²⁾	656,297	90.20
⁽¹⁾ Total may not match sum of totals from individual Non-Residential Energy Efficiency Program components due to rounding.		
⁽²⁾ Net savings are not used to meet PPL Electric Utilities' energy savings compliance target.		

5.4 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 5-8. The total resource cost (TRC) benefits were calculated using gross verified impacts. Net present value (NPV) PYTD costs and benefits are expressed in PY12 dollars (PY12 includes months in both 2020 and 2021). NPV costs and benefits for P3TD financials are expressed in the PY8 dollars. The TRC costs and benefits in this table do not include costs and benefits from unverified projects.

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.²⁶ A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix L. Non-Energy Benefits*.

²⁶ Guidance on the Inclusion of fossil fuel and H₂O benefits in the TRC Test, Statewide Evaluation Team, March 25, 2018.

Table 5-8. Summary of Program Finances – Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽¹⁾	
1	EDC Incentives to Participants	\$12,783		\$49,507	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$45,816		\$238,223	
4	Incremental Measure Costs (Sum of rows 1 through 3) ⁽²⁾	\$58,600		\$287,730	
		EDC	CSP	EDC	CSP
5	Design & Development ⁽³⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽⁴⁾	\$157	-	\$830	-
7	Marketing ⁽⁵⁾	-	\$802	-	\$2,770
8	Program Delivery ⁽⁶⁾	-	\$6,193	-	\$24,902
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽²⁾	\$7,153		\$28,502	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$3,007		\$14,160	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ⁽⁷⁾	\$68,760		\$330,392	
14	Total NPV Lifetime Electric Energy Benefits	\$120,633		\$442,985	
15	Total NPV Lifetime Electric Capacity Benefits	\$17,767		\$68,266	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$6,643		\$23,157	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	(\$7,577)		(\$23,747)	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ⁽⁸⁾	\$137,466		\$510,661	
19	TRC Benefit-Cost Ratio ⁽⁹⁾	2.00		1.55	

⁽¹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

⁽²⁾ May not sum to total due to rounding.

⁽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 ICSP and marketing costs by program ICSPs.

⁽⁶⁾ 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.

⁽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 5-9 presents program financials and cost-effectiveness on a net savings basis.

Table 5-9. Summary of Program Finances – Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽¹⁾	
1	EDC Incentives to Participants	\$8,552		\$46,353	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$29,503		\$226,066	
4	Incremental Measure Costs (Sum of rows 1 through 3) ⁽²⁾	\$38,055		\$272,420	
		CSP	EDC	CSP	EDC
5	Design & Development ⁽³⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽⁴⁾	\$157	-	\$830	-
7	Marketing ⁽⁵⁾	-	\$802	-	\$2,770
8	Program Delivery ⁽⁶⁾	-	\$6,193	-	\$24,902
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11 ⁽⁷⁾	Program Overhead Costs (Sum of rows 5 through 10) ⁽²⁾	\$7,153		\$28,502	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$1,834		\$13,286	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ⁽⁸⁾	\$47,042		\$314,208	
14	Total NPV Lifetime Electric Energy Benefits	\$79,737		\$412,510	
15	Total NPV Lifetime Electric Capacity Benefits	\$11,773		\$63,799	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$4,491		\$21,554	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	(\$5,168)		(\$21,952)	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ⁽⁹⁾	\$90,833		\$475,911	
19	TRC Benefit-Cost Ratio ⁽¹⁰⁾	1.93		1.51	

(1) All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

(2) May not sum to total due to rounding.

(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 ICSP and marketing costs by program ICSPs.

(6) 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.

(7) Rows 1-11 are presented in nominal dollars.

(8) Total TRC Costs includes Total EDC Costs and Participant Costs.

(9) 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.

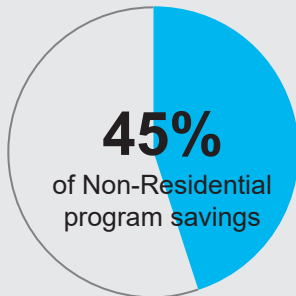
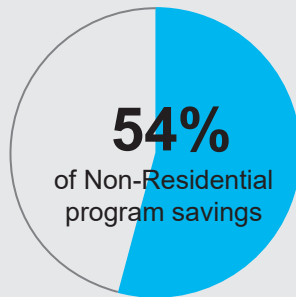
(10) TRC Ratio equals Total NPV TRC Benefits divided by Total NPV TRC Costs.

EFFICIENT EQUIPMENT PROGRAM

This program promotes the purchase and installation of high-efficiency equipment and lighting by offering customers financial incentives to offset purchase costs and by providing information on efficiency features and benefits.

VERIFIED ENERGY SAVINGS

Phase III
has saved
495,629 MWh/yr



**PY12 saved
87,440 MWh/yr**

PY12 PARTICIPATION

A total of **617** participants



341 Prescriptive Lighting

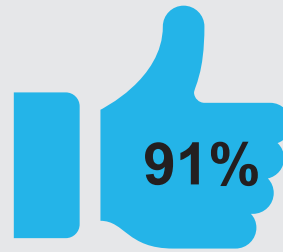


224 Direct Discount Lighting



52 Equipment

PROGRAM SATISFACTION



Satisfied with
overall program

100% satisfied with **Direct Discount Lighting**

89% satisfied with **Prescriptive Lighting**

60% satisfied with **Equipment**

98% satisfied with the **professionalism** of the
program representatives

90% satisfied with the **time it took to
process their application**

89% satisfied with the **ease of the
online application process**

88% satisfied with **communication**
throughout the project

84% satisfied with the **information provid-
ed about the application process**

81% satisfied with the **ability to
track their rebates**

6 Non-Residential Efficient Equipment Program

The Efficient Equipment component of the Non-Residential Energy Efficiency Program (hereafter referred to as 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 by 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 and equipment (HVAC, refrigeration, motors, food service, office, and agricultural) through two delivery channels—prescriptive and direct discount.

Prescriptive delivery channel. In the prescriptive delivery channel, 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 \$0.02 to \$0.17 per annual kWh saved. Incentives may be capped at 50% to 100% of the total project costs (excluding internal labor), with a maximum incentive of \$500,000.

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 fixtures and controls, commercial refrigeration equipment and controls, and compressed air system upgrades. This channel does not have a maximum energy savings cap but is limited to small C&I facilities with GS-1 or GS-3 rate codes. 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. The customer pays the contractor for the discounted equipment up front, thereby lowering the overall cost burden. PPL Electric Utilities awards the incentive to the contractor who has already passed the cost savings to the customer.

In this report, projects are referred to as either lighting or equipment (non-lighting). The report is organized first by lighting then by equipment.

6.1 Lighting

6.1.1 Definition of a Lighting Participant

A **prescriptive lighting participant** is defined as a unique job initiated by a customer. In PY12, the prescriptive lighting channel had 341 lighting jobs (9,000 individual database records) and 311 unique customers.

A **direct discount lighting participant** is defined as a unique job completed for a unique customer. In PY12, the direct discount lighting delivery channel had 224 jobs (1,835 individual database records) and 221 unique customers. In PY9, Cadmus evaluated the lighting jobs from the direct discount delivery channel as a separate stratum from the prescriptive lighting jobs. Since PY10, Cadmus has grouped the direct discount lighting jobs with the prescriptive lighting stratum because the PY9 evaluation did not

find meaningful differences in the coefficient of variation or the realization rates between the two delivery channels.²⁷

6.1.2 Program Participation and Reported Impacts for Lighting

Table 6-1 presents the participation counts, reported energy and demand savings, and incentive payments for the lighting portion of the Efficient Equipment Program in PY12, by customer segment.

Table 6-1. PY12 Efficient Equipment Program Lighting Participation and Reported Impacts

Parameter	Small C&I	Large C&I	GNE	Total ⁽¹⁾
PYTD # Participants	476	48	41	565
PYRTD MWh/yr	69,459	11,499	5,392	86,350
PYRTD MW/yr	9.97	1.87	0.85	12.69
PYVTD MWh/yr	68,152	10,994	5,099	84,245
PYVTD MW/yr	9.17	1.72	0.79	11.69
PY12 Incentives (\$1000) ⁽²⁾	N/A			
⁽¹⁾ May not match due to rounding.				
⁽²⁾ Incentives are tracked at the program level and reported in findings for the Non-Residential Energy Efficiency Program.				

6.2 Gross Impact Evaluation – Lighting

The evaluation sampling strategy is shown in Table 6-2. See *Appendix D.1.2 Ex Post Verified Savings Methodology for Lighting* for additional details.

Cadmus verified 42 projects. All projects in the verification sample undergo a detailed records review, but due to COVID-19 restrictions, on-site inspections were not possible for all sampled projects. Cadmus conducted virtual site inspections for six of the 42 projects by verifying details of installation and operation in phone interviews through video calls with the customer representatives. Representatives at businesses for the virtual site visits and desk reviews also provided self-report data during phone interviews and pictures of the installed lighting equipment and other documentation.

Table 6-2. PY12 Efficient Equipment Program Lighting Gross Impact Evaluation Sample Design

Stratum	Participants ⁽¹⁾	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Prescriptive and Direct Discount Lighting	565	90/10 (Minimum sample size of 10/stratum)	36	Desk review
			6	In-person or virtual site visit ⁽²⁾
Program Total	565		42	
⁽¹⁾ A participant is defined as a unique job completed for a unique customer.				
⁽²⁾ All site visits were conducted virtually				

²⁷ PPL Electric Utilities. *Annual Report Program Year 9: June 1, 2017–May 31, 2018*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2018.

6.2.1 Gross Savings Impact Evaluation Results - Lighting

Table 6-3 shows the program's verified gross energy savings.

Table 6-3. Efficient Equipment Program Lighting Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	67,246	112,402	93,138	121,451	84,245	478,482 ⁽¹⁾
⁽¹⁾ Phase III verified savings may not match sum of program years due to rounding.						

In PY12, the lighting portion of the Efficient Equipment Program reported energy savings of 86,350 MWh/yr, as shown in Table 6-4, and demand reduction of 12.69 MW/yr, as shown in Table 6-5. See *Appendix D.1 Site Visit and Desk Review Findings – Lighting* for additional information.

Table 6-4. PY12 Efficient Equipment Program Lighting Gross Impact Results for Energy

Substratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 90% C.L.	PYVTD (MWh/yr) ⁽¹⁾
Lighting -- Small	7,580	99.9%	0.023	1.38%	7,570
Lighting -- Medium	14,712	98.5%	0.187	17.4%	14,495
Lighting -- Large	23,916	89.9%	0.238	27.1%	21,495
Lighting -- Threshold	40,142	101.4%	0.054	0.78%	40,685
Lighting Total ⁽²⁾	86,350	97.6%	-	5.5%	84,245
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ May not match due to rounding.					

Table 6-5. PY12 Efficient Equipment Program Lighting Gross Impact Results for Demand

Substratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 90% C.L.	PYVTD (MW/yr) ⁽¹⁾
Lighting -- Small	1.01	95.8%	0.113	6.9%	0.97
Lighting -- Medium	2.17	97.8%	0.172	16.0%	2.12
Lighting -- Large	3.53	91.0%	0.221	25.1%	3.21
Lighting -- Threshold	5.99	90.0%	0.221	3.2%	5.39
Lighting Total ⁽²⁾	12.69	92.1%	-	5.7%	11.69
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ May not match due to rounding.					

Lighting projects achieved 84,245 MWh per year of verified energy savings with a 97.6% energy realization rate and 11.69 MW/yr of verified demand reduction with a 92.1% demand realization rate. The primary contributors to the energy and demand realization rates that differed from 100% were differences in calculated hours of use from metered data and in coincidence factors. Other contributors were differences in verified existing and/or installed fixture quantities, types and wattages, lighting control types, and verified space conditioning types. Additional information is in *Appendix D.1 Lighting*.

6.3 Net Savings Impact Evaluation – Lighting

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,²⁸ which discusses the common methods used to determine free ridership and spillover. Cadmus used self-report surveys, administered online and by phone, to assess free ridership and spillover for the Efficient Equipment Program.

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

Table 6-6 lists the methods and sampling strategy used to determine net savings for the lighting portion of the Efficient Equipment Program in PY12. Additional details about methodology are in *Appendix D.1.2 Ex Post Verified Savings Methodology for Lighting* and *Appendix N Survey Methodology*.

Table 6-6. PY12 Efficient Equipment Program Lighting Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size	Achieved Sample Size	NTG Activity
Prescriptive and Direct Discount Lighting	Participants	565	61 ⁽¹⁾	Self-report survey
⁽¹⁾ Three respondents did not respond to free ridership questions and are not included in the NTG analysis.				

Table 6-7 shows the free ridership, spillover, and NTG ratios by program stratum.

Table 6-7. PY12 Efficient Equipment Program Lighting Net Impact Evaluation Results

Stratum	Number of Surveys	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 90% C.L.	Ex Post kWh/yr Gross Population Savings
Prescriptive and Direct Discount Lighting	61	28% ⁽¹⁾	0%	0.72	16%	84,244,509
⁽¹⁾ 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 equipment-level free ridership estimate than do the respondents who achieved lower energy savings.						

The Phase III Evaluation Framework requires the identification and oversampling of high-impact measures and services to assess free ridership with greater certainty.²⁹ In the Efficient Equipment Program, Cadmus determined that commercial lighting projects contributed greater than 5% of the overall PY12 savings to the non-residential sector and therefore classified commercial lighting as a high-impact measure. For net savings calculations, 61 lighting participants completed the NTG questions in self-report surveys. At 90% confidence, Cadmus calculated a NTG ratio of 0.72 with relative precision of 16% and at 85% confidence with a relative precision of 14%.

²⁸ 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. Final version May 8, 2018.

²⁹ Ibid.

6.4 Verified Savings Estimates – Lighting

In Table 6-8, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the lighting portion of the Efficient Equipment Program in PY12.

Table 6-8. PYTD and P3TD Efficient Equipment Program Lighting Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD Gross	86,350	12.69
PYVTD Gross	84,245	11.69
PYVTD Net ⁽¹⁾	60,656	8.41
P3RTD Gross	484,972	68.55
P3VTD Gross	478,482	67.34
P3VTD Net ⁽¹⁾	355,226	49.98
⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		

6.5 Equipment

6.5.1 Definition of an Equipment Participant

An equipment participant is defined as a unique job initiated by a unique customer. A unique customer can submit multiple equipment jobs in different equipment categories (HVAC, refrigeration, motors, food service, office, and agricultural). In PY12, the equipment portion of this program had 51 equipment jobs and 50 unique equipment customers (115 database records). All but 13 of the PY12 equipment jobs followed the prescriptive delivery channel. Because the population was so small, Cadmus grouped the 13 direct discount delivery channel equipment jobs with the prescriptive stratum in PY12.

6.5.2 Program Participation and Reported Impacts for Equipment

Table 6-9 presents the participation counts, reported energy and demand savings, and incentive payments for the equipment portion of Efficient Equipment Program in PY12, by customer segment.

Table 6-9. PY12 Efficient Equipment Program Equipment Participation and Reported Impacts

Parameter	Small C&I	Large C&I	GNE	Total ⁽¹⁾
PYTD # Participants ⁽²⁾	47	1	4	52
PYRTD MWh/yr	2,712	237	227	3,175
PYRTD MW/yr	0.1270	0.0045	0.0052	0.1367
PYVTD MWh/yr	2,722	237	237	3,195
PYVTD MW/yr	0.1238	0.0045	0.0054	0.1337
PY12 Incentives (\$1000) ⁽³⁾	N/A			
⁽¹⁾ May not match due to rounding.				
⁽²⁾ Participants are defined as a unique job initiated by a unique customer by equipment categories. One job number was the same for two equipment categories and is included twice in this count.				
⁽³⁾ Incentives are tracked at the program level.				

6.6 Gross Savings Impact Evaluation – Equipment

Cadmus verified 16 projects. All projects in the verification sample undergo a detailed records review, but due to COVID-19 restrictions, on-site inspections were not possible for all sampled projects. Cadmus conducted virtual site inspections for two projects by verifying details of installation and operation through video calls with the customer representatives. Representatives at businesses for the virtual site visits and desk reviews also provided self-report data during phone interviews and pictures of the installed equipment and other documentation.

Table 6-10 shows the sample design for equipment. See *Appendix D.1.2 Ex Post Verified Savings Methodology for Equipment* and *Appendix N Survey Methodology* for additional details.

Table 6-10. PY12 Efficient Equipment Program Equipment Gross Impact Evaluation Sample Design

Stratum	Participation (Unique Jobs)	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Prescriptive and Direct Discount Equipment	51	85/15	14	Desk review
			2	In-person or virtual site visit
Total	51	85/15	16	

6.6.1 Gross Savings Impact Evaluation Results – Equipment

Table 6-11 shows the program’s verified gross energy savings.

Table 6-11. Efficient Equipment Program Equipment Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	3,671	3,592	3,059	3,630	3,195	17,147 ⁽¹⁾
⁽¹⁾ Phase III verified savings may not match sum of program years due to rounding.						

In PY12, the equipment portion of the Efficient Equipment Program reported energy savings of 3,175 MWh/yr, as shown in Table 6-12, and demand reduction of 0.14 MW, as shown in Table 6-13.

Table 6-12. PY12 Efficient Equipment Program Equipment Gross Impact Results for Energy

Substratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MWh/yr) ⁽¹⁾
HVAC	314	101.5%	0.06	2.52%	318
Motors	319	104.8%	-	-	334
Refrigeration	2,541	100.0%	0.00	0.01%	2,541
Other	1.85	100.0%	0.00	0.00%	1.85
Total ⁽²⁾	3,175	100.6%	-	0.24%	3,195
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ May not match due to rounding.					

Table 6-13. PY12 Efficient Equipment Program Equipment Gross Impact Results for Demand

Substratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD (MW/yr) ⁽¹⁾
HVAC	0.0636	94.4%	0.17	7.35%	0.0600
Motors	0.0119	104.8%	-	-	0.0125
Refrigeration	0.0609	99.8%	0.00	0.01%	0.0608
Other	0.00033	99.9%	0.00	0.00%	0.00033
Total ⁽²⁾	0.1367	97.8%	-	3.14%	0.1337
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings					
⁽²⁾ May not match due to rounding.					

Equipment projects achieved 3,195 MWh per year of verified energy savings with a 100.6% energy realization rate. Equipment projects achieved 0.1337 kW/yr of verified demand reduction with a 97.8% demand realization rate. The primary contributors to the energy and demand realization rates that differed from 100% were in-service rates, incorrect reported equipment capacities, incorrect operating parameters, and incorrect baseline classification. Additional information is in *Appendix D.2 Equipment*.

6.7 Net Savings Impact Evaluation – Equipment

Table 6-14 lists the methods and sampling strategy used to determine net savings for the equipment portion of the Efficient Equipment component of the Non-Residential Energy Efficiency Program in PY12. Additional details about methodology are in *Appendix D.1.2 Ex Post Verified Savings Methodology for Equipment* and *Appendix N Survey Methodology*.

Table 6-14. PY12 Efficient Equipment Program Equipment Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size	Achieved Sample Size	NTG Activity
Prescriptive and Direct Discount Equipment	Participants	51	5	Self-report survey

For net savings calculations, Cadmus attempted to survey all eligible equipment participants and five completed the self-report surveys. Table 6-15 shows the free ridership, spillover, and NTG ratios by program stratum.

Table 6-15. PY12 Efficient Equipment Program Equipment Net Impact Evaluation Results

Stratum	Number of Surveys	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.	Ex Post kWh/yr Gross Population Savings
Prescriptive and Direct Discount Equipment	5	37% ⁽¹⁾	0%	0.63	23%	3,195,226
⁽¹⁾ 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 equipment-level free ridership estimate than do the respondents who achieved lower energy savings.						

6.8 Verified Savings Estimates – Equipment

In Table 6-16, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the equipment portion of the Efficient Equipment Program in PY12.

Table 6-16. PYTD and P3TD Efficient Equipment Program Equipment Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD Gross	3,175	0.14
PYVTD Gross	3,195	0.13
PYVTD Net ⁽¹⁾	2,013	0.08
P3RTD Gross	19,832	1.32
P3VTD Gross	17,147	1.13
P3VTD Net ⁽¹⁾	10,878	0.73
⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		

6.9 Process Evaluation – Lighting and Equipment

6.9.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. The PY12 limited process evaluation of the Efficient Equipment Program assessed participant satisfaction with the program. Activities were consistent with the evaluation plan.

Table 6-17 describes the process evaluation sampling strategy for the lighting and equipment rebates.

Cadmus conducted online and telephone surveys with 69 participants of the Efficient Equipment Program using a stratified random sample. To enhance response rates following the initial email invitation, Cadmus sent two reminder emails and called all non-responders. A total of 62 participants responded to the online survey and seven to the telephone survey between February 2021 and August 2021. These surveys asked identical questions to assess program satisfaction, net savings, and the influence of the program and of the contractor or design engineer on project design, purchase decision, and program participation.

Table 6-17. Process Evaluation Sampling Strategy for the Efficient Equipment Program

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size ^{(1) (2)}	Records Selected for Sample Frame ⁽³⁾	Percent of Sample Frame Contacted to Achieve Sample ⁽⁴⁾
Equipment and Lighting								
PPL Electric Utilities Program and ICSP Staff	Staff	Telephone in-depth interview	2	N/A	2	2	2	100%
Participants	Equipment prescriptive and direct discount	Online survey	51	0.5	69	5 ⁽⁵⁾	18	100%
		Telephone survey		0.5				
	Prescriptive lighting	Online survey	341	0.5		37 ⁽⁶⁾	137	100%
		Telephone survey						
	Direct discount lighting	Online survey	224	0.5		27 ⁽⁷⁾	123	100%
		Telephone survey						
Program Total			618	-	71	71	280	-
⁽¹⁾ Cadmus attempted to complete 23 surveys in each of the three strata but was unable to do this in the equipment stratum due to lack of available records. All available equipment records were exhausted in an attempt to reach the equipment stratum target.								
⁽²⁾ Not all survey respondents answered all the net savings questions or the overall satisfaction question.								
⁽³⁾ Sample frame is a list of participants with contact information who had 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 who 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. See <i>Appendix D.4 Survey Sample Attrition</i> .								
⁽⁴⁾ Percent contacted means the percentage of the sample frame contacted to complete surveys.								
⁽⁵⁾ One was completed via telephone and four were completed online.								
⁽⁶⁾ Three were completed via telephone and 34 were completed online.								
⁽⁷⁾ Three were completed via telephone and 24 were completed online								

Program Satisfaction

The Efficient Equipment Program was delivered effectively in PY12 and maintains high levels of customer satisfaction.

As shown in the program's infographic, 91% of PY12 respondents were satisfied with the overall program (71% were *very satisfied* and 20% were *somewhat satisfied*; n=69).³⁰ Though this was a decrease from PY11,³¹ where overall satisfaction was 95% (n=79), it was not a significant change. All direct discount lighting respondents (100%, n=27), 89% of prescriptive lighting respondents (n=37), and

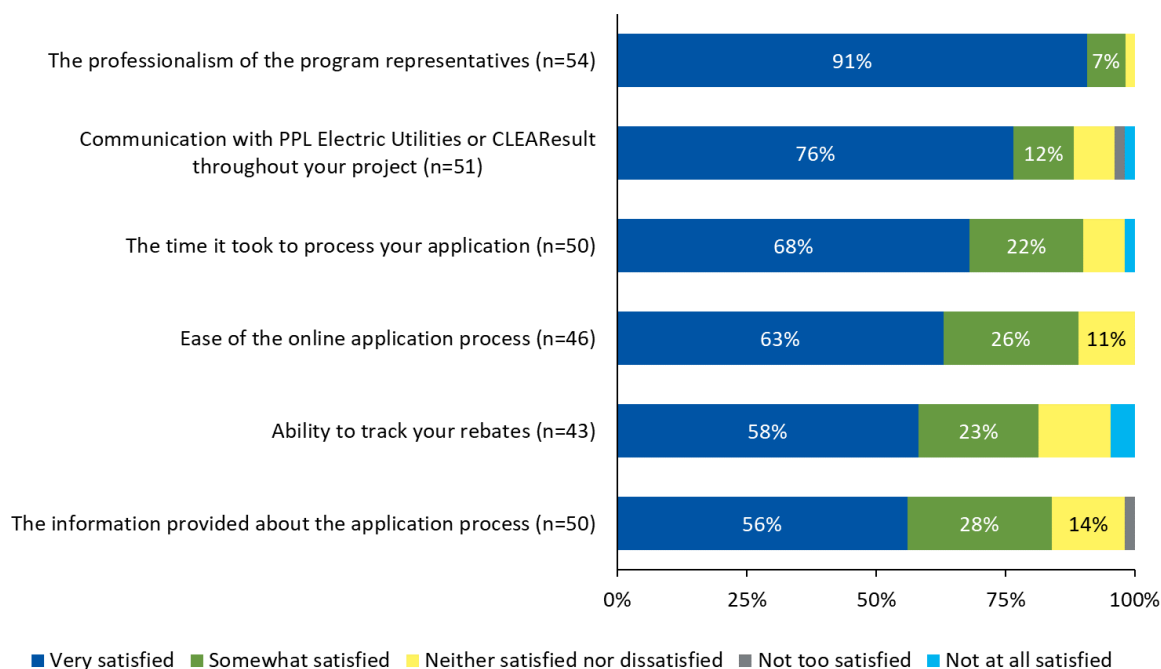
³⁰ Additionally, 6% were *neither satisfied nor dissatisfied* and 3% were *not too satisfied* (n=69).

³¹ PPL Electric Utilities. *Annual Report Program Year 11: June 1, 2019–May 31, 2020*. Presented to PA PUC. Prepared by Cadmus. February 15, 2021.

60% of equipment respondents were *very* or *somewhat satisfied* (n=5).³² Two prescriptive lighting respondents were *not too satisfied* with the program overall.

As shown in Figure 6-1, respondents were most satisfied with the professionalism of the program representatives (98%; n=54), which was not statistically different from PY11 (93%; n=59).³³ Satisfaction with information about the application process decreased from 94% in PY11 (n=54) to 84% in PY12 (n=50), a statistically significant change.³⁴ Satisfaction with all other program components increased from PY11.

Figure 6-1. PY12 Efficient Equipment Program Component Satisfaction



Source: Survey question, "Please indicate how satisfied you are with each program component."

³² Eighty-five percent of direct discount lighting participants were *very satisfied* and 15% were *somewhat satisfied* (n=27). Sixty-eight percent of prescriptive lighting participants were *very satisfied*, 22% were *somewhat satisfied*, 5% were *neither satisfied nor dissatisfied*, and 5% were *not too satisfied* (n=37). Twenty percent of equipment participants were *very satisfied*, 40% were *somewhat satisfied*, and 40% were *neither satisfied nor dissatisfied* (n=5). Totals may not sum to 100% due to rounding.

³³ Cadmus used a two-tailed t-test where p=0.1686.

³⁴ Cadmus used a two-tailed t-test where p=0.0776.

Of the six respondents who were dissatisfied with a program component, five were prescriptive lighting participants and one was an equipment participant. Four of the six respondents provided reasons for their dissatisfaction:

- Rebate and project timing (two responses)
- Meeting follow-up communication (one response)
- Personnel turnover (one response)

Communication Improvements

The PY12 survey asked respondents what could be changed about program-related communication. More than half (73%, n=52) said no changes were needed and 27% left a suggestion to change program-related communication. Table 6-18 shows suggested changes.

Table 6-18. Suggestions for Improving Program Related Communication

Suggested Improvement	Number of Responses (n=14)
Provide more information and updates about available programs and rebates	5
Improve rebate application and approval records	3
Increase program marketing	2
Assign key account managers	1
Provide timely communication	1
Simplify the program process	1
Communication	1
Increase frequency of communication	1
Source: Survey question, "What is one thing PPL Electric Utilities or CLEAResult could change about program-related communication?" Respondents could provide multiple responses so totals may exceed number of respondents.	

Areas for Improvement

The survey asked respondents if anything could be changed to improve the program. Seventy percent of respondents said no changes were needed (n=54), and 30% left a suggestion for improvement. Table 6-19 shows suggested improvements.

Table 6-19. Suggested Improvements for Elements of the Efficient Equipment Program

Suggested Improvement	Number of Responses (n=16)
Increase program marketing	3
Better/more communication (with CLEAResult)	3
Increase rebate amount	3
Streamline application process and materials	2
Send out rebate check/speed up rebate check	2
More information about rebate amounts on the website	1
More accessible status updates in one location	1
Not able to claim savings for products outside the programs offerings	1
Source: Survey question, "What is the one thing PPL Electric Utilities or CLEAResult could change about the program to improve it?" (n=16). Respondents could provide multiple responses so totals may exceed number of respondents.	

COVID-19 Impacts

Sixty-two percent of respondents said their project was not impacted by the COVID-19 pandemic, 31% said only their timeline was impacted, and 8% said both the project scope and timeline were impacted (n=65).

Of 25 respondents who said their timeline and/or project scope was impacted by COVID-19, 24 provided details about how their timeline and/or project scope was impacted (Table 6-20).

Table 6-20. COVID-19 Related Impacts

COVID-19 Impacts	Number of Responses
General project delays	12
Delays in obtaining materials, equipment, or components	5
Reduced staffing, job applicants, or absenteeism	4
Facility or project site closure	3
Scheduling	3
Restrictions on in-person gatherings	3
Shipping delays	2
Project uncertainty	1
General project acceleration	1
Increase in the cost of supplies, components, or inventory	1
Travel restrictions	1
Transition to virtual assessments	1
Receiving contractor bids	1
Source: Survey question, "Was your project scope or timeline impacted by COVID-19 in any way?" Respondents could provide multiple responses so totals may exceed number of respondents. (n=24)	

6.10 Cost-Effectiveness Reporting

Because the Efficient Equipment component is part of the Non-Residential Energy Efficiency Program, cost-effectiveness is presented in *Section 5 Non-Residential Energy Efficiency Program*.

6.11 Recommendations – Lighting and Equipment

Overall, the Efficient Equipment Program has been successful, with the verified savings of 87,440 MWh/year. Most survey respondents (91%; n=69) were satisfied with the program.

Because the program functioned well in PY12, Cadmus does not have any recommendations.

MIDSTREAM LIGHTING

Midstream Lighting is designed to make choosing and procuring high-efficiency lighting from a participating lighting distributor simple and fast, by discounting qualifying LED lamps, bulbs, and fixtures at the point of sale.

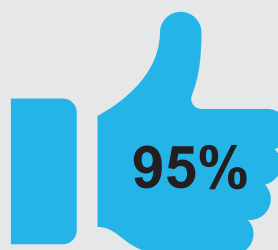
VERIFIED ENERGY SAVINGS

Phase III
has saved
108,127 MWh/yr



PY12 saved
38,196 MWh/yr

PROGRAM SATISFACTION



Satisfied with
overall program

100% **contractors** satisfied with program

92% **distributors** satisfied with program

PY12 PARTICIPATION



23 Distributors participated

7,503 Jobs

6,150 Unique projects

7 Non-Residential Midstream Lighting Program

The Midstream Lighting component of the Non-Residential Energy Efficiency Program is designed to make choosing and procuring high-efficiency lighting simpler and faster than through typical downstream program delivery channels. Contractors and PPL Electric Utilities 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. PPL Electric Utilities pays the distributor the discount, and the distributor is required to pass this discount along to the purchaser.

7.1.1 Definition of a Participant

Distributors, typically an electric equipment supply outlet, are considered to be the participants in the Midstream Lighting component because they receive the incentives. A job is defined as a participating distributor's sale of a specific qualified product to a specific business at a specific point in time.

7.1.2 Program Participation and Reported Impacts

Table 7-1 presents the participation counts and the reported energy and demand savings by customer segment for the Midstream Lighting component in PY12.

Table 7-1. PY12 Midstream Lighting Program Participation and Reported Impacts

Parameter	Residential	Small C&I	Large C&I	GNE	Total ⁽¹⁾
PYTD # Participants	157	3,907	1,337	2,102	7,503
PYRTD MWh/yr	611	19,164	6,784	7,210	33,769
PYRTD MW/yr	0.09	3.15	1.25	1.40	5.89
PYVTD MWh/yr	684	22,200	7,787	7,525	38,196
PYVTD MW/yr	0.08	2.37	0.98	1.07	4.49
PY12 Incentives (\$1000) ⁽²⁾	N/A				
⁽¹⁾ May not match due to rounding.					
⁽²⁾ Incentives are tracked at the program level and reported in findings for the Non-Residential Energy Efficiency Program.					

7.2 Gross Savings Impact Evaluation

7.2.1 Impact Evaluation Data Collection and Sample Design

In PY12, PPL Electric Utilities' tracking database contained one or multiple jobs corresponding to unique invoices for each customer. Therefore, Cadmus used the unique combination of distributor invoice number and account number to define a project for sampling purposes. Cadmus obtained the ICSP's records for all jobs associated with projects in the evaluation sample. These records consisted of the distributors' records of sales to the contractor or end user.

Cadmus sampled Midstream Lighting projects to estimate the realization rate and verified savings with $\pm 15\%$ precision at 85% confidence, assuming a coefficient of variation of 0.5. For all sampled jobs, Cadmus conducted a review of participant tracking data and project documentation as well as either virtual visits or desk reviews.

In PY12, the program reported 7,503 jobs in PPL Electric Utilities' tracking database; these jobs corresponded to 6,150 unique combinations of distributor invoice numbers and account numbers (projects). There were no threshold lighting jobs in the PY12 Midstream Lighting population.

Cadmus stratified the population of Midstream Lighting projects by demand reduction. If a project reported demand reduction of at least 20 kW, Cadmus assigned it to the virtual site visit stratum. Projects reporting less than 20 kW in demand were assigned to the desk review stratum. Cadmus then selected a random sample of projects in each stratum. Based on Q1-Q3 verification results, Cadmus noted a large variance in project-level findings, which warranted an increase in the total sample size; therefore, Cadmus verified an additional 10 projects via desk reviews and phone interviews.

Due to restrictions of the ongoing COVID-19 pandemic, on-site visits were not possible in PY12. Virtual site visits involved verifying details of installation and operation in phone interviews with customer representatives. These representatives also sent pictures of the installed lighting equipment.³⁵

Cadmus defined a site as a business at a given address. During a virtual site visit to verify a randomly sampled job, Cadmus also verified any additional jobs installed at that site during PY12. Cadmus referred to these jobs as siblings to the randomly sampled jobs and assigned them to the convenience stratum. These sibling jobs were included in the calculation of realization rates but not in the calculation of relative precision, which is based solely on the random sample of Midstream Lighting jobs. These sample sizes are shown in Table 7-2. See *Appendix E Ex Post Verified Savings Methodology* for additional details about methodology.

Table 7-2. PY12 Midstream Lighting Program Gross Impact Evaluation Sample Size

Stratum	Population Size (Projects) ⁽¹⁾	Assumed Proportion or Cv in Sample Design	Achieved Sample Size (Projects) ⁽²⁾	Impact Evaluation Activity
Midstream Lighting PY12 Random Sample	6,150	0.5	38	Records review and either desk review or virtual site visits
Midstream Lighting PY12 Convenience Sample ⁽³⁾			12	
Program Total				
⁽¹⁾ In PY12, there were 7,503 job numbers in PPL Electric Utilities' tracking database, corresponding to 6,150 unique combinations of distributor invoice numbers and account numbers (defined as a project) for Midstream Lighting.				
⁽²⁾ The 50 projects that were verified corresponded to 65 verified jobs in the sample.				
⁽³⁾ The convenience sample consisted of 11 sibling site visit projects, and one verified return.				

For the sampled jobs, Cadmus conducted a review of records, as well as either virtual site visits or phone verifications. Table 7-3 shows the number of verifications completed using a desk review or a site visit.

³⁵ Per the SWE guidance memo "PY11 EM&V and the Coronavirus Outbreak," dated June 3, 2020, in-person site visits may be converted to interviews plus the submission of detailed images.

Table 7-3. PY12 Midstream Lighting Impact Evaluation Activities

Evaluation Activity	Randomly Sampled Projects	Convenience Sampled Projects (Sibling and Verified Return)	Total Verified Projects	Total Verified Jobs	Notes
Records Review	38	12	50	65	-
Desk Review (with phone verification)	34	1	35	42	Nested within records review sample
Virtual Site Visit	4	11	15	23	Nested within records review sample

Cadmus post-stratified the population for the Midstream Lighting component using the reported annual energy savings of each project and the distribution of all projects completed during PY12. See *Appendix E.1 Evaluation Post Stratification* for details on these activities.

7.2.2 Gross Savings Impact Evaluation Results

Table 7-4 shows the Midstream Lighting program's verified gross energy savings.

Table 7-4. Midstream Lighting Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	1,917	15,915	24,306	27,794	38,196	108,127 ⁽¹⁾
⁽¹⁾ Phase III verified savings may not match sum of program years due to rounding.						

Table 7-5 highlights the growth in verified savings, demand reduction, distributor participants, and customers from PY8 through PY12.

Table 7-5. Midstream Lighting Program PY8 through PY12 Participation Growth

Year	Distributors	Unique Customers	PYVTD MWh/yr	Year-Over-Year Increase in Energy Savings	PYVTD MW/yr
PY8	12	437	1,917	N/A	0.34
PY9	17	2,046	15,915	830%	2.74
PY10	19	3,256	24,306	153%	4.27
PY11	21	2,336	27,794	114%	4.24
PY12	23	2,124	38,196	137%	4.49

The program achieved realization rates of 113% for energy savings and 76% for demand reduction, as shown in Table 7-6 and Table 7-7, at a relative precision of $\pm 20.10\%$ for energy and $\pm 14.21\%$ for demand. The precision for energy did not meet the $\pm 15\%$ target for the program evaluation, due to significant variability around findings for sampled jobs within each stratum, in spite of the total sample size exceeding initial targets. The energy realization rates for jobs in the sample ranged between 0% and 303%, largely driven by updates to facility types and other key variables.

Table 7-6. PY12 Midstream 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.	PYVTD MWh/yr ⁽¹⁾
Midstream Lighting – Small	7,176	108%	0.71	26.10%	7,724
Midstream Lighting – Medium	11,759	78%	0.58	22.46%	9,157
Midstream Lighting – Large	10,429	164%	0.47	61.44%	17,137
Midstream Lighting – Threshold (> 20kW) ⁽²⁾	3,981	92%	0.94	84.32%	3,682
Midstream Lighting – Convenience Sample ⁽³⁾	424	117%	0.00	0.00%	496
Midstream Lighting Total⁽⁴⁾	33,769	113%	N/A	20.10%	38,196
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ The evaluation team defined a threshold of 20kW in demand reductions for a project to qualify for site visits.					
⁽³⁾ The convenience sample is included in the calculation of realization rates but not in the calculation of evaluation relative precision.					
⁽⁴⁾ May not match due to rounding.					

Table 7-7. PY12 Midstream 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.	PYVTD MW/yr ⁽¹⁾
Midstream Lighting – Small	1.23	80%	0.35	12.84%	0.99
Midstream Lighting – Medium	2.06	87%	0.77	30.00%	1.79
Midstream Lighting – Large	1.57	76%	0.10	13.34%	1.20
Midstream Lighting – Threshold (> 20kW) ⁽²⁾	0.96	46%	1.13	101.48%	0.44
Midstream Lighting – Convenience Sample ⁽³⁾	0.07	100%	0.00	0.00%	0.07
Midstream Lighting Total⁽⁴⁾	5.89	76%	N/A	14.21%	4.49
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ The evaluation team defined a threshold of 20kW in demand reductions for a project to qualify for site visits.					
⁽³⁾ The convenience sample is included in the calculation of realization rates but not in the calculation of evaluation relative precision.					
⁽⁴⁾ May not match due to rounding.					

In the Midstream Lighting component, neither the distributor nor the customer is required to complete a PA TRM Appendix C lighting savings calculator for the job. The distributor must report each sale and include information about the product, the product quantity, the purchaser, and the address of the intended installation. However, key variables required to determine savings for the job, such as facility type and space conditioning type, are often unknown by the ICSP.

The ICSP assigns the *ex ante* baseline and efficient fixture types to qualified products as prescribed in the Midstream Lighting 2016 PA TRM – Interim Measure Protocol (IMP).³⁶ The reported savings are computed assuming a 98% installation rate, according to the IMP.

Cadmus adjusted these key reported variables based on its verification activities. Cadmus made adjustments where applicable IMP prescriptive inputs were not used by the ICSP, where the verified

³⁶ Pennsylvania Public Utility Commission. 2016 PA TRM – Interim Measure Protocol: Lighting Improvements for Midstream Delivery Programs. Version approved January 2019, effective of June 1, 2018–May 31, 2020.

variables differed from those assumed by the IMP (e.g., in-service rate), or where the verified variables differed from those assigned by the ICSP (e.g., facility type).

The most frequent discrepancies between reported and verified variables were the facility type; these variables, in turn, determine the hours of use and coincidence factors specified by the IMP and the space conditioning type. See *Appendix E. Verification Findings* for details on the verification findings. These discrepancies, in turn, result in highly variable realization rates.

In PY11, the largest stratum represented 64% of total verified kWh savings and had a relative precision of 14.45%; there were 1,133 projects in this stratum. In contrast, in PY12, the largest stratum represented 45% of total verified kWh savings and had a relative precision of 61.44%; there were only 262 projects in this stratum. One project in the PY12 evaluation sample had a realization rate of 238% and accounted for approximately 10% of the sample verified kWh savings. Excluding that project from the evaluation sample, results in the overall kWh precision improving from 20% to 15.6%.

7.3 Net Savings Impact Evaluation

Cadmus applied the PY11 ratio in PY12, as approved by the SWE in the evaluation plan. The NTG ratio was 0.62 in PY11.³⁷ In PY11, Cadmus used the methods provided in the Evaluation Framework,³⁸ which discusses the common methods to determine free ridership and spillover. Cadmus used in-depth telephone interviews to assess free ridership for Midstream Lighting in PY11.

7.4 Verified Savings Estimates

In Table 7-8, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for Midstream Lighting in PY12.

Table 7-8. PYTD and P3TD Midstream Lighting Program Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD	33,769	5.89
PYVTD Gross	38,196	4.49
PYVTD Net ⁽¹⁾	23,681	2.79
P3RTD	109,384	20.99
P3VTD Gross	108,127	16.08
P3VTD Net ⁽¹⁾	76,749	11.67

⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.

³⁷ PPL Electric Utilities. *Annual Report Program Year 11: June 1, 2018–May 31, 2019*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. February 15, 2021.
<https://www.puc.pa.gov/pcdocs/1693356.pdf>

³⁸ 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. Final version May 8, 2018.

7.5 Process Evaluation

7.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation in PY12. Activities were consistent with the evaluation plan, but the sample composition of purchasers was altered to include contractors only. The target was up to 15 contractor purchaser interviews to inform the process evaluation and market effects analysis.

Cadmus attempted to contact all 23 distributors, some multiple times, but was able to complete only 12 interviews.

Table 7-9 shows the process evaluation sampling strategy.

Table 7-9. Process Evaluation Sampling Strategy for Midstream Lighting

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size ⁽¹⁾	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	2	N/A	2	2	2	100%
Participating Distributors	Distributors	Telephone in-depth interview	23 ⁽⁴⁾	N/A	15	12	23	100%
Contractor Purchasers	Contractor purchaser for whom contact data were provided	Telephone in-depth interview	491 ⁽⁵⁾	N/A	up to 15	8	340 ⁽⁵⁾	27%
Program Total			516	N/A	32	22	365	-

⁽¹⁾ The achieved sample size is determined by respondents answering the satisfaction question in the interview. In some cases, not all respondents answered every question.

⁽²⁾ Sample frame is a list of participants or purchasers with contact information who have a chance to complete the survey or interview. The final sample frame includes unique records in the PPL Electric Utilities database. After selecting all unique records, Cadmus removed any duplicate records from the population.

⁽³⁾ Percent contacted means the percentage of the sample frame contacted to complete surveys or interviews.

⁽⁴⁾ Cadmus counted distributors with multiple locations, or those that are subsidiaries of the same parent company, as one, for purposes of interview sampling.

⁽⁵⁾ Cadmus used contractor names to determine unique sampling records. Contractors with multiple entries but different phone numbers were included in the population size but not in the records selected for sample frame.

7.5.2 Program Satisfaction

In PY12, 23 unique distributors participated in the Midstream Lighting component.³⁹ Cadmus attempted to contact all of them and completed in-depth interviews with 12, who represented approximately 57% of incentives paid in PY12. Of these distributors, 92% were satisfied with the Midstream Lighting

³⁹ One distributor had two locations managed by the same parent company. For the purposes of process sampling, Cadmus counted these locations as one distributor.

component (eight respondents were *very satisfied* and three respondents were *somewhat satisfied*; n=12). One distributor was *not too satisfied* with the program. This distributor, who only sells lighting, said rebates are too low to make an impact on the business. Cadmus interviewed eight contractors, and all were *very satisfied* with their overall experience. These results are not significantly different from PY11.

Program Awareness

Distributors are the core drivers of awareness for the program. All eight contractors said they first learned about the program, either verbally or through marketing materials, from their distributor. Additionally, even if the contractor already knew about the program, seven of eight said the distributor verbally mentioned Midstream Lighting when they purchased lighting.

Program Delivery

The ICSP kept the same program delivery mechanism in PY12 as in PY11. Due to COVID-19, the ICSP had moved to a fully virtual distributor outreach and audit process, which it found was effective. Distributors agreed, as evidenced by similar distributor satisfaction ratings in PY12 as in PY11. Toward the end of PY12, the ICSP stopped accepting preapprovals for jobs over \$1,800 to allow enough time to finish the installations before the start of Phase IV.

Reporting System

Distributors are happy with and successfully using the portal-based system, which the ICSP activated in PY10, to validate qualifying products and report sales. Since PY11, small functionality changes have been made to the portal, including adding new marketing templates and reorganizing the portal structure. Six distributors (n=12) said these changes improved the portal. One of these distributors specifically mentioned that the portal could be a model for other program administrators to streamline the process. Nevertheless, only one distributor (n=11) reported using the updated marketing templates. Five distributors did not notice the changes to the portal.

When asked what they would like changed about the portal, three distributors provided feedback and each requested a different improvement:

- Improve the search function so distributors can be less specific with their search and stock keeping unit (SKU) and model numbers
- Change the “Resource” button under “Program Information” from grey to a more noticeable color
- Add ability to search by address instead of only by account number (consistent with PY10 and PY11 feedback)

Suggested Improvements

Though distributors expressed high satisfaction, when prompted, they suggested several ways to improve the program. The most common was to add more products to the program (n=7), with six of these distributors specifically mentioning area or outdoor lighting. This request is consistent with feedback from prior program years, and several distributors noted they have provided this feedback

multiple times. One distributor specifically mentioned adding more products common in the commercial sector, such as additional SKUs for tubes, flat panels, and high bays, as opposed to BR30s and PAR38s. Three distributors suggested increasing incentive levels to match competition, and two suggested not requiring an account number.

Two contractors also requested adding more products. One contractor asked for panel boards and switch gears be added to the program. The other contractor said eight-foot fluorescent lamps should be covered. Cadmus confirmed that these products are already offered by the program.

7.5.3 Market Effects

Using interview data, Cadmus conducted a qualitative assessment of Midstream Lighting's effect on sales of efficient products outside the program. In PY12, four of 12 distributors reported expanding the number of program-qualifying products they stock to keep up with higher customer demand, which is consistent with PY11. They attributed this increase in part to utility program incentives, including those offered by Midstream Lighting. One distributor said, “Yes, we manage our inventory to stock as many relatable products as possible. PPL [Electric Utilities] has the widest breadth of qualifying SKUs, so we base our stock levels of different products off of PPL [Electric Utilities].”

Seven distributors were willing to estimate their percentage of sales in the three categories shown in Table 7-10.

Table 7-10. Distributor Sales Estimates Across Three Categories of Lighting Product Efficiency

Type	Efficient Products		Standard Efficiency Products
	Program-Qualifying	Non-Program-Qualifying	
Multiyear Distributor	80%	20%	0%
Multiyear Distributor	75%	0%	25%
Multiyear Distributor	70%	15%	15%
Multiyear Distributor	70%	10%	20%
Multiyear Distributor	70%	0%	30%
Multiyear Distributor	67%	3%	30%
Multiyear Distributor	30%	40%	30%
Average PY12 (n=7) ^{1,2}	66%	13%	21%
Average PY11 (n=11)	62%	20%	18%
Average PY10 (n=7)	53%	20%	27%
¹ Five of 12 distributors did not have enough information to provide an estimate.			
² Change from PY11 to PY12 is not statistically significant and should be interpreted as directional.			

When asked about the impacts of COVID-19 over the last year, four of 12 distributors said there have been increased delays with the supply chain or inspections, which has slowed down the sales cycle. Others noted a transition to more video and online calls. Two distributors said their sales have increased because people received stimulus checks and were spending more time at home, but one distributor said many small businesses have struggled. One distributor noted longer lead times and higher prices on

international orders. Only two of eight contractors said COVID-19 had a substantial effect on their business, with one noting "a tremendous business slowdown, especially for commercial projects."

Recommendation of Efficient Lighting

All eight contractors interviewed in PY12 said they always recommend efficient lighting to their clients and that efficient lighting is always cost-effective over the life of the product. Four of seven contractors said that less than 2% of their customers purchase standard lighting equipment. Two other contractors said 25% or fewer of their customers still choose to purchase standard lighting equipment, despite their recommendation to purchase efficient lighting. One contractor said customers choose standard lighting equipment when they do not own the building and are simply replacing equipment as cheaply as possible without consideration for product life.

Contractors credited both the distributors' recommendations and the Midstream Lighting discounts in their clients' decisions to upgrade their lighting and rated these on a scale of 1 to 5.

These were ratings for distributors' recommendations:

- 5 = *extremely influential* (four contractors)
- 3 = (one contractor)
- 1 = *no influence* (three contractors)

These were the ratings for the instant discounts:

- 5 = *extremely influential* (five contractors)
- 1 = *no influence* (three contractors, with one of these stating that the discounts are "just a nice perk")

These findings are consistent with PY10 and PY11. Likewise, of seven contractors, five said the instant discounts had either a medium or significant impact on their sales volume, and six said the rebate amount is enough to incentivize the purchase of efficient lighting equipment.

These findings suggest that, although Midstream Lighting does help drive efficient lighting sales outside of the program, its direct effects are primarily on the program. Even so, in a market that is moving toward energy efficiency, increasing the rate at which customers choose to upgrade their lighting likely helps to maintain this momentum. Because distributors may not regularly promote qualifying products or the program to contractors and most distributors are not using the marketing materials in the portal, contractors may benefit from increased targeted marketing from PPL Electric Utilities.

7.6 Cost-Effectiveness Reporting

Because the Midstream Lighting Program is part of the Non-Residential Energy Efficiency Program, cost-effectiveness is presented in *Section 5 Non-Residential Energy Efficiency Program*.

7.7 Recommendations

Overall, distributors and contractors were highly satisfied with the program, consistent with prior program years. Distributors said the consistency of program operations, such as the portal and measure list, provided an easy participant experience. Variation in realization rates was largely driven by inputs informed by facility type, which is not collected by the ICSP.

Conclusion 1: Distributors and contractors are not fully aware of the full set of products offered through the program.

Conclusion 2: Realization rates would be less variable if facility types were incorporated into calculation of *ex ante* savings.

- The most common request was to add more products to the program, with six of seven distributors specifically mentioning area or outdoor lighting. This request is consistent with feedback from prior program years, and several distributors noted they have provided this feedback multiple times. One distributor specifically mentioned adding more products that are common in the commercial sector, such as additional SKUs for tubes, flat panels, and high bays, as opposed to BR30s and PAR38s. (See section 7.5.2 *Suggested Improvements*.)
- Two contractors offered suggestions for how to improve the program, and both requested that more products be added. One contractor said eight-foot fluorescent lamps should be covered through the program. Cadmus confirmed that these products are already offered by the program. Another contractor asked for panel boards and switch gears to be added to the program. (See section 7.5.2 *Suggested Improvements*.)
- The most frequent discrepancies between reported and verified variables were the facility type, which, in turn, inform the hours of use and coincidence factors specified by the IMP and the space conditioning type. (See section 7.2.2 *Gross Savings Impact Evaluation Results* and Appendix E. *Evaluation Detail – Midstream Lighting Program*.)

Table 7-11. Status of Recommendations for Midstream Lighting

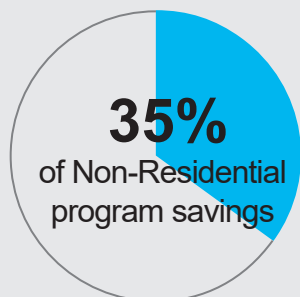
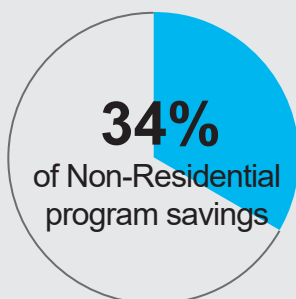
Midstream Lighting Program		
Conclusion	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
Conclusion 1: Distributors and contractors are not fully aware of the full set of products offered through the program.	Coordinate with the ICSP to solicit more specific feedback from distributors with regard to which specific area lighting products they consider are missing from the program.	Being considered.
Conclusion 2: Realization rates would be less variable if facility types were incorporated into calculation of <i>ex ante</i> savings.	Consider adding facility type to the online portal as a required field.	Being considered.

CUSTOM PROGRAM

The program offers financial incentives to customers who install equipment that is not offered in PPL Electric Utilities' other commercial programs.

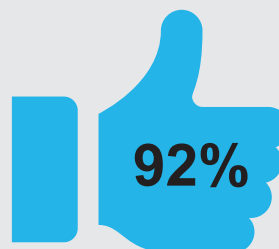
VERIFIED ENERGY SAVINGS

Phase III
has saved
310,705 MWh/yr



PY12 saved
69,132 MWh/yr

PROGRAM SATISFACTION



Satisfied with
overall program

100% satisfied with the **professionalism of the program representatives**

84% satisfied with **communication** throughout the project

83% satisfied with the **information** provided about the **application process**

83% satisfied with the **time it took to process the application**

83% satisfied with the ability to **track your rebates**

77% satisfied with the **ease of the online application process**

PY12 PARTICIPATION

A total of **116** participants:



19 Motors



6 Refrigeration



18 HVAC



2 Lighting



7 Agricultural



1 Combined Heating and Power (CHP)



7 Photovoltaic



56 Other unspecified

8 Non-Residential Custom Program

The Custom Program, a component of the Non-Residential Energy Efficiency Program, offers financial incentives to customers who install equipment that is not offered in PPL Electric Utilities' other commercial programs or is not addressed in the PA TRM. Equipment may include new or replacement energy-efficient products, 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 Custom Program offers incentives for the avoided or reduced energy consumption kWh/yr that result from the completed 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 construction begins. Projects with TRC test score of greater than 0.7 are eligible for an incentive.

PPL Electric Utilities pays the incentive to the customer following successful implementation of a cost-effective project, and the incentive may vary by the type or size of the equipment, system, or improvement. In PY8 through PY10, for projects with expected savings greater than 500,000 kWh/yr (large stratum), PPL Electric Utilities based the incentive payment on verified savings rather than on reported savings. This approach is called real-time evaluation and is a cornerstone of the Custom Program. In PY11, the large stratum boundary was revised to 2,000,000 kWh/yr. Any projects that were previously classified as large in PY8 through PY10 and were undergoing active evaluation in PY11 were retained in this stratum.

The ICSP, CLEAResult, manages the program and handles application intake, assesses eligibility, and calculates project energy savings and incentives.

8.1.1 Definition of a Participant

A PY12 participant is defined as a project that was commercially operable between June 1, 2020, and May 31, 2021, and subsequently received an incentive payment.⁴⁰ Projects for which customers submitted an application during this period that did not receive an incentive or projects that were commissioned during this period that did not receive an incentive are not counted as participants in PY12. An individual customer may have multiple participating projects.

⁴⁰ 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 not operating as intended, is not considered "commercially operable."

8.1.2 Program Participation and Reported Impacts

Table 8-1 presents the participation counts, reported energy and demand savings, and incentive payments for the Custom Program in PY12 by customer segment.

Table 8-1. PY12 Custom Program Participation and Reported Impacts

Parameter	Small C&I	Large C&I	GNE	Total ⁽¹⁾
PYTD # Participants	71	25	20	116⁽²⁾
PYRTD MWh/yr	16,139	26,559	23,367	66,065
PYRTD MW/yr	1.90	3.12	4.73	9.76
PYVTD MWh/yr	17,300	27,637	24,196	69,132
PYVTD MW/yr	2.00	3.32	4.96	10.28
PY12 Incentives (\$1,000)	N/A ⁽³⁾			

⁽¹⁾ Total may not match the sum of columns due to rounding.

⁽²⁾ PPL Electric Utilities' tracking database includes 119 unique records corresponding to 116 unique projects in PY12. Three records in PPL Electric Utilities tracking database are incentive adjustments and are not included in this count.

⁽³⁾ Incentives are reported at the program level.

Table 8-2 lists the types of projects completed in PY12 and the percentage of reported savings.

Table 8-2. PY12 Program Custom Project Types

Project Type	Number of Participants (n=116) ⁽¹⁾	Percentage of Reported Savings Represented by Project Type (n=100%) ⁽²⁾
Motors	19	20%
HVAC	18	17%
Combined Heating and Power (CHP)	1	16%
Other ⁽³⁾	56	15%
Photovoltaic	7	14%
Agricultural	7	11%
Lighting	2	7%
Refrigeration	6	<1%
⁽¹⁾ PPL Electric Utilities' tracking database includes 119 unique records corresponding to 116 unique projects in PY12. Three records in PPL Electric Utilities tracking database are incentive adjustments and are not included in this count.		
⁽²⁾ The sum of the column may not add to 100% due to rounding.		
⁽³⁾ The Other project type typically includes C&I improvements such as replacing old blow-mold injection machines, snow guns, process improvements, controls, and new construction projects.		

8.2 Gross Savings Impact Evaluation

8.2.1 Impact Evaluation Data Collection and Sample Design

Table 8-3 shows the evaluation sampling strategy. The target confidence and precision levels for each stratum were chosen to meet an overall program target of 85% confidence and 15% precision (85/15). More details are in *Appendix F Evaluation Detail – Custom Program*.

Table 8-3. PY12 Custom Program Gross Impact Evaluation Sample Design

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Large	17	Census	17	17	File review, site-specific M&V plans, baseline and post-installation visits, deployed data loggers (if required), verified savings analysis and report
Small	101	CP= 85/20 Cv = 0.35 (assumed)	10	10	File review, site-specific measurement and verification plans, post-installation virtual visits, verified savings analysis and report
CHP	1	Census	1	1	File review, site-specific M&V plans, baseline and post-installation visits, metering installed (if required), verified savings analysis and report
Total Participants	119^[1]	N/A	28	28	
^[1] PPL Electric Utilities' tracking database includes 119 unique records corresponding to 116 unique projects in PY12. Three of these are incentive adjustments					

Due to COVID-19 restrictions, in-person site visits were not possible for all sites. Some site visits were conducted virtually via video call per customer preference and evaluation needs.

Cadmus conducted virtual and in-person site visits for nine projects in the small stratum by verifying details of installation and operation in on-site or phone interviews with customer representatives.⁴¹ These representatives also sent pictures of the installed equipment and in some cases recent trend data for parameters influencing savings calculations.

For some large stratum projects, Cadmus captured metered data by shipping data loggers to the site and having the customer's licensed electricians install the loggers while Cadmus joined through a virtual video call. All site visits in the large stratum in PY12 were virtual.

To verify savings for other projects, Cadmus relied on customer interviews and data provided by the customer or the customer's installation contractor (such as EMS trending data).

8.2.2 Gross Savings Impact Evaluation Results

Table 8-4 shows the program's verified gross energy savings.

Table 8-4. Phase III Custom Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	70,740	29,826	63,938	77,068	69,132	310,705 ⁽¹⁾
⁽¹⁾ Phase III verified savings may not match sum of program years due to rounding.						

⁴¹ Of the 10 projects in the small custom stratum, nine had site visits (virtual or in-person). The customer for one project did not allow for a site visit but did provide the data needed to complete the verification analysis. For one of the small custom sample projects, both a virtual and an in-person site visit was conducted. The in-person site visit occurred because during the virtual visit Cadmus determined that metering was required.

In PY12, the Custom Program reported energy savings of 66,065 MWh/yr, as shown in Table 8-5, and demand reduction of 9.76 MW/yr, as shown in Table 8-6.

The achieved precision for the program-level results was in compliance with the Evaluation Framework, exceeding the requirements to meet 85/15 target levels.⁴² Energy savings for the program overall, including large, small, and CHP strata, are reported with 4.51% precision at the 85% confidence level.

Table 8-5. PY12 Custom Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MWh/yr ⁽¹⁾
Custom – Large	36,869	100%	0.00	0.00%	36,869
Custom – Small	18,709	116%	0.32	15.18%	21,777
Custom – CHP	10,486	100%	0.00	0.00%	10,486
Program Total ⁽²⁾	66,065	105%	-	4.51%	69,132
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ Total may not match sum of rows due to rounding.					

Table 8-6. PY12 Custom Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MW/yr ⁽¹⁾
Custom – Large	5.40	100%	0.00	0.00%	5.40
Custom – Small	3.15	116%	0.73	34.27%	3.66
Custom – CHP	1.22	100%	0.00	0.00%	1.22
Program Total ⁽²⁾	9.76	105%	-	11.52%	10.28
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ Total may not match sum of rows due to rounding.					

The energy (kWh/yr) realization rate is 100% for the real-time evaluated projects in the large stratum because savings were verified before the incentive was paid.

For all projects verified in PY12 through virtual or on-site visits, Cadmus updated the assumed equipment parameters or operating sequences used to determine the reported savings and calculated the verified savings (see *Appendix F Evaluation Detail – Custom Program*).

For the small stratum, several factors led to differences between reported and verified savings and to the observed realization rates. Each factor may have contributed to an increase or decrease in project energy savings, depending on the specific circumstances of the project. Further discussion on the sources of factors affecting the realization rate is in *Appendix F Evaluation Detail – Custom Program*.

⁴² 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. Final version May 8, 2018.

8.3 Net Savings Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,⁴³ 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.

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

Table 8-7 lists the methods and sampling strategy used to determine net savings for the Custom Program in PY12. Cadmus conducted online and telephone self-report surveys with 13 of 79 Custom Program participants between February 2021 and August 2021. Additional details about methodology are in *Appendix F.3 Net-to-Gross Ratio Findings* and *Appendix M Net Savings Impact Evaluation*.

Table 8-7. PY12 Custom Program Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population ⁽¹⁾	Achieved Sample Size	Response Rate ⁽²⁾	NTG Activity
Custom	Participants	79	13	16%	Self-Report Surveys
<p>⁽¹⁾ The total population was 79 at the time of the survey. After selecting unique participants, Cadmus removed any records from the population if customers had participated in a survey in the last three months, did not have valid contact information (email or telephone number), were on the do not call list, opted out of the online survey, or did not have PY12 savings (incentive adjustments). The sample frame was 37, and 13 participants completed the survey. One respondent was not included in the process evaluation but was included in net analysis.</p> <p>⁽²⁾ Response rate is calculated as the number of respondents who answered the free ridership questions (n=13) divided by the number of records in the population.</p>					

Table 8-8 shows the free ridership, spillover, and NTG ratio for the Custom Program for PY12. Free ridership was 39%, weighted by the size of the project completed by respondents. The respondents represented 26% of the program's verified population savings. Five respondents had a large stratum project, and eight had small stratum projects. A survey was not completed with the one CHP stratum project in the population.

Additional details are in *Appendix F.3 Net-to-Gross Ratio Findings* and *Appendix M Net Savings Impact Evaluation*.

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. Final version May 8, 2018.

Table 8-8. PY12 Custom Program Net Impact Evaluation Results

Stratum	Number of Surveys	Free Ridership (%) ⁽¹⁾	Spillover (%)	NTG Ratio	Relative Precision at 85% C.L.
Custom (all projects)	13	39%	0%	0.61	18%
⁽¹⁾ Weighted by verified kWh/yr savings.					

Table 8-9 shows PY12 Custom Program free ridership by stratum. The weighted average free ridership for small stratum projects is 32%, and these surveyed projects represent 12% of the analysis sample verified savings. The overall program free ridership estimate of 39% is heavily weighted toward the large stratum free ridership of 40%, as large stratum respondents represent 88% of the overall custom analysis sample verified savings.

Table 8-9. PY12 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.
Custom – Large	5	40%	88%	43%	24%
Custom – Small	8	32%	12%	10%	46%
Program Total	13	39%	100%	31%	18%
⁽¹⁾ Weighted by verified kWh/yr savings.					

Because custom projects are unique and nearly all are high impact, a separate group of high-impact projects was not selected for the net savings analysis in PY12. Cadmus did not identify any high-interest projects that were not already selected into the large, small, or CHP strata.

8.4 Verified Savings Estimates

In Table 8-10, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the PY12 Custom Program component of the Non-Residential Energy Efficiency Program.

Table 8-10. PYTD and P3TD Custom Program Savings Summary

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD	66,065	9.76
PYVTD Gross	69,132	10.28
PYVTD Net ⁽¹⁾	42,171	6.27
P3RTD	312,801	38.34
P3VTD Gross	310,705	40.16
P3VTD Net ⁽¹⁾	212,253	27.22
⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		

8.5 Process Evaluation

8.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. The PY12 limited process evaluation of the Custom Program assessed participant satisfaction with the program. Activities were consistent with the evaluation plan. Table 8-11 lists the process evaluation sampling strategy.

Table 8-11. PY12 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	2	100%
Participants ⁽⁴⁾	Custom	Online	79 ⁽⁵⁾	N/A ⁽³⁾	All	6	37	100%
		Telephone				6		100%
Program Total	N/A	N/A	81	N/A	N/A	14	39	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 Electric Utilities tracking database for projects that generated savings. 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, opted out of the online survey, or did not have PY12 savings (incentive adjustments). This left 37 records available to contact for the 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. ⁽⁴⁾ One respondent was not included in the process evaluation but was included in net analysis. ⁽⁵⁾ This population includes participants that were available at the time of survey distribution.								

Cadmus conducted online and telephone self-report surveys with 13 of 37 Custom Program participants between February 2021 and August 2021. One respondent was not included in the process evaluation so results are based on 12 respondents. The online and telephone surveys asked identical questions to assess satisfaction, net savings, and the influence of the contractor or design engineer on project design.

Satisfaction

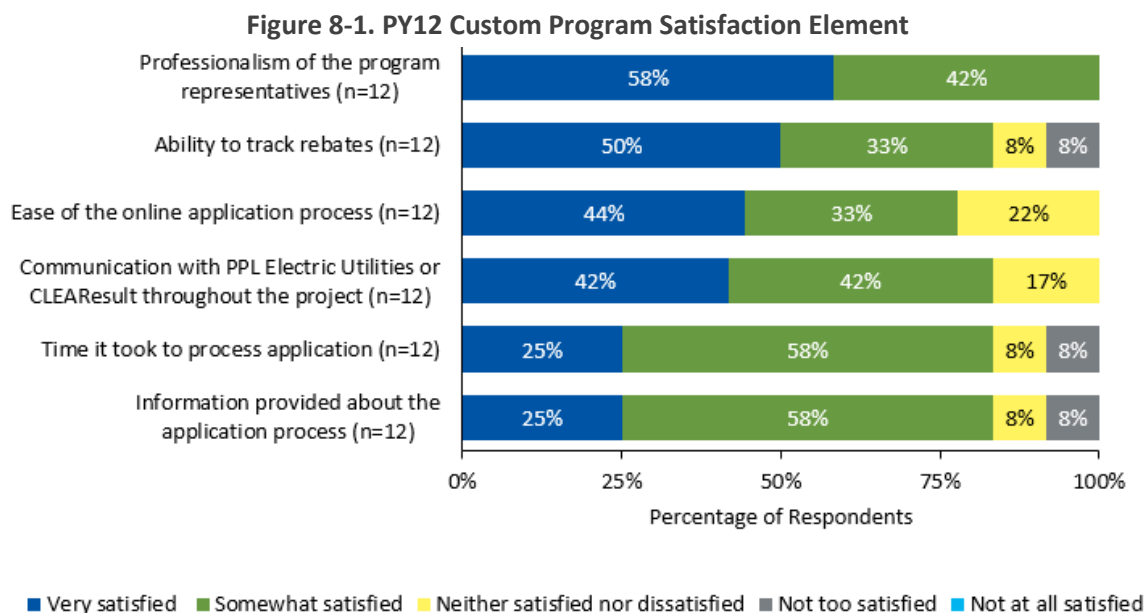
The Custom Program was delivered effectively in PY12 and maintains high levels of customer satisfaction. The ICSP delivered the program in PY12 similar to PY11. As shown in the program's infographic, overall, 92% of PY12 respondents were satisfied with the program (42% were *very satisfied* and 50% were *somewhat satisfied*; n=12).⁴⁴

⁴⁴ Additionally, 8% were *neither satisfied nor dissatisfied* (n=12).

As shown in Figure 8-1, participants were most satisfied with the professionalism of program representatives (100% were satisfied; n=12).

One respondent expressed dissatisfaction with three of the six program elements.

“The rebate process was not real clear on what the baseline data which was being used for rebate purposes. We replaced a chiller of over 10 yrs. of age and the baseline data for calculating the rebate was later said to have to be a similar in kind unit built to today's standards. This was not clearly explained in the beginning and the data that needed to be collected was not real clear until we got into the process. Luckily I had an engineering firm I was working with to help validate data and make necessary corrections to get more of a rebate.”



Source: Survey question, “Please indicate how satisfied you are with each program component.”

Combined totals for *very* and *somewhat satisfied* may not match text due to rounding.

Totals of *very* and *somewhat satisfied* may not sum to total on infographic due to rounding.

Areas for Improvement

Five of 12 respondents provided comments and recommendations to improve program-related communication. Respondents suggestions included these:

- “Assign an account manager for customers with many accounts.”
- “Be a little more proactive with follow-up and reach out to the client on any changes to data and the rebate process. During our last rebate process it seemed to require phone calls to keep the process moving forward.”
- “Clearer communication between engineers and companies.”
- “Send communications to more than just one person, such as two points of contact at my organization instead of just one.”

- “There was a recent and brief webinar for business customers that provided some program updates. The webinar did not go into a lot of details and suggested customers could track down more information elsewhere. I was confused by the various different programs offered.”

Seven of 12 respondents also provided recommendations to improve the program overall. Two suggested allocating more funds toward the program and bigger incentives, and two said to make it easier for the customer to confirm their rebate status. One respondent suggested assigning a CLEAResult engineer or consultant to work more closely with the customer to help with any barriers in the rebate process. This suggestion is similar to the suggestion by three respondents asking that an account representative be assigned to each customer.

COVID-19 Impacts

Five of 12 respondents said their project was impacted by the COVID-19 pandemic. Three of these respondents said their timeline was impacted, and two said both the project scope and the timeline were impacted. Two said there were delays in getting materials, and three said there were internal delays due to budget or access to the facility.

Looking ahead, seven of 12 respondents did not think their facilities’ interest in or ability to complete other energy efficiency projects would be impacted as a result of COVID-19. Three respondents said there may be less budget available for future projects.

8.6 Cost-Effectiveness Reporting

Because the Custom Program is a component in the Non-Residential Energy Efficiency Program, cost-effectiveness is presented in *Section 5 Non-Residential Energy Efficiency Program*.

8.7 Recommendations

Overall, respondents reported high satisfaction with the program and program elements. The Custom Program has been highly successful, with the verified savings of 69,132 MWh/year (10.28 MW/year) and realization rate of approximately 105% for both energy and demand savings.

Recommendations are provided in Table 8-12, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: Despite high satisfaction with the program, some respondents reported difficulty with program related communication.

- Three respondents (n=12) suggested more proactive or clearer communication, one suggested sending communication to more than one contact, and one suggested assigning an account manager to customers with multiple accounts. (See *Areas for Improvement* section.)
- When asked about satisfaction with the Custom Program, 25% (n=12) of respondents reported being *very satisfied* and 58% reported being *somewhat satisfied* with the information provided about the rebate process (the lowest scoring satisfaction category). (See *Areas for Improvement* section.)
- While 83% percent of respondents were satisfied with the ability to track their rebate in the portal, one suggested more clarity on how to review project status through the portal. (See *Areas for Improvement* section.)

Table 8-12. Status of Recommendations for the Custom Program

Custom Program		
Conclusion	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
Conclusion 1: Despite high satisfaction with the program, some respondents reported difficulty with program-related communication.	Provide customers with more instruction about how to track rebate status on the online portal.	Implemented in a new online portal for Phase IV.

ENERGY EFFICIENT HOME PROGRAM

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.

VERIFIED ENERGY SAVINGS

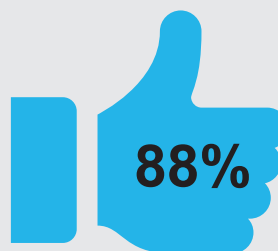
Phase III
has saved
90,460 MWh/yr

123%
of projected

102%
of projected

PY12 saved
22,967 MWh/yr

PROGRAM SATISFACTION



Satisfied with
overall program

95% equipment participants
satisfied with program

91% in-home audit participants
satisfied with program

88% weatherization participants
satisfied with program


84% online marketplace participants
satisfied with program

84% online assessment participants
satisfied with program

PY12 PARTICIPATION

A total of **16,368** received rebates for

 **10,094** Efficient equipment

 **2,565** Online and in-home audit
and energy conservation kits

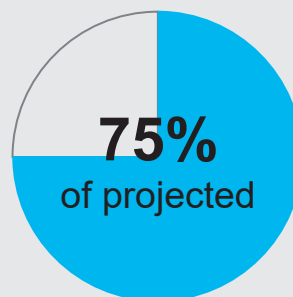
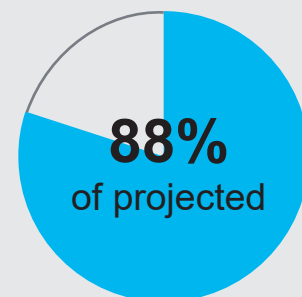
 **1,328** Online marketplace

 **890** Weatherization

 **1,491** New homes

ACTUAL EXPENDITURES (\$1,000)

Phase III
expenditures
\$30,726



PY12
expenditures
\$6,765

9 Energy Efficient Home Program

The Energy Efficient Home Program is designed for new construction and 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 five components: Audit and Kits (two subcomponents: in-home energy audits and online home energy assessments, both of which include energy-savings kits), Weatherization, Efficient Equipment, the Online Marketplace, and New Homes (new home construction incentives).

Audit and Kits. The Audit and Kits component offers in-home energy audits and the online home energy assessments and provides tools and information that help residential customers make decisions about actions they can take to improve the energy efficiency of their homes. Energy savings accrue from the kit of low-cost energy-efficient products mailed to customers. The kits contain LEDs, faucet aerators, energy-efficient showerheads, and pipe insulation. Faucet aerators and showerheads are distributed only to homes with electric water heating. In-home audit customers can also have the temperature of their water heater set back.

Weatherization. The Weatherization component provides rebates to customers who make any of these three eligible home improvements: ceiling insulation (minimum of R11 added, for total insulation between R-38 and R-49), wall insulation (minimum of R6 added), or air sealing.

Efficient Equipment. The Efficient Equipment component offers rebates for these eligible products or services:

- Air source heat pumps (ASHP) (SEER 16+)
- Ductless heat pumps (DHP) (< 5.4 tons, ≥ SEER 16, ≥ HSPF 8.6)
- Central air conditioners (CAC) (SEER 16+)
- Heat pump water heaters (HPWH) (≥ 2.3 EF)
- Efficient pool pumps (variable speed drive)
- ENERGY STAR refrigerators and dehumidifiers
- Advanced smart thermostats
- ASHP tune-ups
- Duct sealing
- Fuel-switching to non-electric ENERGY STAR water heaters or high-efficiency central heating equipment (natural gas or propane furnace [AFUE 95], oil furnace [AFUE 85], or fossil fuel boiler [AFUE 85])

Rebates for fuel-switch central heating equipment ended in PY11 and were not offered in PY12.

Online Marketplace. The Online Marketplace component is a web-based storefront through which qualified customers can order energy-efficient products, submit inquiries via e-mail, and view educational materials. Customers must have a PPL Electric Utilities account number to shop. Incentives are applied directly to the energy-efficient products, but customers can also see the pre-incentive price. The marketplace offers products that differ seasonally, such as weather stripping, rope caulk, LED bulbs, LED holiday light strings, advanced power strips, occupancy sensor switches, smart thermostats, and dehumidifiers. PPL Electric Utilities occasionally conducts marketing to drive marketplace sales and runs special manufacturer promotions on specific products.

New Homes. In PY12, the New Homes component offered 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.

PPL Electric Utilities' energy efficiency program staff provide overall strategic direction and program management. The evaluation staff oversee evaluation activities and coordinate with program staff.

CLEAResult, the ICSP, manages the program and delivers the Audit and Kit, Weatherization, and Efficient Equipment components to customers. This involves maintaining a call and rebate processing center, conducting in-home audits, recruiting and educating trade allies, and marketing the program to achieve sufficient participation.

Performance Systems Development (PSD) is a subcontractor to the ICSP and is responsible for the program's New Homes component. PSD processes applications and assists builders and Home Energy Rating System (HERS) raters.

The Online Marketplace is managed by the Energy Federation, Inc. (EFI), a subcontractor to the ICSP.

In Phase III, the objectives of the Energy Efficient Home Program were these:⁴⁵

- Encourage customers to view energy efficiency in a holistic manner
- Educate construction industry professionals and other trade allies about the benefits of energy efficient homes
- Promote the construction of energy-efficient new homes
- Provide customers with education, audits, surveys, and energy-saving solutions
- Reduce energy consumption by approximately 73,000 MWh/year in gross verified savings
- Achieve high customer and trade ally satisfaction with the program

9.1.1 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 in the program tracking data. For the New Homes component, a participant is defined as a single-family home or a tenant unit in a newly constructed multifamily building.

9.1.2 Program Participation and Reported Impacts

Table 9-1 presents participation counts, reported energy savings and demand reductions, and incentive payments for the Energy Efficient Home Program in PY12, by customer segment.

⁴⁵ Program objectives are listed in PPL Electric Utilities' revised EE&C Plan (Docket No. 2015-2515642), November 2018.

Table 9-1. Energy Efficient Home Program Participation and Reported Impacts

Parameter	Residential	Small C&I	GNE	Total ⁽¹⁾
PYTD # Participants	16,290	65	13	16,368
PYRTD MWh/yr	21,009	169	22	21,199
PYRTD MW/yr	4.56	0.03	0.01	4.60
PYVTD MWh/yr	22,753	190	24	22,967
PYVTD MW/yr	4.10	0.04	0.01	4.14
PY12 Incentives (\$1000)	\$3,511	\$26	\$1	\$3,537
⁽¹⁾ Total may not match sum of columns due to rounding.				

9.2 Gross Savings Impact Evaluation

9.2.1 Impact Evaluation Data Collection and Sample Design

To evaluate PY12 savings, Cadmus conducted database reviews for all rebated products in the Audit and Kit, Weatherization, Efficient Equipment, and Online Marketplace program components. It used findings from the records review and participant survey to evaluate select measures in the Efficient Equipment component that typically generate the majority of the savings for the Energy Efficient Home Program. Cadmus also used participant survey findings to calculate an in-service rate (ISR) for measures in the Online Marketplace component.

Savings for the New Homes component were verified using desk reviews of the REM/Rate models in addition to in-person site visits. Cadmus used site visits data and data collected from HERS raters to confirm REM/Rate model inputs and provide detailed lighting and appliance information. Additional information can be found in *Appendix G* for the New Homes component.

The evaluation sampling strategy is summarized in Table 9-2. Cadmus evaluated all components with basic levels of rigor and used stratified random sampling for records reviews. In the sampling approach, each individual product and service represented a stratum and program components represented a stratum group. Cadmus selected the products and services for the records review based on historical evaluation findings or whether these products and services were new to the program.

For four Efficient Equipment measures that generate a large quantity of energy savings—DHPs, ASHPs, HPWHs, and smart thermostats with professional installation—Cadmus used a nested sampling approach. Cadmus first conducted a survey of participants who installed any of the four measures, attempting to contact a census of participants. Survey findings contributed to both the process and impact evaluations. Cadmus then conducted a records review of survey respondents. Cadmus selected a random subset of DHP and HPWH survey respondents and used all available respondents for ASHP and smart thermostats with professional installation.

Table 9-2. PY12 Energy Efficient Home Program Gross Impact Sample Design

Stratum Group	Population Size ⁽¹⁾	Sampled Impact Evaluation Activity	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size
Audit and Kit	2,565	N/A	0.5	N/A	N/A
Weatherization	890	N/A	0.5	N/A	N/A
Efficient Equipment	10,094	Nested participant survey (online) and records review ⁽²⁾	0.5	100	94
Online Marketplace	1,328	Verification survey (online)	0.5	All eligible participants	63 ⁽³⁾
New Homes	1,491	REM/Rate modeling review	0.5	20	19
		Site visits	0.5	20	19
Program Total	16,368	-	-	-	176

⁽¹⁾ The number of unique rebate projects in PPL Electric Utilities' PY12 tracking database. Includes four Weatherization and three Efficient Equipment projects that are database corrections for pre-existing projects.

⁽²⁾ The final sample consisted of a set of projects for which Cadmus conducted a participant survey and a records review for each.

⁽³⁾ The number of respondents that answered questions pertaining to the in-service rate. May not equal the total number of survey respondents.

The Energy Efficient Home Program's gross impact evaluation activities produced results with $\pm 10.88\%$ relative precision at 85% confidence.

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 and the Phase III Evaluation Framework and using sampling weights (w_i) proportional to the sampling probability of each unit.⁴⁶

The following sections describe the data collection activities for each component. For more information about how program-level *ex post* savings were calculated, see *Appendix G Evaluation Detail – Energy Efficient Home Program*.

Audit and Kits, Weatherization, Efficient Equipment, and Online Marketplace

With the exception of New Homes, Cadmus conducted a database review for a census of projects. This process included independently calculating savings using inputs from PPL Electric Utilities' participant tracking database (where available) or deemed inputs from the PA TRM,⁴⁷ applied to the appropriate PA TRM algorithms. Cadmus also verified that dehumidifiers, refrigerators, and Online Marketplace LED bulbs were ENERGY STAR-certified in accordance with the PA TRM.

⁴⁶ 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>

⁴⁷ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017.

Except for the four Efficient Equipment measures sampled for the participant survey and records review analysis, Cadmus calculated the realization rate for all measures by comparing the total *ex post* savings from the database review to total reported savings.

For the four Efficient Equipment measures (DHPs, ASHPs, HPWHs, and smart thermostats with professional installation), Cadmus calculated the realization rate using the *ex post* savings from the sampled projects compared to the reported savings for these projects. For the ASHP and Smart Thermostat records review samples, the sample size was less than the target of 25 because there were insufficient survey responses at the time the team requested the project documentation.

Cadmus used the records review and participant surveys to verify different savings inputs for each of the four sampled measures, as shown in Table 9-3.

Table 9-3. PY12 Verified Savings Inputs for Sampled Measures

Equipment Type	n	Survey Verification	Records Review Verification (Rebate Forms, AHRI Certificate, and Invoices)
DHP	25	<ul style="list-style-type: none"> Installed and operating Rooms impacted (primary/secondary) Pre-existing heating and cooling system 	<ul style="list-style-type: none"> Model number (indoor) EER/SEER/HSPF (indoor) Capacity (indoor)
ASHP	21	<ul style="list-style-type: none"> Installed and operating Replaced heating and cooling system 	<ul style="list-style-type: none"> Model number EER/SEER/HSPF (based on verified model number) Capacity (based on verified model number)
HPWH	25	<ul style="list-style-type: none"> Installed and operating Installation location/conditioned space Electric heating or cooling 	<ul style="list-style-type: none"> Model number Energy factor efficient water heater (based on verified model number) Tank size (based on verified model number)
Smart Thermostats (professionally installed only)	23	<ul style="list-style-type: none"> Installation type Quantity Heating and cooling system type Installed and operating Thermostat is programmed Baseline thermostat (conventional or programmable) 	<ul style="list-style-type: none"> Heating and cooling system capacity

In addition, in PY12, Cadmus used participant survey data to calculate ISRs for high-volume Online Marketplace products (smart thermostats, LEDs, dehumidifiers, smart strips, and weatherstripping). For lighting controls, Cadmus assumed a 100% ISR because there were only nine customers who purchased lighting controls and zero survey respondents. No one purchased night lights or light strings, so Cadmus did not apply an ISR to these measures.

For products in program components other than Online Marketplace, Cadmus used ISRs calculated in PY10.⁴⁸

⁴⁸ PPL Electric Utilities. *Annual Report Program Year 10: June 1, 2018–May 31, 2019*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2019.

New Homes

For the New Homes component, Cadmus verified a sample of 19 homes, which involved reviewing REM/Rate models, collecting HERS rater documentation, and conducting site visits. Cadmus confirmed reference home assumptions and modeling output to verify heating and cooling savings and conducted engineering analyses to verify energy savings and demand reductions for lighting and appliances, according to the PA TRM. To calculate *ex post* savings for lighting and appliances, Cadmus also used field data gathered from site visits or HERS rater documents. Cadmus was not able to achieve the target sample size of 20 homes due to COVID-19 and complications with coordinating site visits.

The revised sampling protocol is explained in more detail in *Appendix G Evaluation Detail – Energy Efficient Home Program*.

9.2.2 Gross Savings Impact Evaluation Results

Table 9-4 shows the program's verified gross savings for each year of Phase III and Phase III as a whole.

Table 9-4. Energy Efficient Home Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified ⁽¹⁾	PY12 Verified	Phase III Verified ⁽²⁾
MWh/yr	9,943	18,802	17,661	21,085	22,967	90,460
⁽¹⁾ PY11 verified savings includes savings from the New Homes component realized in PY11 but verified as part of the PY12 evaluation.						
⁽²⁾ Phase III verified savings may not match sum of program years due to rounding.						

In PY12, the Energy Efficient Home Program reported energy savings of 21,199 MWh/yr, as shown in Table 9-5, and demand reduction of 4.60 MW/yr, as shown in Table 9-6.

Table 9-5. PY12 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.	PYVTD MWh/yr
Audit and Kit ⁽¹⁾	645	76%	N/A	6.79%	487
Weatherization	976	100%	N/A	0.00%	977
Efficient Equipment	15,151	112%	N/A	14.54%	17,025
Online Marketplace	220	90%	N/A	9.96%	197
New Homes	4,207	102%	N/A	8.26%	4,282
Program Total ⁽²⁾	21,199	108%⁽³⁾	N/A	10.88%	22,967
⁽¹⁾ Includes online assessments and in-home audits; both channels delivered energy-savings kits to customers.					
⁽²⁾ Program total may not match sum of rows due to rounding. Similarly, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings due to rounding.					
⁽³⁾ The program-level realization rate is weighted by stratum.					

Table 9-6. PY12 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.	PYVTD MW/yr
Audit and Kit ⁽¹⁾	0.06	69%	N/A	7.01%	0.04
Weatherization	0.09	91%	N/A	0.00%	0.08
Efficient Equipment	2.83	112%	N/A	5.26%	3.16
Online Marketplace	0.01	99%	N/A	12.45%	0.01
New Homes	1.60	52%	N/A	9.50%	0.84
Program Total ⁽²⁾	4.60	90% ⁽³⁾	N/A	4.42%	4.14
⁽¹⁾ Includes online assessments and in-home audits; both channels delivered energy-savings kits to customers.					
⁽²⁾ Program total may not match sum of rows due to rounding. Similarly, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings due to rounding.					
⁽³⁾ The program-level realization rate is weighted by stratum.					

In PY11, the Energy Efficient Home Program reported unverified savings for the New Homes Component (representing 20% of PY11 reported savings). Verification of these projects was completed in PY12. The New Homes component achieved 4,157 MWh per year of verified energy savings with a 102% energy realization rate, as shown in Table 9-7, and 0.72 MW/yr of demand reductions at a demand realization rate of 52%, as shown in Table 9-8.

Table 9-7. PY11 Unverified New Homes Program Gross Impact Results for Energy (Verified in PY12)

Stratum	PY11 Unverified RTD MWh/yr	PY11 Verified in PY12 VTD MWh/yr	PY11 -Verified in PY12 Energy Realization Rate
New Homes (Verified in PY12)	4,084	4,157	102%

Table 9-8. PY11 Unverified New Homes Program Gross Impact Results for Demand (Verified in PY12)

Stratum	PY11 Unverified RTD MW/yr	PY11 Verified in PY12 VTD MW/yr	PY11 -Verified in PY12 Demand Realization Rate
New Homes (Verified in PY12)	1.38	0.72	52%

A number of factors led to variation between the reported and verified savings and to the observed realization rates of less than or greater than 100% for energy savings and/or demand reductions. This section presents highlights from the analysis. Additional information can be found in *Appendix G* for each of these program components.

Audit and Kit. The Audit and Kit stratum group had a 76% realization rate for energy and 69% realization rate for demand. The realization rates were largely driven by online assessments, which contributed 456 MWh/yr of this stratum group's 487 verified MWh/yr savings and .042 MW/yr of its .045 MW/yr savings. Online assessments had realization rates below 100%, primarily because Q1 kits included 9-watt standard LEDs. This bulb had an energy realization rate of 17% and a demand realization rate of 15% because the baseline shifted to post-2020 values in PY12, as stipulated in the PA TRM.⁴⁹ In Q2, this bulb

⁴⁹ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017.

was replaced with a BR30 reflector, which was not subject to the baseline shift. However, participation also dropped sharply in Q2 because the ICSP had technology issues with the online platform.

Weatherization. The Weatherization stratum group had a 100% energy realization rate and a 91% demand realization rate. The low realization rate for demand reductions, similar to PY10 and PY11 results, was because the ICSP applied the PA TRM's alternate cooling equivalent fuel load hours (EFLH) to calculate reported demand reduction whereas Cadmus used the PA TRM's default cooling EFLH.

Efficient Equipment. The Efficient Equipment stratum group had a 112% realization rate for both energy and demand. These are the primary factors affecting the realization rate:

- The difference in EFLH values that were used led to an increased realization rate for energy and a lower realization rate for demand for heating and cooling systems.
- Realization rates for DHPs were 117% for energy and 121% for demand. The DHP records review found that all rebated DHP seasonal energy efficiency rating (SEER) and heating seasonal performance factor (HSPF) values in PPL Electric Utilities' participant tracking database matched AHRI certificate values, but with some minor discrepancies related to efficient unit heating and cooling capacity and zip code (which determines the appropriate EFLH value). DHP participant survey responses confirmed that all units were installed and operating and verified all primary and secondary room designations in PPL Electric Utilities' participant tracking database. In several cases, survey responses indicated different heating or cooling baselines, resulting in extreme realization rates (ranging from 30% to over 1,100%). The majority of DHPs had realization rates above 100% because the participant reported a room air conditioner baseline whereas PPL Electric Utilities' participant tracking database reported no cooling.
- Realization rates for ASHPs were 105% for energy savings and 98% for demand reductions. Again, use of the default EFLH values increased energy savings and decreased demand reductions. Cadmus found several small discrepancies through the records review and participant survey responses.
- Realization rates for HPWHs were 100% for energy savings and 98% for demand reduction. Cadmus found no discrepancies between PPL Electric Utilities' participant tracking database and the information provided on rebate forms; however, review of the ENERGY STAR certificates for each unit revealed some discrepancies in tank size (up to 15 gallons difference) and minor discrepancies in rated efficiency. Some survey respondents reported a different heating or cooling condition for the installed HPWH than reported in PPL Electric Utilities' participant tracking database, but the net effect on savings was minimal. Of 25 respondents, 16 said their unit exhaust was vented to the outside, which mitigated interaction with heating and cooling systems.
- The realization rate for smart thermostats was 87% for energy savings. In accordance with the PA TRM, demand reductions were not evaluated. The realization rate was driven by the findings from the records review of smart thermostats with professional installation projects, which had a realization rate of 82%. Cadmus identified several factors that reduced the realization rate. Most of the difference (approximately 10% of reported savings for the sample) was due to

installation type. Two of the 23 respondents said that although the contractor installed the thermostat, the contractor provided no instruction on how to use it. Cadmus evaluated these projects as self-install projects, which reduced savings. The participant survey also found some discrepancies in heating systems: two respondents connected their thermostat to a gas furnace. Another project reported a quantity of two thermostats, but because savings are calculated on a whole-home basis, Cadmus could verify savings for only one thermostat. Separate data on each heating and cooling system are required for each rebated unit.

Online Marketplace. The Online Marketplace stratum group had a 90% energy realization rate and a 99% demand realization rate. The difference was driven mainly by the evaluated ISRs Cadmus applied from the PY12 survey, in particular the ISRs for lighting (87%) and smart thermostats (83%). The ISR for weatherstripping was 59%, low relative to the other products, but this had a minor effect on savings since weatherstripping accounts for only 10% of reported savings and less than 1% of reported demand reductions.

New Homes. The New Homes stratum group had a 102% realization rate for energy savings and a 52% realization rate for demand reductions. These are the primary factors affecting the realization rates:

- Estimated lighting savings in REM/Rate, which is used by the ICSP to calculate *ex ante* savings, were less than the savings Cadmus calculated according to the PA TRM.⁵⁰ This was primarily due to the bulb mix Cadmus found in the sample—specifically downlights, reflectors, and EISA-exempt specialty bulbs accounted for 60% of the installed lighting observed during data collection. Baseline wattages for these bulb types are high, which improved the realization rate.
- The REM/Rate models included energy savings for all appliances, whereas verified savings can be calculated only for appliances present at the time the home was rated. Of the 19 verified homes, 14 were missing at least one appliance. As a result, verified savings for appliances were less than the estimated savings in REM/Rate, and this decreased the realization rate.
- The REM/Rate models included energy savings for all homes with electric storage hot water heaters. According to the PA TRM, only homes with heat pump water heaters are eligible to claim energy savings. None of the verified homes in the PY12 sample had heat pump water heaters, so they were ineligible to claim hot water savings. This resulted in a lower realization rate.

In the New Homes component, the realization rate was 52% for peak demand reductions. Cadmus used the PA TRM to calculate demand reductions for weather-sensitive measures and lighting and appliances. Cadmus was unable to determine the cause of the discrepancies between the *ex post* and the *ex ante* demand reductions reported in PPL Electric Utilities participant tracking database because REM/Rate files lack the detail needed for determining peak demand reductions by component.

⁵⁰ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017.

For more information about how program-level *ex post* savings were calculated, see *Appendix G Evaluation Detail – Energy Efficient Home Program*.

9.3 Net Savings Impact Evaluation

For NTG in PY12, Cadmus surveyed only DHP, ASHP, HPWH, and smart thermostat equipment. The NTG estimates for other measures are from PY8, PY9, and PY11. A detailed explanation of the methodology for these components and equipment types can be found in the PY8, PY9, and PY11 annual reports.^{51,52,53} Cadmus calculated net savings only to inform future program planning. Energy savings compliance targets were met using verified gross savings.

Table 9-9 lists the methods and sampling strategy used to determine net savings for the Efficient Equipment and New Homes stratum groups in PY12. The New Homes stratum interviews were performed in PY11 and are being reported for the first time in PY12 because PY11 savings were verified in PY12. Additional details about methodology and findings are in *Appendix M Net Savings Impact Evaluation* and *Appendix G.4 Net-to-Gross Ratio Findings*.

Table 9-9. PY12 Energy Efficient Home Program Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size ⁽¹⁾	Achieved Sample Size	NTG Activity
Efficient Equipment - DHP	Participants (Customers)	1,039	91 ⁽²⁾	Participant online survey
Efficient Equipment - ASHP		493	40 ⁽²⁾	
Efficient Equipment - HPWH		409	39 ⁽²⁾	
Efficient Equipment - Smart Thermostat		454	48 ⁽²⁾	
New Homes ⁽³⁾	Participant Builders	53	11	Builder self-report interviews from PY11
Program Total		2,448	229	
⁽¹⁾ Population refers to unique participants at time of the survey, which may not match the final population count for the entire program year. ⁽²⁾ Achieved sample size is based on number of survey respondents answering the first free ridership question J1 to J4, “Which of the following would have happened if you had not received the \$[Field-REBATE] [MEASURE] from PPL Electric Utilities?” and answering at least of one of the questions from J5a to J5b, “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. J5a. The discount for the [MEASURE], J5b. PPL Electric Utilities’ information about energy efficiency ⁽³⁾ PY11 savings were verified in PY12. PY11 NTG results are applied to PY12 verified gross savings. PY11 NTG results were not reported in the PY11 evaluation.				

⁵¹ PPL Electric Utilities. November 15, 2017. *Annual Report Program Year 8: June 1, 2016–May 31, 2017*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

⁵² PPL Electric Utilities. November 15, 2018. *Annual Report Program Year 9: June 1, 2017–May 31, 2018*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

⁵³ PPL Electric Utilities. February 15, 2021. *Annual Report Program Year 11: June 1, 2019–May 31, 2020*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

Table 9-10 shows the efficient equipment stratum free ridership, spillover, and NTG ratios by equipment category. For NTG in PY12, Cadmus surveyed only DHP, ASHP, HPWH, and smart thermostat equipment categories; NTG estimates for other equipment categories are from PY8 and PY9.

**Table 9-10. Energy Efficient Home Program –
Efficient Equipment Stratum Net Impact Evaluation Results**

Equipment Category	PYVTD kWh/yr	Evaluation Year	Free Ridership (%) ⁽¹⁾	Spillover (%)	NTG Ratio
Refrigerator	85,554	PY9	63%	11%	0.48
Dehumidifier	254,078	PY9	48%	16%	0.68
Central Air Conditioner	370,251	PY8	44%	7%	0.63
DHP	1,108,016	PY12	62%	1%	0.39
ASHP	12,664,391	PY12	54%	1%	0.47
HPWH	1,240,086	PY12	23%	1%	0.78
Smart Thermostat	523,627	PY12	43%	1%	0.58
Other (pool pump and fuel switching)	778,551	PY8	47%	7%	0.60
Stratum Total ^{(2) (3)}	17,024,553	-	51%	2%	0.51
⁽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 have a greater influence on the equipment-level free ridership estimate than do respondents who achieved lower energy savings. ⁽²⁾ Equipment- level free ridership, spillover, and NTG estimates were weighted by the product's verified kWh/yr program population savings to arrive at the efficient equipment stratum NTG ratio of 0.51. ⁽³⁾ May not match due to rounding.					

Table 9-11 shows the free ridership, spillover, and NTG ratios by program component.

Table 9-11. Energy Efficient Home Program Net Impact Evaluation Results

Stratum	PYVTD kWh/yr	Evaluation Year	Free Ridership (%) ⁽¹⁾	Spillover (%)	NTG Ratio
Audit & Kit	487,381	PY8	7%	9%	1.02
Weatherization	976,570	PY8	49%	7%	0.58
Efficient Equipment	17,024,553	PY12, PY9, PY8	51%	2%	0.51
Online Marketplace	196,779	PY11	25%	0%	0.75
New Homes ⁽²⁾	4,281,771	PY11	84%	0%	0.16
Program Total ^{(3) (4)}	22,967,053	-	56%	2%	0.46
⁽¹⁾ Free ridership estimates were weighted by the survey sample-verified program kWh/yr savings. This method ensured that respondents who achieved higher energy savings through the program products had a greater influence on the equipment-level free ridership estimate than did the respondents who achieved lower energy savings. ⁽²⁾ PY11 savings were verified in PY12. PY11 NTG results are applied to PY12 verified gross savings. ⁽³⁾ The stratum-level free ridership, spillover, and NTG ratio estimates were weighted by the stratum's verified kWh/yr program population savings to arrive at the final Energy Efficient Home Program NTG ratio of 0.46. ⁽⁴⁾ Total may not match sum of rows due to rounding.					

9.4 Verified Savings Estimates

In Table 9-12, the realization rates determined by Cadmus are applied to the reported energy and demand reductions to calculate the verified savings estimates for the Energy Efficient Home Program in PY12.

Table 9-12. PYTD and P3TD Energy Efficient Home Program Savings Summary

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD Gross	21,199	4.60
PYVTD Gross	22,967	4.14
PYVTD Net ⁽¹⁾	10,579	1.85
P3RTD Gross	94,220	17.77
P3VTD Gross	90,460	15.91
P3VTD Net ⁽¹⁾	54,248	9.12
⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' energy savings compliance target.		

9.5 Process Evaluation

9.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. The PY12 limited process evaluation of the Energy Efficient Home Program was to assess participant satisfaction using data collected through online participant surveys. Table 9-13 shows the sampling strategy for the process evaluation.

These activities were consistent with the evaluation plan except for stakeholder interviews. Cadmus originally planned to conduct three stakeholder interviews with PPL Electric Utilities, its ICSP, and the ICSP's subcontractor. Because the program did not experience major changes or updates in PY12, Cadmus conducted only one interview with PPL Electric Utilities.

A total of 714 participants completed the online survey. Cadmus contacted all eligible participants for each program component and administered the online survey in waves throughout PY12. To provide timely respondent feedback and information to PPL Electric Utilities and the ICSP, the survey was administered Q1 through Q4 for the Efficient Equipment participants, Q1 and Q2 for the online assessment participants, and Q1 through Q4 for the Online Marketplace, Audit and Kit, and Weatherization participants.

The sample sizes noted in this report may vary by survey question because respondents could skip questions if they chose not to answer; therefore, not all respondents provided answers to every question. Cadmus included all survey respondents who answered the satisfaction question when calculating overall satisfaction even if they did not complete the entire survey.

Additional details about the approach to contacting customers and the sample attrition are presented in *Appendix G Evaluation Detail – Energy Efficient Home Program* and *Appendix N. Survey Methodology*.

Table 9-13. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size ⁽¹⁾	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size ⁽²⁾	Number of Records Selected for Sample Frame ⁽³⁾	Percent of Sample Frame Contacted to Achieve Sample ⁽⁴⁾
Program Stakeholders	PPL Electric Utilities Program and ICSP Staff	Telephone in-depth interview	3	N/A	3	1	1	100%
Participants ⁽¹⁾	Audit and Kit	Online survey	120	90/10	All records	10	107	100%
	Online Assessment	Online survey	2,424	90/10	All records	154	2,196	100%
	Efficient Equipment	Online survey	6,806	90/10	All records	449	5,178	100%
	Weatherization	Online survey	588	85/15	All records	38	437	100%
	Online Marketplace	Online survey	898	90/10	All records	63	683	100%
Program Total			10,839	-	-	715	8,602	100%

⁽¹⁾ For participants, population refers to unique projects at the time of the survey activity, which may not match the final population count for the entire program year.

⁽²⁾ Achieved sample size is based on number of survey respondents answering the first demographic question: “What type of residence do you live in?” Some respondents completed surveys but did not answer the Overall Satisfaction question or answered the Overall Satisfaction question but did not complete the survey. Therefore, data captured from additional surveys contributed to various analyses discussed in this report.

⁽³⁾ Sample frame is a list of participants with contact information. The final sample frame includes unique records in the PPL Electric Utilities’ tracking database at the time of the survey. 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 national Do Not Call list, or opted out of the online survey.

⁽⁴⁾ Percent contacted means the percentage of the sample frame contacted to complete surveys.

9.5.2 Program Satisfaction

Participant satisfaction with the Online Marketplace, Efficient Equipment, Weatherization components and the Audit and Kits component’s online assessment and in-home audit are reported in this section. In PY12, 88% (n=720) of respondents said they were satisfied with the Energy Efficient Home Program ($\pm 5\%$ at 90% confidence, shown in this program’s infographic).⁵⁴ Sixty-five percent were *very satisfied* and 23% were *somewhat satisfied*.⁵⁵ Compared to PY11 (91%, n=705), these satisfaction results are

⁵⁴ Cadmus included all survey respondents who answered the satisfaction question even if they did not complete the entire survey. Cadmus applied weights to the survey sample for the satisfaction question to match the population distribution.

⁵⁵ Of the remaining respondents, 5% were *neither satisfied nor dissatisfied*, 2% were *not too satisfied*, 1% were *not at all satisfied* with the overall program, and two respondents said don’t know. The total may not sum to 100% due to rounding.

significantly lower.⁵⁶ However, removing the New Homes builders from the PY11 results to give a direct comparison results in a satisfaction score of 90% (n=694), which is not statistically different from PY12.

Component-Level Satisfaction

Across program components, nearly all participants were satisfied with their experience in the Energy Efficient Home Program (Table 9-14). Satisfaction with the program was lower for online assessment (84%) and Online Marketplace participants (84%) than for the Efficient Equipment component (95%).⁵⁷ This is consistent with PY11, when 80% of online assessment participants (n=123) were satisfied with the program, significantly lower than Efficient Equipment component participants. All component-level satisfaction results in PY12 were not significantly different from PY11.

Table 9-14. Overall Satisfaction by Program Component

Component	Percent Satisfied (<i>very or somewhat satisfied</i>)	
	PY12	PY11
Equipment	95% (n=447)	95% (n=488)
In-Home Audit	91% (n=11)	100% (n=7)
Weatherization	88% (n=40)	94% (n=34)
Online Marketplace	84% (n=64)	88% (n=42)
Online Assessment	84% (n=158)	80% (n=123)
Total	88% (n=720)	91% (n=705)

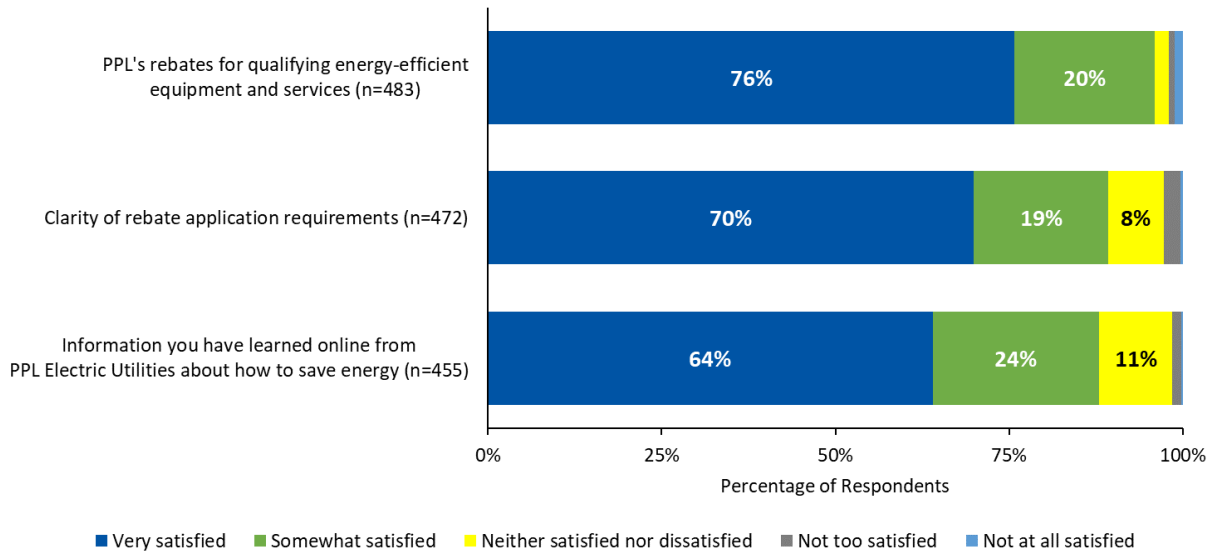
Program Delivery

Participant survey respondents reported their satisfaction with various elements of program delivery. As shown in Figure 9-1, Efficient Equipment, Audit and Kit, and Weatherization participants were highly satisfied. Over 88% said they were *very satisfied* or *somewhat satisfied* with each program delivery element listed in the participant survey. Results in PY12 were not significantly different from PY11.

⁵⁶ p=.0434

⁵⁷ Online Assessment: p=.0004; Online Marketplace: p=.0352

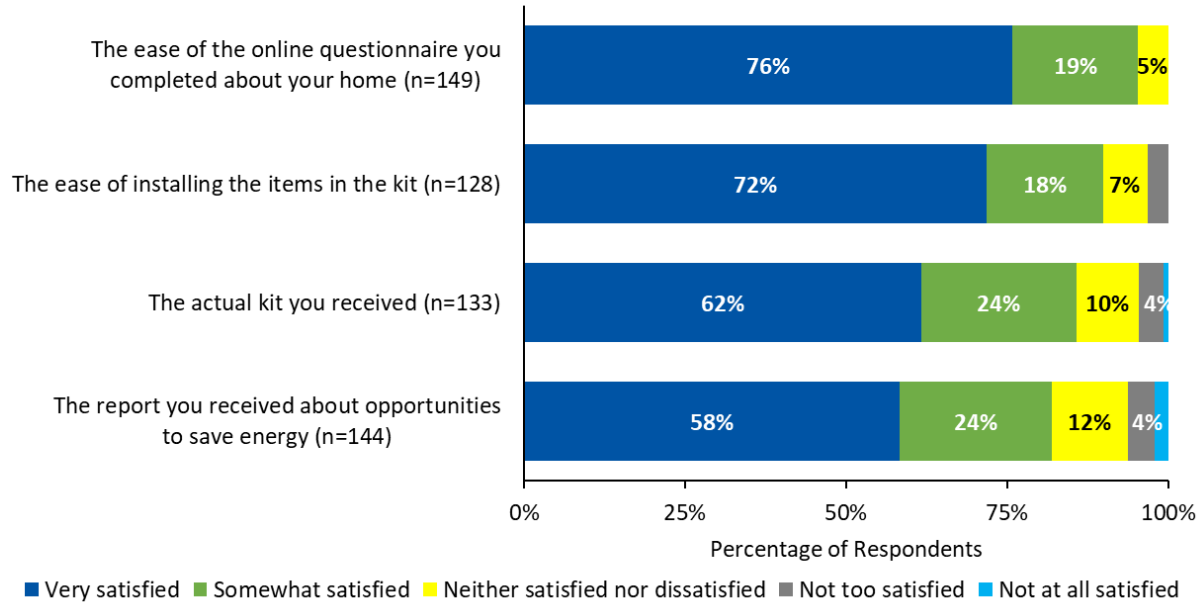
**Figure 9-1. PY12 Program Element Satisfaction:
Equipment, Audit and Kit, Weatherization Components**



Source: Questions, “Please indicate how satisfied you are with each of the following program components: clarity of application requirements, information you have learned online from PPL Electric Utilities about how to save energy, and PPL Electric Utilities’ rebates for qualifying energy-efficient equipment and services.”

Similarly, online assessment respondents rated their satisfaction with specific aspects of the program’s delivery (Figure 9-2). Though satisfaction was over 80% for all program elements, the percentage of respondents who were *very satisfied* with “The report you received about opportunities to save energy” and “The actual kit you received” was lower than for other aspects of their experience. These satisfaction levels are consistent with PY11.

Figure 9-2. PY12 Program Element Satisfaction: Online Assessment

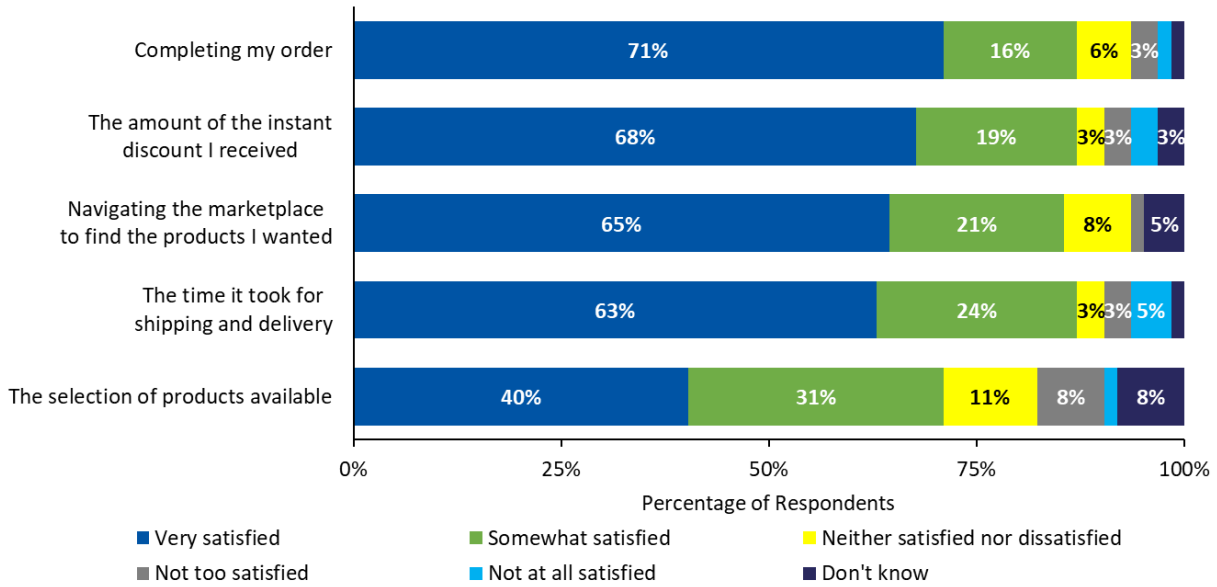


Source: Questions, "Please indicate how satisfied you are with each of the following program components:
The ease of the online questionnaire you completed about your home, the report you received about opportunities to save energy, the actual kit you received, and the ease of installing items in the kit."

Online Marketplace

Respondents were highly satisfied with the Online Marketplace, with 84% reporting they were *very* or *somewhat satisfied* (n=64). As shown in Figure 9-3, over 80% said they were either *very* or *somewhat satisfied* with each program element except for the selection of products available, for which 71% were satisfied. Consistent with PY11, respondents were most satisfied with completing their order (n=62).

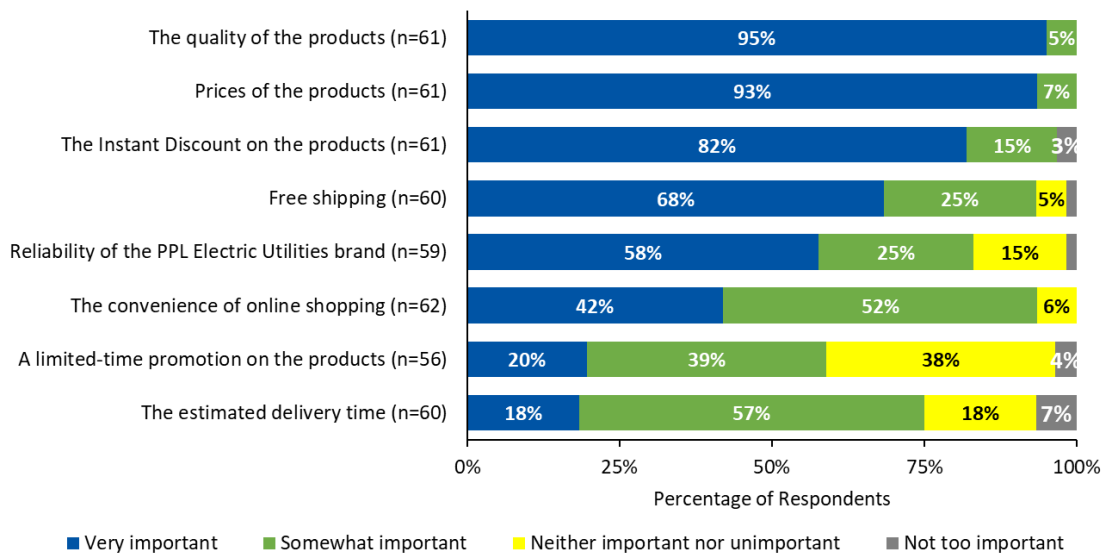
Figure 9-3. PY12 Program Element Satisfaction: Online Marketplace



Source: Question, "Please indicate how satisfied you are with each of the following program components: Completing my order, the time it took for shipping and delivery, the amount of the instant discount I received, navigating the Marketplace to find the products I wanted, the selection of products available." (n=62)

Respondents reported their reasons for choosing to shop on the Online Marketplace (Figure 9-4). Consistent with PY11, the top decision factors were focused on the products themselves, specifically quality, price, and the instant discount customers received for purchasing the product on the Online Marketplace. When asked to pick the most important factor in their decision to shop at the Online Marketplace, nearly all (n=61) said either the price (41%) or the discounts on products (36%).

Figure 9-4. Decision Factors Driving Shoppers to the Online Marketplace



Source: Question H1. “To improve future online shopping experiences, PPL Electric Utilities is interested in learning more about decisions to purchase products from the Energy Efficiency Marketplace, instead of purchasing elsewhere. Please rate the importance of the following factors in your decision to purchase products from the Marketplace.”

9.5.3 Suggested Improvements (All Program Components)

Respondents provided various suggestions to improve the Energy Efficient Home Program. These were the top suggestions from all respondents, with most coming from Efficient Equipment component respondents:

- Improve clarity and simplify the application process (51 of 224). Respondents asked for clearer instructions and more support when completing their applications.
- Increase the breadth of rebate-eligible equipment (32 of 224), specifically by expanding offerings to include a bigger price range (specifically for the Online Marketplace) and a wider selection of eligible energy-efficient appliances. Though most respondents did not specify the type of products, those who did suggested washers and dryers (one response), small appliances (one response), “other ENERGY STAR items” (one response), and electric vehicle charging equipment (one response).
- Increase the rebate amount (26 of 224) to help make it worth the customer’s time to apply.
- Better customer service and follow-up (20 of 224), specifically related to providing an easier way to track the rebate status (10 responses) and notifying customers when more information is needed to process the rebate (six responses).

Of the 32 online assessment respondents who had suggestions, the most often requested was more flexibility with kit items (five responses) and improved information on how to save energy (four responses). This contrasts with PY11, when suggestions for improving the online assessment focused

mostly on clarifying details of the report (12 comments from 34 respondents). This indicates an improvement in how customers perceive the report in PY12.

Of the 26 Online Marketplace respondents who provided feedback, 12 requested a greater selection of rebate-eligible products. Though most respondents did not specify the types of products they wanted, three specifically suggested additional energy-efficient appliances, a wider selection of brands, and a wider selection of value-priced products.

9.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 9-15. Cadmus calculated the TRC benefits using gross verified impacts. The net present value program year to date (NPV PYTD) benefits and costs are expressed in PY12 dollars (PY12 includes months in both 2020 and 2021). Net present value costs and benefits for P3TD financials are expressed in PY8 dollars.

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.⁵⁸ A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix L Non-Energy Benefits*.

⁵⁸ Guidance on the Inclusion of fossil fuel and H₂O benefits in the TRC Test, Statewide Evaluation Team, March 25, 2018.

Table 9-15. Summary of Energy Efficient Home Program Finances—Gross Verified ⁽¹⁰⁾

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁹⁾	
1	EDC Incentives to Participants	\$3,537		\$11,947	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$10,918		\$40,716	
4	Incremental Measure Costs (Sum of rows 1 through 3) ⁽¹⁾	\$14,455		\$52,663	
		EDC	CSP	EDC	CSP
5	Design & Development ⁽²⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽³⁾	\$77	-	\$268	-
7	Marketing ⁽⁴⁾	-	\$374	-	\$1,171
8	Program Delivery ⁽⁵⁾	-	\$2,777	-	\$13,031
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽¹⁾	\$3,228		\$14,469	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$123		\$6,979	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^{(6) (1)}	\$17,806		\$74,111	
14	Total NPV Lifetime Electric Energy Benefits	\$14,688		\$43,088	
15	Total NPV Lifetime Electric Capacity Benefits	\$2,864		\$8,765	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$3		\$534	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	\$8,008		\$23,428	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^{(7) (1)}	\$25,564		\$75,815	
19	TRC Benefit-Cost Ratio ⁽⁸⁾	1.44		1.02	

⁽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. Costs attributed to the New Homes component are excluded because the savings were not verified.

⁽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.

⁽⁹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

⁽¹⁰⁾ Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.

Table 9-16 presents program financials and cost-effectiveness on a net savings basis.

Table 9-16. Summary of Energy Efficient Home Program Finances–Net Verified ⁽¹⁰⁾

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁹⁾	
1	EDC Incentives to Participants	\$1,526		\$10,448	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	\$4,710		\$36,090	
4	Incremental Measure Costs (Sum of rows 1 through 3) ⁽¹⁾	\$6,236		\$46,538	
		EDC	CSP	EDC	CSP
5	Design & Development ⁽²⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽³⁾	\$77	-	\$268	-
7	Marketing ⁽⁴⁾	-	\$374	-	\$1,171
8	Program Delivery ⁽⁵⁾	-	\$2,777	-	\$13,031
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽¹⁾	\$3,228		\$14,469	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	\$63		\$6,935	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^{(6) (1)}	\$9,527		\$67,942	
14	Total NPV Lifetime Electric Energy Benefits	\$6,664		\$37,108	
15	Total NPV Lifetime Electric Capacity Benefits	\$1,272		\$7,579	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$3		\$534	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	\$4,289		\$20,656	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^{(7) (1)}	\$12,227		\$65,876	
19	TRC Benefit-Cost Ratio ⁽⁸⁾	1.28		0.97	

⁽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⁾ 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.
⁽⁹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.
⁽¹⁰⁾ Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.

9.7 Recommendations

Overall, the Energy Efficient Home Program continues to deliver reliable savings and receives positive ratings from participants. The program achieved 22,967 MWh/yr in verified savings. The majority of participants, 88%, were *very* or *somewhat satisfied* with the program in which they participated.

Recommendations are provided in Table 9-17, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: PPL Electric Utilities has an opportunity to expand the reach of the Online Marketplace through an increase in the variety of products in the portfolio.

- Respondents were highly satisfied with all but one aspect of their experience on the Online Marketplace: the selection of products available (71% satisfaction compared to over 80% for other factors). (See section 9.5.2 *Program Satisfaction*.)
- Of the 26 Online Marketplace respondents providing feedback, 12 requested a greater selection of rebate-eligible products. Though most did not specify what types of products they wanted to see, three respondents specifically suggested additional energy-efficient appliances, a wider selection of brands, and a wider selection of value-priced products. (See section 9.5.3 *Suggested Improvements (All Program Components)*.)

Conclusion 2: Higher savings could be achieved for customers who install smart thermostats if they receive education that qualifies as self-installation with education.

- Most of the reduction in evaluated savings for smart thermostats relative to reported savings was because two of the 23 sampled participants reported that their contractor did not provide education. (See section 9.2.2 *Gross Savings Impact Evaluation Results*.)

Table 9-17. Status of Recommendations for the Energy Efficient Home Program

Energy Efficient Home Program		
Conclusion	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
Conclusion 1: PPL Electric Utilities has an opportunity to expand the reach of the Online Marketplace through a greater selection in the product portfolio.	Consider expanding the Online Marketplace to include additional product categories, such as other small energy-efficient appliances like air purifiers and room air conditioners, and a wider variety of brands and price-points. Providing customers with additional options can help improve satisfaction and increase the number of total purchases when current offerings do not meet a customer's needs. Cadmus notes that PPL Electric Utilities is planning to expand offerings in PY13.	Being considered. New measures will be added during Phase IV.
Conclusion 2: Higher savings could be achieved for customers who install smart thermostats if they receive education that qualifies as self-installation with education.	Design a training for customers about the installation and operation of their thermostat and require them to complete it before receiving their rebate. Additionally, by requiring the same account information to log in that customers provide on the rebate form, the ICSP can track which customers have completed the training. If the training has controls in place to ensure participants actually engage with the material (rather than skipping to the end), the ICSP can independently confirm and document that participants have received training.	Being considered. Planning to develop and implement.

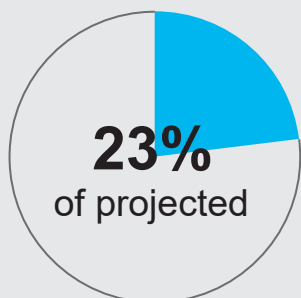
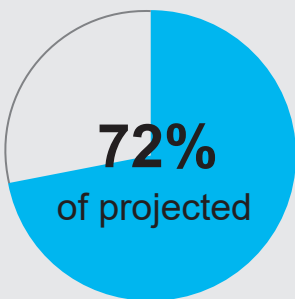


HOME ENERGY EDUCATION PROGRAM

The program encourages customers to save energy by sending them home energy reports that provide data about their energy use, a comparison of household energy use to similar customers in the same geographic area, tips for saving energy, and product recommendations.

VERIFIED ENERGY SAVINGS

Phase III
has saved
163,926 MWh/yr

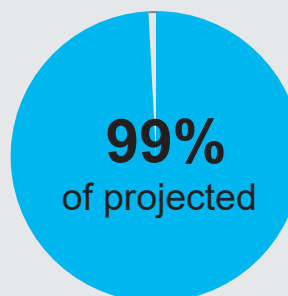
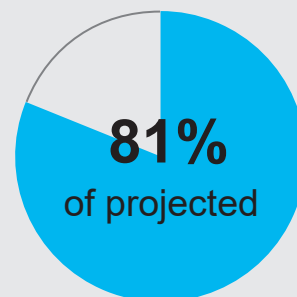


PY12 saved
13,316 MWh/yr

Totals exclude savings attributable to the low-income sector

ACTUAL EXPENDITURES (\$1,000)

Phase III
expenditures
\$8,190



PY12
expenditures
\$2,343

Totals exclude expenditures attributable to the low-income sector

PY12 PARTICIPATION



14,944

residential income-eligible customers
received Home Energy Reports

The Home Energy Reports acknowledged that the COVID-19 pandemic may have changed customers' living situation and focused on providing income-eligible customers with low- and no-cost energy savings tips.

10 Home Energy Education Program

The Home Energy Education Program encourages customers to save energy by sending them home energy reports that provide data about their current and historical electricity consumption, a comparison of their household electricity consumption to that of similar households in the same geographic area, and tips for saving energy (such as turning off lights and taking short showers) and product recommendations (such as LEDs, power strips, and appliances). These reports also guide customers to PPL Electric Utilities' online energy management portal, Ways To Save,⁵⁹ where they can take a home energy assessment by entering detailed information about their home and request a kit with energy-saving products.⁶⁰

CLEAResult, the ICSP for all of PPL Electric Utilities' residential programs, administers the Home Energy Education Program and manages the home energy reports vendor. The ICSP subcontracts with Uplight (formerly Tendril) to administer the program, including the home energy reports, online energy management portal, and online home energy assessments.

In PY12, the program delivered home energy reports to the low-income customer cohort that launched in 2014. These customers received two print home energy reports and those with valid email addresses also received reports in electronic format. Customers could also access the program's energy management portal to set and track their progress toward planned energy-savings, receive energy savings recommendations, and check off any actions they had completed.

The objectives of the Home Energy Education Program for Phase III were these:⁶¹

- 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 226,000 MWh/year gross verified savings
- Achieve high customer satisfaction with the program

The program was implemented as a randomized controlled trial where eligible customers were randomly assigned to a treatment group or a control group. Customers in the treatment group received

⁵⁹ Ways to Save is an online customer engagement portal with information about all available rebates, tips to save, and the home energy assessment. All PPL Electric Utilities' customers have access; however, treatment group customers receive specific encouragement through the home energy reports to visit this energy management portal.

⁶⁰ Savings for the kits and energy-saving products are reported in the Energy Efficient Home Program.

⁶¹ Program objectives and targets are listed in PPL Electric Utilities' revised EE&C Plan, November 2018.

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 and were not told they were part of the control group. The consumption of control group customers provided the baseline for estimating the savings from the home energy reports.

The same treatment and control group assignments from Phase II carried over into Phase III. The home energy reports vendor identified new treatment and control group customers to expand the program for Phase III. Cadmus made the random assignments of these additional customers in early PY8.

10.1.1 Definition of a Participant

A participant in the Home Energy Education Program is defined as a residential customer assigned to the treatment group. For the savings analysis, participants who opted out of the program are considered participants, even after they stopped receiving reports.

The customer population is divided into six cohorts of customers known as “waves” defined by the dates customers began receiving the home energy reports:

- Phase I Legacy Wave 1 received first report in PY2, April or May 2010⁶²
- Phase I Legacy Wave 2 received first report in PY3, June 2011⁶³
- Phase II Expansion Wave received first report in PY6, October or December 2014⁶⁴
- Phase II Low-Income Wave 1 received first report in PY6, October or December 2014 (after PY10, only customers who were still identified as low-income received reports)
- Phase II Low-Income Wave 2 received first report in PY7, June 2015 (discontinued after PY10)
- Phase III Expansion Wave received first report in PY8, June 2016⁶⁵

In PY12, only customers in Low-Income Wave 1 received the home energy reports. The savings for this wave are evaluated in this report. However, because home energy report savings have a one year measure life and the four residential waves received their last report in November 2019, Cadmus evaluated the savings for these waves through October 2020. Cadmus evaluated savings through May 2021 for Low-Income Wave 1. Cadmus did not evaluate any savings for the subset of Low-Income Wave 1 customers that were no longer low-income because they received their last report in PY10.

⁶² In November 2019, PPL Electric Utilities ceased sending the home energy reports to residential customers in this wave.

⁶³ Ibid.

⁶⁴ Ibid.

⁶⁵ Ibid.

In PY8 through PY10, PPL Electric Utilities claimed savings generated by customers in the Phase II Low-Income Wave toward the residential sector savings for Phase III compliance. In PY11 and PY12, PPL Electric Utilities reallocated a portion of the program’s planned energy savings, budget, and participants to the low-income sector and reported this information under WRAP in the EE&C plan.⁶⁶ In PY11 and PY12, PPL Electric Utilities sent dedicated low-income reports to the customers in this wave who were still at or below 150% of the federal poverty level and claimed these savings toward the low-income sector.

10.1.2 Program Participation and Reported Impacts

Table 10-1 presents the participation counts, reported energy, and demand savings for the Home Energy Education Program in PY12 by customer segment (residential and low-income). The count of participants is based on the number of unique job numbers (referring to an account number for one household) in PPL Electric Utilities’ tracking database. Cadmus’ impact analysis includes the number of treatment group customers who were active at the beginning of PY12.

In PY12, the home energy report vendor treated only the subset of customers in Low-Income Wave 1 who were verified by PPL Electric Utilities as still having an income at or below 150% of the federal poverty level. The remaining residential waves received their last home energy report in November 2019. Although home energy reports are considered to have a one-year measure life and some PY12 savings for the four remaining residential waves could have been reported in PY12, the ICSP did not report these savings.

Table 10-1. PY12 Home Energy Education Program Participation and Reported Impacts

Parameter	Residential	Low-Income ⁽¹⁾	Total ⁽²⁾
PYTD # Participants ⁽³⁾	0	14,944	14,944
PYRTD MWh/yr	0	1,534	1,534
PYRTD MW/yr	0.00	0.27	0.27
PYVTD MWh/yr	13,316	1,468	14,784
PYVTD MW/yr	5.37	0.25	5.61
PY12 Incentives (\$1000)	\$0	\$0	\$0

⁽¹⁾ A home energy report sent to low-income cohorts is an approved low-income measure. PY12 verified low-income savings are counted toward the low-income savings compliance target.

⁽²⁾ Total may not match sum of columns due to rounding.

⁽³⁾ The participant count in PPL Electric Utilities’ tracking database is based on the number of unique job numbers (referring to an account number for one household), while the participant count for the impact analysis includes the number of treatment group customers who were active at the beginning of PY12 and included in the energy savings analysis.

⁶⁶ PPL Electric Utilities. *Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642. Approved November 2018.

10.2 Gross Savings Impact Evaluation

10.2.1 Impact Evaluation Data Collection and Sample Design

The impact evaluation estimated the Home Energy Education Program's PY12 energy savings. The program's experimental design and the large number of customers in the randomized treatment and control groups allowed Cadmus to obtain accurate and precise estimates of the program's savings. For each wave, Cadmus conducted a panel regression analysis of individual customer monthly billing consumption for customers in the treatment and control groups.

To estimate demand impacts, Cadmus followed the approach used in previous Phase III evaluations by multiplying the PY12 average annual energy savings per-hour per-customer by the ratio of average peak demand savings per customer to the average annual energy savings per hour per customer, where the ratio was obtained from the PY4 evaluation.

Cadmus did not make any changes to the evaluation activities due to COVID-19.

Because the home energy reports encourage 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). Cadmus subtracted the uplift savings from the residential portfolio savings to avoid double-counting the uplift savings. (See section *10.3.1 Uplift Analysis*.)

The PY12 sampling strategy is summarized in Table 10-2. Cadmus included treatment group customers in the regression analysis regardless of whether they ever received treatment (a home energy report) or opted out of the program because of the randomized experimental design. Since some customers did not receive treatment, the regression analysis results in an estimate of the program intent-to-treat effect. This estimate is multiplied by the number of treatment days to obtain an estimate of the overall home energy report savings. Only customers with 11 complete months of pre-period billing data and at least one month of sufficient post-period billing data were included in the regressions. However, all treatment group customers, regardless of their billing data, were still credited with savings.

Additional details about methodology and attrition are in *Appendix C.1 Methodology*.

Table 10-2. PY12 Home Energy Education Program Gross Impact Sample Design

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	47,814	47,805	Regression analysis on monthly billing data to estimate treatment effect (by stratum)
Legacy Wave 2	55,040	25,003	N/A	50,375	22,820	
Expansion Wave 1	48,711	12,653	N/A	47,178	12,257	
Low-Income Wave 1 – Low-Income ⁽⁴⁾	73,500	18,560	N/A	17,577	4,544	
Phase III Expansion Wave 1	30,584	12,234	N/A	27,016	10,835	
Program Total ⁽⁵⁾	257,835	118,450	N/A	189,960	98,261	

⁽¹⁾ Population size is based on the number of customers originally randomized prior to the start of the program.
⁽²⁾ The population for each wave is based on data at the time of enrollment. 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 the analysis who had at least 11 months of pretreatment and at least one month of posttreatment billing data (details on attrition can be found in *Appendix C.1 Methodology*). These counts include customers whose accounts became inactive before PY12.
⁽⁴⁾ In PY12, similar to PY11, the home energy reports vendor treated only the subset of customers in this wave identified by PPL Electric Utilities as still being at or below 150% of the federal poverty level.
⁽⁵⁾ Total may not sum to all rows due to rounding.

10.2.2 Gross Savings Impact Evaluation Results

Table 10-3 shows the program’s annual verified gross energy savings and the total for Phase III.

Table 10-3. Home Energy Education Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	34,326	36,232 ⁽¹⁾	42,829	38,787	14,784	166,958 ⁽²⁾

⁽¹⁾ PY9 verified savings were reduced by 96 MWh/yr to conform with the SWE PY9 annual report findings. From Pennsylvania Public Utility Commission. *SWE Annual Report Act 129 Program Year 9*. Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, BrightLine Group, and Demand Side Analytics LLC. February 28, 2019.
⁽²⁾ Phase III verified savings may not match sum of program years due to rounding.

In PY12, the Home Energy Education Program reported energy savings of 1,534 MWh/yr, as shown in Table 10-4, and demand reduction of 0.27 MW/yr, as shown in Table 10-5. Cadmus verified 964% of the reported energy savings and 2,099% of the reported demand savings. These high realization rates were driven by verifying savings for the four waves that sent reports in PY11 but not PY12.

Table 10-4. PY12 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.	PYVTD MWh/yr ⁽¹⁾
Legacy Wave 1	0	N/A	0.18	25.73%	3,282
Legacy Wave 2	0	N/A	0.20	28.93%	5,104
Expansion Wave 1	0	N/A	0.23	33.71%	3,906
Low-Income Wave 1 – Low-Income	1,534	96%	0.87	125.89%	1,468
Phase III Expansion Wave 1	0	N/A	0.52	74.77%	1,024
Program Total ⁽²⁾	1,534	964% ⁽³⁾	N/A	19.87%	14,784

⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
⁽²⁾ Total may not sum to all rows due to rounding.
⁽³⁾ High overall realization rate was driven by verifying savings for the four waves that sent reports in PY11 but not PY12.

Table 10-5. PY12 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.	PYVTD MW/yr ⁽¹⁾
Legacy Wave 1	0.00	0	0.38	54.30%	1.32
Legacy Wave 2	0.00	0	0.39	56.05%	2.06
Expansion Wave 1	0.00	0	0.41	58.93%	1.57
Low-Income Wave 1 – Low-Income	0.27	93%	0.98	140.56%	0.25
Phase III Expansion Wave 1	0.00	0	0.64	91.67%	0.41
Program Total ⁽²⁾	0.27	2,099% ⁽³⁾	N/A	30.69%	5.61

⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
⁽²⁾ Total may not sum to all rows due to rounding.
⁽³⁾ High overall realization rate was driven by verifying savings for the four waves that sent reports in PY11 but not PY12.

The following was the primary factor affecting the program's achievements in PY12:

- **Only the Low-Income Wave 1 was treated in PY12 and received home energy reports.** The other residential waves last received treatment in November 2019. This led to lower overall reported and verified savings as the residential waves comprised the majority of the program participation.

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

- **In PY12, the HER vendor treated only the subset of customers in the Low-Income Wave 1 who were verified by PPL Electric Utilities as still having an income at or below 150% of the federal poverty level.** The remaining customers in the residential waves were last treated in November 2019. However, because home energy reports are considered to have a one-year measure life, savings through October of PY12 for customers in the other residential waves can be claimed as residential sector savings. Cadmus measured these savings and applied the savings to the

residential sector. PPL Electric Utilities did not claim these residential savings in its tracking database, leading to overall energy and demand realization rates of well over 100%. The energy and demand realization rates for Low-Income Wave 1 were close to 100%, indicating alignment for the wave for which savings were reported. The demand realization rate was higher than the energy realization rate because the five evaluated months for the residential waves included the summer months, so they achieved full demand savings while only achieving partial year energy savings.

10.3 Net Savings Impact Evaluation

The Home Energy Education Program evaluation resulted in an estimate of net savings because the analysis compares the change in consumption after treatment for the treatment and control groups. The estimate included any possible spillover in treated customer homes. No free ridership was anticipated because customers did not choose to receive the home energy reports and no incentives were provided. Therefore, the NTG ratio is not relevant in this analysis.

10.3.1 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 PY12. Participation uplift savings appeared in the regression-based estimate of Home Energy Education Program savings and the savings of any other PPL Electric Utilities efficiency programs that experienced uplift. Therefore, Cadmus subtracted the Home Energy Education Program savings that were counted in other programs 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.⁶⁷ For example, installation of a high-efficiency air conditioner in PY4 is expected to yield savings in PY12 and through the expected life of the product. To estimate the home energy report savings in PY12 attributable to the prior adoption of high-efficiency air conditioners and other products, Cadmus collected historical energy efficiency program data from the PPL Electric Utilities' tracking database. See *Appendix C.1.4 Uplift Analysis Methodology* for details on participation uplift and uplift savings estimation methodology.

Participation Uplift

To estimate the effect of the Home Energy Education Program on participation in PPL Electric Utilities' other efficiency programs, Cadmus compared the rates of participation between treatment and control group customers in other Act 129 programs in PY12. Home energy reports had a positive effect on participation in other programs if rates of cross-program participation were greater for treatment group

⁶⁷ 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. Final version May 8, 2018.

customers. On average, across all waves, treatment customers participated in other PY12 programs at a rate 7% greater than control customers.

Savings Uplift

Cadmus estimated the HER savings 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 PY12 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 allocated their annual savings across calendar months using a weather-effects weight based on the product's end use.

For PY12, Cadmus deducted Home Energy Education Program uplift savings of 1,687 MWh/yr (11%) and 0.54 MW/yr (10%) from total program savings. More than half of the uplift savings were achieved through PPL Electric Utilities' downstream programs and the remainder were achieved through the upstream lighting program and the low-income LED bulb giveaway in PY7. Cadmus deducted program uplift savings from the residential portfolio as opposed to the Home Energy Education Program savings because uplift savings are jointly attributable to the HER program and the other programs for which Cadmus verified savings.

10.4 Verified Savings Estimates

Table 10-6 shows the reported and verified energy and demand savings. Because the NTG ratio is not relevant in this analysis, net savings are the same as verified gross savings.

Table 10-6. PYTD and P3TD Home Energy Education Program Savings Summary

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD Gross	1,534	0.27
PYVTD Gross	14,784	5.61
PYVTD Net ^{(1) (2)}	14,784	5.61
P3RTD Gross	154,101	74.72
P3VTD Gross ⁽³⁾	166,958	32.26
P3VTD Net ^{(1) (2)}	166,958	32.26
⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' compliance target for energy-savings.		
⁽²⁾ The NTG ratio is not relevant; net savings are the same as verified gross savings.		
⁽³⁾ Cadmus estimated a 12% demand realization rate in PY8, leading to large discrepancies in P3RTD and P3VTD demand savings.		

10.5 Process Evaluation

Cadmus conducted a full process evaluation earlier in Phase III. In PY12, the limited process evaluation involved receiving updates about program delivery via email from the PPL Electric Utilities program manager, the ICSP, and the home energy reports vendor along with program updates during regular

check-in calls. Program delivery did not change between PY11 and PY12, so Cadmus did not conduct formal staff interviews. Cadmus also completed a review of the home energy reports.

10.5.1 Program Delivery

Due to the COVID-19 pandemic, PPL Electric Utilities revised messaging. For the first time during Phase III, the home energy reports did not promote other energy efficiency programs in PY12. Instead, reports acknowledged that the COVID-19 pandemic may have changed customers' living situation and focused on providing low-income customers with low- and no-cost energy savings tips. The reports had the following statement placed at the top:

"We understand that many people will be spending more time in their homes as a precaution against COVID-19. We're including tips to help you manage your energy use as you make changes in your daily life."

Treatment group customers in the Low-Income Wave 1 received two print and/or electronic home energy reports in PY12.⁶⁸ As shown in Table 10-7, treatment group customers in the Low-Income Wave 1 received the same number of reports as the previous program year.

Table 10-7. Home Energy Report Delivery Frequency

Wave (Launch Year)	PY8	PY9	PY10	PY11	PY12
Phase I Legacy Wave 1 (2010)	6 print reports and/or 6 electronic reports	6 print reports and/or 6 electronic reports	5 print reports and/or 5 electronic reports	2 print reports and/or 2 electronic reports	--
Phase I Legacy Wave 2 (2011)	6 print reports and/or 6 electronic reports	6 print reports and/or 6 electronic reports	5 print reports and/or 5 electronic reports	2 print reports and/or 2 electronic reports	--
Phase II Expansion Wave 1 (2014)	6 print reports and/or 6 electronic reports	6 print reports and/or 6 electronic reports	7 print reports and/or 7 electronic reports	3 print reports and/or 3 electronic reports	--
Phase II Low-Income Wave 1 (2014)	--	1 electronic report	1 print report and 7 electronic reports	2 print report and 2 electronic reports ⁽¹⁾	2 print reports and/or 2 electronic reports
Phase II Low-Income Wave 2 (2015)	--	1 electronic report	1 print report and 7 electronic reports	--	--
Phase III Expansion Wave 1 (2016)	6 print reports and/or 6 electronic reports	6 print reports and/or 6 electronic reports	7 print reports and/or 7 electronic reports	3 print reports and/or 3 electronic reports	--

⁽¹⁾ In PY12, the home energy report vendor treated only the subset of customers in this wave identified by PPL Electric Utilities as still being at or below 150% of the federal poverty level.

⁶⁸ Print and electronic home energy reports were identical in content.

10.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 10-8. Cadmus calculated TRC benefits using gross verified impacts. The NPV PYTD benefits and costs are expressed in PY12 dollars (PY12 includes months in both 2020 and 2021). Net present value costs and benefits for P3VTD financials are expressed in PY8 dollars. Net verified savings are equal to gross verified savings because the program is assumed to have a NTG ratio of 1.0.

Table 10-8. Summary of Home Energy Education Program Finances—Gross and Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁹⁾	
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 and Development ⁽²⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽³⁾	\$42	-	\$173	-
7	Marketing ⁽⁴⁾	-	\$394	-	\$1,071
8	Program Delivery ⁽⁵⁾	-	\$1,951	-	\$5,698
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽¹⁾	\$2,388		\$6,942	
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) ⁽⁶⁾ ⁽¹⁾	\$2,388		\$6,942	
14	Total NPV Lifetime Electric Energy Benefits	\$738		\$6,318	
15	Total NPV Lifetime Electric Capacity Benefits	\$401		\$1,811	
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) ⁽⁷⁾ ⁽¹⁾	\$1,138		\$8,129	
19	TRC Benefit-Cost Ratio ⁽⁸⁾	0.48		1.17	

⁽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⁾ 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. Uplift is not applied to a single program but to the overall portfolio so will not be reflected in the TRC Ratio.

⁽⁹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

10.7 Recommendations

Overall, the Home Energy Education Program achieved 14,784 MWh/yr savings in PY12. No immediate recommendations are currently provided as the program will be discontinued at the beginning of Phase IV.



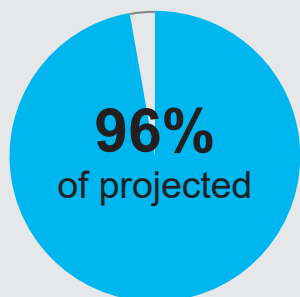
WINTER RELIEF ASSISTANCE PROGRAM (WRAP)

The program offers products and services to income-qualified customers to help to reduce their electric consumption.

VERIFIED ENERGY SAVINGS

Phase III has saved
69,216 MWh/yr

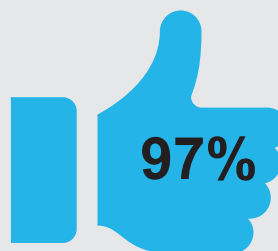
109%
of projected



PY12 saved
10,852 MWh/yr

Totals include low-income savings from Home Energy Education and Student Energy Efficient Education programs

PROGRAM SATISFACTION



Satisfied with
overall program

98% satisfied with the **ease of program enrollment**

97% satisfied with the process of **answering auditor's questions**

96% satisfied with the **energy education received**

95% satisfied with the **quality of energy efficiency products**

PY12 PARTICIPATION



A total of **32,975** participants

2,879 Baseload jobs

2,500 Low-cost jobs

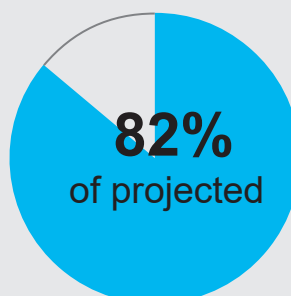
14,944 HEE participants

12,652 SEEE participants

ACTUAL EXPENDITURES (\$1,000)

Phase III
expenditures
\$36,782

83%
of projected



PY12
expenditures
\$5,951

Total expenditures include low-income expenditures for the Home Energy Education and Student Energy Efficient Education programs

11 Act 129 Winter 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 income eligible customers.

Throughout Phase III, PPL Electric Utilities offered services to income-qualified customers residing in single-family homes, master-metered multifamily units, individually metered multifamily units, and manufactured homes.⁶⁹ In PY12, PPL Electric Utilities made changes to program operations in response to the COVID-19 pandemic. It limited program participation to delivered jobs in single-family homes and individually metered multifamily units and did not offer the program via the Manufactured Homes Initiative or to master-metered multifamily buildings.

WRAP is delivered by CMC Energy, the ICSP, which is responsible for outreach, customer recruitment, audits, education, the delivery of customized energy efficiency kits to customers, and the direct installation of equipment in customers' homes. The ICSP also operates a customer call center and supports marketing and tracking activities. The ICSP uses qualified contractors for tasks that include installing energy-saving products and services and replacing outdated and inefficient equipment with program-qualifying energy-efficient equipment.

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 and are within the program's plan (program acquisition cost and total funding). PPL Electric Utilities offers these qualifying customers direct installation of a range of energy efficiency products and services,⁷⁰ including HVAC, lighting, weatherization, water saving and heating, appliances, appliance recycling, and home health and safety. WRAP auditors also deliver energy education and make recommendations to encourage customers to conserve energy.

In PY12, the ICSP offered remote energy assessments in response to the COVID-19 pandemic. Participating customers can receive energy efficiency items such as LEDs, night lights, tier 2 power strips, low-flow showerheads, and low-flow faucet aerators based on responses to questions about their water heater type and heating fuel, number and type of light bulbs in each room, and number of showers and sinks. Throughout the remote energy assessment, the auditor also provides tips on how to save energy. Following the assessment, the ICSP mails the energy efficiency kit to participants with instructions on how to install each item.

⁶⁹ Individually metered income eligible multifamily residences are eligible for the same improvements as individually metered single-family income-eligible residences under WRAP. Furthermore, individually metered manufactured homes are eligible for the same improvements as any other type of individually metered home receiving services from WRAP.

⁷⁰ PPL Electric Utilities eliminated refrigerators and window air conditioners from the program in February 2018.

At the end of PY11, in response to COVID-19, the ICSP stopped distributing postcard reminders of energy-savings tips to customers but resumed in April 2021. Reminder postcards are sent 30 days and 90 days after the completion of the remote energy assessment.

In PY12, PPL Electric Utilities provided two types of service (also known as job types) at no cost to the income-qualified customer. These services are baseload (offered to customers without electric heat and without an electric water heater) and low-cost (offered to customers without electric heat but with electrically heated water).

The objectives of WRAP are these:⁷¹

- Provide low-income customers with an array of no-cost energy-saving equipment, products, and education to help reduce their energy costs
- Increase the health and safety of low-income customers' homes by installing no-cost products such as smoke and carbon monoxide detectors, which may be coordinated with or implemented by USP LIURP 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
- Achieve a total approximate reduction in energy use of 50,000 MWh/year gross verified savings in Phase III

11.1.1 Definition of a Participant

An Act 129 WRAP participant is defined as a PPL Electric Utilities customer who lives in an income-eligible household (150% of the federal poverty income guidelines, or FPIG) and receives a WRAP audit. Each treated household (single-family or multifamily) is identified in the PPL Electric Utilities' tracking database with a unique billing account number.

11.1.2 Program Participation and Reported Impacts

Table 11-1 presents the participation counts, reported energy savings and demand reductions, and incentive payments for WRAP in PY12 by customer segment. (See *Appendix H Evaluation Detail – Winter Relief Assistance Program* for additional discussion about participant counts.)

⁷¹ Program objectives are listed in PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642), November 2018.

Table 11-1. WRAP Participation and Reported Impacts

Parameter	Low-Income ^{(1), (2)}	Total ⁽³⁾
PYTD # Participants	5,379	5,379
PYRTD MWh/yr	9,031	9,031
PYRTD MW/yr	0.85	0.85
PYVTD MWh/yr	7,215	7,215
PYVTD MW/yr	0.69	0.69
PY12 Incentives (\$1,000)	\$0	\$0
⁽¹⁾ This does not include results from Student Energy Efficient Education and Home Energy Education Low-Income components. These savings are counted toward the low-income compliance target, but they are reported in the individual program chapters. See <i>Chapter 13 Student Energy Efficient Education Program</i> and <i>Chapter 10 Home Energy Education Program</i> . ⁽²⁾ Unlike in previous years, no savings were attributed to Small C&I and GNE primarily because there were no master-metered multifamily participants in PY12. ⁽³⁾ Total may not match sum of columns due to rounding.		

11.2 Gross Savings Impact Evaluation

Cadmus conducted the following activities to evaluate WRAP gross impacts.

- **Database review.** Cadmus reviewed all records in PPL Electric Utilities' tracking database and compared these to the participant records in the ICSP's Energy Reduction Management System (ERMS) database. Cadmus verified discrepancies with the ICSP prior to conducting any analyses.
- **Audit records review.** Cadmus reviewed a random sample of the ICSP's home-audit records for baseload and low-cost strata.⁷² Reviews of audit records completed by the home energy auditors at the job site involved verifying reported quantities and relevant inputs for savings calculations. Cadmus verified all data fields in the audit records against the PPL Electric Utilities' tracking database (e.g., home address, water heater fuel type, heating fuel type, reported quantities, and baseline conditions).
- **Engineering analysis.** Cadmus conducted an engineering analysis for baseload and low-cost strata and used the findings from the audit records review as inputs to the engineering algorithms from the PA TRM.⁷³
- **Participant phone surveys.** Cadmus conducted two waves of phone surveys with a random sample of WRAP participants to verify that products were installed as reported and to collect supporting data to analyze the impact of energy education.

11.2.1 Impact Evaluation Data Collection and Sample Design

In PY12, Cadmus collaborated with PPL Electric Utilities and the ICSP to collect the required data to verify energy savings and demand reductions for WRAP. Each quarter, the ICSP provided Cadmus with the ERMS database extract for verification and assessment of participant records and with the audit

⁷² There were no full-cost jobs or jobs in manufactured homes or master-metered multifamily buildings.

⁷³ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017.

records for a random sample of sites. Cadmus conducted two waves of phone surveys with a stratified random sample of participants to verify that products were installed as reported.

Cadmus designed the verification sample for WRAP to meet requirements of 85% confidence with $\pm 15\%$ precision. To examine savings in detail, Cadmus organized the population into baseload and low-cost strata. Cadmus continued to sample the population by project number instead of by account number for simplicity and consistency with previous years.⁷⁴ Within each stratum, Cadmus applied a simple random sampling method to select a sample of homes for verification. Table 11-2 shows the sampling strategy.

Table 11-2. PY12 WRAP Gross Impact Evaluation Sample Design

Stratum ⁽¹⁾	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Baseload	2,879	0.5	24	24	Records review and engineering analysis
Low-Cost	2,500		24	24	
Program Total	5,379	-	48	48	-

⁽¹⁾No full-cost, manufactured home, or master-metered multifamily jobs were completed in PY12.

11.2.2 Gross Savings Impact Evaluation Results

Table 11-3 shows the program's verified gross savings.

Table 11-3. Winter Relief Assistance Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	2,652	14,423 ⁽¹⁾	19,097	13,764	7,215	57,152 ⁽²⁾

⁽¹⁾ PY9 verified includes PY8 reported savings verified in PY9.
⁽²⁾ Phase III verified savings may not match sum of program years due to rounding.

In PY12, WRAP reported energy savings of 9,031 MWh/yr, as shown in Table 11-4. In PY12, WRAP achieved a program energy realization rate of 80%, weighted by stratum. Table 11-5 shows reported demand reductions of 0.85 MW/yr and achieved a program demand realization rate of 81%. Both tables are shown by program stratum.

Table 11-4. PY12 WRAP Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MWh/yr
Baseload	4,210	79%	0.16	4.82%	3,307
Low-Cost	4,820	81%	0.09	2.72%	3,908
Program Total ⁽¹⁾	9,031	80%	N/A	2.61%	7,215

⁽¹⁾ Total may not match sum of rows due to rounding. Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.

⁷⁴ Because every unit in master-metered multifamily jobs are tied to a single account number (the building), Cadmus sampled by project number for all jobs in Phase III. For baseload and low-cost jobs, account numbers generally correspond at a one-to-one ratio with project numbers, although some jobs receive multiple visits over the year or over multiple years.

Table 11-5. PY12 WRAP Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MW/yr
Baseload	0.40	79%	0.40	11.97%	0.31
Low-Cost	0.45	82%	0.17	5.15%	0.37
Program Total ⁽¹⁾	0.85	81%	N/A	6.29%	0.69
⁽¹⁾ Total may not match sum of rows due to rounding. Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

Cadmus identified three primary factors and some minor differences in the audit records and reported data that led to differences between reported and verified savings and the overall realization rate for WRAP in PY12:

There were differences in in-service rates (ISRs) for six products:

- In PY12, LEDs had an overall ISR of 91%; LED nightlights had 94%; tier 2 smart strips had 92%; showerheads had 81%; kitchen aerators had 76%; and bathroom aerators had 86%.
- Most home energy audits occurred remotely, and most WRAP participants had to install all measures themselves. For this reason, ISRs in PY12 were lower compared to PY8 through PY11 because measures were installed directly by contractors.^{75,76}

There were differences in energy education savings:

- The ICSP reported *ex ante* savings of 160 kWh/yr for every participant. Cadmus evaluated savings from each survey wave as 76 kWh/yr in PY12 Q1-Q2 and 129 kWh/yr in PY12 Q3-Q4 and applied these results to the corresponding jobs delivered in PY12 Q1-Q2 and PY12 Q3-Q4. This resulted in a weighted average energy education savings by population of 105 kWh/yr.
- Energy education savings and participation (respondents who said they took some energy savings action) increased substantially in PY12 Q3-Q4 compared to PY12 Q1-Q2.
- Per-participant energy education savings increased 43% in PY12 Q1-Q2 (76 kWh/year) compared to PY11 Q1-Q2 (53 kWh/year). This may be due to the transition from the in-home assessment delivery structure to a remote assessment delivery structure. In PY11 Q1-Q2, participants received an in-home assessment and reminder postcards, but their per-participant energy education savings were lower than the PY12 Q1-Q2 participants who received a remote energy assessment and no reminder postcards. Similarly, per-participant energy education savings for PY12 Q3-Q4 remote energy assessment participants who received reminder postcards were 45%

⁷⁵ PPL Electric Utilities. *Annual Report Program Year 8: June 1, 2016–May 31, 2017*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2017.

⁷⁶ PPL Electric Utilities. *Annual Report Program Year 11: June 1, 2018–May 31, 2019*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. February 15, 2021.

higher (129 kWh/year) than the PY10 in-home assessment participants who received reminder postcards (89 kWh/year).⁷⁷

There were differences in tier 2 smart strips savings and other minor differences:

- Cadmus derated savings for tier 2 smart strips installed in entertainment centers with less than three devices plugged in to an “unspecified use” case. The tier 2 smart strips section of the PA TRM determines savings based on a study from the California Plug Load Research Center,⁷⁸ which determines a percentage savings based on five devices plugged into an entertainment center. The “unspecified use” case in the PA TRM assumes the same savings factor applies,⁷⁹ but the connected load to the smart strip is lower. To reach the per-unit savings of 307 kWh/yr for a tier 2 smart strip plugged into an entertainment center, more than two devices need to be plugged in.
- For most of Phase III, Cadmus found fewer than three devices plugged into tier 2 smart strips. In PY12, verified savings had a larger decrease than previous years because tier 2 smart strips had the largest contribution (46%) to reported energy savings. In other years, LEDs contributed the majority of savings, but in PY12 post-EISA 2020 baselines substantially reduced lighting savings.
- In Cadmus’ sample of 48 audit records, 41 participants received tier 2 smart strips, and all but one were installed in entertainment centers. Sample homes averaged 3.26 tier 2 smart strips per home and fewer than three devices plugged into one. For 14 jobs, Cadmus changed the tier 2 smart strips from entertainment centers to unspecified use, which dropped the realization rate to 82%.
- Differences in the reported savings and Cadmus’ calculations in the records review were minor and had only a small effect on the overall realization rate. See the *Records Review Findings* section in *Appendix H Evaluation Detail – Winter Relief Assistance Program* for additional details.

11.3 Net Savings Impact Evaluation

WRAP is offered to income-eligible customers and at no cost to the customer. No free riders are anticipated because income-constrained customers are not likely to purchase the energy efficiency products on their own. An NTG ratio of 1.0 is appropriate for this program. Therefore, the evaluation did not estimate net savings.

⁷⁷ PPL Electric Utilities. *Annual Report Program Year 8: June 1, 2016–May 31, 2017*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2017.

⁷⁸ California Plug Load Research Center. *Tier 2 Advanced Power Strip Evaluation for Energy Saving Incentive*. May 2014. https://www.embertec.com/assets/pdf/CalPlug_Tier2_APS_Evaluation.pdf.

⁷⁹ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017.

11.4 Verified Savings Estimates

Cadmus applied PY12 realization rates to the reported energy savings and demand reductions estimates to calculate the verified savings and demand reductions estimates for WRAP in PY12 (Table 11-6). Because the NTG ratio is 1.0, net savings are the same as verified gross savings.

Table 11-6. PYTD and P3TD WRAP Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD Gross	9,031	0.85
PYVTD Gross	7,215	0.69
PYVTD Net ^{(1) (2)}	7,215	0.69
P3RTD Gross	66,399	6.47
P3VTD Gross	57,152	5.91
P3VTD Net ^{(1) (2)}	57,152	5.91
⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		
⁽²⁾ Cadmus assumed there is no free ridership in this income-eligible program. Therefore, no net savings analyses were conducted.		

11.5 Process Evaluation

11.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. In PY12, the limited process evaluation assessed participants' and multifamily building property managers' satisfaction with the WRAP. The evaluation activities were consistent with planned activities with one exception. Cadmus did not conduct interviews with master-metered multifamily property managers because no jobs were completed in master-metered multifamily units in PY12. See *Appendix H Evaluation Detail – Winter Relief Assistance Program* and *Appendix N Survey Methodology* for details about Cadmus' approach to contacting customers and the sample attrition.

Table 11-7 lists the process evaluation sampling strategy. Completed participant surveys produced a measurement of program satisfaction with $\pm 10\%$ precision at 90% confidence. In PY12, Cadmus achieved an 8% response rate of 2,458 phone records attempted.

Table 11-7. WRAP Process Evaluation Sampling Strategy

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⁾
PPL Electric Utilities Program and ICSP Staff	Key individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	3	N/A	3	3	3	100%
Home Energy Auditor	Home energy auditor and inspector	Telephone in-depth interview	10	N/A	5	5	5	100%
Participants	Program participants (baseload and low-cost jobs)	Telephone survey	5,379	0.5	208 ⁽³⁾	208	5,079	48%
Program Total			5,392	-	216	216	5,087	-

⁽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 at the time of the surveys. 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, had been 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.

⁽²⁾ Percent contacted means the percentage of the sample frame contacted to complete surveys.

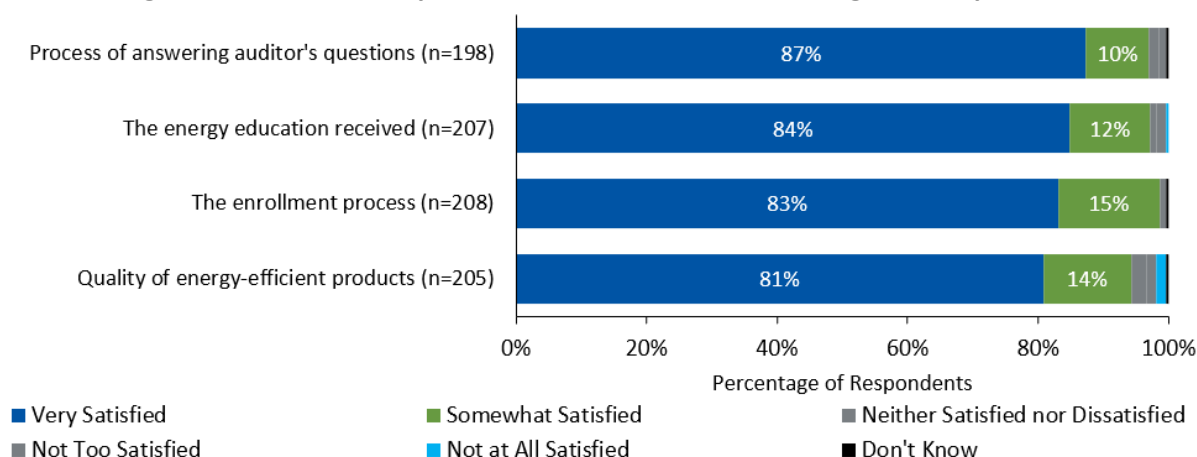
⁽³⁾ Cadmus developed the target sample size of 208 participants to achieve $\pm 10\%$ precision at 90% confidence for each wave of survey. Cadmus conducted the first wave of participant phone surveys in February 2021 (n=110) and the second wave in July 2021 (n=98).

11.5.2 Participant Satisfaction

Cadmus conducted telephone surveys with participants to assess program satisfaction, calculate energy education savings, and verify product installation. Cadmus administered the first wave of surveys (n=110) in February 2021 and the second wave (n=98) in July 2021. Cadmus used the same survey questions for both waves. Cadmus stratified the random sample to target 117 baseload job participants and 91 low-cost job participants across the two waves, a total of 208 survey respondents.

Cadmus found that 97% of PY12 survey respondents were satisfied (83% were *very satisfied* and 14% were *somewhat satisfied*; n=208) with their overall program experience, as shown in this program's infographic.⁸⁰ Respondents were generally satisfied with the program components listed in Figure 11-1. Respondents were most satisfied with the enrollment process (98% were *very* or *somewhat satisfied*).

Figure 11-1. PY12 Participant Satisfaction with Different Program Components



Source: Survey Question D2, "Please indicate how satisfied you are with each of the following components..." (n=208)

11.5.3 Program Delivery

Despite the switch from in-home to remote home energy audits in PY12, Cadmus found that the ICSP continued to deliver WRAP well in PY12. The ICSP created a phone script for the home energy auditor to use during the remote energy assessment.

Areas Working Well

The ICSP coordinator and home energy auditors reported success in the transition from on-site to remote assessments, and the participant survey results support these findings. When asked about

⁸⁰ Additionally, 1% were *neither satisfied nor dissatisfied*, 1% were *not too satisfied*, 1% were *not at all satisfied* with the overall program, and 0% said don't know (n=208).

program implementation, home energy auditors said that the talking points provided by the ICSP helped them conduct the remote energy assessment successfully in these ways:

- **Identifying customer equipment needs based on the equipment currently installed in the home.** Home energy auditors reported difficulty obtaining water heater type and water heating fuel source from the customer, so they prompted with additional questions such as whether customers pay a natural gas bill.
- **Providing energy education to the customer.** More PY12 survey respondents (88%, n=208) said their WRAP home energy auditor provided recommendations about how to save energy and reduce energy costs than did PY11 respondents (59%, n=155) and PY10 respondents (75%, n=155).⁸¹
- **Encouraging customers to install the items that will be mailed to them.**

Three of the five home energy auditors interviewed said the virtual format allowed them to complete more assessments per day because there were no travel requirements. Some said the remote audits made it easier to reach non-English speakers (because the ICSP partners with translators to join the calls if needed) and customers who live in rural communities (no need to drive to the customers' home). They also thought the telephone assessment format encouraged most customers to be highly engaged during the assessment process, unlike an in-home assessment where customers often do not accompany the auditor throughout their home.

Suggested Program Improvements

Program participants, the ICSP coordinator, and home energy auditors provided the following suggestions for program improvements:

- **More education about the program and products installed.** Survey respondents recommended more education about the program or products installed (13%, n=48). Specific suggestions included video instructions for installing products (rather than written instructions), a detailed list of all products offered by the program, and an overview of what customers should expect to provide to the home energy auditor.⁸²
- **Improve communication with customers.** Three home energy auditors recommended that the program upgrade its phone system to mitigate issues of spotty audio quality during the calls.⁸³ One auditor also recommended that, during the assessment, the program enable the use of photos or videos to enable a clear understanding of the exact equipment being discussed.

⁸¹ Cadmus used a two-tailed t-test and found that differences between PY12 and PY11 results are significant at the 95% confidence level ($p < 0.05$).

⁸² The ICSP staff reported that they are developing instructional videos for PY13.

⁸³ ICSP staff reported that phone upgrades will occur in PY13.

11.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 11-8. TRC benefits were calculated using gross verified impacts. NPV PYTD costs and benefits are expressed in PY12 dollars (PY12 includes months in both 2020 and 2021). NPV costs and benefits for P3TD financials are expressed in PY8 dollars. Net verified savings are equal to gross verified savings because the program is assumed to have a NTG ratio of 1.0.

PPL Electric Utilities incorporates the cost of kits into the TRC as program delivery costs rather than as incentives to participants. Because PPL Electric Utilities' tracking and internal reporting systems are in place to catalog these costs as a program delivery cost, it would be cost-prohibitive for PPL Electric Utilities to change its processes and reporting procedures for Phase III. PPL Electric Utilities will change its approach in Phase IV, as required in the final TRC Order.

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.⁸⁴ A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix L. Non-Energy Benefits*.

⁸⁴ Guidance on the inclusion of fossil fuel and H₂O benefits in the TRC test, Statewide Evaluation Team, March 25, 2018.

Table 11-8. Summary of WRAP Finances—Gross and Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁹⁾	
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⁾	\$180	-	\$950	-
7	Marketing ⁽⁴⁾	-	\$338	-	\$1,352
8	Program Delivery ⁽⁵⁾	-	\$4,587	-	\$28,249
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽¹⁾	\$5,106		\$30,551	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	-		\$1	
13	Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) ^{(6) (1)}	\$5,106		\$30,552	
14	Total NPV Lifetime Electric Energy Benefits	\$1,964		\$11,484	
15	Total NPV Lifetime Electric Capacity Benefits	\$256		\$1,798	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	\$38		\$3,040	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	\$1,273		\$6,726	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ⁽⁷⁾	\$3,530		\$23,048	
19	TRC Benefit-Cost Ratio ⁽⁸⁾	0.69		0.75	

⁽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⁾ 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.

⁽⁹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

11.7 Recommendations

Overall, in PY12, WRAP performed well especially considering changes to the program delivery due to the COVID-19 pandemic. In PY12, WRAP saved 7,215 MWh/yr of energy and 0.69 MW of demand and had a customer satisfaction score of 97%. According to the ICSP, the switch to remote energy assessments increased program equity by making it easier to serve non-English speakers and rural customers than possible with the in-home delivery structure. PPL Electric Utilities has exceeded its Phase III energy savings compliance target for the low-income sector.

Recommendations are provided in Table 11-9, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: The ICSP's remote energy assessment process, which uses standardized talking points and requires a high level of customer engagement throughout the assessment, may lead to higher per-participant energy education savings than the in-home assessment process.

- The ICSP embeds energy education tips throughout the remote assessment script, and the home energy auditors reported that program participants are more engaged during the remote assessments than the in-home assessments. (See section 11.5.3 *Program Delivery*.)
- Significantly more PY12 respondents (88%, n=208) said their WRAP energy assessor provided recommendations about how to save energy and reduce energy costs than PY11 respondents (59%, n=155) and PY10 respondents (75%, n=155). (See section 11.5.3 *Program Delivery*.)

Conclusion 2: Participants who receive tier 2 smart strips intended to be installed in entertainment centers may be receiving too many. They are not plugging in enough devices to realize the full savings stated in the TRM.

- Tier 2 smart strip savings are realized when three or more devices are plugged into them. A home can have many entertainment centers, but savings are maximized for entertainment centers with at least three devices plugged into the tier 2 smart strip. In PY12, participants in Cadmus' sample averaged 3.26 smart strips per home and, on average, plugged in fewer than three devices in each smart strip. This indicates that more smart strips were given out than needed to meet the savings criteria. (See section 11.2.2 *Gross Savings Impact Evaluation Results*.)

Conclusion 3: In terms of customer satisfaction and program equity, the ICSP's switch to a remote energy assessment delivery mechanism in PY12 was successful.

- Ninety-seven percent of survey respondents were satisfied with their overall program experience. (See section 11.5.2 *Participant Satisfaction*.)
- The home energy auditors said the remote assessment format allows them to complete more assessments per day than does the in-home program delivery structure. Some also noted that it is easier to serve rural customers and non-English speakers over the phone than through the in-home program delivery structure.

Table 11-9. Status of Recommendations for the Winter Relief Assistance Program

WRAP		
Conclusion	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
Conclusion 1: The ICSP's process for remote energy assessments, which uses standardized talking points and requires a high level of customer engagement throughout the assessment, may lead to higher per-participant energy education savings than the in-home assessment process.	Continue to embed energy education throughout the remote energy assessment phone script. If the ICSP resumes in-person home energy assessments in Phase IV, explore ways to encourage customers to be engaged throughout the assessment so that they can be active recipients of energy education.	Implemented. Already being done in the remote energy assessment and will be implemented in Phase IV for the in-person jobs.
Conclusion 2: Participants who receive tier 2 smart strips intended to be installed in entertainment centers may be receiving too many. They are not plugging in enough devices to realize the full savings stated in the TRM.	The threshold for giving participants tier 2 smart strips in entertainment centers needs to be more precisely defined. An entertainment center should be defined as a TV and at least two of the following (but not limited to) devices plugged in—audio equipment, DVD/Blu-Ray players, cable boxes, gaming systems, streaming devices, and routers.	Implemented for tier 2 smart strips. Also, in Phase IV, the majority of smart strips offered will be tier 1 which do not have the plug requirements of tier 2 according to the TRM.
Conclusion 3: In terms of customer satisfaction and program equity, the ICSP's switch to a remote energy assessment delivery mechanism in PY12 was successful.	Since the remote energy assessment has mitigated the participation barriers of geography and language, boost targeted program marketing to customers in rural zip codes and to non-English speakers.	Being considered. PPL Electric Utilities has a vast marketing program that targets customers generally by OnTrack ⁽¹⁾ and income status without terms of ZIP code or language. That said, PPL Electric Utilities has in the past and will in the future target ZIP codes by income levels at both the total population level as well as in higher density areas which could assist both communities.
⁽¹⁾ OnTrack is a payment plan offered by PPL Electric Utilities to households with an income at or below 150% of the Federal poverty income guidelines that provides lower fixed monthly payments and debt forgiveness.		

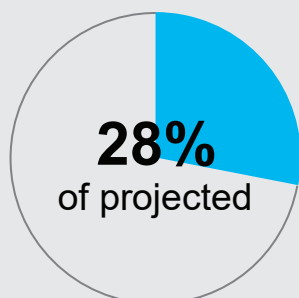
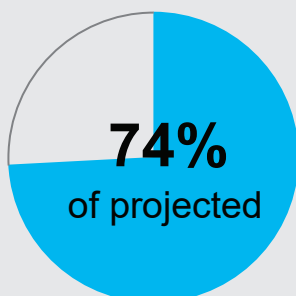


APPLIANCE RECYCLING PROGRAM

The program offers an incentive to customers who turn in eligible appliances and provides free pick-up and environmentally sound recycling services.

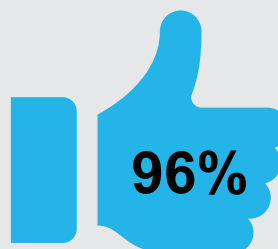
VERIFIED ENERGY SAVINGS

Phase III
has saved
48,215 MWh/yr



PY12 saved
4,332 MWh/yr

PROGRAM SATISFACTION



Satisfied with
overall program

94% satisfied with the **clarity of application** requirements

93% satisfied with the **PPL Electric Utilities' rebates** for qualifying equipment and services

84% satisfied with the **information learned online from PPL Electric Utilities**

PY12 PARTICIPATION

A total of **3,603** customers
recycled **5,395** units



3,590 Refrigerators



756 Room air conditioners



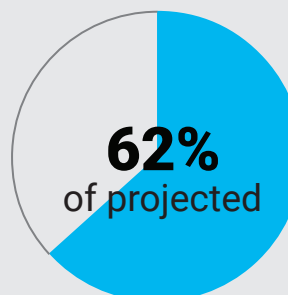
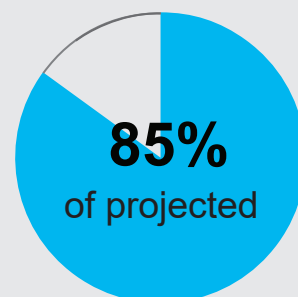
722 Freezers



327 Dehumidifiers

ACTUAL EXPENDITURES (\$1,000)

Phase III
expenditures
\$10,002



PY12
expenditures
\$1,749

12 Appliance Recycling Program

In the Appliance Recycling Program, PPL Electric Utilities offers an incentive 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. Both primary and secondary refrigerators and freezers are eligible. Eligible appliances must be plugged in and functioning when picked up. If customers recycle a refrigerator or freezer, they can also turn in room air conditioners and dehumidifiers. Unlike prior years, no bulk recycling events were held during PY12 due to the COVID-19 pandemic.

Table 12-1 shows the appliance eligibility parameters and incentives.

Table 12-1. Eligible Equipment and Incentives for the Appliance Recycling Program

Equipment	Eligibility Rating	Incentive 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
Dehumidifiers	Working unit	Between \$10 and \$25

PPL Electric Utilities' energy efficiency program staff provides overall strategic direction and program management. Its evaluation staff oversees evaluation activities and coordinates with the program's delivery staff.

In PY12, CLEAResult, the ICSP, delivered the Appliance Recycling Program along with its pick-up subcontractor, Key Recycling.

The objectives of the Appliance Recycling Program are these:⁸⁵

- Encourage customers to dispose of their existing, inefficient refrigerators, freezers, air-conditioning units, and dehumidifiers 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 secondary market
- Promote other PPL Electric Utilities' energy efficiency programs
- Achieve a total energy reduction of approximately 65,000 MWh/yr gross verified savings
- Achieve high customer and trade ally satisfaction with the program
- Enhance relationships with box stores and independent retailers to encourage participation in the "buy new and recycle" component

⁸⁵ Program objectives are stipulated in PPL Electric Utilities revised *Energy Efficiency and Conservation Plan Act 129 Phase III*, EE&C plan (Docket No. 2015-2515642), November 2018.

12.1.1 Definition of a Participant

Cadmus defined participants as unique appliances that were 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, room air conditioner, or dehumidifier.

12.1.2 Program Participation and Reported Impacts

Table 12-2 presents the participation counts, reported, and verified energy and demand savings, and incentive payments for the Appliance Recycling Program in PY12 by customer segment.

Table 12-2. PY12 Appliance Recycling Program Participation and Reported Impacts

Parameter	Residential	Small C&I	GNE	Total ⁽¹⁾
PYTD # Participants	5,277	82	36	5,395 ⁽²⁾
PYRTD MWh/yr	4,016	66	29	4,111
PYRTD MW/yr	0.66	0.01	0.00	0.67
PYVTD MWh/yr	4,232	70	30	4,332
PYVTD MW/yr	0.68	0.01	0.00	0.70
PY12 Incentives (\$1000)	\$169	\$7	\$1	\$177
⁽¹⁾ Total may not match sum of columns due to rounding.				
⁽²⁾ 3,603 participants recycled a total of 5,395 appliances.				

12.2 Gross Savings Impact Evaluation

To evaluate the gross impacts of the Appliance Recycling Program, Cadmus reviewed the PPL Electric Utilities' tracking database and compared these records to those in the tracking data provided by the ICSP. Cadmus verified energy and peak demand savings for room air conditioners by confirming that the ICSP mapped data to the appropriate city, which reflected heating and cooling degree days and equivalent full-load hours (EFLH), as specified in the PA TRM.⁸⁶ For dehumidifiers, Cadmus also verified mapping of ZIP codes to the appropriate city by applying the fully deemed savings in the dehumidifier retirement interim measure protocol.⁸⁷

12.2.1 Impact Evaluation Data Collection and Sample Design

Cadmus calculated gross verified savings by reviewing a census of records from the PPL Electric Utilities tracking database. No participants were sampled for evaluation activities in PY12.

⁸⁶ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017.

⁸⁷ The interim measure protocol was approved by the Statewide Evaluator (SWE) July 7, 2017.

12.2.2 Gross Savings Impact Evaluation Results

Table 12-3 shows the program's verified gross savings for Phase III.

Table 12-3. Appliance Recycling Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	11,844	10,731	11,362	9,945	4,332	48,215 ⁽¹⁾
⁽¹⁾ Phase III verified savings may not match sum of program years due to rounding.						

Table 12-4 shows the Appliance Recycling Program reported energy savings of 4,111 MWh/yr for PY12.

Table 12-4. PY12 Appliance Recycling Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate ⁽¹⁾	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MWh/yr
Appliance Recycling	4,111	105%	0.07	10%	4,332
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

Table 12-5 shows the number of verified units recycled in PY12 and the verified energy savings by product.

Table 12-5. PY12 Gross Energy Results by Product Recycled

Product	PYVTD MWh/yr	Product Count
Refrigerator	3,448	3,590
Freezer	511	722
Room Air Conditioner	100	756
Dehumidifiers	272	327
Program Total ⁽¹⁾	4,332	5,395
⁽¹⁾ Total may not match due to rounding.		

Table 12-6 shows a reported demand reduction 0.67 MW/yr in PY12.

Table 12-6. PY12 Appliance Recycling Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate ⁽¹⁾	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MW/yr
Appliance Recycling	0.67	104%	0.07	10%	0.70
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

In PY12, Cadmus applied PY10 verified gross per-unit kWh/yr savings for refrigerators and freezers.⁸⁸ The energy realization rate of 105% for the program was driven by slightly different inputs into the per-unit savings calculations for refrigerators and freezers. The overall demand realization rate of 104% was slightly lower than the energy realization rate because room air conditioners and dehumidifiers, both with measure-level realization rates of 100%, account for a larger share of demand savings.

⁸⁸ PPL Electric Utilities. *Annual Report Program Year 10: June 1, 2018–May 31, 2019*. Presented to PA PUC. Prepared by Cadmus. November 15, 2019.

12.3 Net Savings Impact Evaluation

Because the net-to-gross ratio has remained stable over time, Cadmus applied the PY10 ratio in PY12, as approved by the SWE. The NTG ratio was 0.66 in PY10. In PY10, Cadmus calculated the NTG ratio using the methodology described in the Common Methods for Appliance Recycling programs specified by the SWE (Phase III Evaluation Framework, Appendix B).⁸⁹ This is consistent with the Uniform Methods Project (UMP) appliance recycling protocol to determine program net savings.⁹⁰

12.4 Verified Savings Estimates

Table 12-7 shows the reported energy savings (PYRTD) and the verified gross and net energy savings estimates calculated by Cadmus for the Appliance Recycling Program in PY12.

Table 12-7. PYTD and P3TD Appliance Recycling Program Savings Summary

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD Gross	4,111	0.67
PYVTD Gross	4,332	0.70
PYVTD Net ⁽¹⁾	2,859	0.46
P3RTD Gross	54,014	8.22
P3VTD Gross	48,215	7.57
P3VTD Net ⁽¹⁾	31,822	5.00
⁽¹⁾ Net savings are not used to meet PPL Electric Utilities' energy savings compliance target.		

12.5 Process Evaluation

12.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation in PY8 and PY9. The limited process evaluation in PY12 assessed participant satisfaction with the Appliance Recycling Program. The evaluation plan for PY12 called for an interview with the ICSP's new contractor, but Cadmus conducted an interview with the ICSP's program staff to discuss participant satisfaction and also to review the overall status of program implementation considering COVID-19 and the changes the program had to make.

Table 12-8 lists the process evaluation sampling strategy. Details about Cadmus' approach to contacting customers and the sample attrition are presented in *Appendix I Survey Sample Attrition* and *Appendix N Survey Methodology*.

⁸⁹ 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. Final version May 8, 2018.

⁹⁰ National Renewable Energy Laboratory. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*. "Chapter 7: Refrigerator Recycling Evaluation Protocol." September 2017. <https://www.nrel.gov/docs/fy17osti/68563.pdf>

Table 12-8. PY12 Appliance Recycling Program Process Evaluation Sampling Strategy

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⁾
Program Staff and ICSP	CLEAResult	Telephone in-depth interview	1	N/A	1	1	N/A	100%
Participants	Appliance Recycling	Online survey	2,125 ⁽³⁾	-	As many as possible	166 ⁽⁴⁾	1,325	100%
Total			2,126	N/A	N/A	167	1,325	N/A

⁽¹⁾ Sample frame is a list of participants with email contact information drawn from the PPL Electric Utilities' tracking database. After selecting all unique records, Cadmus removed any records from the population if 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⁾ Number of rebates for refrigerators and freezers available in PPL Electric Utilities' tracking database at the time of the PY12 survey efforts.

⁽⁴⁾ Number includes only completed surveys. Number used to calculate overall satisfaction included partial or incomplete surveys. Respondents could skip questions.

12.5.2 Program Delivery

In PY12, CLEAResult, the ICSP, delivered the Appliance Recycling Program to customers and was responsible for marketing and managing 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. The ICSP onboarded a new subcontractor, Key Recycling, to be responsible for pick-up, decommissioning, and recycling of appliances. According to the ICSP, the transition went smoothly, and participant survey findings (detailed below) support that feedback.

In July 2020, PPL Electric Utilities resumed the Appliance Recycling Program, which was suspended from March to June of 2020 due to COVID-19. For the remainder of PY12, the program offered only contactless pick-up and asked customers to move their units outdoors to be picked up. Some rare exceptions were made for customers who were unable to move their units without assistance. Customers who requested appliance recycling during the suspension were put on a waitlist and given priority once the program resumed. Although the program was available to customers for most of PY12, participation was lower than in previous years.

12.5.3 Participant Satisfaction

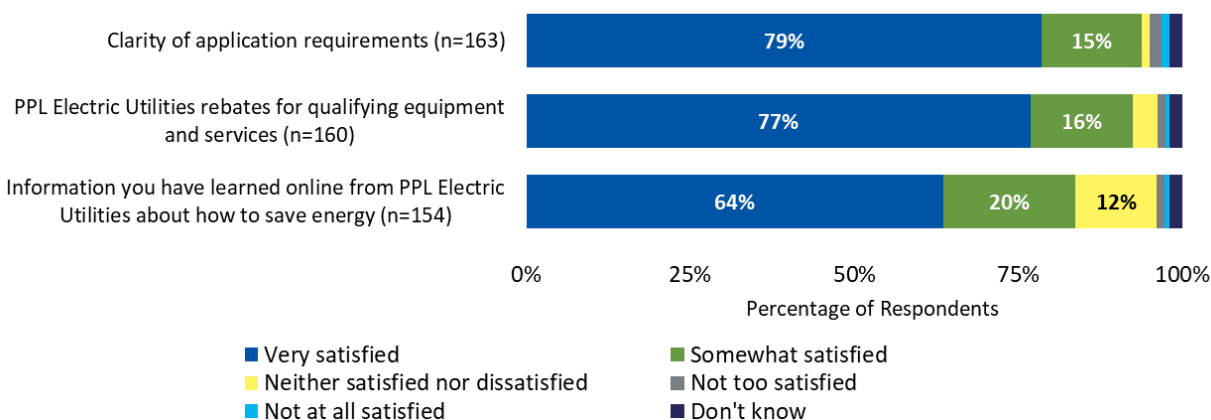
Overall Satisfaction

Cadmus contacted all Appliance Recycling Program participants with email addresses who recycled refrigerators and freezers in PY12 Q1 through Q3. The PY12 online survey resulted in 96% program

satisfaction with $\pm 2\%$ precision at 90% confidence (n=172). Eighty-one percent of respondents were *very satisfied* and 15% were *somewhat satisfied* with the program overall.⁹¹

Respondents also showed high levels of satisfaction for individual program components (Figure 12-1). Ratings for these components in PY12 were statistically equivalent to ratings in PY11.

Figure 12-1. ARP PY12 Component Satisfaction



Source: Survey question, “How satisfied are you with ... [INSERT EACH STATEMENT]?” (n=154-160)

Pick-Up and Rebate Satisfaction

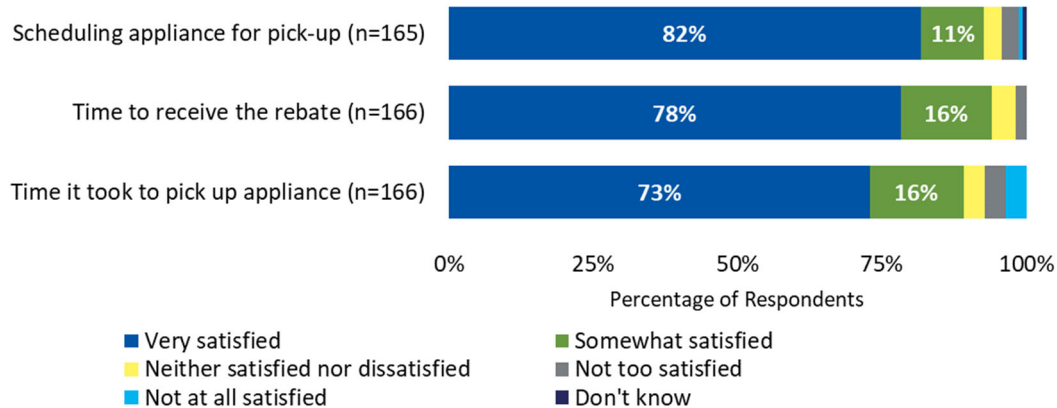
Cadmus assessed participant satisfaction related to scheduling, pick-up, and rebate processing. Figure 12-2 shows that about 90% of PY12 respondents gave *very satisfied* or *somewhat satisfied* ratings for these aspects of the program. The percentage of respondents who were *very satisfied* with scheduling appliances for pick-up in PY12 (82%; n=165) was significantly lower than in PY11 (88%, n=506)⁹², while the other PY12 ratings were statistically equivalent to PY11.⁹³

⁹¹ Three percent were *neither satisfied nor dissatisfied*, 1% were *not too satisfied*, 1% were *not at all satisfied* with the overall program, and 0% said, “Don’t know.” The total does not sum to 100% due to rounding. Though 183 respondents started the survey, only 172 answered the overall satisfaction question. For all other survey questions, Cadmus reported results from the 166 respondents who completed the entire survey.

⁹² PPL Electric Utilities. *Annual Report Program Year 11: June 1, 2019–May 31, 2020*. Presented to PA PUC. Prepared by Cadmus. February 15, 2021.

⁹³ $p < .05$, based on two-proportions z-test test procedure.

Figure 12-2. ARP PY12 Scheduling, Pick-up, and Rebate Receipt Satisfaction



Source: Survey question, “How satisfied are you with... [INSERT EACH STATEMENT]?” (n=165-166)

12.5.4 Program Communication

Pick-Up Contractors

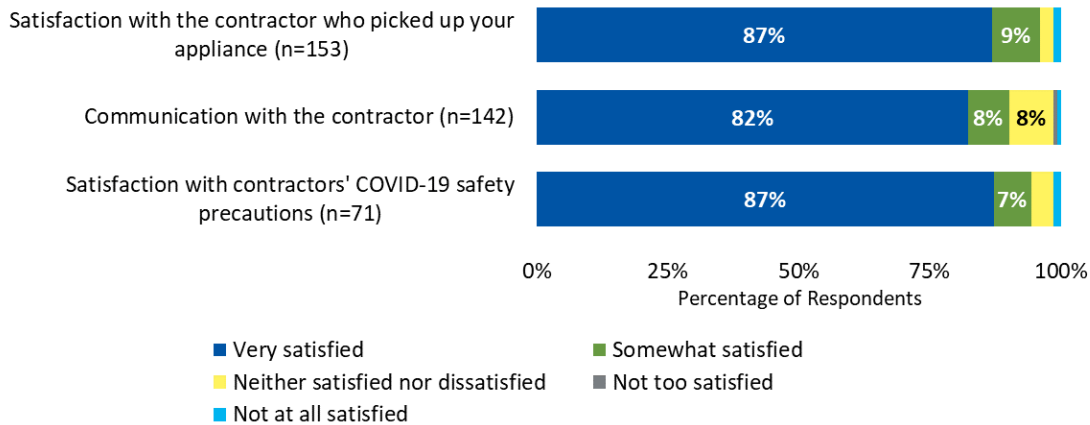
In general, respondents were highly satisfied with the contractors who picked up their appliances and with communication from the contractors (Figure 12-3). However, compared to PY11,⁹⁴ a larger percentage of PY12 participants could not rate the contractors or their communications with them (*don't know* ratings), which was likely due to the contactless pick-up protocols implemented during PY12. The percentage of customers who were *very satisfied* with the contractor who picked up their appliances in PY12 (87%) was significantly lower than PY11 (92%, n=500), while PY12 ratings for satisfaction with communications from contractors were statistically equivalent to PY11.⁹⁵

Cadmus also asked PY12 respondents if they had had any interaction with the pick-up contractors and, if so, how satisfied were they with the contractors’ COVID-19 safety precautions. Fewer than half reported interacting with contractors (44%; n=165), and those who did reported high satisfaction with the safety precautions (Figure 12-3). Two survey respondents provided feedback about their low ratings for satisfaction with contractors’ COVID-19 safety precautions. Both said the contractors did not wear masks but also noted the contractors had remained outdoors.

⁹⁴ Cadmus reanalyzed survey results from PY11 to remove *don't know* responses in order to make ratings across years more comparable.

⁹⁵ $p < .10$, based on two-proportions z-test test procedure.

Figure 12-3. ARP PY12 Contractor Component Satisfaction



Source: Survey question, “How satisfied are you with... [INSERT EACH STATEMENT]?” (n=142-153) and “How satisfied were you with how well the contractors practiced COVID-19 safety precautions?” (n=71)

Nine survey respondents (5%; n=166) provided information about what contractors could have done to improve their experience. The most common suggestion was better contractor communication or customer service (five respondents). Three expressed confusion over program requirements about whether units needed to be plugged in and the location of units for outdoor pick-up. Another respondent wished that the contractors had called to let them know they were running late, and the fifth said the contractors “*seemed to be bothered by having to get the appliance.*”

Of the remaining four respondents, one said the contractors did not show up for their originally scheduled appointment, one said the contractors were late for their appointment, one was disappointed the contractors did not pick up their room air conditioner, and one wished the contractors had provided more information about other PPL Electric Utilities offerings.

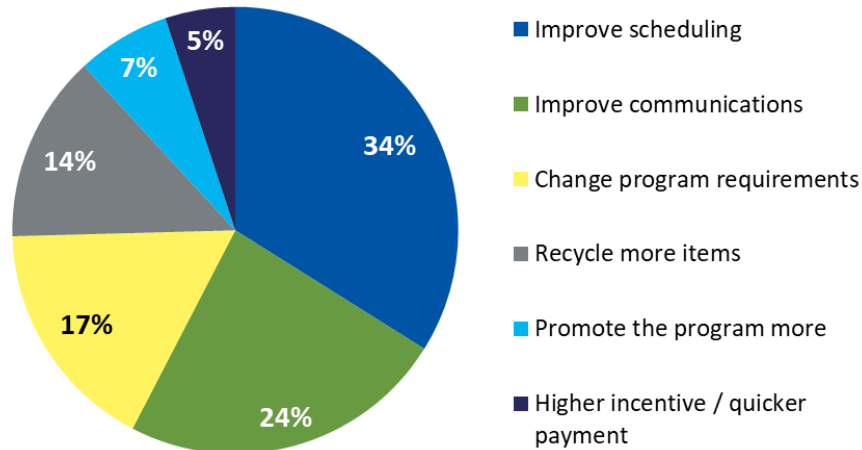
Participant Suggestions for Improvement

Fifty-four survey respondents (33%, n=166) provided suggestions for how PPL Electric Utilities could improve the Appliance Recycling Program. Cadmus catalogued these as 59 suggestions across six categories (Figure 12-4). In PY11, the most common suggestions were to improve communications, but in PY12 the most comments were about scheduling (34% of suggestions). Many comments pertained to program delivery changes or challenges during COVID-19. Though some customers were understanding of scheduling delays, others also said communication could have been smoother about the program pause and some said contactless pick-up was a challenge for them. The following comments are examples of suggestions that were categorized under *improve scheduling*:

- “There was a long delay before our refrigerator was picked up, but that was due to COVID-19 so we completely understood.”
- “[Improve your] communication. We scheduled a pick-up and when no one came we called again. [They] said we were not on the schedule and that the program had been discontinued. [I] told them that it is still on the website. Then [they] gave us another pick-up date for I believe another month out.”

- “The program is great for the rebate under normal circumstances. However, it took about six months sitting on my back porch to get rid of it because of COVID-19. The initial appointment was canceled. When the rebate program started up again they told me I had to put the refrigerator near the road in front of my house and be able to prove [that] it runs. That was very difficult for me as I had to find someone strong to help me get it there. I had to rent one of those dollies to get the fridge down four steps and down my driveway to the curb.”

Figure 12-4. ARP PY12 Participant Suggestions for Improvement



Source: Survey question, “What is the one thing PPL Electric Utilities could change about the program to improve it?” (n=59 suggestions)

Suggestions for changing program requirements most often focused on not requiring the unit to be plugged in and running for pick up (six of 10 suggestions). Two customers suggested the program could pick up air conditioners and dehumidifiers separately from refrigerators and freezers, another suggested owners should not have to be present for pick-up, and one suggested there should not be limits on the number of units recycled.

12.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 12-9. Cadmus calculated the TRC benefits using gross verified impacts. The NPV PYTD benefits and costs are expressed in PY12 dollars (PY12 includes months in both 2020 and 2021). Net present value costs and benefits for P3TD financials are expressed in PY8 dollars.

Table 12-9. Summary of Appliance Recycling Program Finances—Gross Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁹⁾	
1	EDC Incentives to Participants	\$177		\$1,485	
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⁾	\$177		\$1,485	
		EDC	CSP	EDC	CSP
5	Design & Development ⁽²⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽³⁾	\$75	-	\$229	-
7	Marketing ⁽⁴⁾	-	\$231	-	\$916
8	Program Delivery ⁽⁵⁾	-	\$1,266	-	\$6,069
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽¹⁾	\$1,572		\$7,213	
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) ^{(1) (6)}	\$1,749		\$8,698	
14	Total NPV Lifetime Electric Energy Benefits	\$944		\$12,621	
15	Total NPV Lifetime Electric Capacity Benefits	\$191		\$2,467	
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) ^{(1) (7)}	\$1,135		\$15,088	
19	TRC Benefit-Cost Ratio ⁽⁸⁾	0.65		1.73	

⁽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⁾ 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.

⁽⁹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

Table 12-10 presents program financials and cost-effectiveness on a net savings basis.

Table 12-10. Summary of Appliance Recycling Program Finances—Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁹⁾	
1	EDC Incentives to Participants	\$177		\$1,485	
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⁾	\$177		\$1,485	
		EDC	CSP	EDC	CSP
5	Design & Development ⁽²⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽³⁾	\$75	-	\$229	-
7	Marketing ⁽⁴⁾	-	\$231	-	\$916
8	Program Delivery ⁽⁵⁾	-	\$1,266	-	\$6,069
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽¹⁾	\$1,572		\$7,213	
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) ^{(1) (6)}	\$1,749		\$8,698	
14	Total NPV Lifetime Electric Energy Benefits	\$623		\$12,382	
15	Total NPV Lifetime Electric Capacity Benefits	\$126		\$2,419	
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) ^{(1) (7)}	\$749		\$14,800	
19	TRC Benefit-Cost Ratio ⁽⁸⁾	0.43		1.70	

⁽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⁾ 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.

⁽⁹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

12.7 Recommendations

The Appliance Recycling Program experienced high levels of customer satisfaction despite changes to program operations due to COVID 19. Overall, 96% of survey respondents were satisfied with the program (n=172) and 96% were satisfied with the contractor who picked up their appliances (n=153).

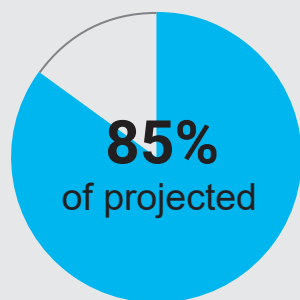
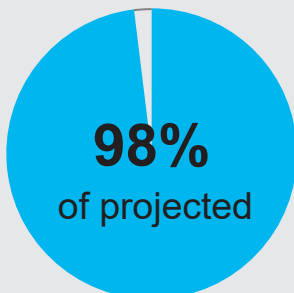
Because the program functioned well in PY12, Cadmus does not have any recommendations.

STUDENT ENERGY EFFICIENT EDUCATION PROGRAM

The program provides THINK! ENERGY, a school-based energy efficiency education curriculum, through classroom presentations to students and classroom materials for teachers.

VERIFIED ENERGY SAVINGS

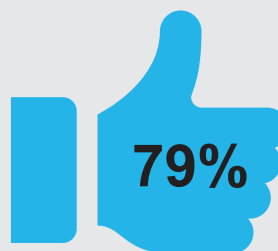
Phase III
has saved
17,504 MWh/yr



PY12 saved
1,636 MWh/yr

Totals exclude savings attributable to the low-income sector

PROGRAM SATISFACTION



Satisfied with
overall program

85% Bright Kids (2nd – 3rd grades)

79% Take Action (5th – 7th grades)

74% Innovation Tier 1 (9th – 12th grades)

74% Innovation Tier 2 (9th – 12th grades)

PY12 PARTICIPATION



A total of **10,259** participants

1,958 Bright Kids (2nd – 3rd grades)

6,184 Take Action (5th – 7th grades)

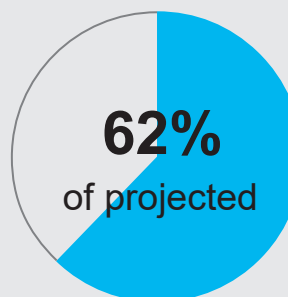
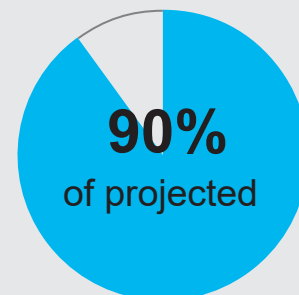
1,574 Innovation Tier 1 (9th – 12th grades)

543 Innovation Tier 2 (9th – 12th grades)

Totals exclude participation within low-income schools and includes verified participant counts not reported

ACTUAL EXPENDITURES (\$1,000)

Phase III
expenditures
\$5,076



PY12
expenditures
\$876

Totals exclude expenditures attributable to the low-income sector

13 Student Energy Efficient Education Program

The Student Energy Efficient Education (SEEE) Program provides THINK! ENERGY, a school-based energy efficiency education curriculum, through classroom presentations to students and classroom materials for teachers. THINK! ENERGY is offered once during the school year, typically in the fall. In response to disruptions to in-person school during the 2020-21 school year, program activities extended into early March in PY12. Other changes for the program year due to the COVID-19 pandemic included offering virtual presentations, making follow-up calls and chat sessions, and refining materials for the online learning environment.

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. 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. HEWs could be completed online or returned to a teacher. Table 13-1 shows the kit items for each cohort.

Table 13-1. Kit Items by Cohort

Cohort	Kit Items
Bright Kids	LED Nightlight, Kitchen Aerator, Bathroom Aerator
Take Action ⁽¹⁾	LED Nightlight, Kitchen Aerator, Showerhead
Innovation Tier 1 ⁽¹⁾	Kitchen Aerator, Bathroom Aerator, Showerhead, Tier 1 Smartstrip
Innovation Tier 2 ⁽¹⁾	Kitchen Aerator, Bathroom Aerator, Showerhead, Tier 2 Smartstrip
⁽¹⁾ These cohorts also received education that included instructions for setting back water heater temperatures.	

CLEAResult, PPL Electric Utilities' residential ICSP, subcontracted to National Energy Foundation (NEF) to undertake a broad range of responsibilities. These include 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. The ICSP provides oversight and direction to its subcontractor.

PPL Electric Utilities collaborates with the ICSP on the program's strategic direction while maintaining overarching responsibility for Act 129 administration, program support, evaluation, and data management.

The objectives of the SEEE Program are these:⁹⁶

- Expand and promote energy efficiency literacy through education outreach programs
- Provide energy efficiency education to students offered through school assemblies and classroom curriculum

⁹⁶ From PPL Electric Utilities Corporation. *Energy Efficiency and Conservation Plan Act 129 Phase III*. Docket No. M-2015-2515642. Approved November 2018.

- Confirm that energy efficiency education correlates to the Pennsylvania Department of Education’s academic standards
- Provide students with take-home kits 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 of approximately 85,000 students through 2021 and achieve approximately 18,000 MWh/yr of gross verified savings
- Achieve high customer (students and teachers) satisfaction with the program

13.1.1 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)

In PY12, the ICSP and the ICSP’s subcontractor continued to split the Innovation cohort by offering some classrooms tier 2 smart power strips and some tier 2 smart power strips. Cadmus evaluated these separately and refers to these groups as Innovation Tier 1 and Innovation Tier 2.

Each energy-savings kit distributed is counted as a participant and is recorded in the ICSP’s database and PPL Electric Utilities’ tracking database with an identifier for school, classroom, and teacher. This identifier represents one classroom and is recorded with the number of kits distributed in that specific classroom. PPL Electric Utilities did not collect or record utility account numbers of classroom students who received a kit.

13.1.2 Program Participation and Reported Impacts

Table 13-2 presents the participation counts and reported energy and demand savings for the SEEE Program in PY12 by customer segment (residential and low-income). The program does not offer incentives; the kits are offered free of charge.

As in PY11, a portion of PY12 savings were attributed to the low-income sector, determined using the Pennsylvania Department of Education data specifying the percentage of students receiving reduced-fee and free lunches. PPL Electric Utilities reallocated a portion of the SEEE Program’s energy savings, budget, and participants to the low-income sector and reported this information under WRAP.

Table 13-2. PY12 Student Energy Efficient Education Participation and Reported Impacts

Parameter	Residential	Low-Income ⁽¹⁾	Total ⁽²⁾
PYTD # Participants ⁽³⁾	8,388	14,523	22,911
PYRTD MWh/yr	1,503	2,573	4,075
PYRTD MW/yr	0.12	0.21	0.33
PYVTD MWh/yr	1,636	2,170	3,806
PYVTD MW/yr	0.15	0.20	0.36
PY12 Incentives (\$1,000)	\$0	\$0	\$0
⁽¹⁾ Student education provided to students who qualify for reduced-fee and free lunches is an approved low-income product. PY12 verified low-income savings are counted toward the low-income savings compliance target. ⁽²⁾ Total may not match sum of columns due to rounding. ⁽³⁾ The participant count reported by sector in this table is based on the designation in PPL Electric Utilities' tracking database. This does not match the verified participant counts presented in the infographic. Cadmus verified 10,259 residential sector participants and 12,652 low-income sector participants.			

Verified Savings Attributed to the Low-Income Sector

The SEEE Program was offered to schools in PPL Electric Utilities' service territory that offer free lunches to children from households with income below 130% of the federal poverty level (FPL), a more conservative percentage than the 150% of the FPL used as the income qualification guideline for Act 129 low-income programs. The program is also offered to schools that offer lunches at reduced cost to students of families with incomes below 185% of the FPL, which includes families with incomes between 130% and 150% of the FPL.

The Pennsylvania Department of Education publishes the number and percentage of reduced-fee and free lunches for each school and each grade in the school.⁹⁷ Cadmus used these published data to determine the percentage of low-income participants in the SEEE Program, assuming that the percentage of students enrolled in the school free-lunch program was representative of the percentage within any particular grade-level classroom participating in the program. These savings were assigned to the low-income sector. Cadmus also assumed that half the students who qualify for reduced-fee lunches met the 150% FPL guideline and assigned savings for these students to the low-income sector.

Due to the COVID-19 pandemic and the resulting changes in schools' use of the federal School Nutrition Program (SNP) on which free and reduced-fee lunch data are based, many schools were omitted from

⁹⁷ Pennsylvania Department of Education. 2020. "National School Lunch Program Reports." Accessed May 2020. <https://www.education.pa.gov/Teachers%20-%20Administrators/Food-Nutrition/reports/Pages/National-School-Lunch-Program-Reports.aspx>

the Pennsylvania Department of Education’s report. For this reason, for PY12 Cadmus applied 2019 data on reduced-fee and free lunches.⁹⁸

Cadmus assigned program-verified savings of 3,806 MWh/yr, using the 2019 free and reduced-fee lunch data, to the residential and low-income sectors as follows:

- 2,101,046 kWh/yr savings for all students receiving free lunches assigned to the low-income sector (55% of program total)
- 68,630 kWh/yr savings for half the students receiving reduced-fee lunches assigned to the low-income sector (2% of program total)
- 1,636,049 kWh/yr savings assigned to the residential sector (43% of program total)

13.2 Gross Savings Impact Evaluation

13.2.1 Impact Evaluation Data Collection and Sample Design

Cadmus conducted the PY12 impact evaluation for the SEEE Program using PY12 survey data gathered through paper and online HEWs to estimate savings for all energy-savings products in the kits.

To calculate aerator savings for the Bright Kids cohort, Cadmus used average water heater saturation, people per household, and home type information from the HEWs for the Take Action and Innovation cohorts because these data were not available from the Bright Kids HEWs.

Table 13-3 summarizes the impact evaluation’s sampling strategy. The impact evaluation produced energy and demand savings with $\pm 3.45\%$ and $\pm 3.69\%$ precision, respectively, each with 85% confidence.

Table 13-3. PY12 Student Energy Efficient Education Program Gross Impact Evaluation Sample Design

Stratum	Population Size	Assumed Proportion or Cv in Sample Design ⁽¹⁾	Achieved Sample Size (All returned PY12 HEWs)	Impact Evaluation Data Source
Bright Kids 2 nd – 3 rd grades	5,108	N/A	2,331	PY12 paper and online HEWs
Take Action 5 th – 7 th grades	12,803	N/A	5,931	PY12 paper and online HEWs
Innovation Tier 1 9 th – 12 th grades	2,482	N/A	1,319	PY12 paper and online HEWs
Innovation Tier 2 9 th – 12 th grades	2,518	N/A	1,440	PY12 paper and online HEWs
Program Total	22,911	N/A	11,032 ⁽²⁾	N/A
⁽¹⁾ Because this program’s evaluation did not include sampling, Cv and planned precision are not meaningful.				
⁽²⁾ In 11 classrooms, the number of returned surveys exceeded the number of students in the classroom, so all surveys were used.				

⁹⁸ Due to the COVID-19 pandemic, many school food authorities (SFAs) are operating under the Seamless Summer Option (SSO) or Summer Food Service Program (SFSP) and are not included in the 2020 Pennsylvania Department of Education’s report. Only SFA’s that submitted a claim for reimbursement for October 2020 under the School Nutrition Program (SNP) are included in the 2020 report.

13.2.2 Gross Savings Impact Evaluation Results

Table 13-4 shows the program's verified gross savings. Overall, the program achieved lower savings than prior years due to the removal of LED bulbs from the energy efficiency kits

Table 13-4. Student Energy Efficient Education Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY12 Verified	Phase III Verified
MWh/yr	4,539	6,024	6,011	6,158	3,806	26,536 ⁽¹⁾
⁽¹⁾ Phase III verified savings may not match sum of program years due to rounding.						

In PY12, the SEEE Program reported energy savings of 4,075 MWh/yr, as shown in Table 13-5, and demand reduction of 0.33 MW/yr, as shown in Table 13-6.

Table 13-5. PY12 Student Energy Efficient 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.	PYVTD MWh/yr ⁽¹⁾
Bright Kids	266	198%	0.33	3.73%	526
Take Action	2,527	79%	0.73	6.07%	1,999
Innovation Tier 1	499	98%	0.34	7.09%	488
Innovation Tier 2	783	101%	0.18	4.18%	793
Program Total ⁽²⁾	4,075	93%	N/A	3.45%	3,806
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ Total may not match sum of rows due to rounding.					

Table 13-6. PY12 Student Energy Efficient 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.	PYVTD MW/yr ⁽¹⁾
Bright Kids	0.02	321%	0.40	4.51%	0.06
Take Action	0.19	91%	0.83	6.96%	0.17
Innovation Tier 1	0.05	108%	0.32	6.67%	0.05
Innovation Tier 2	0.07	109%	0.19	4.36%	0.08
Program Total ⁽²⁾	0.33	110%	N/A	3.69%	0.36
⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					
⁽²⁾ Total may not match sum of rows due to rounding.					

Reported savings aligned relatively closely with verified savings in PY12. The following factors contributed to the 93% overall energy realization rate and 110% demand realization rate for the SEEE Program:

- Reported savings for smart strips in PPL Electric Utilities' tracking database did not account for smart strips installed in entertainment centers. Smart strips installed in entertainment centers generate more savings than when installed in unknown locations, increasing realization rates.

- Cadmus found lower installation rates in the HEWs than assumed in the nightlight *ex ante* savings calculations, leading to lower realization rates for nightlights.
- The ICSP used higher per-unit *ex ante* savings to calculate reported savings for showerheads than Cadmus found after analyzing PY12 HEWs, decreasing the realization rate. Cadmus used the number of showers per home provided in the HEWs, which was higher than the number of deemed showers per home in the PA TRM,⁹⁹ lowering the realization rate.
- For both kitchen and bathroom aerators, Cadmus used the number of persons per home provided in the HEWs, which was higher than the deemed number of persons per home in the PA TRM, increasing the realization rate.
- All factors that contributed to the energy realization rates also contributed to the demand realization rates. The demand realization rates were higher than the energy realization rates due to differences in each measure's contribution to energy and demand savings. For example, nightlights do not contribute any demand savings; therefore, though nightlights lowered the overall energy realization rates for the Bright Kids and Take Action cohorts, they had no impact on the demand realization rates.

See *Appendix J Evaluation Detail – Student Energy Efficient Education Program* for additional details.

13.3 Net Savings Impact Evaluation

The SEEE Program is a select offering to schools, and the energy-savings kits are provided free of charge to teachers, who in turn provide the kits to their students. No free riders are anticipated for the population receiving the kits. 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 purchase the kit, Cadmus assumes there is no free ridership. In addition, spillover is not measured.

The program is assumed to have a net-to-gross (NTG) ratio of 1.0.

13.4 Verified Savings Estimates

In Table 13-7, 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 PY12.

⁹⁹ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017.

Table 13-7. PYTD and P3TD Student Energy Efficiency Education Program Savings Summary

Savings Type	Energy (MWh/yr) ⁽¹⁾	Total Demand (MW/yr) ⁽¹⁾
PYRTD	4,075	0.33
PYVTD Gross	3,806	0.36
PYVTD Net ^{(2), (3)}	3,806	0.36
P3RTD	27,125	2.56
P3VTD Gross	26,536	2.73
P3VTD Net ^{(2), (3)}	26,536	2.73
⁽¹⁾ Total may not match sum of rows in previous tables due to rounding.		
⁽²⁾ Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		
⁽³⁾ Net savings are the same as verified savings.		

13.5 Process Evaluation

13.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation of the SEEE Program earlier in Phase III. For PY12, a limited process evaluation assessed student participant satisfaction and teacher satisfaction with the program. Activities were consistent with the evaluation plan with the exception of fewer program staff interviews and the inclusion of teacher satisfaction data (collected by the ICSP). The evaluation planned to complete three interviews with program and ICSP staff, but these were not needed because the program is well-established. COVID-19 did not cause any changes to the process evaluation activities for the SEEE Program.

Table 13-8 describes the process evaluation sampling strategy.

Table 13-8. PY12 Student Energy Efficient 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	Records Selected for Sample Frame	Percent of Sample Frame Contacted to Achieve Sample ⁽¹⁾
Program Staff and ICSP	PPL Electric Utilities, CLEAResult staff	Telephone in-depth interview	Up to 3	N/A ⁽²⁾	3	1	N/A	100%
Students	Bright Kids, Take Action, Innovation Tier 1 and Tier 2	ICSP subcontractor-administered paper and online HEWs	22,911	N/A ⁽²⁾	All returned surveys	10,860 ⁽³⁾	All eligible	100%
Teachers	Bright Kids, Take Action, Innovation Tier 1 and Tier 2	ICSP subcontractor-administered paper and online HEWs	801 ⁽⁴⁾	N/A ⁽²⁾	All returned surveys	50	All eligible	100%
Program Total			23,717+		1+	10,911	N/A	N/A
⁽¹⁾ Percent contacted means the percentage of the sample frame contacted to complete surveys. ⁽²⁾ Because this program's evaluation did not include sampling, Cv and target precision are not meaningful. ⁽³⁾ Sample size represents the number of returned HEWs with the satisfaction question answered, which is less than the sample size of HEWs used for the Impact evaluation. ⁽⁴⁾ Out of 801 teachers, five participated in two classrooms.								

13.5.2 Student Satisfaction

Student participants completed HEWs, which were developed and administered by the ICSP's subcontractor, either online or on the paper forms included in the energy-savings kits. The number of completed surveys produced a measurement of program satisfaction with $\pm 0.68\%$ precision at 85% confidence.

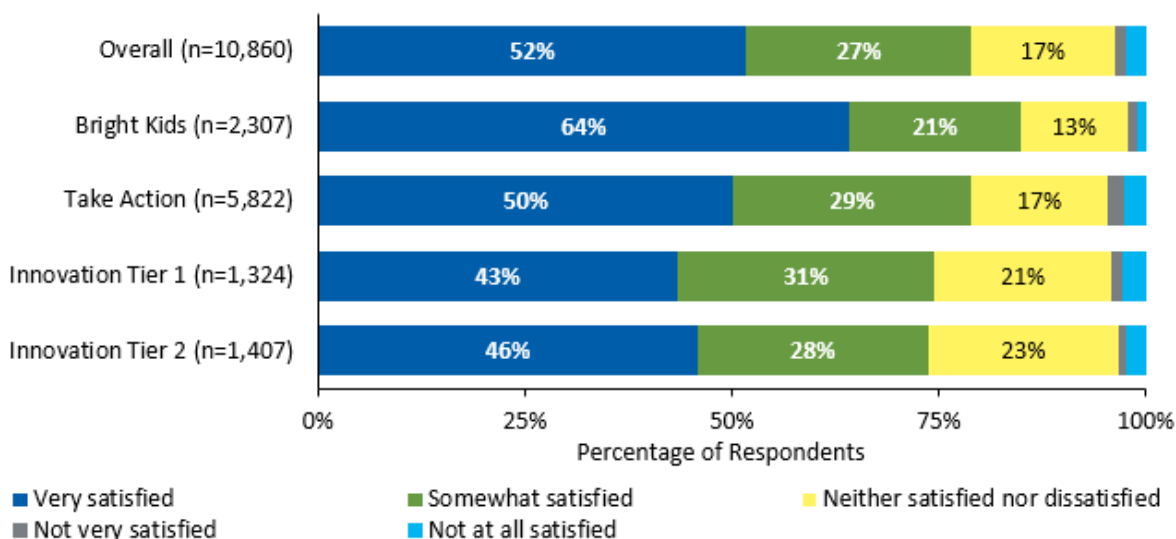
Forty-seven percent of participants completed HEWs and answered the satisfaction question, a decrease from 69% in PY11.¹⁰⁰ Figure 13-1 summarizes the results of the student satisfaction by cohort. Of 10,860 students who responded to the question, 79% said they were *very satisfied* (52%) or *somewhat satisfied* (27%) with the program overall, which was significantly lower than the satisfaction level in PY11 (83% *very satisfied* or *somewhat satisfied*).¹⁰¹

¹⁰⁰ PPL Electric Utilities. February 15, 2020. *Annual Report Program Year 11: June 1, 2019–May 31, 2020*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus.

¹⁰¹ $p < 0.01$, two sample test for proportions

In line with prior program year findings, the cohort most frequently *very satisfied* was Bright Kids (64%; n=2,307). The cohort least frequently *very satisfied* was Innovation (43% for Tier 1, n=1,324; 46% for Tier 2, n=1,407).

Figure 13-1. PY12 Participant Satisfaction with Student Energy Efficient Education Program Overall by Cohort

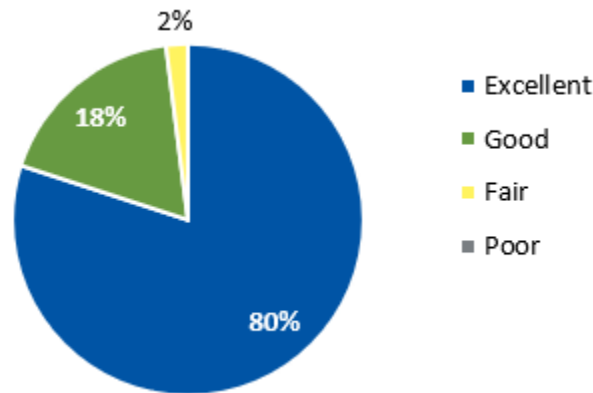


Home Energy Worksheet Q7 (*Bright Kids*) and Q20 (*Take Action, Innovation Tier 1 and Tier 2*):
 “Please rate your overall satisfaction with the Think! Energy program.” Total may not sum to 100% due to rounding.
 Sum of *very* and *somewhat satisfied* may not match percentage reported on infographic due to rounding.

13.5.3 Teacher Satisfaction

After participating in the teacher’s classroom presentation, the ICSP’s subcontractor asked teachers to complete an evaluation survey to rate the program’s delivery. Six percent of participating teachers completed program evaluation forms in PY12 (n=801). Figure 13-2 summarizes the results of teacher satisfaction. Of 50 surveyed teachers, 98% rated the program as *excellent* (80%) or *good* (18%). Bright Kids teachers rated their impression of the program as *Excellent* more often than the other cohorts.

Figure 13-2. PY12 Participating Teacher Satisfaction with Student Energy Efficient Education Program Overall



Teacher Evaluation Q5 (n=50): “Please share your impression of Think! Energy...Program overall”
Total may not sum to 100% due to rounding.

13.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 13-9. The TRC benefits were calculated using gross verified impacts. NPV PYTD benefits and costs are expressed in PY12 dollars (PY12 includes months in both 2020 and 2021). NPV benefits and costs for P3TD financials are expressed in PY8 dollars. Net verified savings are equal to gross verified savings because the program is assumed to have an NTG ratio of 1.0.

PPL Electric Utilities incorporates the cost of kits into the TRC as program delivery costs rather than as incentives to participants. Because PPL Electric Utilities’ tracking and internal reporting systems are in place to catalog these costs as a program delivery cost, it would be cost-prohibitive for PPL Electric Utilities to change its processes and reporting procedures for Phase III. PPL Electric Utilities will change its approach in Phase IV, as required in the final TRC Order.

Cadmus quantified non-energy benefits in accordance with the SWE’s Guidance Memo.¹⁰² A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix L. Non-Energy Benefits*.

¹⁰² Guidance on the Inclusion of fossil fuel and H₂O benefits in the TRC Test, Statewide Evaluation Team, March 25, 2018.

Table 13-9. Summary of Student Energy Efficient Education Program Finances—Gross and Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁹⁾	
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⁾	\$54	-	\$222	-
7	Marketing ⁽⁴⁾	-	\$278	-	\$800
8	Program Delivery ⁽⁵⁾	-	\$1,344	-	\$4,478
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ⁽¹⁾	\$1,676		\$5,500	
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) ^{(6) (1)}	\$1,676		\$5,500	
14	Total NPV Lifetime Electric Energy Benefits	\$1,370		\$6,218	
15	Total NPV Lifetime Electric Capacity Benefits	\$164		\$923	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	-		\$1,420	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	\$5,929		\$13,126	
18	Total NPV TRC Benefits (Sum of rows 14 through 17) ^{(7) (1)}	\$7,463		\$21,687	
19	TRC Benefit-Cost Ratio ⁽⁸⁾	4.45		3.94	

⁽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. PPL Electric Utilities incorporates the cost of kits into the TRC as program delivery costs rather than as incentives to participants. PPL Electric Utilities will change its approach in Phase IV, as required in the final TRC Order.

⁽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.

⁽⁹⁾ All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.

13.7 Recommendations

Overall, the SEEE Program performed well in PY12, distributing more kits than projected and exceeding the program's planned savings. Overall, the program achieved lower savings than prior years due to the removal of LED bulbs from the energy efficiency kits. The program maintained comparable levels of low-income participation, with the proportion of verified low-income savings dropping slightly to 57%, compared to 61% in PY11.

Recommendations are provided in Table 13-10, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: The Bright Kids HEW was missing questions necessary for calculating savings for aerators.

- The Bright Kids HEW did not contain all of the necessary questions to evaluate savings using primary data. In particular the following inputs were not available in the Bright Kids HEWs: number of occupants, water heating fuel, and home type. (See section 13.2.1 *Impact Evaluation Data Collection and Sample Design*.)

Conclusion 2: Current *ex ante* calculations underestimate savings for aerators and overestimate savings for showerheads.

- *Ex ante* savings for faucet aerators used assumed values for people per home of 2.4 for single-family and 1.9 for multifamily from the PA TRM. The HEW surveys, on average, indicated people per home of approximately 4.5, nearly double the assumed value. This led to underestimating savings for faucet aerators. (See section 13.2.2 *Gross Savings Impact Evaluation Results*.)
- *Ex ante* savings for showerheads used the assumed value of 1.2 showers per home from the PA TRM. The HEW surveys indicated 1.7 showers per home on average. This led to overestimating savings for showerheads. (See section 13.2.2 *Gross Savings Impact Evaluation Results*.)

Table 13-10. Status of Recommendations for the Student Energy Efficient Education Program

Student Energy Efficient Education Program		
Conclusion	Recommendation	EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)
Conclusion 1: The Bright Kids HEW was missing questions necessary for calculating savings for aerators.	Update the Phase IV surveys for all cohorts to gather the necessary data for existing measures and any new measures.	Being considered. Cadmus reviewed the HEWs and the ICSP will make changes.
Conclusion 2: Current <i>ex ante</i> calculations underestimate savings for aerators and overestimate savings for showerheads.	Update Phase IV <i>ex ante</i> assumptions to use historical survey data where possible.	Being considered. Planning to implement in PY13.

DEMAND RESPONSE

The Demand Response Program is for commercial and industrial customers and for government, nonprofit, and education customers to voluntarily reduce electricity demand during Act 129 demand response events.

VERIFIED DEMAND REDUCTION

Phase III
saved an
average of
112.8 MW

123%
of Act 129
target

105%
of Act 129
target

PY12 saved
an average of
96.9 MW

PROGRAM SATISFACTION AND IMPACTS FROM PANDEMIC



Satisfied with
overall program

6 of 6

said they would likely participate
in the program again if offered

4 of 6

satisfied with interaction with ICSP

2 of 6

said COVID-19 pandemic
affected their event participation

PY12 PARTICIPATION

A total of **5** events with **118**
participants

113

facilities curtailed 109.6 MW
on July 20, 2020 event

114

facilities curtailed 102.4 MW
on July 27, 2020 event

107

facilities curtailed 76.5 MW
on July 29, 2020 event

114

facilities curtailed 91.3 MW
on August 25, 2020 event

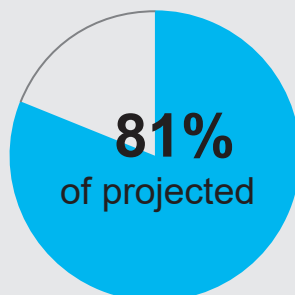
111

facilities curtailed 104.7 MW
on August 27, 2020 event

ACTUAL EXPENDITURES (\$1,000)

Phase III
expenditures
through PY12
\$9,655

78%
of projected



PY12
expenditures
\$2,549

14 Demand Response Program

To comply with the Pennsylvania Public Utility Commission's Act 129 Phase III demand response compliance targets, PPL Electric Utilities' Demand Response Program must reduce its system load (measured at the generator level) by an average of 92 MW during demand response events in PY9, PY10, and PY11 of Phase III.¹⁰³ In addition, PPL Electric Utilities is required to achieve a minimum of 85% of the 92 MW compliance target, or 78.2 MW, during each event during these program years. Compliance with Act 129 will not be based on performance in PY12 per the Pennsylvania Public Utility Commission's Phase III Modification Order that the Pennsylvania electric distribution companies may operate the demand response programs in PY12 on a voluntary basis.¹⁰⁴ The Commission modified the compliance requirements in response to disruptions to electric utility customer operations related to the COVID-19 pandemic. However, the Commission encouraged the utilities to operate their programs in PY12, and PPL Electric Utilities elected to continue operating the program for commercial and industrial (C&I) customers and for government, nonprofit, and education (GNE) customers.

PPL Electric Utilities manages the implementation conservation service provider (ICSP) and provides overall strategic direction for the program. CPower, the ICSP, enrolls and contracts with PPL Electric Utilities retail customers to reduce electricity demand during Act 129 demand response events.¹⁰⁵ After the summer season concludes, the ICSP makes performance-based payments to participating customers.¹⁰⁶

PPL Electric Utilities did not make any significant changes to program operations in PY12. Events were the same length as during previous program years. The ICSP did enroll new participants including a large number of retail stores.

14.1.1 Definition of a Participant

A participant in the Demand Response Program in PY12 is defined as a customer facility that participated in at least one of PPL Electric Utilities' Act 129 demand response events. The ICSP enrolled 43 customers representing 126 facilities in PY12. A total of 36 customers with 118 facilities participated in at least one Act 129 demand response event.

¹⁰³ Program objectives are stipulated on PPL Electric Utilities' revised EE&C Plan (Docket No. M-2015-2515642) filed with the Pennsylvania Public Utilities Commission in July 2018 and approved in November 2018.

¹⁰⁴ Pennsylvania Public Utility Commission. June 3, 2020. *Phase III Modification Order*. Docket No. M-2014-2424864.
http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/energy_efficiency_and_conservation_ee_c_program.aspx

¹⁰⁵ CPower, the ICSP, contracted with four PPL Electric Utilities' customer facilities through the demand response aggregators NRG, COI Energy Services, and Direct Energy.

¹⁰⁶ In PY12, 43 customers representing 126 facilities were enrolled in the program; however, seven customers representing eight facilities did not participate in any events.

14.1.2 Program Participation and Reported Impacts

Table 14-1 presents the participation counts, reported demand reductions, and incentive payments for the Demand Response Program in PY12 by customer segment and Act 129 event. In PY12 (summer of 2020), there were five Act 129 events. The program reported demand savings of approximately 108.7 MW on July 20, 103.0 MW on July 27, 79.4 MW on July 29, 93.3 MW on August 25, and 109.2 MW on August 27. Between 93% and 98% of the reported demand savings for each of these events were attributable to large C&I customers.

Table 14-1. PY12 Demand Response Program Participation and Reported Demand Reductions

Parameter	Small C&I (Non-GNE)	Large C&I (Non-GNE)	GNE	Total ⁽¹⁾
PYTD Number of Participants ⁽²⁾	78	32	8	118
Event 1, July 20, 2020, Reported MW	1.0	104.6	3.1	108.7
Event 2, July 27, 2020, Reported MW	1.4	99.3	2.3	103.0
Event 3, July 29, 2020, Reported MW	2.5	73.7	3.1	79.4
Event 4, August 25, 2020, Reported MW	1.6	90.3	1.5	93.3
Event 5, August 27, 2020, Reported MW	0.3	106.7	2.2	109.2
Total Average Reported MW	1.4	94.9	2.4	98.7
PYVTD MW	2.1	92.2	2.6	96.9
PY12 Incentives (\$1000)	\$26	\$1,344	\$37	\$1,407
The load impacts reported in this table have been grossed up to reflect transmission and distribution losses.				
⁽¹⁾ Total may not equal total of row due to rounding.				
⁽²⁾ Number of facilities that participated in at least one event (118) in PY12, not the number enrolled in the program (126).				

A dual-enrolled participant is a facility that participated in PPL Electric Utilities' Demand Response Program and is enrolled in a PJM demand response program. In PY12, all but three PPL Electric Utilities demand response program participants were dual-enrolled participants. Table 14-2 reports the number of these dual-enrolled and Act 129-only participating facilities and the incentives paid.

Table 14-2. PY12 Dual-Enrolled Participants (PPL Electric Utilities Act 129 and PJM programs)

Dual-Enrolled and Participating Customer Facilities	Act 129-Only and Participating Customer Facilities	Incentives Paid to Dual-Enrolled Customers	Incentives Paid to Act 129-Only Customers
115	3	\$1,384,812.95	\$22,193.68

14.2 Gross Savings Impact Evaluation

14.2.1 Impact Evaluation Data Collection and Sample Design

In PY12, 118 facilities operated by 36 customers of PPL Electric Utilities participated in one or more Act 129 demand response events. Table 14-3 shows the number of participating facilities by customer stratum. About two-thirds (66%) of the participants were small C&I facilities, one-quarter (27%) were

large C&I customers, and the remainder (7%) were GNE customers.¹⁰⁷ Cadmus estimated load impacts for all participant facilities for one or more events.

Table 14-3. PY12 Program Sampling Strategy

Stratum	Population Size (Facilities)	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Small C&I	78	NA	Census	78	Analysis of individual customer hourly consumption
Large C&I	32	NA	Census	32	
GNE	8	NA	Census	8	
Program Total	118	NA	Census	118	

Compliance targets for demand response programs were established at the generator level, which means load reductions measured at the customer meter must be increased to reflect transmission and distribution losses (line losses). The peak demand impact estimates presented in this report have been adjusted for these line losses. PPL Electric Utilities uses the following line loss percentages and/or multipliers by customer sector:

- Small C&I = [8.75% or 1.0875]
- Large C&I = [4.2% or 1.0420]

Cadmus evaluated each facility's demand savings by comparing the facility's metered demand during event hours with an estimated baseline. The baseline was estimated using either regression analysis or a day-matching method.¹⁰⁸ For each facility, Cadmus analyzed interval consumption data to identify the most accurate baseline calculation method. Additional details about the evaluation and baseline selection methodology are in *Appendix K*.

14.2.2 Gross Savings Impact Evaluation Results

PPL Electric Utilities met its Phase III Act 129 demand reduction compliance target specified in the Implementation Order and Phase III Modification Order. Figure 14-1 shows the PY9-PY11 gross verified savings, the basis for determining Phase III compliance. For Phase III, the verified Act 129 event load reductions were 112.8 MW (the average load reduction over PY9, PY10, and PY11 event hours), which exceeds the Phase III compliance target of 92 MW. In addition, in PY9, PY10, and PY11, PPL Electric Utilities met its per-event compliance target of at least 78.2 MW (85% of the total compliance target) in each demand response event.

Figure 14-1 also shows the gross verified savings for PY12 by event. In PY12, verified Act 129 event load reductions were 96.9 MW (equal to the average demand reduction over the five demand response events), a realization rate of 98.2% relative to the reported (*ex ante*) load reduction.

¹⁰⁷ Appendix A.1 provides a count of participants by stratum for each Act 129 event in PY12.

¹⁰⁸ Cadmus applied standard day-matching baseline calculation methods, such as selecting the seven days of the previous 10 with the highest average demand, in accordance with Statewide Evaluator (SWE) guidelines.

These verified load impacts are based on Cadmus analysis of participant AMI consumption data and have been grossed up to reflect transmission and distribution losses.

Figure 14-1. Gross Verified Savings Compared to Act 129 Targets, PY9-PY12

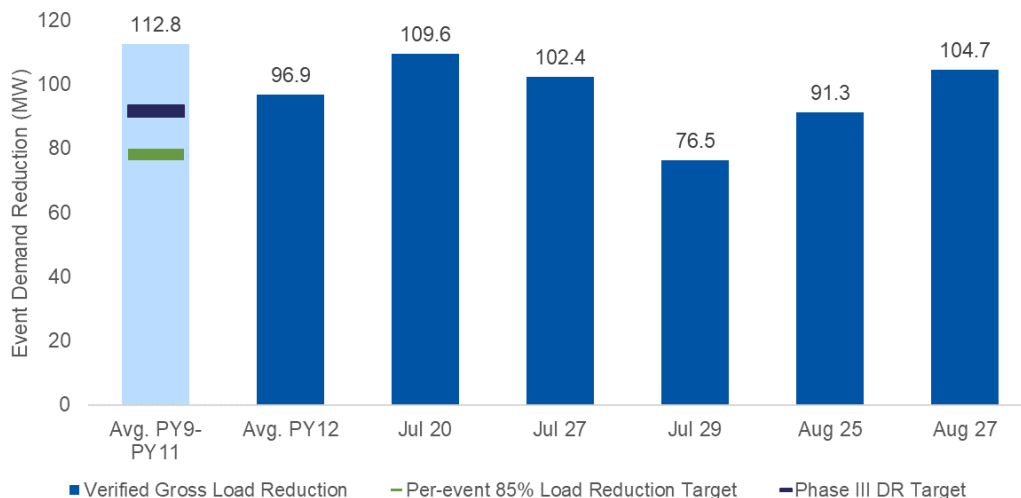


Table 14-4 shows PY12 Demand Response Program load reduction achievements by sector and demand response event.

The reported and evaluated savings were close, but the following factors may have contributed to differences between the reported and verified savings and to realization rates that deviated from 100%.

- Different treatment of estimated readings.** The ICSP provided estimates rather than actual values for fewer than 1% of all hourly interval readings for participating facilities on event or weekdays that were not holidays or notification days between April 1, 2020, and September 11, 2020. Cadmus replaced these estimated readings with missing values and did not include them in the analysis dataset.
- Different methods for calculating customer baselines.** To the extent possible, the ICSP attempted to align its baseline calculation method with Cadmus' method. However, whereas the ICSP employed day-matching, Cadmus employed regression analysis to calculate the baseline for 95% of small C&I facilities, 71% of GNE facilities, and 38% of large C&I facilities. The ICSP employed day-matching because it is transparent and easier for participants to understand savings (and anticipated incentives) than regression. Cadmus chose regression after determining this method yielded more accurate *ex post* savings estimates than day-matching.

Table 14-4. PY12 Demand Response Program Gross Impact Results for Demand by Sector

Stratum	Event	Number of Participants	PYRTD MW	Demand Realization Rate ⁽¹⁾	PYVTD MW ⁽²⁾	Standard Error	Relative Precision at 90% C.L. ⁽³⁾
Small C&I	July 20, 2020	77	1.0	204%	2.1	0.1	11.4%
	July 27, 2020	78	1.4	121%	1.6	0.1	14.6%
	July 29, 2020	78	2.5	80%	2.0	0.1	11.2%
	August 25, 2020	78	1.6	178%	2.9	0.1	8.3%
	August 27, 2020	77	0.3	543%	1.9	0.1	11.7%
Large C&I	July 20, 2020	28	104.6	99%	103.1	4.2	6.7%
	July 27, 2020	28	99.3	98%	97.5	4.2	7.0%
	July 29, 2020	22	73.7	97%	71.2	3.5	8.1%
	August 25, 2020	29	90.3	97%	87.6	4.1	7.7%
	August 27, 2020	30	106.7	95%	101.5	4.2	6.8%
GNE	July 20, 2020	8	3.1	143%	4.5	0.6	22.2%
	July 27, 2020	8	2.3	139%	3.2	0.6	29.3%
	July 29, 2020	7	3.1	106%	3.3	0.5	27.1%
	August 25, 2020	7	1.5	58%	0.9	0.4	78.7%
	August 27, 2020	4	2.2	58%	1.3	0.5	59.8%
Event ⁽⁴⁾	July 20, 2020	113	108.7	101%	109.6	4.3	6.4%
	July 27, 2020	114	103.0	99%	102.4	4.2	6.8%
	July 29, 2020	107	79.4	96%	76.5	3.5	7.6%
	August 25, 2020	114	93.3	98%	91.3	4.1	7.4%
	August 27, 2020	111	109.2	96%	104.7	4.2	6.7%
Average	-	112	98.7	98%	96.9	4.1	3.1%

⁽¹⁾ Due to rounding, multiplying the PYRTD savings by the realization rate may not exactly equal the final verified savings.

⁽²⁾ Based on Cadmus' analysis of participant AML consumption data. MW were grossed up to reflect transmission and distribution losses.

⁽³⁾ Precision accounts for covariances of facility savings across hours of each event but not between events.

⁽⁴⁾ Total may not sum due to rounding.

14.3 Process Evaluation

14.3.1 Process Evaluation Data Collection and Sample Design

The process evaluation gathered program implementation details and assessed customer satisfaction with the Demand Response Program. Table 14-5 lists the process evaluation sampling strategy. Unlike the impact evaluation, which analyzed the entire population of participating facilities, the process evaluation attempted a survey of enrolled customers contracted by the ICSP CPower. Customers did not have to participate in an event in PY12 to qualify for the survey but must have enrolled for the PY12 program and received the event notifications.

Table 14-5. PY12 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	2	2	2	N/A
Customer Surveys	Enrolled Companies Contracted by CPower	Online and telephone survey	38 ⁽³⁾	N/A	12	6	36	100%
Program Total			40	N/A	14	8	38	N/A

⁽¹⁾ Sample frame is the enrolled customer companies with contact information that were asked to complete the survey. The final sample frame includes unique records in the PPL Electric Utilities tracking database.

⁽²⁾ Percent contacted means the percentage of the sample frame that were emailed to complete surveys.

⁽³⁾ The ICSP contracted with 38 unique companies that enrolled in the PY12 Demand Response Program. Cadmus included all enrolled companies, even those that did not participate in any events, in its survey population. Cadmus did not survey the companies under contract with the demand response aggregators NRG, COI Energy Services, and Direct Energy. The survey population, therefore, differs from the population used in the impact evaluation. The impact evaluation counts as participants all facilities that participated in at least one event across CPower, NRG, COI Energy Services, and Direct Energy.

In October 2020, Cadmus contacted 36 enrolled companies by email and telephone, even if they did not participate in any PY12 events, to ask them to complete a short survey.¹⁰⁹

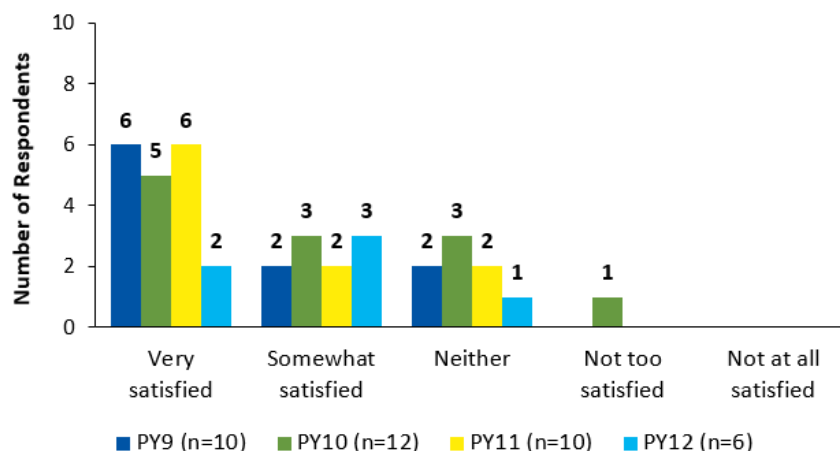
The survey was directed to the person who authorized the events at each company, typically an energy manager. Cadmus coordinated with the ICSP on emailing notice of the survey in advance. Cadmus made four attempts to gather survey responses. The first, second, and third attempts were by email; the fourth attempt was by telephone. Despite multiple attempts, Cadmus only gathered six completed surveys, which was less than the target of 12 completed surveys. Because of the small number of respondents, the expected confidence and precision levels for survey data are not reported here. Therefore, data gathered from the participant surveys should be viewed as qualitative.

Program Satisfaction

In PY12, five of six respondents were satisfied with the Demand Response Program—two were *very satisfied* and three were *somewhat satisfied*. No respondent reported being dissatisfied. Figure 14-2 shows overall satisfaction with the program for PY9 through PY12.

¹⁰⁹ Cadmus did not survey the enrolled customers under contract with the demand response sub-contractors NRG, COI Energy Services, and Direct Energy, only customers enrolled under contract with CPower.

Figure 14-2. Overall Satisfaction with Demand Response Program



Source: Survey question, “How would you rate your overall satisfaction with the Demand Response Program?”

The survey asked respondents a follow-up question about the reason for their program satisfaction rating. Three respondents answered the question. One *very satisfied* respondent said their rating was because of the simplicity of participation. One *somewhat satisfied* respondent said they were less than very satisfied due to a reduction in their incentive payments. The one respondent who said they were *neither satisfied nor dissatisfied* said it was because of the short notice, which made it challenging for their business.

14.4 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 14-6. Total resource cost (TRC) benefits were calculated using gross verified impacts. Per the TRC Order, 75% of the customer incentive payment is used as a proxy for the participant cost when calculating the TRC ratio for the program. PYTD values represent PY12 costs and benefits, and P3TD values represent phase costs and benefits up to PY12. Net present value (NPV) PYTD costs and benefits are expressed in PY12 dollars. NPV costs and benefits for P3TD financials are expressed in PY8 dollars.

Table 14-6. Summary of Demand Response Program Finances – Gross and Net Verified

Row #	Cost Category	PYTD (\$1,000)		P3TD (\$1,000) ⁽⁶⁾	
1	EDC Incentives to Participants	\$1,407		\$4,529	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	(\$352)		(\$1,132)	
4	Incremental Measure Costs (Sum of rows 1 through 3) ⁽¹⁾	\$1,055		\$3,397	
		EDC	CSP	EDC	CSP
5	Design & Development ⁽²⁾	-	-	-	-
6	Administration, Management, and Technical Assistance ⁽³⁾	\$36	-	\$282	-
7	Marketing ⁽⁴⁾	-	-	-	-
8	Program Delivery ⁽⁵⁾	-	\$1,105	-	\$3,304
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	Program Overhead Costs (Sum of rows 5 through 10) ^{(1), (6), (10)}	\$1,142		\$3,587	
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) ^{(1), (7)}	\$2,197		\$6,983	
14	Total NPV Lifetime Electric Energy Benefits	-		-	
15	Total NPV Lifetime Electric Capacity Benefits	\$4,452		\$16,792	
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) ^{(8), (1)}	\$4,452		\$16,792	
19	TRC Benefit-Cost Ratio ⁽⁹⁾	2.03		2.40	

⁽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⁾ P3TD amounts are discounted back to PY8.
⁽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⁾ Total costs include those incurred for PY11 after the Semi-Annual Report filed Jan. 15, 2020.

14.5 Recommendations

Because the program did well in PY12 and will not be delivered in Phase IV, Cadmus does not have any recommendations to make for the program.

Appendix A. Site Inspection Summary

Table A-1 summarizes programs receiving verification site visits by Cadmus or the ICSP (listed in column “Inspection Firm”). The table includes the number of inspections, and resolution of discrepancies.

Table A-1. Site Inspection Summary

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In Person	Virtual		
Non-Residential Sector					
Custom	Warren Energy Engineering (on behalf of Cadmus)	10 ⁽¹⁾	19 ⁽¹⁾	9	<ul style="list-style-type: none">Discrepancies only found on small sample sites (9 of 19 virtual site visits) though all equipment and quantities matched reported values.
	CLEAResult (ICSP)	0	0	49	<ul style="list-style-type: none">Contractor/customer estimate of original savings was not accurate.Actual metered data used in place of estimates.Project not modeled accurately originally compared to installed condition.Project scope deviation and possibly not understanding systems installed for Custom.
Efficient Equipment Equipment (HVAC)	Cadmus	0	1	0	None
Efficient Equipment Equipment (Motors)	Cadmus	0	1	1	Incorrect motor efficiency
Efficient Equipment Equipment	CLEAResult (ICSP)	0	3	1	<ul style="list-style-type: none">Project savings may have increased or decreased as a result of site visits which made the projects switch from prescriptive to customer submitted HOU.Ineligible equipment removed from applications.Project scope deviation and possibly not understanding systems installed.

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In Person	Virtual		
Efficient Equipment Lighting	Warren Energy Engineering (on behalf of Cadmus)	0	6	5	<ul style="list-style-type: none"> • Wrong HOU given on Appendix C form vs. what was found from customer interviews on site. • Wrong number of lights submitted on application. • Incorrect controls for baseline and post-install fixtures. • Incorrect wattage selected for post install fixtures.
	CLEAResult (ICSP)	0	455	62	<ul style="list-style-type: none"> • Wrong HOU given on Appendix C form vs. what was found from customer interviews on site. • Wrong number of lights submitted on application. • Wrong amount of bulbs in the ballast/fixture submitted. • Incorrect wattage selected for baseline fixtures. • Projects started before receiving pre-approval. • Integrated fixtures not used in application. • Projects over 120,000 switched from prescriptive to customer provided HOU (or custom hours removed when not over 120,000).
Midstream Lighting	Warren Energy Engineering (on behalf of Cadmus)	0	4	4	<ul style="list-style-type: none"> • Verified space conditioning different from Appendix C reported type. • Verified fixture count different from quantity listed in PPL Electric Utilities' tracking database. • Verified baseline and post install fixture wattage different from information in PPL Electric Utilities' tracking database. • Verified controls different from type listed in PPL Electric Utilities' tracking database.
	CLEAResult (ICSP)	0	482	57	<ul style="list-style-type: none"> • Distributor submitted the wrong account for a project; had to be resubmitted. • Need to be returned. • COVID-19 exception customer not available. • Fail/Not Installed- Customer is unaware of program requirements.

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In Person	Virtual		
Residential Sector					
Energy Efficient Home (New Homes)	Cadmus	9	0	9	<ul style="list-style-type: none">• Lighting: The verified energy savings, which were calculated using the PA TRM, are greater than the savings reported in the REM/Rate models. REM/Rate calculates lighting savings based on home square footage and doesn't take bulb type into account. The bulb mix found in the sample resulted in greater verified savings.• Appliances: REM/Rate calculates savings for all appliances, whereas verified savings are only calculated for appliance present during the time of the site visit. Of the 19 sample homes, 14 were missing at least one appliance at the time of the site visit.• DHW: REM/Rate applies savings to all electric water heaters. The PA TRM only allows savings for heat pump water heaters, and there were none installed.
	Energy Auditors (on behalf of Cadmus)	7	0	7	
	Fekete Thermal Inspections (on behalf of Cadmus)	3	0	3	
	PSD	56	1	49	<ul style="list-style-type: none">• Cooling Equipment (25) – Cooling Equipment discrepancies were most often caused by misreported efficiency ratings.• Windows (23) – Window discrepancies are most often caused by misreported window area or the orientation of the windows.• Heating Equipment (22) – Heating Equipment discrepancies were most often caused by misreported efficiency ratings.• Orientation (17) – Orientation discrepancies are caused by misreported building orientation.• Appliances (16) – Appliance discrepancies were most often caused by misreported equipment efficiency ratings.• Lighting (16) – 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.
Low-Income Sector ⁽²⁾					
WRAP (baseload jobs)	CMC (ICSP)	0	1,002 ⁽³⁾	18	Did not install all measures after several outreach attempts.
WRAP (low-cost jobs)	CMC (ICSP)	0	779 ⁽⁴⁾	15	Did not install all measures after several outreach attempts.
⁽¹⁾ One project received both a virtual and an in-person visit. ⁽²⁾ In PY12, no master-metered multifamily, manufactured home, or full costs jobs were completed. ⁽³⁾ Includes 639 mid-process and 363 quality confirmation surveys. ⁽⁴⁾ Includes 496 mid-process surveys and 283 quality confirmation surveys.					

Appendix B. PY12 and P3TD Summary by Customer Segment and Carveout

Table B-1. PY12 and P3TD Energy Savings Summary (Verified Gross MWh/Year)

Program Sector	Program Name	Residential		Low-Income		Small C&I		Large C&I		GNE		Total ⁽³⁾	
		PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD
Residential	Appliance Recycling	4,232	47,352	-	-	70	504	-	14	30	344	4,332	48,215
	Efficient Lighting	-	345,807	-	-	-	80,945	-	-	-	-	-	426,752
	Energy Efficient Home	22,753	89,495	-	-	190	687	-	6	24	272	22,967	90,460
	Home Energy Education	13,316	163,926	1,468	3,032	-	-	-	-	-	-	14,784	166,958
	Student Energy Efficient Education	1,636	17,504	2,170	9,033	-	-	-	-	-	-	3,806	26,536
	Residential Program Total	41,936	664,084	3,638	12,065	260	82,136	-	21	55	616	45,888	758,921
	Low-Income Compliance Total ⁽¹⁾⁽³⁾	-	-	3,638	12,065	-	-	-	-	-	-	3,638	12,065
	GNE Compliance Total ^{(2) (3)}	-	-	-	-	-	-	-	-	55	616	55	616
Low-Income	Energy Efficiency Kits and Education	-	-	-	41,240	-	-	-	-	-	-	-	41,240
	WRAP	-	0	7,215	54,242	-	483	-	-	-	2,426	7,215	57,152
	Low Income Program Total	-	0	7,215	95,482	-	483	-	-	-	2,426	7,215	98,392
	Low-Income Compliance Total ⁽¹⁾⁽³⁾	-	0	7,215	95,482	-	483	-	-	-	2,426	7,215	98,392
	GNE Compliance Total ^{(2) (3)}	-	-	-	-	-	-	-	-	-	-	-	-
Non-Residential	CEI	-	-	-	-	-	-	-	-	-	1,190	-	1,190
	Custom	-	662	-	-	17,300	42,276	27,637	133,388	24,196	134,379	69,132	310,705
	Efficient Equipment	684	2,191	-	-	93,074	350,079	19,017	162,130	12,861	89,356	125,636	603,755
	Non-Residential Program Total	684	2,853	-	-	110,374	392,354	46,654	295,518	37,057	224,925	194,768	915,650
	Low-Income Compliance Total												
	GNE Compliance Total	-	-	-	-	-	-	-	-	37,057	224,925	37,057	224,925

Program Sector	Program Name	Residential		Low-Income		Small C&I		Large C&I		GNE		Total ⁽³⁾	
		PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD
Portfolio Total	Low-Income Compliance Total	-	-	10,852	107,547	-	483	-	-	-	2,426	10,852	110,456
	GNE Compliance Total	-	-	-	-	-	-	-	-	37,057	224,925	37,057	224,925
	Portfolio Compliance Total	42,620	666,937	10,852	107,547	110,634	474,974	46,654	295,539	37,111	227,967	247,871	1,772,963
Adjustment for Residential Energy-Efficiency Behavior & Education Double-Counted Savings		-	-	-	-	-	-	-	-	-	-	(1,687)	(23,651)
Adjusted Total		-	-	-	-	-	-	-	-	-	-	246,184	1,749,311
⁽¹⁾ Savings count toward the low-income compliance target of 79,367 MWh/yr. ⁽²⁾ Savings count toward the GNE compliance target of 50,507 MWh/yr. ⁽³⁾ Totals may not sum due to rounding.													

Table B-2. PY12 and P3TD Demand Reduction Savings Summary (Verified Gross MW/yr)

Program Sector	Program Name	Residential		Low Income		Small C&I		Large C&I		GNE		Total ⁽¹⁾	
		PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD	PYTD	P3TD
Residential	Appliance Recycling	0.68	7.45	-	-	0.01	0.07	-	0.00	0.00	0.05	0.70	7.57
	Efficient Lighting	-	39.86	-	-	-	16.97	-	-	-	-	-	56.83
	Energy Efficient Home	4.10	15.69	-	-	0.04	0.13	-	0.00	0.01	0.09	4.14	15.91
	Home Energy Education	5.37	31.74	0.25	0.51	-	-	-	-	-	-	5.61	32.26
	Student Energy Efficient Education	0.15	1.81	0.20	0.92	-	-	-	-	-	-	0.36	2.73
	Residential Program Total	10.30	96.56	0.45	1.43	0.05	17.17	-	0.00	0.01	0.14	10.81	115.30
Low-Income	Energy Efficiency Kits and Education	-	-	-	4.13	-	-	-	-	-	-	-	4.13
	WRAP	-	0.00	0.69	5.64	-	0.04	-	-	-	0.22	0.69	5.91
	Low Income Program Total	-	0.00	0.69	9.77	-	0.04	-	-	-	0.22	0.69	10.03
Non-Residential	CEI	-	-	-	-	-	-	-	-	-	0.60	-	0.60
	Custom	-	0.02	-	-	2.00	5.00	3.32	15.41	4.96	19.73	10.28	40.16
	Demand Response	-	-	-	-	2.10	1.70	92.18	102.41	2.63	4.26	96.91	108.37
	Efficient Equipment	0.08	0.32	-	-	11.66	48.33	2.70	22.06	1.87	13.85	16.31	84.56
	Non-Residential Program Total	0.08	0.34			15.76	55.03	98.20	139.88	9.47	38.44	123.50	233.68
Total⁽¹⁾		10.38	96.90	1.14	11.20	15.81	72.24	98.20	139.88	9.48	38.80	135.00	359.02
Adjustment for Residential Energy-Efficiency Behavior & Education Double-Counted Savings		-	-	-	-	-	-	-	-	-	-	(0.543)	(2.989)
Adjusted Total		-	-	-	-	-	-	-	-	-	-	134.46	356.03
⁽¹⁾ Totals may not sum due to rounding.													

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 to evaluate the Home Energy Education Program in PY12. Major data preparation steps involved cleaning and compiling the program tracking data, analyzing billing consumption and weather data, and testing for significant differences in annual pretreatment consumption between treatment and control customers, by wave.

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 PY12. These data included treatment group customers who received home energy reports in the current or a previous year and control group customers tracked since the program's inception. Because the Home Energy Education Program was implemented as a randomized control trial, Cadmus included all randomized customers in its evaluation, adopting a "once in, always in" policy for customers originally randomized into either the treatment or control group prior to the launch of the home energy reports.

Table C-1 shows customer attrition through PY12, by treatment and control groups, by wave, and as originally randomized and active at the beginning of treatment in PY12. The attrition process captures customers whose accounts closed (became inactive) since the launch of the program.

Table C-1. PY12 Customer Attrition

Wave	Originally Randomized		Active at the Beginning of Treatment in PY12 ⁽¹⁾	
	Treatment	Control	Treatment	Control
Legacy Wave 1	50,000	50,000	30,494	30,447
Legacy Wave 2	55,040	25,003	35,266	15,963
Expansion Wave 1	48,711	12,653	34,504	8,927
Low-Income Wave 1 ⁽²⁾	73,500	18,560	15,447	3,943
Phase III Expansion Wave 1	30,584	12,234	23,665	9,524
Program Total	257,835	118,450	139,376	68,804
⁽¹⁾ Customers active at the beginning of PY12 were not necessarily included in the billing data analysis if they had insufficient billing data. Customers who were included were not necessarily active at the beginning of PY12 and may have contributed only to previous program year estimates.				
⁽²⁾ When Low-Income Wave 1 customers were randomized into treatment and control groups in 2014, all customers were verified as low-income except any whose low-income status changed between randomization and program launch. After PY10, PPL Electric Utilities identified customers who were still verified to be low-income, which substantially diminished the number of treatment customers.				

Billing Data

Cadmus collected PY12 customer billing data for each wave from PPL Electric Utilities to supplement the billing data it had collected and cleaned in previous program years. After reviewing the SWE's Act 129 Program Year 11 report,¹¹⁰ Cadmus incorporated some additional steps to clean the billing data. The following are all of the steps in cleaning the billing data:

1. Drop customers whose accounts went inactive before delivery of the first energy reports
2. Drop customers assigned to multiple waves and groups (added in PY11)
3. Clean and calendarize bills, which involved dropping bills that covered more than 92 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
4. Drop bills that were present in the billing data after the inactive date for that customer (when the inactive date was known) or drop Phase III bills for "legacy inactive" customers who went inactive after Phase II when a new Phase III home energy reports vendor was selected and inactive dates are unknown (added in PY11)
5. Remove calendarized bills with average daily consumption that exceeded 300 kWh/day and fell outside of four standard deviations of the customer's mean average daily consumption for that season (added in PY11)
6. Drop customers with less than 11 months of pretreatment bills

Table C-2 provides the attrition in the PY12 analysis sample from data cleaning. The final modeling sample included customers in Cadmus' final tracking data who were not dropped during the data cleaning. Some customers in the final sample did not have active billing accounts at the beginning of treatment in PY12.

¹¹⁰ Pennsylvania Public Utility Commission. *SWE Annual Report Act 129 Program Year 11*. Prepared by NMR Group, Inc., Demand Side Analytics, LLC, and BrightLine Group. Final Report, May 25, 2021. Available online: https://www.puc.pa.gov/media/1536/act129-swe_ar_y11_052521.pdf

Table C-2. PY12 Sample Attrition from Data Cleaning

Step in Attrition	Legacy Wave 1		Legacy Wave 2		Expansion Wave 1		Low-Income Wave 1 Low-Income ¹		Phase III Expansion Wave 1	
	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
Originally Randomized Customers	50,000 (100%)	50,000 (100%)	55,040 (100%)	25,003 (100%)	48,711 (100%)	12,653 (100%)	17,735 (100%)	4,574 (100%)	30,584 (100%)	12,234 (100%)
Assigned to Only One Wave and Group	49,746 (99%)	49,765 (100%)	54,492 (99%)	24,792 (99%)	48,704 (100%)	12,644 (100%)	17,735 (100%)	4,574 (100%)	30,584 (100%)	12,234 (100%)
Included in Billing Data	49,243 (98%)	49,233 (98%)	53,689 (98%)	24,408 (98%)	48,083 (99%)	12,491 (99%)	17,735 (100%)	4,574 (100%)	28,357 (93%)	11,356 (93%)
Non-missing Zip Code	49,036 (98%)	49,022 (98%)	53,540 (97%)	24,343 (97%)	47,968 (98%)	12,463 (98%)	17,734 (100%)	4,574 (100%)	28,323 (93%)	11,338 (93%)
At Least One Posttreatment Month	48,723 (97%)	48,714 (97%)	53,158 (97%)	24,145 (97%)	47,582 (98%)	12,372 (98%)	17,734 (100%)	4,574 (100%)	28,323 (93%)	11,338 (93%)
At Least 11 Pretreatment Months	47,814 (96%)	47,805 (96%)	50,375 (92%)	22,820 (91%)	47,178 (97%)	12,257 (97%)	17,577 (99%)	4,544 (99%)	27,016 (88%)	10,835 (89%)
Final Modeling Sample	47,814 (96%)	47,805 (96%)	50,375 (92%)	22,820 (91%)	47,178 (97%)	12,257 (97%)	17,577 (99%)	4,544 (99%)	27,016 (88%)	10,835 (89%)

⁽¹⁾ The originally randomized Low-Income Wave 1 had 73,500 treatment customers and 18,560 control customers. 17,735 treatment customers and 4,574 control customers were later identified as still qualifying as low-income in PY10.

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 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 pretreatment energy use, as it does every year. Cadmus conducted the random assignment of eligible customers to treatment or control groups for Legacy Wave 2 in Phase I, Expansion Wave 1 and Low-Income Waves 1 and 2 in Phase II, and Expansion Wave 1 in Phase III. The ICSP made the random assignments for Legacy Wave 1. Cadmus verified the equivalence of waves using the final modeling sample's cleaned billing data by testing for statistical differences in average annual consumption per customer for treatment group and control group customers from before the launch of the program.

Table C-3 provides the PY12 results of the tests for significant differences in pretreatment consumption between the treatment and control groups. Cadmus found that all but the Low-Income Wave 1 were balanced at the 10% significance level. No statistically significant differences existed in the pretreatment consumption between treatment and control groups in these waves.

In PY12, Cadmus ran a regression model only for customers in the Low-Income Wave 1 who were identified as being at or below the 150% federal poverty level. PPL Electric Utilities wanted to claim low-income savings for these customers and had identified them in both the treatment and control groups. For this refined group of low-income customers, Cadmus found statistical differences in the annual pretreatment consumption between treatment and control groups at the 10% significance level, as shown in Table C-3. Cadmus ran models that controlled for these pretreatment differences.

Table C-3. PY12 Tests for Significant Differences in Annual Pretreatment 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	47,814	47,805	18,539	18,473	66	0.144
Legacy Wave 2	50,375	22,820	27,665	27,780	114	0.113
Expansion Wave 1	47,178	12,257	23,215	23,205	10	0.850
Low-Income Wave 1	17,577	4,544	13,249	13,444	194	0.099
Phase III Expansion Wave 1	27,016	10,835	15,184	15,182	3	0.959

⁽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

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,¹¹¹ and to the approach described in the Uniform Methods Project.^{112,113} Methods also followed those described in the Phase III Evaluation Framework for behavioral programs.¹¹⁴

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 the customers' pretreatment energy use, month-by-year fixed effects, and weather.¹¹⁵ The model is estimated only with posttreatment 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 pretreatment and posttreatment customer bills.

Both models yielded savings estimates that were within each other's confidence intervals, meaning that their results were not statistically different (illustrated in Figure C-1 and Figure C-2 later in this section). In PY12, Cadmus reported the results of the post-only model, consistent with previous Phase III program years.

The error terms of the post-only model and D-in-D fixed effects model should be uncorrelated with program participation ($PART_i$) and other observable variables because of the random assignment of

¹¹¹ 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) <http://www.evo-world.org/>

¹¹² 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) http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

¹¹³ 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) http://www1.eere.energy.gov/office_eere/de_ump_protocols.html

¹¹⁴ 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. Final version May 8, 2018. See Behavior Section 6.1.1.

¹¹⁵ 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.

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 correlation in each customer's 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 customer ' i ' in month ' t ' as given by Equation C-1.

Equation C-1

$$ADC_{it} = \beta_1 PART_i * PY_t + \beta_2 Pre-Usage_i + \beta_3 Pre-Summer_i + \beta_4 Pre-Winter_i + \beta_5 Pre-Usage_i \times \tau_t + \beta_6 Pre-Summer_i \times \tau_t + \beta_7 Pre-Winter_i \times \tau_t + W' \gamma + \tau_t + \varepsilon_{it}$$

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).
- β_2 = Coefficient representing the conditional average effect of pretreatment electricity use on posttreatment average daily consumption (kWh per customer per day).
- $Pre-Usage_i$ = Mean household energy consumption of customer ' i ' across all pretreatment months.
- β_3 = Coefficient representing the conditional average effect of pretreatment summer electricity use on posttreatment 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 pretreatment period.
- β_4 = Coefficient representing the conditional average effect of pretreatment winter electricity use on posttreatment 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 pretreatment 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	=	The month-by-year fixed effects, which reflect unobservable factors that affect consumption of all households during the month 't'.
β_5	=	Coefficient representing the conditional average effect of pretreatment electricity use, given month 't', on posttreatment average daily consumption (kWh per customer per day).
β_6	=	Coefficient representing the conditional average effect of pretreatment summer electricity use, given month 't', on posttreatment average daily consumption (kWh per customer per day).
β_7	=	Coefficient representing the conditional average effect of pretreatment winter electricity use, given month 't', on posttreatment 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 C-2:

Equation C-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 posttreatment (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	=	The customer fixed effects, which reflect unobservable, non-weather-sensitive, and time-invariant factors specific to the customer.
τ_t	=	The month-by-year fixed effects, which reflect unobservable factors that affect consumption of all households during the month 't'.
ϵ_{it}	=	Error term for customer 'i' in month 't'

Annual Program Energy Savings

Cadmus estimated program savings in PY12 for each wave's population of treated customers as the product of average daily savings per participant and the number of days these customers were treated

in PY12, shown in Equation C-3. Cadmus assumed that the ICSP intended to treat all eligible Low-Income Wave 1 customers at least once in PY12 and included treatment days for customers who should have received treatment in PY12 (i.e., those who were still active and randomized as a treatment customer), even when customers were not explicitly flagged as receiving PY12 treatment. The same intent-to-treat methodology described above for Low-Income Wave 1 applied to the four residential customer waves who last received treatment in PY11.

Equation C-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 C-1.

$Treatment\ Days_{i,h}$ = The number of days customer 'i' in wave 'h' was treated in PY12

Cadmus estimated realization rates for each wave as the ratio of verified program savings to reported program savings (estimated by the ICSP).

Table C-4 shows the *post-only* energy savings estimates and standard errors for each wave. It also shows the total number of treatment days, the final evaluated energy savings and the 85% confidence interval around the evaluated energy savings. Only Low-Income Wave 1 had savings that were not significant at the 85% confidence level. This can be seen by examining the confidence intervals. Intervals that contain zero do not have statistically significant results at the specified confidence level.

Table C-4. PY12 Home Energy Education Program Savings Estimate

Wave	'Post-Only' Savings Estimate (kWh/day)	Standard Error of Savings Estimate	Treatment Days	Total Evaluated MWh ⁽¹⁾	85% Confidence Interval (Lower Bound)	85% Confidence Interval (Upper Bound)
Legacy Wave 1	-0.710	0.127	4,620,916	3,282	2,438	4,127
Legacy Wave 2	-0.956	0.192	5,340,881	5,104	3,627	6,580
Expansion Wave	-0.749	0.175	5,215,717	3,906	2,590	5,223
Low-Income Wave 1	-0.271	0.237	5,424,020	1,468	-380	3,316
Phase III Expansion Wave	-0.286	0.149	3,576,884	1,024	258	1,789
Total Program ⁽¹⁾	-	-	24,178,418	14,784	11,847	17,721
⁽¹⁾ May not match due to rounding.						

Ex Post Verified Savings across Time

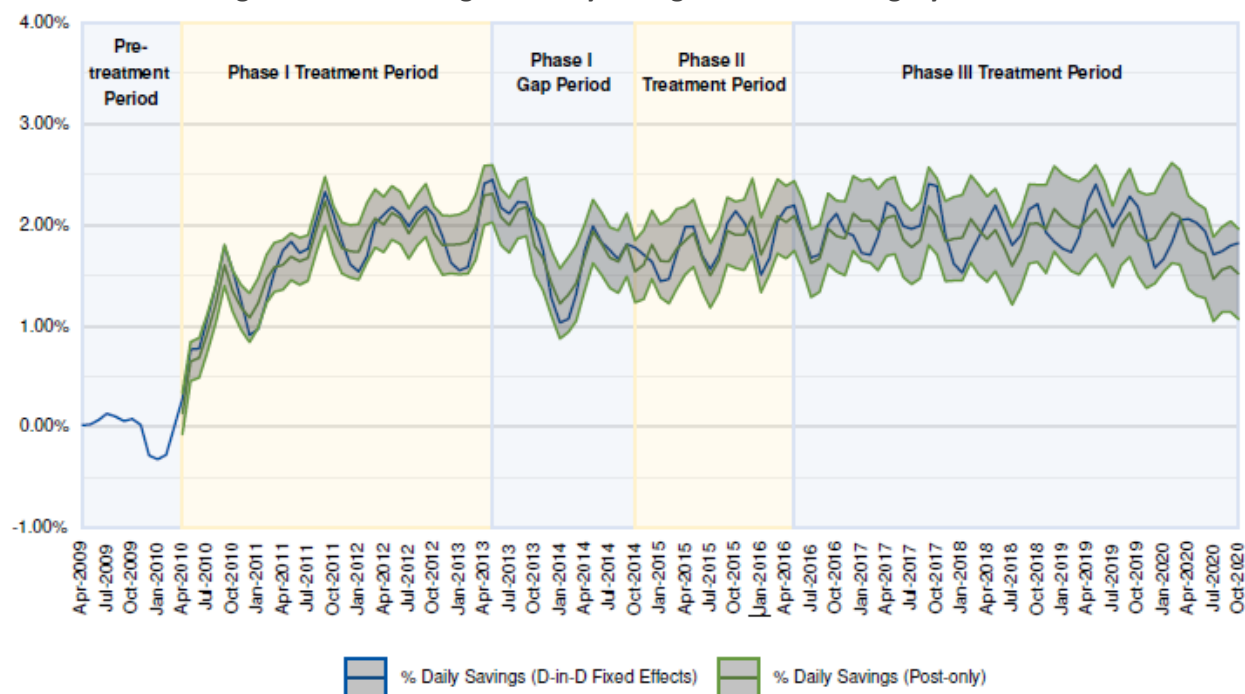
Figure C-1 through Figure C-6 provide the percentage daily electricity savings across time for each pre- and posttreatment month through PY12. Cadmus calculated the percentage savings for each month as the ratio of average daily savings to the average daily control group consumption for the month.

These figures report the post-only results for each wave, with the monthly percentage savings and confidence intervals (gray) resulting from the D-in-D fixed effects model (blue) plotted to show pretreatment consumption trends.

The green line in the figures shows the monthly savings resulting from the 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.¹¹⁶ 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).

Figure C-1 shows steady savings across months in PY12 for Legacy Wave 1. A slight downward trend is observed for Legacy Wave 1 from November 2019 through October 2020, likely as a result of not receiving any more home energy reports after November 2019. Legacy Wave 1 savings were fairly consistent through all of Phase III.

Figure C-1. Percentage Monthly Savings across Time: Legacy Wave 1



¹¹⁶ 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 the post-only analyses did not include pretreatment bills).

Figure C-2 and Figure C-3 show that month-to-month savings in Legacy Wave 2 and Expansion Wave 1 are more variable than in Legacy Wave 1, and these savings may have declined in Phase III from Phase II. Savings for Legacy Wave 2 customers appeared to steadily degrade over Phase III, which may have reflected savings fatigue or an increasingly efficient control group. Expansion Wave 1 savings also appeared to degrade in Phase III but rebounded toward the end of Phase III even after stoppage of home energy reports. Monthly savings reflect actual weather, though, so small changes in savings from year to year may not be related to the program and may be driven by any increases or decreases in seasonal temperatures.

Figure C-2. Percentage Monthly Savings across Time: Legacy Wave 2

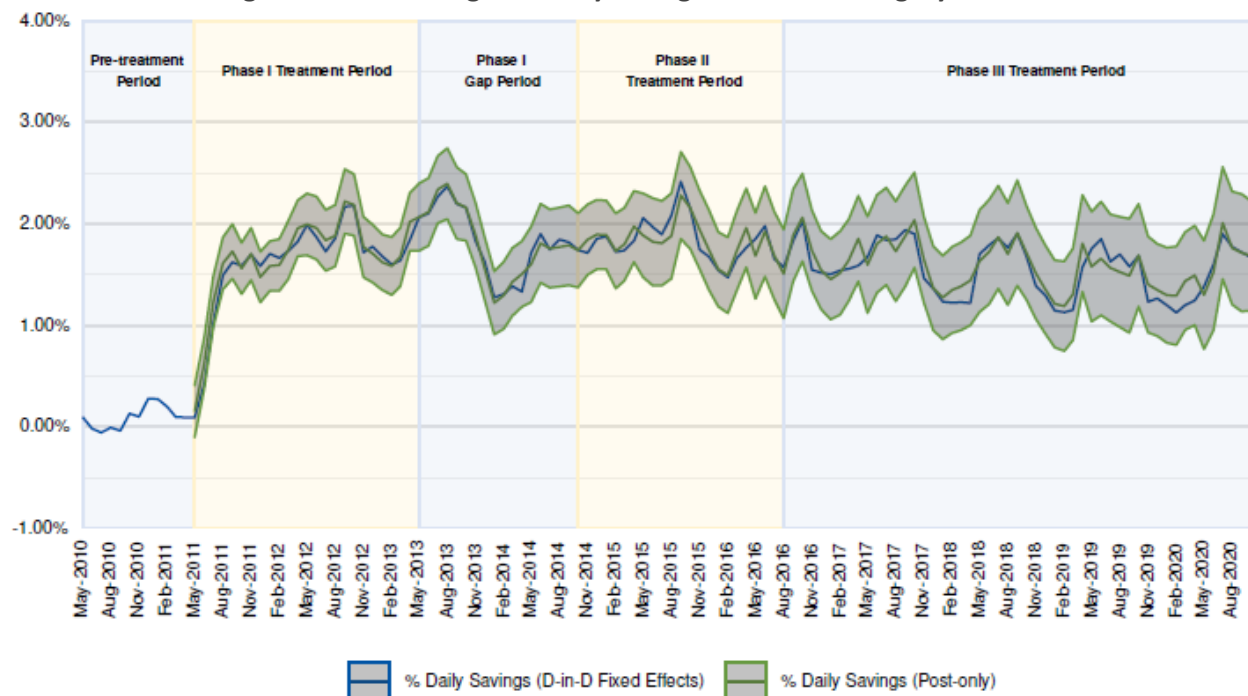


Figure C-3. Percentage Monthly Savings across Time: Expansion Wave 1

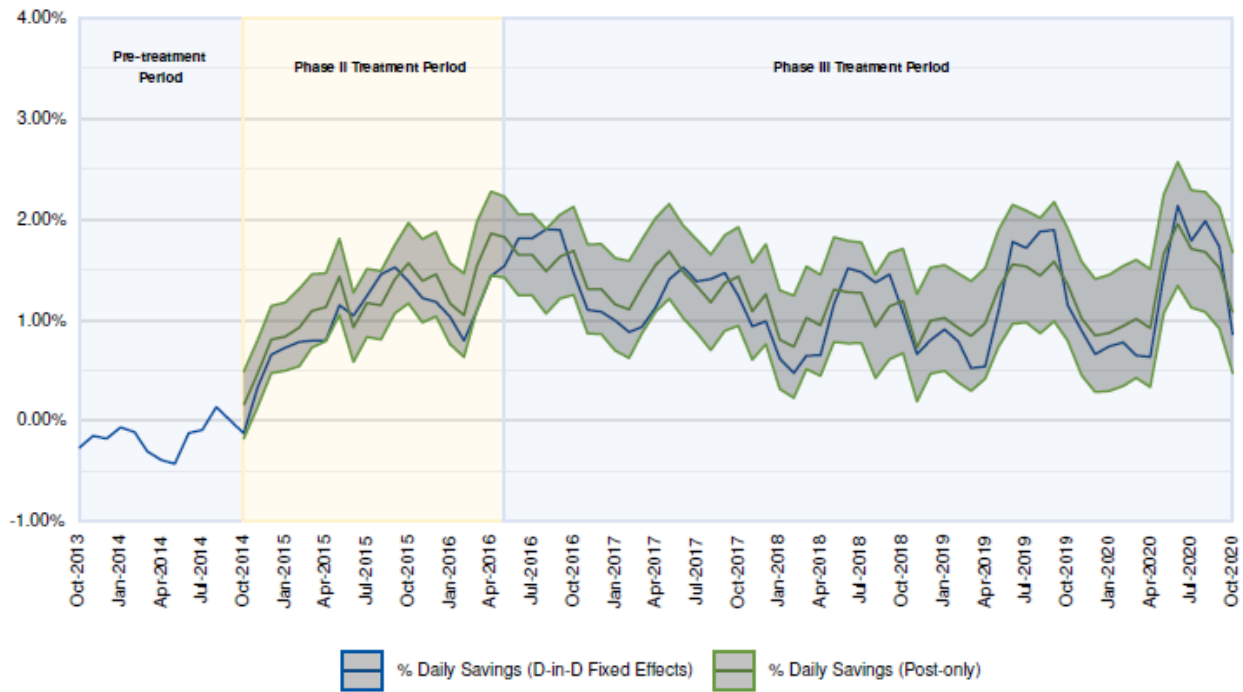


Figure C-4 shows monthly savings estimates for the remaining low-income customers in Low-Income Wave 1. Because few low-income control customers are in the Low-Income Wave 1, average savings estimates for the low-income group are less precise and often include 0% savings in the 85% confidence intervals.

Figure C-4. Percentage Monthly Savings across Time: Low-Income Wave 1-Low-Income

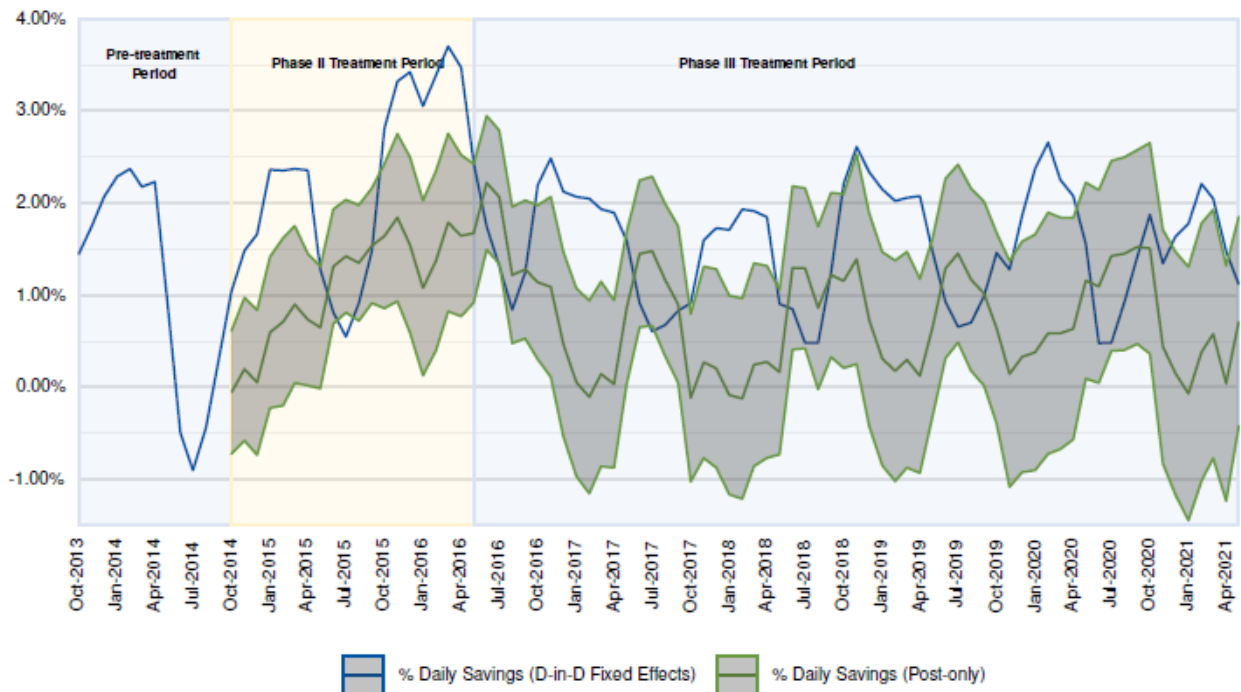
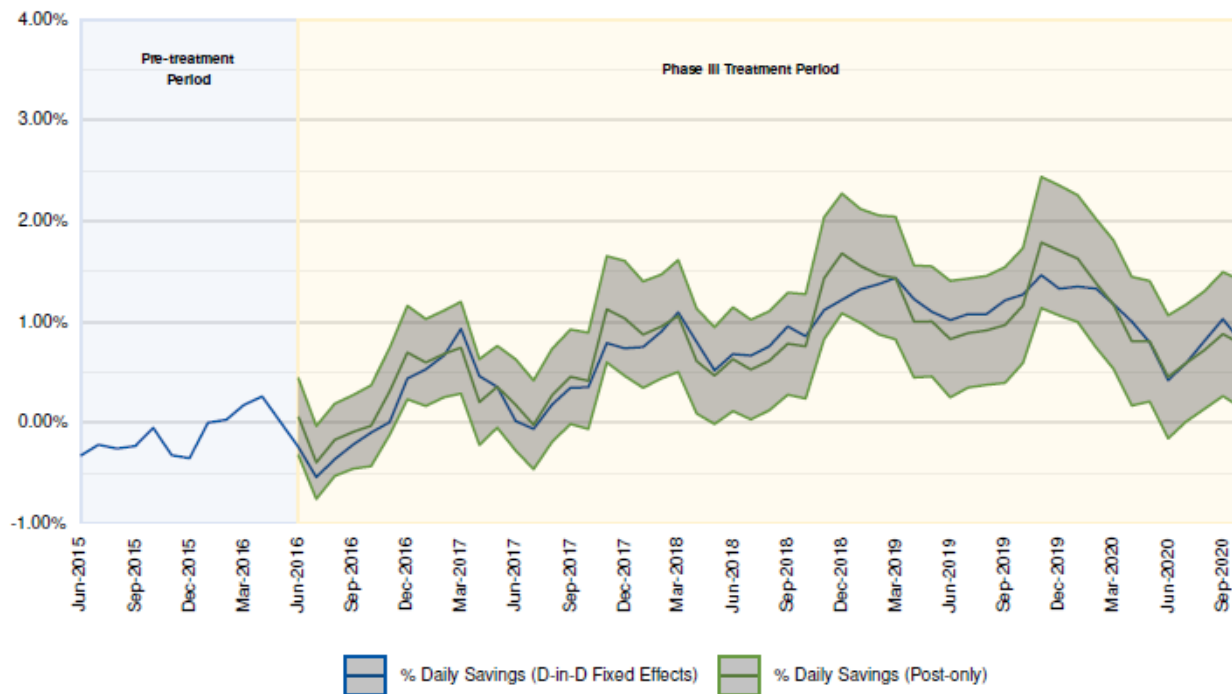


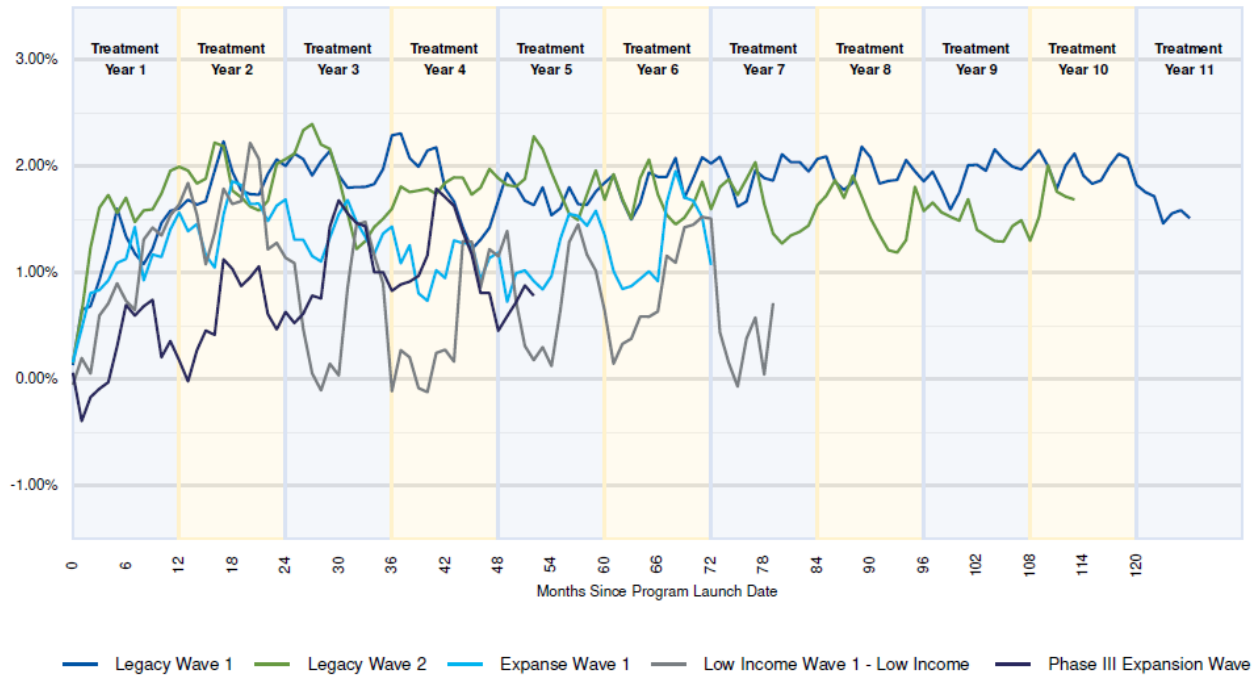
Figure C-5 shows the percentage daily savings by month for the Phase III Expansion Wave. The monthly percentage daily savings have increased throughout Phase III. Savings did appear to start going down in the last months of Phase III after customers stopped receiving home energy reports.

Figure C-5. Percentage Monthly Savings across Time: Phase III Expansion Wave 1



To compare how savings trended since treatment started across waves, Figure C-6 shows percentage daily savings by the number of months since first treatment for each wave. The first waves had the highest savings, likely due to the implementer picking customers with the highest expected savings for these waves. For all of the waves there is seasonal variation, likely driven by differences in weather. The newer waves appeared to have more seasonal variation in savings. Across all of the waves savings generally ramped up in the first 12 – 24 months, and then achieved a steady state.

Figure C-6. Percentage Average Monthly Savings from First Month of Treatment



Demand Reduction Evaluation Methodology

To estimate demand savings for the Home Energy Education Program, Cadmus converted each wave's PY12 average energy savings into demand reductions by multiplying the average energy savings per treatment group customer per hour in PY12 by the ratio of average peak demand savings per customer to the average energy savings per customer per hour from the PY4 evaluation.

Cadmus estimated average peak demand savings per treatment group customer of 0.041 kWh/hr for Legacy Wave 1 and 0.056 kWh/hr for Legacy Wave 2, which were equal to 193% for Legacy Wave 1 and 108% of Legacy Wave 2 of the average hourly energy savings per customer. Cadmus used the weighted average¹¹⁷ of these ratios (148%) to convert PY12 program energy savings estimates into demand reduction estimates, assuming the ratios stayed constant through time.

Note that the definition of peak demand changed between PY4 and PY12. In PY4, peak demand was calculated for the top 100 hours of PPL Electric Utilities' system demand. In PY12, peak hours are defined as the four consecutive hours with highest demand on days when day-ahead forecasts for the PJM market demand are 95% or more of the PJM peak summer demand 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 PY12, some customers who installed efficiency

¹¹⁷ The weighted average was based on the number of customers in Legacy Wave 1 and Legacy Wave 2.

products because of the 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 PY12. 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 generated by the Home Energy Education Program, Cadmus subtracted cross-participation savings from the program savings, as recommended by the Statewide Evaluator. 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 PY12.¹¹⁸

Home Energy Education Program treatment and control customers participated in 9 downstream PPL Electric Utilities rebate programs from PY2 through PY12. These were the Appliance Recycling Program, Energy Efficiency Kits and Education Program,¹¹⁹ Energy Efficient Home Program, Low-Income WRAP, Non-Residential Energy Efficiency Program, Renewable Energy Program, Residential Energy Assessment

¹¹⁸ 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.

¹¹⁹ Formerly named the E-Power Wise Program.

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.

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 PY10, 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-5 shows the PY12 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.

Table C-5. 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	Phase III Expansion Wave 1
Appliance Recycling	0.42 34.93%	-0.23 -19.00%	0.61 77.41%	0.1 6.36%	-0.27 -19.51%
Energy Efficient Home	-0.37 -5.36%	0.23 3.04%	-0.05 -0.75%	-0.6 -26.26%	0.16 2.77%
Low-Income WRAP	0.16 55.32%	-0.06 -17.01%	0.04 16.43%	0.1 0.74%	0.11 34.15%

C.1.5 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,¹²⁰ Cadmus followed these steps to estimate uplift savings from downstream programs:

1. Match the program tracking data for each program year to the treatment and control customers by a unique identifier

¹²⁰ 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. Final version May 8, 2018. See Behavior Section 6.1.1.8.

2. Assign each transaction to a month based on the participation date field in the tracking data
3. Exclude any installations that occurred prior to the customer being assigned to the treatment or control group
4. Calculate the average monthly electricity savings of each efficient product installed by a Home Energy Education Program customer, proportioned across months by the accrued HDDs and CDDs 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. Sum the monthly average savings, by customer, for all products installed prior to a given month through the end of PY12. Cadmus incorporated customer inactive dates and measure lives of products when aggregating monthly savings.
6. Calculate the average annual savings accrued per customer for the treatment and control groups during PY12
7. Calculate 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 PY12 yielded the estimate of total savings for the Home Energy Education Program from participation in other PPL Electric Utilities energy efficiency programs and counted by the other efficiency programs.

Table C-6. and Table C-7. show energy and demand savings uplift results for PY12 resulting from PPL Electric Utilities' downstream programs. The home energy reports increased energy and demand savings in other downstream programs by 1,012 MWh/yr and 0.36 MW/yr, about 7% and 6% of program total energy and demand savings.

Table C-6. PY12 Home Energy Education Downstream Uplift Energy 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	103	100	3	92	3%
Legacy Wave 2	114	105	38	309	6%
Expansion Wave 1	68	64	7	144	4%
Low-Income Wave 1	487	464	21	350	24%
Phase III Expansion Wave 1	54	49	17	116	11%
Program-Total ⁽¹⁾				1,012	7%
⁽¹⁾ May not match due to rounding.					

Table C-7. PY12 Home Energy Education Downstream Uplift Demand Savings Summary

Wave	Average Cross-Program Savings per Customer (kW/yr)			Total Uplift Savings (MW/yr)	Percent of Program Total Savings
	Treatment Group	Control Group	Difference		
Legacy Wave 1	0.063	0.062	0.000	0.013	1%
Legacy Wave 2	0.065	0.061	0.004	0.136	7%
Expansion Wave 1	0.038	0.036	0.002	0.072	5%
Low-Income Wave 1	0.063	0.059	0.004	0.063	25%
Phase III Expansion Wave 1	0.029	0.026	0.003	0.073	18%
Program Total ⁽¹⁾				0.358	6%
⁽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, as shown in Table C-8. and Table C-9.¹²¹ See *Appendix C.1.4 Uplift Analysis Methodology* for further details on the uplift analysis for upstream lighting.

Table C-8. PY11 Home Energy Education Upstream Lighting Uplift Energy Savings Summary

Stratum	Population Verified Savings (MWh/yr) ⁽¹⁾	Years in Program	Reduction Factor	Upstream Lighting Uplift (MWh/yr)
Legacy Wave 1	3,190	10.5	3.00%	95.71
Legacy Wave 2	4,795	9.5	3.00%	143.84
Expansion Wave 1	3,762	6	3.00%	112.87
Low-Income Wave 1	1,118	6.5	3.00%	33.53
Phase III Expansion Wave 1	907	4.5	3.00%	27.22
Program Total ⁽²⁾	13,772	N/A	N/A	413
⁽¹⁾ Savings are adjusted to remove downstream uplift.				
⁽²⁾ Total may not sum to all rows due to rounding.				

¹²¹ 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. Final version May 8, 2018.

Table C-9. PY11 Home Energy Education Upstream Lighting Uplift Demand Savings Summary

Stratum	Population Verified Savings (MW/yr) ⁽¹⁾	Years in Program	Reduction Factor	Upstream Lighting Uplift (MW/yr)
Legacy Wave 1	1.31	10.5	3.00%	0.04
Legacy Wave 2	1.92	9.5	3.00%	0.06
Expansion Wave 1	1.50	6	3.00%	0.05
Low-Income Wave 1 – Low-Income	0.18	6.5	3.00%	0.01
Low-Income Wave 1 - Residential	0.34	4.5	3.00%	0.01
Phase III Expansion Wave 1	5.26	N/A	N/A	0.16
Program Total ⁽²⁾	1.31	10.5	3.00%	0.04
⁽¹⁾ Savings were adjusted to remove downstream uplift.				
⁽²⁾ Total may not sum to all rows due to rounding.				

Cadmus deducted 262.43 MWh/yr and 0.03 MW/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 treatment groups in the low-income waves, distributed through the Phase II Residential Retail Program¹²². 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 PY12.

¹²² The LED giveaway provided free bulbs for treatment group participants in the original 2014 Low Income Wave and the discontinued 2015 low-income wave. Because treatment was discontinued for the 2015 low income wave and the 2014 Low Income wave was significantly reduced from its original size after identifying those that were still below 150% of the federal poverty limit, Cadmus prorated the LED giveaway savings based on the proportion of low-income customers still receiving treatment relative to all of the low-income customers that were eligible to receive bulbs in PY7.

Appendix D. Evaluation Detail – Efficient Equipment Program

D.1 Lighting

D.1.1 Impact Evaluation Sampling Approach - Lighting

Cadmus calculated an annual sample size for Efficient Equipment Lighting projects to meet evaluation requirements described in the Phase III Evaluation Framework.¹²³ The PY12 evaluation sampling plan was designed to meet 90% confidence and $\pm 10\%$ precision (90/10) for the lighting stratum because lighting is a high impact- measure, contributing 43% of savings to the Non-Residential Program and 34% of savings to the portfolio.

The Evaluation Framework requires evaluating all projects with *ex ante* annual savings greater than 750,000 kWh/yr. Cadmus evaluated all lighting projects (prescriptive and direct discount) below the threshold with a basic level of rigor and all lighting projects at or above the threshold with an enhanced level of rigor, as stipulated in the PA TRM.¹²⁴

Table D-1 shows the PY12 sampling plan by quarter for a final sample size of 43 projects.

Table D-1. PY12 Efficient Equipment Program Lighting Sampling Strategy

Quarter	Population Size (1)	Target Levels of Confidence & Precision	Target Sample Size (2)	Achieved Sample Size	Evaluation Activity
Q1	94	90/10	N/A	11	In-person and virtual site visits and desk reviews
Q2	122			10	
Q3	107			10	
Q4	135			11	
Q5	107	N/A		N/A	
Total	565	90/10	-	42	-

(1) Population size refers to the number of unique project job numbers.

(2) 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.

Cadmus used a stratified ratio estimation approach to sampling because it is more efficient than using simple random sampling and results in smaller sample sizes. Cadmus divided all lighting projects into four substrata: small, medium, large, and threshold. These boundaries were established by the substratum's contribution to total gross reported kWh/yr savings, following the methods in *Chapter 13: Sampling in The California Evaluation Framework*.¹²⁵ Cadmus determined the number of sample points,

¹²³ 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. Final version May 8, 2018.

¹²⁴ Table 1-2 in the PA TRM defines the thresholds for end-use categories that must be reviewed with enhanced levels of rigor.

¹²⁵ TecMarket Works. *The California Evaluation Framework*. 2004. Pages 368-371.

where a point was a job, for each stratum using a Neyman allocation routine that accounts for the variance in each stratum.¹²⁶

Table D-2 shows the substrata lighting boundaries for high- and low-energy savings by quarter. In all quarters, Cadmus verified the census of projects whose *ex ante* energy savings were greater than the 750,000 kWh/yr threshold, which require enhanced levels of rigor according to the PA TRM. In PY12, 24 of the 42 projects in the final verification sample were threshold lighting projects. This led to a larger evaluation sample than originally planned.

Table D-2. PY12 Quarterly Efficient Equipment Program Lighting Substrata Boundaries

Substratum	Q1		Q2		Q3		Q4	
	kWh /yr High	kWh/yr Low	kWh/yr High	kWh/yr Low	kWh/yr High	kWh/yr Low	kWh/yr High	kWh/yr Low
Small	65,008	326	98,157	896	263,533	604	119,619	1,117
Medium	240,519	66,896	268,377	99,387	654,271	281,151	401,373	132,660
Large	670,449	457,847	532,327	274,426	749,000	744,963	749,000	451,490
Threshold	3,962,957	750,000	N/A ⁽¹⁾	N/A ⁽¹⁾	1,758,556	750,000	1,365,363	750,000

⁽¹⁾ There were no threshold projects in quarter 2.

The PY12 lighting projects were post-stratified at the end of the program year into the final substrata shown in Table D-3. As shown in the breakdown of total participants and reported savings by final substratum, post-stratification conducted for the final analysis included all projects. Therefore, a project classified as small, for example, when received in Q1 could be reclassified in the post-stratification.

Table D-3. PY12 Efficient Equipment Program Lighting Post-Stratification

Substratum	kWh/yr High	kWh/yr Low	Reported Participants ⁽¹⁾	Reported Savings (MWh/yr)	Percentage Reported Savings
Small	66,219	0.00	109	7,580,289	9%
Medium	248,321	66,219	366	14,712,486	17%
Large	750,000	248,321	61	23,915,791	28%
Threshold	N/A	750,000	29	40,141,734	46%
Total ⁽²⁾	N/A	N/A	565	86,350,301	100%

⁽¹⁾ Defined by unique job number.
⁽²⁾ Total may not match sum of rows due to rounding.

D.1.2 Ex Post Verified Savings Methodology for Lighting

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

¹²⁶ 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.

D.1.3 Site Visit and Desk Review Findings – Lighting

Cadmus conducted virtual site visits and desk reviews for 42 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. Cadmus conducted measurement and verification activity for 24 of 29 threshold lighting projects for Q1 through Q4. One project could not be completed as the site contact declined a virtual site visit and four projects were not evaluated due to time constraints. Cadmus reviewed logger data files from lighting hours-of-use measurement devices and the ICSP's logger data analysis if the ICSP determined hours of use using metering. The results of this desk review were combined with the findings from site visits to determine the verified savings for each of the sampled projects.

If the ICSP's project documentation and logged or metered data for lighting operating hours were complete and accurate, Cadmus did not conduct a site visit. If the information in the project documentation and calculated energy savings could not be fully verified, Cadmus conducted a site visit.

Of the 24 threshold lighting projects, Cadmus conducted 23 desk reviews and one virtual site visits. Across the remaining strata, Cadmus conducted 13 desk reviews and five virtual site visits.

If a project had numerous records (approximately 20 or more) in the PA TRM Appendix C Lighting Audit and Design Tool for Commercial and Industrial Projects,¹²⁷ Cadmus selected and inspected a sample using 90/20 criteria for confidence and precision, according to the Phase III Evaluation Framework.¹²⁸ Cadmus also interviewed facility representatives to determine operating schedules and estimate lighting hours of use.

Verified savings incorporated site-specific and measure-specific data. Reasons for adjustments to the ICSP's reported data included corrections to the following:

- Annual lighting hours of use and associated coincidence factor calculated from metered logger data
- Fixture type and quantity
- Lighting control type
- Space cooling type
- Heating fuel type
- Fixture wattage

Overall, the adjustments made to the annual hours of use and coincidence factor were the most common adjustments to impact verified savings across the 42 projects. The number of remaining adjustments for lighting verified savings was minimal.

¹²⁷ The PA TRM Appendix C Lighting Audit & Design Tool was designed to document the pre- and post-installation cases of the lighting retrofit and facilitate calculation of energy and demand reductions for large lighting installations.

¹²⁸ Sampling to meet 90/20 within a facility is based on section 3.3.3.2.3 in the evaluation framework prepared for the 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. Final version May 8, 2018.

D.2 Equipment

D.2.1 Impact Evaluation Sampling Approach - Equipment

Cadmus evaluated all sampled equipment projects with a basic level of rigor, according to the Phase III Evaluation Framework.¹²⁹

The PY12 evaluation sampling plan was designed to meet levels of 85% confidence and 15% precision (85/15) for the equipment stratum. Cadmus first selected the projects with the largest savings from each stratum to ensure that a large percentage of the total savings were represented. Cadmus then drew a simple random sample from each substratum to fill the remaining sample target. The sites where these sampled projects were implemented were reviewed to determine if additional rebated equipment had been installed.

Cadmus reviewed the sample of 16 project records, which involved verifying information from the PPL Electric Utilities' tracking database using rebate applications, customer-submitted supporting documentation, and information recorded by the ICSP to calculate energy savings.

In PY12, Cadmus conducted two virtual site visits and fourteen desk reviews to verify 16 sampled projects. Table D-4 presents annual population and sample sizes by substrata.

Table D-4. PY12 Efficient Equipment Program Equipment Sampling Strategy

Substratum	Population Size ⁽¹⁾	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
HVAC	22	N/A ⁽²⁾	N/A ⁽²⁾	8	Virtual site visit, desk review ⁽³⁾
Motors	3			1	Virtual site visit
Refrigeration	26			6	Desk review
Other	1			1	Desk review
Equipment Total	51⁽⁴⁾	85/15	-	16	-
⁽¹⁾ Population size refers to the number of unique project job numbers per equipment type. ⁽²⁾ Sample size is determined at the program level and allocated to individual strata based on contribution to total component savings. ⁽³⁾ Cadmus verified one HVAC project through virtual site visit and the remaining through desk reviews and customer inputs. ⁽⁴⁾ One project was assigned to two different end uses (HVAC and Refrigeration) so is represented in each substratum.					

D.2.2 Ex Post Verified Savings Methodology for Equipment

The *ex post* savings incorporated installation rates, adjustments for nonqualifying equipment, and adjustments for equipment details determined through the sample of projects selected for desk reviews and in-person and virtual site visits. Cadmus verified eligibility and installation rates for all sampled records.

¹²⁹ Levels of rigor are described in the Section 3.3.2.2. 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. Final version May 8, 2018.

D.2.3 Site Visit and Desk Review Findings – Equipment

Cadmus completed virtual site visits and desk reviews for 16 unique customers who received rebates for 16 equipment projects. Cadmus verified the as-built conditions for each project and identified discrepancies in the data reported by the ICSP in the project file. Verified savings incorporated site-specific data. Reasons for adjustments to the ICSP’s reported data included corrections to the following:

- Equipment efficiency
- Facility square footage
- Baseline control type
- Equipment capacity

Overall, the factors that had the greatest impact on verified savings across the 16 projects were the equipment capacity and in-service rates, followed by reported facility type and equipment efficiency.

D.3 Net-to-Gross Ratio Sampling and Findings for Lighting and Equipment

Table D-5 lists the sampling strategy for the lighting and equipment strata.

Table D-5. PY12 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⁾
Lighting ⁽³⁾	Lighting projects	565 ⁽⁴⁾	0.5	85/15	69	260	61 ⁽⁵⁾	100%
Equipment	Equipment projects	51	0.5	85/15		18	5	100%
Total		616	-	-	69	278	66	100%

⁽¹⁾ Population refers to number of paid projects in PY12.

⁽²⁾ Sample frame is a list of contacts who have a chance to be selected into the sample. Percent contacted means the percentage of the sample frame called to complete surveys.

⁽³⁾ Prescriptive lighting and direct discount lighting were combined.

⁽⁴⁾ Combined population of prescriptive lighting and direct discount lighting participants.

⁽⁵⁾ Three respondents did not respond to free ridership questions and are not included in the NTG analysis.

D.3.1 Free Ridership

Cadmus summed the intention and influence components to estimate the total intention and influence method free ridership average by stratum, weighted by *ex post* gross kWh/yr savings. Table D-6 summarizes the intention, influence, and free ridership scores for each stratum. The savings weighted intention score found 31% of the equipment savings and 19% of the lighting stratum savings could be classified as free ridership. The savings-weighted average influence scores showed 6% of the equipment stratum savings and 9% of the lighting stratum savings could be classified as free ridership.

**Table D-6. Efficient Equipment Program
Intention, Influence, and Free Ridership Score by Stratum**

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
Lighting	61	19%	9%	28%
Equipment	5	31%	6%	37%

D.3.2 Spillover

The data collected through the surveys did not provide enough information to reliably quantify spillover in commercial settings; therefore, spillover is reported qualitatively.

Of the lighting stratum respondents, four purchased additional energy-efficient lighting, one purchased HVAC equipment, and one purchased variable speed drives after participating in the Efficient Equipment Program. All respondents credited factors related to PPL Electric Utilities as having some level of influence on their purchasing decisions.

None of the equipment stratum respondents purchased additional energy-efficient equipment after participating in the Efficient Equipment Program.

D.3.3 Net-to-Gross

Table D-7 shows the NTG ratio results for the equipment and lighting strata of the Efficient Equipment Program.

Table D-7. PY12 Efficient Equipment Program NTG Ratio Summary

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision
Lighting	61	28%	0%	0.72	16% ⁽¹⁾
Equipment	5	37%	0%	0.63	23% ⁽²⁾
⁽¹⁾ At 90% confidence interval.					
⁽²⁾ At 85% confidence interval.					

D.4 Survey Sample Attrition

After removing records from the participant population for the reasons cited in Table D-8, a census of participants were first invited to complete the survey via email. Respondents who did not complete the survey online received two email reminders and were then contacted by telephone to complete the survey. Table D-8 lists the total records used for surveys and the outcome (final disposition) of each record.

Table D-8. Efficient Equipment Program Participant Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Online	
Population (number of unique jobs)	616
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	338
Removed: incomplete or invalid email address	0
Survey Sample Frame (email invitations sent)	278
Email was returned (bounce back), did not respond, or opted-out	208
PPL Electric Utilities or market research employee	0
Cannot confirm project location	8
Completed Surveys	62
Online Response Rate	22%
Telephone	
Population (number of unique jobs)	616
Removed: Respondents who completed the survey online, partially completed the survey online, or could not confirm project location.	408
Survey Sample Frame (used for telephone survey calls)	208
Not attempted	0
Records Attempted	208
Not reached or screened out: No answer, answering machine, phone busy, refused, cannot confirm equipment/not aware of participation, employment, ESCO	201
Completed Surveys	7
Telephone Response Rate	3%
Total Completed Surveys (total for all modes)	69
Overall Response Rate	25%

Appendix E. Evaluation Detail – Midstream Lighting Program

E.1 Evaluation Post Stratification

Cadmus post-stratified the population for the Midstream Lighting component using the reported annual energy savings of each project and the distribution of all projects completed during PY12.

Table E-1 provides the definitions, population, and sample sizes for all strata.

Table E-1. PY12 Midstream Lighting Impact Evaluation Stratum Definitions and Sample Sizes

Stratum	Reported Annual Energy Savings (kWh)	Population Size ⁽¹⁾	Sample Size
Midstream Lighting – Small	7,176	4,787	17
Midstream Lighting – Medium	11,759	1,059	15
Midstream Lighting – Large	10,429	262	3
Midstream Lighting – Threshold (> 20kW) ⁽²⁾	3,981	31	4
Midstream Lighting – Convenience Sample ⁽³⁾	424	11	11
Midstream Lighting Total⁽⁴⁾	33,769	6,150	50

⁽¹⁾ Population size in this table refers to the number of unique combinations of distributor invoice numbers and account numbers in each stratum. In PY12, there were 7,503 job numbers in PPL Electric Utilities' tracking database corresponding to 6,150 unique combinations of distributor invoice numbers and account numbers.

⁽²⁾ The evaluation team defined a threshold of 20kW in demand reductions for a project to qualify for site visits.

⁽³⁾ This stratum was not limited by size of reported savings. The one verified return job was included in the same stratum as the original sale job.

⁽⁴⁾ May not match due to rounding.

Having projects with both exceptionally high variance in observed realization rates and disproportionately high savings was not typical in prior years. In PY12, adjusting the post-stratification boundaries to combine these projects with others resulted in lower precision because of the outsize impact on the average stratum-level realization rates. In turn, this increased the level of error for other projects in the strata. Additionally, because the realization rate is based on *ex post* adjustments, stratifying or sampling based on *ex ante* information would not have been able to anticipate this result.

E.1.1 Ex Post Verified Savings Methodology

Records Review

For the jobs sampled for the impact evaluation, Cadmus reviewed distributors' invoices submitted to PPL Electric Utilities and the ICSP as well as distributors' records of sales to the contractor or end-user purchaser, when available. Cadmus reviewed the technical specification of the reported installed equipment, confirmed the correct application of the IMP's baseline and efficient lighting pairing, and verified the hours of use for the building type.

Desk Review and Phone Interview

To calculate verified savings, Cadmus reviewed 35 projects and prepared a modified PA TRM Appendix C lighting calculator using information compiled during the records review and the phone verification interviews.

Cadmus used the desk review phone survey, approved by PPL Electric Utilities and the SWE, to verify the products installed. The site contact was either the customer or the contractor who purchased and installed the products for the customer. During the interview, Cadmus confirmed the contact was familiar with the incentivized purchase and the installed location and verified the quantity of the reported purchase, building type, hours of use, and space conditioning system with the data in PPL Electric Utilities' tracking database to the extent the respondent could provide this information. Cadmus also gathered information regarding the *in situ* baseline fixtures and lamps.

The modified Appendix C lighting calculator included columns to record the verified baseline and post-installation quantities, coincidence factors, hours of use, savings factors, interactive factors, and post-installation in-service rates. *Ex post* savings were calculated using verified quantities and the independent variables listed in the IMP, according to the methods detailed in the evaluation plan.

Site Visits

To calculate verified savings, Cadmus conducted four virtual site visits (comprising 23 jobs, including 16 sibling jobs). Due to COVID-19 restrictions, on-site visits were not possible in PY12.

At the site of each sampled job, Cadmus reviewed additional sibling jobs associated with the site address for that program year. These additional jobs sometimes included the same product and thus could not always be distinguished from the sampled record.

During the virtual site visits, Cadmus verified the building type and, when physical conditions and customer acceptance allowed, confirmed the independent variables used in the savings algorithms in the Midstream IMP. Cadmus used a modified PA TRM Appendix C tool to document the jobs reviewed and verified during the site visit, including the sampled and sibling jobs. The tool has columns to record the observed or participant reported *in situ* baseline fixtures and their wattages, observed baseline and post-installation quantities, evaluated coincidence factors, hours of use, savings factors, interactive factors, and post-installation in-service rates. *Ex post* savings were calculated using the observed and evaluated values for the independent variables listed in the Lighting Improvements for Midstream Delivery Programs IMP.

E.1.2 Verification Findings

In PY12, Cadmus conducted 50 virtual site visit and desk review verifications, for a total of 65 jobs in PPL Electric Utilities' tracking database. Cadmus adjusted reported savings calculation inputs based on verified conditions if they differed from the tracking database.

Table E-2 shows the frequency of various adjustments. A site can have multiple adjustments, which is why the total number of adjustments in this table is greater than the sample size. Also note that a single

site visit may have included the randomly sampled job and any siblings and may be represented multiple times with the same savings adjustment type.

**Table E-2. PY12 Midstream Lighting Verified Savings Adjustments Summary
Shown in Order of Frequency**

Savings Adjustment Type	Number of Adjusted Jobs	Percentage of Adjusted Jobs ⁽¹⁾	Primary Reason for Adjustment
Facility Type	47	72%	Not typically known by ICSP, default is Unknown/Misc.
Hours of Use	47	72%	Based on facility type (or hours of use schedule verified during virtual site visits).
Coincidence Factor	47	72%	Based on facility type.
Energy Interactive Factor	33	51%	Based on space conditioning and heating fuel, verified during site visit or desk review.
Demand Interactive Factor	28	43%	Based on space conditioning, verified during site visit or desk review.
Fixture Control Type	20	31%	Adjusted IMP defaults to match the verified control type (e.g., daylighting photosensors, timeclocks, occupancy sensors) for the space where equipment was installed.
Post-Install Lamp/Fixture Quantity	15	23%	Revised if Cadmus could not confirm installation of the lamps sold as part of the job, the lamps were intended as spares (and therefore put in storage), and/or the customer did not plan to install them before the end of the program evaluation period. The installation rate for the evaluation sample was 93%.
Post-Install Lamp/Fixture Wattage	11	17%	Reported values differed from tested and verified wattages documented by DesignLights Consortium (DLC). Half the adjustments were less than 1 watt due to rounding.
Baseline Lamp/Fixture Wattage	4	6%	Adjustments were all less than 1 watt due to rounding of reported IMP wattages.
Eligibility	5	8%	New construction or not DLC-qualified.
Pre-Install Lamp/Fixture Quantity	2	3%	Primarily due to de-lamping (fewer lamps installed than those replaced).
⁽¹⁾ Percentage of adjusted jobs is calculated based on the total of 65 sample job verifications.			

E.2 Process Details

E.2.1 Participant Profile

Distributors

The following is a summary of 12 participating distributors Cadmus interviewed:

- Seven distributors reported a multistate presence, and their self-reported estimates of sales to customers in PPL Electric Utilities' service territory varied widely.
- Six distributors said contractors or electricians made up the majority of their lighting sales.
- Three said end-user purchasers made up approximately 80% of their sales.
- Two said sales between contractors and end users was relatively equal.
- One said sales between contractors and energy service companies was relatively equal.

Contractors

The following describes interviewed contractors who purchased Midstream Lighting products (not all contractors answered all questions):

- Five of seven contractors had companies with 10 or fewer employees.
- Five of seven contractors served primarily commercial customers of various sizes with the remaining two serving both commercial and residential customers.

E.2.2 Survey Sample Attrition

In May through July 2021, Cadmus conducted telephone interviews with 12 distributors and eight contractors. Table E-3 lists total numbers of records and the outcome (final disposition) of each record.

Table E-3. PY12 Midstream Lighting Program Sample Attrition Table

Description of Call Outcomes	Number of Records	
	Distributors	Contractors
Telephone Interview		
Population (number of contact names) ⁽¹⁾	23	491
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, incomplete or invalid phone number	1	151
Interview Sample Frame (used for interview calls)	22	340
Not attempted	0	248
Records Attempted	22	92
Non-working number and wrong number	0	12
Refusal	0	8
No answer/answering machine/phone busy/non-specific or specific callback scheduled	10	64
Partial complete (not included in interview findings analysis)	0	0
Total Completed Surveys	12	8
Telephone response rate	52%	9%
⁽¹⁾ Number of contacts available at the time of the survey effort.		

Appendix F. Evaluation Detail – Custom Program

F.1 Evaluation Sampling Approach

For the Custom Program, a component of the Non-Residential Program, Cadmus defined projects in three strata:

- **Large stratum.** In PY8 through PY10, 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 this stratum, as determined by the ICSP or Cadmus. In PY11, the stratum boundary was revised to 2,000,000 kWh/yr. In PY12, this stratum had 17 projects.¹³⁰ Cadmus verified savings for all of these projects.
- **Small stratum.** Projects that were not classified as large or combined heat and power (CHP) were assigned to the small stratum. There were 101 small stratum records corresponding to 98 unique projects reported in PY12. Cadmus verified savings for a sample of 10 projects.
- **Combined heat and power (CHP) stratum.** All CHP projects were assigned to this stratum. One CHP project reported savings in PY12. Cadmus verified savings for this project.

As of May 31, 2021, nine large stratum projects had submitted applications but did not complete construction by the end of PY12. These projects were evaluated during PY12 but were not considered PY12 participants and are not included in this report. Many of these projects will probably be commissioned, reported, and evaluated in Phase IV.

Cadmus did not identify a high-interest stratum in PY12—that is, any projects that were not already selected into the large, small, or CHP strata—but one may be added in future program years. This stratum would include projects in which equipment or systems exhibit high uncertainty in system or equipment operation, calculated savings, or both. This stratum could include new or emerging technologies under consideration by PPL Electric Utilities and the ICSP for new offerings or approaches.

Cadmus evaluated all sampled projects, verifying savings at a high level of rigor, using approaches described in the International Performance Measurement and Verification Protocol (IPMVP). A discussion of the approach, by stratum, follows.

F.1.1 Large Stratum

The ICSP either calculated the initial savings or used estimated savings (called reserved savings) provided by the contractor to determine which projects were entered into the large stratum.¹³¹ The ICSP informed Cadmus of these projects during the application process.

¹³⁰ The large stratum population is 17 projects, and none had an incentive adjustment.

¹³¹ 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.

Calculation methodologies and verification approaches vary by project. Cadmus prepared the site -specific measurement and verification plan (SSMVP), typically in coordination with the ICSP, and conducted pre--installation site visits (often virtually) to gather baseline data for all large stratum projects except new construction (for which there was no existing condition).

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

Due to COVID-19 restrictions, in-person site visits were not always possible. For these projects, Cadmus captured metered data by shipping data loggers to the site and having the customer's on-site licensed electricians install the loggers. Cadmus joined through a virtual video call to verify that loggers were installed on the correct equipment and to gather other required parameters for savings calculations. In some instances, the customer provided photographic evidence and trend data.

In PY12, Cadmus verified savings for all large projects before the ICSP reported project savings.

F.1.2 Small Stratum

At the end of Q2 and the end of Q3, Cadmus randomly selected 10 projects (five in Q2, five in Q3) for the small stratum sample. Cadmus did not conduct pre-installation site visits because small stratum projects cannot be sampled until after equipment is installed and the incentive is paid. Cadmus prepared the SSMVP for each project then conducted post-installation site visits and calculated verified savings. However, due to COVID-19 restrictions, in-person site visits were not possible for some sampled small stratum projects in PY12.

Cadmus verified details of installation and operation through either on-site or phone interviews with customer representatives. These representatives also sent pictures of the installed equipment and, in some cases, provided recent trend data for parameters influencing savings calculations.

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

F.1.3 CHP Stratum

In PY12, the one CHP project with claimed savings was included in the evaluation sample. Cadmus prepared the SSMVP, in coordination with the ICSP, then conducted a post-installation site visit to verify equipment operated as designed. Data were collected for approximately 11 months to determine electricity generated by the CHP, parasitic loads, useful heat recovered from the CHP, and net gas usage (CHP gas consumption less gas usage offset by heat recovery). Typically, Cadmus conducts a regression analysis to compare CHP electric generation, useful heat recovered, and natural gas usage to any related independent variables (e.g., outside air temperature) then annualizes using a year of typical data (e.g., TMY3 weather data, average annual production) to determine first-year project savings.

In PY12, Cadmus conducted the post-installation inspection for the CHP project in a phone interview in the same way as for the large stratum. In PY12, Cadmus verified savings for this CHP project before the ICSP reported project savings.

The Custom Program cost-effectiveness calculations include the impacts on grid-supplied natural gas.

F.2 Realization Rate Findings

Cadmus found various reasons for the differences between *ex ante* and *ex post* savings, as detailed below.

Large stratum. There is no realization rate discrepancy in the large stratum. Projects in this stratum are evaluated prior to being reported, so *ex ante* savings are typically equal to *ex post* savings. The ICSP has the option of reporting *ex ante* savings prior to the conclusion of evaluation activities. This might be done to accelerate payment of the incentive. This has been done occasionally in prior program years but was not done in PY12.

Small stratum. For projects in the small stratum, the ICSP's and Cadmus' savings methodologies differed depending on the information available, customer data trending capabilities, the ratio of estimated savings to overall customer usage, and Cadmus' ability to deploy logging equipment. Cadmus noted the following sources for discrepancies in realization rates in small stratum projects:

- In most cases, the ICSP had collected metering or trend data and based the reported savings on these data. Reported savings were typically not based solely on engineering calculations. For all of these projects, Cadmus conducted an independent analysis of the data by changing the form of regressions, adjusting the power factor or voltage assumptions, or applying more extensive analysis of metering data outliers.
 - For one project, energy savings were reduced by 38%, and for two additional projects savings were reduced by 25% and 29%.
 - For three projects, energy savings increased by more than 50%, and for two additional projects savings increased by 22% and 26%.
 - For the remaining projects in the sample, energy savings were largely unchanged.
- For one project, Cadmus collected additional post-installation metering or utility data. These expanded datasets resulted in a large difference between the reported and verified savings. The realization rate for this project was 75% (25% reduction in savings versus reported).
- A single project is responsible for 68% of the difference between the verified and reported kWh/yr savings. It is unusual for a project with savings of this magnitude to be included in the small stratum. The high realization rate combined with the very large savings created the unusually large impact of this single project on the small stratum realization rate. The *ex ante* approach was correct, but Cadmus could not collect post-installation data due to pandemic-related restrictions. Cadmus found that the difference between the reserved and *ex post* savings was due to several changes to the *ex ante* analysis of the data.

CHP stratum. There is no realization rate discrepancy in the CHP stratum. Projects in this stratum are evaluated prior to being reported, so *ex ante* savings are equal to *ex post* savings.

F.3 Net-to-Gross Ratio Findings

Cadmus summed the intention and influence components of the net savings algorithm to estimate the free ridership average, weighted by *ex post* gross program savings. Table F-1 summarizes the intention, influence, and free ridership score.

Table F-1. PY12 Custom Program Intention, Influence, and Free Ridership Scores

n	Intention Score	Influence Score	Free Ridership Score
13	30%	9%	39%

For the four largest projects of the survey respondents in PY12, the savings-weighted free ridership score was 38%. These four projects represented 76% of the analysis sample's verified savings,¹³² and they accounted for 30 percentage points of the program-level free ridership estimate of 39%. Table F-2 lists the sector for the four projects with the largest verified savings.

Table F-2. PY12 Custom Program Free Ridership for Four 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
GNE/Large	4,261,868	24%	6%	25%
Large C&I/Large	3,754,804	21%	5%	63%
Small C&I/Large	3,370,542	19%	5%	38%
GNE/Large	2,454,743	14%	4%	25%
Total ⁽¹⁾	13,841,957	76%	20%	38% ⁽²⁾
⁽¹⁾ Total may not match due to rounding.				
⁽²⁾ Weighted by verified kWh/yr savings. Relative precision at 85% confidence is 29%.				

F.4 Survey Participant Profile

This section provides a profile of all customers who participated in the Custom Program and summarizes the firmographics of survey respondents included in the process evaluation (n=12). Not all survey questions were answered by all respondents, so totals for each question may differ. Table F-3 shows the sectors represented in the survey population and in the full participant population.

¹³² The four largest projects in the analysis sample represented 71% of the verified savings for the Custom Program population.

Table F-3. PY12 Custom Program Sector Breakdown

Sector	Total Population (n=79)	Survey Respondents (n=12)
Large	24%	17%
Small	54%	42%
GNE	20%	42%
Source: PPL Electric Utilities' tracking database and survey question; may not total 100% due to rounding.		

More than three-quarters of survey respondents (83%; n=12) said they had previously participated in the Custom component of the Non-Residential Energy Efficiency Program before PY12.

Seven of 12 survey respondents said their facilities were 100,000 square feet or more. Eight of 12 respondents said their facility had 100 employees or more.

Table F-4 shows the types of facilities by Custom Program participants and by survey respondents. Most of the total population and most survey respondents were from the manufacturing segment.

Table F-4. PY12 Facility Types of Custom Program Participants and Survey Respondents

Facility Use	Total Population (n=79) ⁽¹⁾	Survey Respondents (n=12) ⁽²⁾
Manufacturing	27%	17%
Grocery – supermarket or convenience store	24%	0%
Education	13%	17%
Dining	8%	0%
Agriculture	5%	0%
Office	5%	8%
Hospital or healthcare	2%	17%
Retail	1%	8%
Warehouse	1%	0%
Motion picture theater	1%	0%
Lodging	1%	8%
Other ⁽³⁾	11%	25%
⁽¹⁾ Source: PPL Electric Utilities tracking database. Total may not sum to 100% due to rounding.		
⁽²⁾ Source: Survey question, "What is the primary use of your facility?" Totals may not total 100% because of rounding.		
⁽³⁾ Other responses included a poultry facility, greenhouse facility, and energy management facility		

F.4.1 Survey Sample Attrition

Cadmus conducted online and telephone surveys, reaching out to all PY12 participants in February 2021 (Q1 and Q2 participants) and in August 2021 (Q3 and Q4 participants).

Cadmus' cleaning and survey sample preparation process reduced the available sample from 79 to 37. Additional information is found in *Appendix N Survey Methodology*.

Table F-5 lists the total records used for surveys and the outcome (final disposition) of each record.

Table F-5. PY12 Custom Program Participant Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Online	
Population	79
Removed: duplicate, inactive customer, completed survey in past 3 months, on opt out list, duplicate contact, on do not contact list, incomplete or invalid email address, no savings in PY12 (incentive adjustment)	42
Survey Sample Frame (email invitations sent)	37
Email was returned (bounce back), did not respond, opted out, or did not complete survey	30
Ineligible: PPL Electric Utilities employee/cannot confirm project location	1
Completed Surveys	6
Online Response Rate	16%
Telephone	
Population	79
Removed: duplicate, inactive customer, completed survey in past 3 months, on opt-out list, duplicate contact, on do not contact list, incomplete or invalid phone number, no savings in PY12 (incentive adjustment)	42
Completed online survey or was ineligible	7
Survey Sample Frame (used for telephone survey calls)	30
Not attempted	0
Records Attempted	30
Not reached: no answer, answering machine, phone busy, refused	20
Ineligible: cannot confirm equipment/not aware of participation, employment, ESCO	3
Partial complete (not included in survey findings analysis)	1
Completed Surveys	6
Telephone Response Rate	20%
Total Completed Surveys (total for all modes)	12
Overall Response Rate (for both modes)	32%

Appendix G. Evaluation Detail – Energy Efficient Home Program

G.1 Ex Post Savings Calculation

In PY12, Cadmus used the same approach as in previous years to evaluate savings for the upstream and downstream components of the Energy Efficient Home Program. In the sampling approach, each individual product and service represented a stratum and program components represented a stratum group. The Audit and Kits stratum group contains two components—the in-home energy audits and the online home energy assessment, both of which include energy-savings kits. All other components (Weatherization, Efficient Equipment, the Online Marketplace, and New Homes) each represent their own stratum group.

G.1.1 Audits and Kits, Weatherization, Efficient Equipment, and Online Marketplace

Cadmus calculated *ex post* savings for each stratum group by building up from the individual measures (strata) within the stratum group, using one of two methods. For most strata, Cadmus conducted a database review to calculate the *ex post* savings for each project. For these, Cadmus calculated the realization rate as the total *ex post* savings divided by the total *ex ante* (reported) savings. The second method, applied to four Efficient Equipment strata, involved conducting a records review and participant survey to calculate a realization rate for a sample of records; this realization rate was then applied to the total *ex ante* savings to calculate total *ex post* savings.

Next, Cadmus summed the stratum total *ex post* savings to derive the stratum group *ex post* savings, then summed these savings to calculate the program total *ex post* savings. Cadmus calculated the program realization rate by dividing the program total *ex post* savings by the program total *ex ante* savings.

For PY12, Cadmus included one extra step for the Online Marketplace component. Unlike other components, if a customer returns the products purchased through the Online Marketplace, the rebate is returned to the program and the sale is essentially erased, from a savings impact and cost standpoint. Beginning in PY12, these returns appear in PPL Electric Utilities' participant tracking database as negative quantities and savings. Cadmus evaluated these PY12 returns as reported, so that the return records cancel out the corresponding PY12 purchase.

G.1.2 New Homes

Sampling

Cadmus verified savings for a sample of 19 homes of the 1,491 unique projects in the New Homes component. All 19 were single-family homes.

Due to COVID-19, the original evaluation plan for PY12 was modified to recruit HERS raters to collect and share data on lighting, appliances, and mechanical systems as they were rating the homes instead of

sending Cadmus technicians on site. Cadmus offered a stipend to the HERS raters for collecting the additional data and photos. HERS raters provided data for 10 homes.

After reassessing the challenges of collecting data via HERS raters along with the COVID-19 situation at the time, Cadmus decided to have Cadmus technicians perform the rest of the site visits in person in late May. To satisfy the health and safety concerns of PPL Electric Utilities, the ICSP, and Cadmus, the site visits were performed only at unoccupied homes to avoid any indoor interactions with customers. These homes had recently been rated or were about to be rated. This approach, along with the traveling logistics of the site visits, affected which homes could be included in the sample. Cadmus conducted nine site visits, for a total sample size of 19 homes.

Impact Analysis Methodology

Cadmus used a review of the REM/Rate models, data collected from PY12 site visits, and HERS rater documentation to calculate *ex post* savings for the 19 homes sampled in PY12. The verified *ex post* savings is the sum of all weather-sensitive and non-weather-sensitive savings calculated and verified by Cadmus.

Cadmus calculated savings associated with non-weather-sensitive equipment (heat pump water heaters, refrigerators, dishwashers, clothes washers, clothes dryers, and lighting) according to the algorithms in the PA TRM. For these equipment types, Cadmus used data collected during site visits and HERS rater documentation to identify the algorithm inputs needed for energy savings and demand reductions. Cadmus calculated savings only for the ENERGY STAR appliances that were on site at the time the home was rated. Only the lamps found in the ENERGY STAR Qualified Products List (QPL) were considered eligible to claim savings. Cadmus used information listed in the QPL to identify the correct baseline wattages from Tables 2-2, 2-3, and 2-4 in the PA TRM.

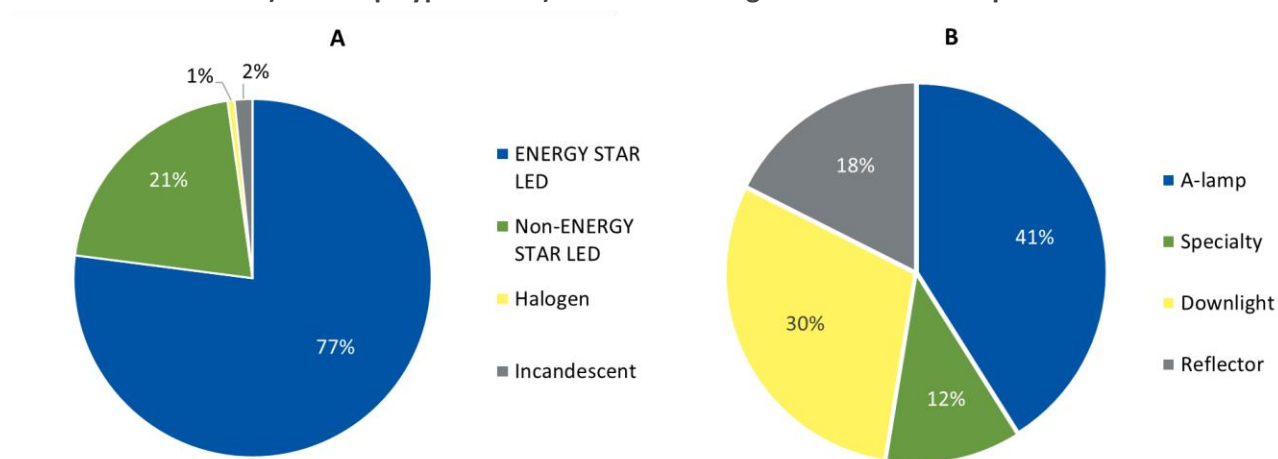
For weather-sensitive measures, Cadmus examined the REM/Rate files and *ex ante* savings provided by the ICSP's subcontractor to determine if inputs to the simulations and savings were reasonable. Cadmus used REM/Rate version 16.0 and incorporated the built-in baseline reference home that RESNET specifically designed for PPL Electric Utilities' New Homes component.

The ICSP reports whole-home energy savings and peak demand reductions for the New Homes component directly from the REM/Rate software output that HERS raters use to verify that a home meets program requirements. The model calculates energy and peak demand reductions for all components of the home; however, the methods and equations used by REM/Rate differ from the PA TRM for most components.

Discrepancies between the *ex ante* and *ex post* lighting savings are caused by different calculation methods. REM/Rate uses the equations in ANSI/RESNET/ICC 301-2014 Addendum G-2018 to calculate savings associated with residential lighting. These equations differ from the PA TRM in that they are based on the square footage of the home and they do not differentiate between various bulb types. The PA TRM calculates residential lighting savings individually for each bulb, and the baseline wattage is dependent on the bulb type and lumen rating. Cadmus found that over half of the ENERGY STAR bulbs in the sample homes were downlights, reflectors, or EISA-exempt specialty bulbs, all of which are assigned

baseline wattages significantly higher than their respective energy-efficient wattages. When residential lighting savings are calculated according to the PA TRM, this difference in wattage results in greater savings. The bulb mix of the PY12 verified homes can be found in Figure G-1.

**Figure G-1. Lighting Mix in PY12 Sampled Homes:
A) All Lamp Types and B) Bulb Mix Among ENERGY STAR Lamps**



Source: PY12 site visits and HERS rater documentation (n=19)

G.2 In-Service Rates

In PY12, Cadmus used participant survey data to calculate ISRs for high-volume products in the Online Marketplace component. Cadmus contacted all eligible Online Marketplace participants from Q1 through Q4 for an online survey and received responses for five of the six measures with reported participation. Occupancy sensors was the only product for which no participants responded. Night lights and holiday string lights had no participation in PY12. Cadmus removed any respondents who had returned their product to separate the impacts of product returns from the ISR analysis.

To assess the ISR for bulbs, smart thermostats, and smart strips, the online survey asked for the number of purchased items currently installed. The ISR for these measures was based on the number of units installed divided by the total units purchased by respondents.

For weatherstripping, the survey asked for the portion of the package installed (all, three quarters, half, one quarter, or none). Cadmus used these estimated quantities and the linear feet of the specific product purchased by the respondent to determine total linear feet installed and total linear feet purchased. Because the sample for weatherstripping was very small (four respondents), Cadmus combined the sample with the PY11 sample and calculated the ISR for the two-year period.

Table G-1 shows the sample size (number of rebated items or linear feet) for each measure and the calculated ISR.

Table G-1. PY12 ISRs for High-Volume Online Marketplace Measures

Online Marketplace Measure	N (Measure Quantity)	PY12 Evaluated ISRs
Lighting ⁽¹⁾	99	87%
Smart thermostats	30	83%
Weatherstripping	1,052 (linear ft)	59%
Smart strips	10	77%
Dehumidifiers	18	90%
⁽¹⁾ Represents first-year installation only; not adjusted to account for installation of stored bulbs in later years. Does not include holiday string lights or night lights.		

G.3 Survey Participant Profile

The PY12 customer surveys collected demographic information about Energy Efficient Home Program participants.¹³³ The majority of respondents had the following characteristics:

- Lived in a single-family detached residence (84%; 599 of 710)
- Had an average household size of 2.3 people (n=680)
- Averaged 61 years of age (n=633)
- Had completed some college education or more (78%; 540 of 695)
- Had an annual household income of \$50,000 or greater (74%; 390 of 528)

G.3.1 Survey Sample Attrition

Table G-2 lists total numbers of records contacted via online survey and the outcome (final disposition) of each record. Additional details on the survey methodology are in *Appendix N. Survey Methodology*.

¹³³ Includes data on Online Marketplace, Efficient Equipment, Audit and Kit (online assessments and in-home audits), and Weatherization components.

Table G-2. Energy Efficient Home Sample Attrition Table

Contract Outcome Description	Number of Records				
	In-Home Audit (Q1-Q4)	Online Assessment (Q1-Q2)	Weatherization (Q1-Q4)	Equipment (Q1-Q4)	Online Marketplace (Q1-Q4)
Population (number of unique jobs)⁽¹⁾	120	2,424	588	6,806	898
Removed: inactive customer, completed survey in past three months, on “opt out” list, selected for a different survey, duplicate contact, on “do not contact” list	5	228	89	1,300	215
Incomplete or invalid email address	8	0	62	328	0
Survey Sample Frame (email invitations sent)	107	2,196	437	5,178	683
Email was returned (bounce back), did not respond, opted-out, or did not complete survey	96	2,023	396	4,692	605
PPL Electric Utilities or market research employee	0	5	1	27	9
Cannot confirm equipment/not aware of participation	0	10	0	10	5
Completed Surveys	10	154	38	449	63
Response Rate	9%	7%	9%	9%	9%
⁽¹⁾ Number of rebates recorded in PPL Electric Utilities’ tracking database at the time of the final survey effort.					

G.4 Net-to-Gross Ratio Findings

For NTG in PY12, Cadmus surveyed only the DHP, ASHP, HPWH, and smart thermostat equipment categories in the Efficient Equipment stratum group. These equipment categories were high-impact measures in PY12 and were sampled at 85% confidence and 15% precision (85/15).

Cadmus summed the *ex post* gross program savings weighted intention and influence components of the net savings algorithm to estimate the free ridership average for a stratum. Table G-3 summarizes the intention, influence, and free ridership score for the Efficient Equipment stratum group’s DHP, ASHP, HPWH, and smart thermostat equipment categories and for the New Homes stratum group. Interviews for the New Homes stratum group were performed in PY11 and are being reported for the first time in net savings calculations in PY12 because PY11 savings were verified in PY12. Free ridership for New Homes was particularly high. Cadmus attributes this to the fact that Pennsylvania adopted a new residential energy code in 2018¹³⁴ and many builders were already building more efficiently as required by code. The program continued to use the 2009 International Energy Conservation Code (IECC) as the baseline, which was consistent with the PA TRM.

¹³⁴ The updated energy code, 2015 International Energy Conservation Code (IECC) with Amendments, went into effect in October 2018.

**Table G-3. PY12 Energy Efficient Home Program
Intention, Influence, and Free Ridership Scores by Stratum**

Stratum	n	Intention Score	Influence Score	Free Ridership Score	Relative Precision at 85% C.L.
Efficient Equipment - DHP	91	34%	20%	62%	11%
Efficient Equipment - ASHP	40	34%	20%	54%	13%
Efficient Equipment - HPWH	39	17%	6%	23%	30%
Efficient Equipment - Smart Thermostat	48	27%	16%	43%	25%
New Homes ⁽¹⁾	11	49%	35%	84%	12%
⁽¹⁾ PY11 savings were verified in PY12. PY11 NTG results are applied to PY12 verified gross savings. PY11 NTG results were not reported in the PY11 evaluation.					

Table G-4 lists the quantity of spillover energy-efficient equipment types that the respondents for the PY12 DHP, ASHP, HPWH, and smart thermostat equipment categories attributed to PPL Electric Utilities. The table also lists the per-unit energy savings and source of the estimated energy savings used in the spillover analyses.

**Table G-4. Energy Efficient Home Program Spillover Products and Savings
for DHP, ASHP, HPWH, and Smart Thermostat Equipment Categories**

Spillover Product	Equipment (DHP, ASHP, HPWH, Smart Thermostat) Respondent Quantity	Per-Unit Savings (kWh/yr)	Savings Source
Air Conditioning Equipment	3 ⁽¹⁾	256.1	PY12 PPL Electric Utilities Gross Verified Savings
Air Source Heat Pump	1	550.5	PY12 PPL Electric Utilities Gross Verified Savings
Clothes Dryer	1	25.1	PA TRM
Clothes Washer	5 ⁽²⁾	48.7	PA TRM
Dishwasher	8 ⁽³⁾	40.8	PA TRM
Freezer	3 ⁽¹⁾	22.0	PA TRM
Heat Pump Water Heater	1	1,756.5	PY12 PPL Electric Utilities Gross Verified Savings
Refrigerator	7 ⁽²⁾	56.4	PY12 PPL Electric Utilities Gross Verified Savings
Variable Speed Pool Pump	1	1,412.1	PY12 PPL Electric Utilities Gross Verified Savings
⁽¹⁾ 50% of per-unit savings kWh/yr applied to one unit due to a maximum PPL Electric Utilities influence rating of three, on a 1 to 5 scale, with 1 meaning "not at all influential" and 5 meaning "extremely influential."			
⁽²⁾ 50% of per-unit savings kWh/yr applied to two units due to a maximum PPL Electric Utilities influence rating of three.			
⁽³⁾ 50% of per-unit savings kWh/yr applied to three units due to a maximum PPL Electric Utilities influence rating of three.			

Table G-5 shows the spillover results for the PY12 DHP, ASHP, HPWH, and smart thermostat equipment categories of the Efficient Equipment stratum group of the Energy Efficient Home Program.

Table G-5. Energy Efficient Home Program Spillover Calculation for DHP, ASHP, HPWH, and Smart Thermostat Equipment Categories

Variable	Variable Description	Equipment (DHP, ASHP, HPWH, Smart Thermostat)	Source
A	Survey Sample Size (n)	218	Survey Data
B	Total Survey Sample Spillover kWh/yr Savings	5,238	Survey Data/Engineering Estimates
C	Average SO kWh/yr Savings Per Survey Respondent	24.0	Variable B ÷ Variable A
D	Program Participant Population	4,631 ^[1]	Program Tracking Data
E	SO kWh/yr Savings Extrapolated to the Participant Population	111,265	Variable C × Variable D
F	Evaluated Program Population kWh/yr Savings	15,536,119	Evaluated Gross Impact Analysis
G	Spillover Percentage Estimate	1%	Variable E ÷ Variable F
^[1] 4,631 unique participants.			

Appendix H. Evaluation Detail – Winter Relief Assistance Program

H.1 Job Type Definitions and Verification References

H.1.1 Baseload Job Type

Baseload jobs require no additional qualifications beyond the general Winter Relief Assistance Program (WRAP) income-eligibility requirements. In general, baseload customers have non-electric heating and a non-electric water heater.¹³⁵ Table H-1 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.

Table H-1. PY12 Baseload Items for Winter Relief Assistance Program

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 Advanced Power 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
Furnace Whistle ⁽¹⁾	Furnace Whistle – Section 2.2.7
⁽¹⁾ Cooling only; a furnace whistle with electric heating is a full-cost item.	

H.1.2 Low-Cost Job Type

Homes with electrically heated water qualify for low-cost jobs. Low-cost jobs are eligible for the items in Table H-2 and all items offered to baseload job types.

Table H-2. PY12 Low-Cost Items for Winter Relief Assistance Program

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

¹³⁵ If a customer had an electric water heater but refused water heater products, the customer was categorized as a baseload customer.

H.2 Energy Education and Behavior Savings

Cadmus evaluated the impacts of electric consumption associated with behavior changes by participants in the program using calculations derived from a combination of engineering estimates, secondary research, and survey data. Cadmus selected three behavioral recommendations—adjust thermostats, wash clothes in cold water, and take shorter or fewer showers—that reasonably corresponded to energy-saving activities in the PA TRM.

H.2.1 Adjust Thermostat for Heating and Cooling Season

Cadmus assumed that participants who adjusted their thermostats saved energy similar to savings from a programmable thermostat and applied the PA TRM’s algorithms accordingly.¹³⁶

H.2.2 Wash More Loads of Laundry in Cold Water

Cadmus estimated the energy savings from participants washing clothes in cold water in two steps:

1. Estimated the energy usage of a clothes washer (using algorithms from the PA TRM)¹³⁷
2. Weighted the results based on WRAP PY12 survey results

H.2.3 Take 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 (the weighted flow rate for WRAP participants), then added a term to subtract the energy education recommendation for shower length from the default.¹³⁸

H.3 Participant Counts

Cadmus used the unique utility account number as the participant. During the review of extracts from the PPL Electric Utilities’ tracking database, Cadmus found that seven accounts had baseload and low-cost jobs. These seven accounts initially received only baseload measures then later received low-cost measures. Thus, the account numbers were reported in both job types, but Cadmus trued up the results so each account number was reported in one stratum. Table H-3 presents participation counts for WRAP in PY12.

¹³⁶ Pennsylvania Public Utility Commission. *Technical Reference Manual*. June 2016, Errata Update February 2017. Section 2.2.8.

¹³⁷ 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.

¹³⁸ 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 H-3. PY12 WRAP Participant Counts

WRAP Job Type	Accounts	Reported Participants	Difference	Notes
Baseload	2,886	2,879	7	Seven accounts initially received only baseload measures, but later received low-cost measures.
Low-Cost	2,500	2,500	0	
Program Total	5,386 ⁽¹⁾	5,379 ⁽²⁾	7	
⁽¹⁾ The total is the sum of unique accounts in the baseload stratum and low-cost stratum.				
⁽²⁾ The reported participants represent the unique accounts in the program.				

H.4 Records Review Findings

Findings from Cadmus’ review of records are shown in Table H-4. These findings, along with ISRs of products and energy education savings, are the reasons for differences between reported and verified savings.

Table H-4. PY12 WRAP Record Review Findings

Product	Finding	Number of Jobs	Effect on Savings
LEDs	Used the correct waste heat factors (WHFs) associated with gas heating or exterior bulbs	36	Increase
	Updated baseline from deemed values in TRM to 45 lumens/watt for non-exempt bulbs	44	Increase
	Updated hours of use and coincidence factors (CFs) from overall household to those of specific rooms listed in the record reviews	1	Increase
	LED bulb reported in PPL Electric Utilities’ tracking database but not recorded in audit records	1	Decrease
Tier 2 Smart Strips	Smart strip installed in entertainment center with less than three devices plugged in	14	Decrease
	Multiple smart strips installed in multiple entertainment centers, but listed number of devices plugged into only one of the smart strips; derated other smart strip to unknown because unlikely multiple entertainment centers have three or more devices plugged into them	1	Decrease
Showerheads	Row house or manufactured home mapped to multifamily house	2	Decrease
Bathroom Aerators	Row house or manufactured home mapped to multifamily house	2	Increase
Kitchen Aerators	Row house or manufactured home mapped to multifamily house	2	Decrease

H.5 Energy Education Savings Analysis Findings

Table H-5 shows energy-savings recommendations considered in estimating energy education savings, behavioral element that education could change, PA TRM reference, WRAP participant survey results, and per-unit energy savings and demand reductions in each half of the year. The estimate for per-household verified energy education savings is 75.55 kWh/yr in PY12 Q1-Q2 and 128.74 kWh/yr in PY12 Q3-Q4.

The *ex ante* assumption was 160 kWh/yr. Verified savings were lower than the *ex ante* savings.

Table H-5 shows that the main driver in the energy education savings was *adjust thermostats in the winter*. In PY12 Q1-Q2, 31% of survey respondents said they lowered their thermostat temperature in the winter. In PY12 Q3-Q4, 55% of survey respondents said they lowered their thermostat in the winter.

Table H-5. WRAP Verified Energy Education Savings and Assumptions Summary Table

Energy Savings Recommendation	Behavioral Assumption	PA TRM Reference	Ex Post Verified Savings			
			Q1-Q2		Q3-Q4	
			kWh/yr	kW	kWh/yr	kW
Adjust Thermostats – Summer	Participants lower their thermostat in winter and raise it in summer	Programmable Thermostats – Section 2.2.8	0.96	-	4.18	-
Adjust Thermostats – Winter			38.70	-	92.53	-
Wash Clothes in Cold Water	Participants increase number of loads of laundry they wash in cold water	Water Heater Temperature Setback – Section 2.3.6	22.83	0.002	27.30	0.002
Take Shorter Showers	Participants decrease duration of each shower	Low Flow Showerheads – Section 2.3.9	13.07	0.001	4.73	0.000
Total ⁽¹⁾			75.55	0.003	128.74	0.003

⁽¹⁾ Each component is summed to get the total. Total may not sum due to rounding.

Table H-6 shows the overall percentage change of WRAP participants who *take shorter showers* and *wash clothes in cold water*. Compared to adjusting thermostats, these behavior changes have more marginal savings; however, savings increase when a greater percentage of the WRAP survey population report taking action.

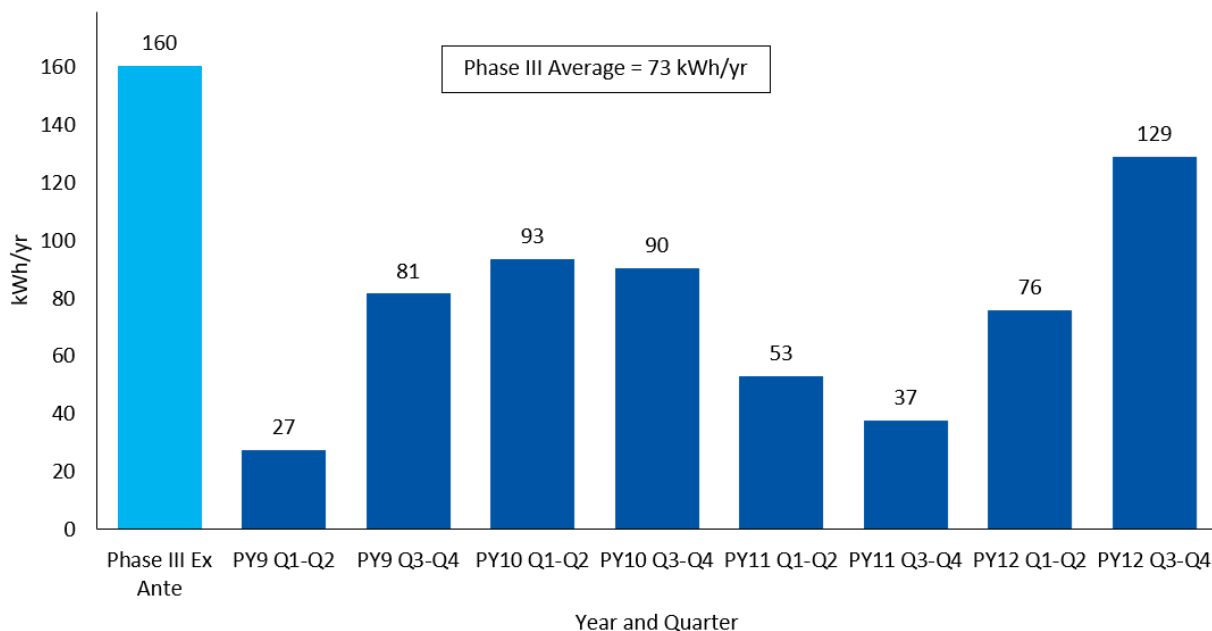
Table H-6. WRAP Calculation and Results of Energy Education Percent Change Components

Energy Savings Recommendation	Q1-Q2			Q3-Q4		
	Percent Before	Percent After	Percent Change ⁽¹⁾	Percent Before	Percent After	Percent Change ⁽¹⁾
Of Those Who Took Action						
Take Shorter Showers	52%	64%	12%	48%	54%	6%
Wash Clothes in Cold Water	56%	67%	12%	67%	81%	15%
Overall Percentage Change						
Energy Savings Recommendation and Action	Percent Change	Percent of Population ⁽²⁾	Overall Percent Change ^{(1), (3)}	Percent Change	Percent of Population ⁽²⁾	Overall Percent Change ^{(1), (3)}
Take Shorter Showers - Action	12%	78%	9%	6%	75%	5%
Take Shorter Showers - No Action	0%	22%		0%	25%	
Wash Clothes in Cold Water - Action	12%	75%	9%	15%	71%	10%
Wash Clothes in Cold Water - No Action	0%	25%		0%	29%	

⁽¹⁾ Percent change may not add up due to rounding.
⁽²⁾ Percentage of surveyed population who took action.
⁽³⁾ Cadmus took the weighted average of the percentage change and proportion of population that took action or did not. By definition, those who took no action had a 0% change.

Figure H-1 shows that energy education savings have been variable over Phase III because savings are very sensitive to survey results and outreach. That is, changing behavior can be difficult. Nevertheless, PY12 had some of the best results in Phase III, bringing up the overall average, per-unit energy education savings to 73 kWh/yr.

Figure H-1. WRAP Energy Education Savings in Phase III



H.6 In-Service Rates

Cadmus surveys addressed six products—LEDs, LED nightlights, kitchen aerators, bathroom aerators, showerheads, and tier 2 advanced power strips. Cadmus found no meaningful difference between participant surveys conducted in PY12 Q1-Q2 and PY12 Q3-Q4. Therefore, Cadmus aggregated survey results to determine the PY12 ISR for each of the products. Table H-7 compares the ISRs in Phase III.

Table H-7. WRAP Comparison of ISRs in Phase III

Product	PY8 ⁽¹⁾	PY9 Q1-Q2	PY9 Q3-Q4	PY10	PY11	PY12
LEDs	94%	97%	99%	100%	99%	91%
LED Nightlights	69%	83%	96%	96%	97%	94%
Kitchen Aerators	78%	86%	95%	98%	96%	76%
Bathroom Aerators	61%	76%	90%	93%	97%	86%
Showerheads	88%	91%	93%	94%	99%	81%
Tier 2 Advanced Power Strips	44%	66%	88%	85%	94%	92%

⁽¹⁾ ISRs collected via site visit data.

H.7 Survey Participant Profile

In the participant phone surveys, Cadmus collected demographics and home characteristics. The respondents' homes had the following characteristics (n=201).¹³⁹

- Single-family detached residence (28%)
- Attached house (townhouse, rowhouse, or twin) (27%)
- Mobile or manufactured home (11%)
- Multifamily apartment or condo building with four or more units (33%)

WRAP respondents have the following level of education (n=202):¹⁴⁰

- Less than high school diploma or equivalent (10%)
- High school diploma or equivalent (40%)
- Technical or business school certificate/two-year college degree/some college (34%)
- Four-year college degree/bachelor's degree (13%)
- Graduate or professional degree/masters or doctorate degree (4%)

H.7.1 Survey Sample Attrition

Table H-8 lists the total number of WRAP records and the outcome (final disposition) of each record used for the telephone survey.

Table H-8. PY12 WRAP Sample Attrition Table for Participant Telephone Surveys

Description of Call Outcomes	Number of Records
Population (number of unique jobs)	5,379
Removed: inactive customer, completed survey in past three months, on "do not contact" list, selected for a different survey, duplicate contact	259
Incomplete or invalid phone number or email	41
Survey Sample Frame (sent to subcontractor for telephone survey calls)	5,079
Not attempted ⁽¹⁾	2,621
Records Attempted	2,458
Non-working, wrong number, business, language barrier	323
Not reached: No answer, answering machine, phone busy, refused, terminated, non-specific or specific callback scheduled	1,883
Screened out: PPL Electric Utilities or market research employee, cannot confirm equipment/not aware of participation	44
Completed Surveys (telephone)	208
Telephone Response rate	8%
⁽¹⁾ Selected for sample but overall target was reached before attempted.	

¹³⁹ Sum of percentages may not equal 100% due to rounding.

¹⁴⁰ Sum of percentages may not equal 100% due to rounding.

H.7.2 Logic Model Review

Cadmus reviewed the logic model and determined that WRAP is operating as expected. Table H-9 lists the outcome of the logic model review.

Table H-9. Winter Relief Assistance Program Logic Model Review

Expected PY12 Outcome	Topics	Actual PY12 Outcome
Marketing and referrals from other income eligible programs (Act 129 and Universal Services) identify participants, establish participants' eligibility, conduct energy audits, assess eligibility for home improvements, install energy-efficient equipment, provide energy education, and generate referrals to other organizations for participant households.	Program Activities	Conducted all activities as expected but due to COVID-19, the program switched from in-home assessments to remote assessments and the ICSP did not directly install energy-efficient equipment. Instead, the ICSP completed remote assessments via phone and mailed customized kits to customers based on the assessment results. The program continued to offer energy education as part of the assessment.
The ICSP enrolls income-qualified participants, completes audits, installs energy-savings products, and serves clients.	Outputs Produced by Program Activities	Met all expected outputs but instead of completing an in-home assessment and installing equipment directly, the program switched to remote assessments. The ICSP completed remote assessments via phone and mailed customized kits to customers based on the assessment results.
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	Met short-term outcomes but due to COVID-19 changed the delivery from direct install to remote energy assessment. The assessment provided customers with energy saving tips and identified needed equipment for installation. The program continued to provide access to other services.
Energy savings accrue from participant households through installation of efficient equipment.	Intermediate Outcomes	Met intermediate outcomes. Participating households received products to install in their homes and these products generated energy savings.
Energy savings continue to result from energy-efficient equipment upgrades and conservation behaviors in the participating income eligible population.	Long-Term Outcomes	Program met its long-term outcome.

Appendix I. Evaluation Detail – Appliance Recycling Program

I.1 Part-Use Factors

Part-use is an adjustment factor specific to appliance recycling that is used to convert the unit energy consumption (UEC) into an average per-unit gross savings. Cadmus calculated part-use factors using PY10 participant survey data and used these in the PY12 evaluation.

I.1.1 Regression Variable Findings

In PY12, Cadmus used program averages or proportions gathered in PY10 for each open variable in the TRM regression equation and compared them to the TRM default values. These results are available in the PY10 Annual Report.¹⁴¹

The unconditioned space x HDD and CDD terms reflect the average daily TMY3 values for each ZIP code and the proportion of units kept in unconditioned spaces reported by PY10 participant survey respondents. Cadmus mapped TMY3 base 65 annual CDD and HDD values by ZIP code rather than using the TRM reference city defaults. The evaluation framework recommends EDC data gathering rather than TRM defaults when feasible. Mapping weather by ZIP code rather than TRM reference city is more granular and more accurately represents weather patterns for each ZIP code.

I.2 Survey Participant Profile

The customer surveys conducted in PY12 collected demographic information about Appliance Recycling Program participants. The majority of survey respondents had the following demographic characteristics:

- Lived in a single-family detached residence (83%; 137 of 166)
- Had an average household size of 2.5 people (n=155)
- Had completed at least some college education (78%; 125 of 160)
- Had an annual household income of \$75,000 or greater (56%; 63 of 113)

I.2.1 Survey Sample Attrition

Cadmus conducted online surveys with PY12 participants who recycled refrigerators and freezers and who had viable email addresses.

Table I-1 lists the numbers of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

¹⁴¹ PPL Electric Utilities. *Annual Report Program Year 10: June 1, 2018–May 31, 2019*. Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2019.

Table I-1. Appliance Recycling Program Online Survey Attrition

Description of Outcomes	Number of Records
Online Survey	
Population (number of unique jobs) ⁽¹⁾	2,125
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	205
Email was incomplete or invalid	595
Survey Sample Frame (email invitations sent to all eligible)	1,325
Email was returned (bounce back), did not respond, opted-out, or did not complete survey	1,147
PPL Electric Utilities or market research employee	6
Cannot confirm equipment/not aware of participation	0
Completed Surveys ⁽²⁾	172
Response rate	13%
⁽¹⁾ Number of participant records available in PPL Electric Utilities' tracking database at the time of the final survey effort. ⁽²⁾ Number includes both completed and partially completed surveys used in the overall satisfaction result. This does not match the number of completed surveys (166) in Table 12-8 because that table only included fully completed surveys.	

Appendix J. Evaluation Detail – Student Energy Efficient Education Program

J.1 Ex Post Verified Savings Methodology

Cadmus independently verified savings according to the PA TRM and the associated algorithms. These algorithms include open variables for which the ICSP or Cadmus can use either the default or the option of “EDC data gathering.” Table J-1 lists the algorithm inputs, method of data collection, and source of the data collected.

Table J-1. Pennsylvania TRM Algorithm Open Variables

Cohort	Open Variable	Data Collection Method	Data Collector
LED Nightlight			
Bright Kids Take Action	ISR	PY12 HEW ISR	ICSP’s Subcontractor
	Wattage of installed bulb	Spec sheet	ICSP
Showerhead			
Take Action Innovation Tier 1 Innovation Tier 2	ISR	PY12 HEW ISR	ICSP’s Subcontractor
	GPM of installed aerator	Spec sheet	ICSP
	Number of persons in household	PY12 HEW	ICSP’s Subcontractor
	Number of showers in household	PY12 HEW	ICSP’s Subcontractor
	Water heater fuel	PY12 HEW	ICSP’s Subcontractor
Kitchen/Bathroom Faucet Aerator			
Bright Kids ⁽¹⁾ Take Action Innovation Tier 1 Innovation Tier 2	ISR	PY12 HEW ISR	ICSP’s Subcontractor
	GPM of installed aerator	Spec sheet	ICSP
	Number of persons in household	PY12 HEW	ICSP’s Subcontractor
	Home type	PY12 HEW	ICSP’s Subcontractor
	Water heater fuel	PY12 HEW	ICSP’s Subcontractor
Smart Power Strip			
Innovation Tier 1 Innovation Tier 2	ISR	PY12 HEW ISR	ICSP’s Subcontractor
	Use (entertainment, computer, unspecified)	PY12 HEW ISR	ICSP’s Subcontractor
Water Heater Setback			
Take Action Innovation Tier 1 Innovation Tier 2	Number of degrees water heater turned down (calculated using the midpoint of the ranges provided in HEW response options)	PY12 HEW	ICSP’s Subcontractor
	Washing machine located in home	PY12 HEW	ICSP’s Subcontractor
	Water heater fuel	PY12 HEW	ICSP’s Subcontractor
⁽¹⁾ As noted in the report, this information was not collected for Bright Kids. Survey data from the two other cohorts was used for Bright Kids.			

J.1.1 Ex Post Verified Savings

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, Cadmus estimated the program-level *ex post* savings.

J.2 In-Service Rates

Table J-2 shows the verified ISRs for each of the items in the energy-savings kits by cohort for PY9, PY10, PY11, and PY12. Consistent with prior years, ISRs were higher for electric products (LED nightlights and smart strips) than for the water-saving products (showerheads and kitchen aerators).

Table J-2. Verified Student Energy Efficient Education ISRs for Measures by Year and Cohort

Cohort	Product Number	PY9	PY10 ⁽¹⁾	PY11	PY12
Showerhead ⁽²⁾					
Take Action	1	32%	N/A	33%	32%
Innovation Tier 1	1	35%	N/A	36%	28%
Innovation Tier 2	1	41%	35%	30%	28%
Kitchen Faucet Aerator ⁽²⁾					
Bright Kids	1	N/A	N/A	N/A	40%
Take Action	1	29%	N/A	29%	25%
Innovation Tier 1	1	N/A	N/A	N/A	19%
Innovation Tier 2	1	N/A	N/A	N/A	21%
Bathroom Faucet Aerator ⁽²⁾					
Bright Kids	1	N/A	N/A	N/A	38%
Innovation Tier 1	1	N/A	N/A	N/A	19%
Innovation Tier 2	1	N/A	N/A	N/A	20%
Smart Power Strip					
Innovation Tier 1	1	77%	N/A	74%	76%
Innovation Tier 2	1	58%	75%	75%	68%
LED Nightlight					
Bright Kids	1	N/A	N/A	N/A	82%
Take Action	1	N/A	N/A	N/A	60%
⁽¹⁾ For the PY10 evaluation, Cadmus did not calculate ISRs for products in the Bright Kids, Take Action, or Innovation Tier 1 kits using HEWs returned in PY10 and instead applied the ISRs determined from HEWs returned in PY9. ⁽²⁾ Cadmus calculated water product ISRs by dividing respondents who installed the product in a home with electric water heat by respondents who answered the question and have electric water heat.					

Appendix K. Evaluation Detail – Demand Response Program

K.1 Evaluation Sampling Approach

The impact evaluation strategy is shown in Table K-1. Cadmus analyzed consumption data to estimate Act 129 demand response event load impacts in PY12 for the population of participating facilities. Participants were facilities that participated in at least one Act 129 demand response event and were associated with any of the four demand response aggregators—CPower or one of its subcontractors: NRG, COI Energy Services, or Direct Energy.

Table K-1. PY12 Demand Response Program Gross Impact Evaluation Design

Stratum	Event	Population Size ⁽¹⁾	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Small C&I	July 20, 2020	77	NA	77	77	Analysis of individual participating facility loads was performed for each event hour
	July 27, 2020	78	NA	78	78	
	July 29, 2020	78	NA	78	78	
	August 25, 2020	78	NA	78	78	
	August 27, 2020	77	NA	77	77	
Large C&I	July 20, 2020	28	NA	28	28	
	July 27, 2020	28	NA	28	28	
	July 29, 2020	22	NA	22	22	
	August 25, 2020	29	NA	29	29	
	August 27, 2020	30	NA	30	30	
GNE	July 20, 2020	8	NA	8	8	
	July 27, 2020	8	NA	8	8	
	July 29, 2020	7	NA	7	7	
	August 25, 2020	7	NA	7	7	
	August 27, 2020	4	NA	4	4	
Program Total ⁽²⁾	July 20, 2020	113	NA	113	113	
	July 27, 2020	114	NA	114	114	
	July 29, 2020	107	NA	107	107	
	August 25, 2020	114	NA	114	114	
	August 27, 2020	111	NA	111	111	

⁽¹⁾ Population size is the count of facilities that participated in one or more Act 129 demand response event hours as reported by the ICSP.

K.2 Ex Post Verified Savings Methodology

Cadmus analyzed advanced metering infrastructure (AMI) interval consumption data for each participating facility. A facility was defined as the area over which the participating customer's electricity consumption was metered and the load reductions measured during PY12 Demand Response Program period (June 1, 2020, through September 30, 2020). In PY12, 118 facilities participated in one or more Act 129 events.

Cadmus estimated the event load impacts for a facility as the difference between the facility's baseline electricity demand and metered demand, as shown in this equation:

$$\text{kW impact} = \text{Baseline kW} - \text{Metered kW}$$

Baseline demand is a counterfactual and represents what the facility's load would have been if the Act 129 demand response event had not been called. The baseline is unobservable and must be estimated. Accurate estimation of load impacts requires establishing a valid method for estimating the baseline. The methods Cadmus employed for estimating the baselines are described below.

K.2.1 Data Collection

Cadmus collected data from several sources to evaluate the PY12 Demand Response Program impacts. Table K-2 lists the data and sources.

PPL Electric Utilities provided 15-minute or one-hour interval consumption data between April 1, 2020, and September 11, 2020, for the participating facilities. Cadmus aggregated all facility 15-minute interval data to the hour level. A small percentage of intervals was estimated or included one or more estimated or missing 15-minute intervals. Cadmus flagged these observations and set them to missing for the analysis. Estimated readings were not used in the calculation of facility baselines or in estimating savings. Cadmus also screened the data for outliers but did not remove any observations.

Table K-2. Data Sources

Data	Population	Period	Variables	Source
Participant information data	Demand Response Program participant facilities	June 1, 2020 – September 30, 2020	Customer name, account number, business segment, ICSP baseline calculation method, enrolled MW, event hour participation indicators and reported load reductions, advance notification times, PJM economic market participation dates	CPower (ICSP)
PJM day-ahead forecasts and Act 129 event dates and hours	PPL Electric Utilities Demand Response Program participants	Summer 2020	Event dates and hours	PJM Interconnection LLC website
Facility interval consumption data	PPL Electric Utilities Demand Response Program participants	April 1, 2020– September 11, 2020	15 minute or hour interval kWh, estimated read indicator	PPL Electric Utilities
Weather	11 weather stations in PPL Electric Utilities service area	April 1, 2020– September 11, 2020	Dry-bulb temperature	NOAA
Solar radiation	Penn State, Pennsylvania SURFRAD site	April 1, 2020– September 11, 2020	Global horizontal irradiance	NOAA ESRL GMD
Line losses	Commercial and industrial electric utility customers	Phase III Act 129	Line loss factor	PA Technical Resource Manual (2016), Table 1-4

Baseline Calculation Approach

Day-Matching Customer Baselines and Regression Baselines

Cadmus estimated individual consumption baselines for each participating facility and event using either a day-matching approach or regression. Day-matching identifies a set of nearby, non-event, non-holiday weekdays for each event day, referred to as the basis window. For each event hour, the baseline is the average consumption during the same hour of the days or subset of days in the basis window.

The facility baseline regression models were estimated with data from days that almost qualified as Act 129 event days. These “almost Act 129 event days” were the 30 non-notification, non-holiday weekdays with the highest PJM day-ahead load forecasts that did not qualify as event days. The load on these days provided a natural baseline for assessing the impact of Act 129 events.

Selection of Facility Baseline Calculation Methods

Before the beginning of PY12, Cadmus assigned each participating facility to one of the following day-matching baseline calculation methods or a regression method:

- 2 previous days¹⁴²
- 3 previous days
- 4 previous days
- 5 previous days
- 10 previous days
- 3 of 5 previous days with highest average load during event hours
- 4 of 5 previous days with highest average load during event hours 7 of 10 previous days with highest average load during event hours
- 3 previous days of the same day type (e.g., Wednesdays)
- 4 previous days of the same day type
- Regressions (one of 81 models)

Cadmus selected the most accurate baseline calculation method for each participating facility based on tests of predictive accuracy.¹⁴³

Table K-3 shows counts of participating facilities by final baseline modeling approach for all facilities, by customer segment, and for 20 facilities with capacity enrollments greater than or equal to 1 MW. These 20 facilities accounted for 92% of enrolled capacity.

Many large C&I facilities used day-matching approaches because they had nearly constant demand or they had highly variable day-to-day demand, and regression did not predict better than day-matching methods. For these facilities, the best predictor of demand was the demand in days close to events, so Cadmus selected X-of-Y-previous-day baseline methods for many large C&I facilities.

¹⁴² When selecting basis days, Cadmus excluded previous weekend days, holidays, Act 129 event days, and Act 129 event notification days from the basis window.

¹⁴³ Cadmus performed a separate analysis for each facility, selecting the day-matching or regression baseline method that performed best in terms of accuracy, bias, and variability (risk). It assessed the accuracy of the baseline using relative root mean squared error (RRMSE), bias using mean absolute percentage error (MAPE) and median percentage prediction error, and variability using the distribution of errors. Cadmus calculated and plotted the distribution of errors to see if for a small number of hours the models predicted poorly.

Table K-3. Number of Facilities by Baseline Modeling Approach

Baseline	All Facilities	GNE	Large C&I	Small C&I	Demand Response Capacity ≥ 1 MW
2 OF 2	4	-	4	-	4
3 OF 3	1	-	1	-	1
3 OF 5	4	2	2	-	1
4 OF 4	-	-	-	-	-
4 OF 5	4	-	2	2	1
5 OF 5	2	-	1	1	1
7 OF 10	5	-	5	-	5
10 OF 10	3	-	3	-	2
Day of Week 4 of 4	3	-	2	1	2
Day of Week 3 of 3	-	-	-	-	-
Regression	92	6	12	74	3
Total	118	8	32	78	20

Impacts of COVID-19 on Baseline Calculation Approach

The COVID-19 pandemic affected the operations and electricity consumption of many PPL Electric Utilities C&I customers, especially at the beginning of the pandemic in spring 2020. A concern is that the baseline calculation methods tested in previous years of normal business operations might perform poorly and not yield accurate estimates of demand savings for the demand response program participants during the COVID pandemic.

To investigate the validity of the baseline calculation methods, Cadmus started by plotting hourly consumption between April 1, 2020, and September 10, 2020, for all participant facilities. Many participants exhibited electricity consumption patterns similar to in previous years, and no COVID impacts were evident. For other participants, particularly for big-box retail stores and other retailers, it was obvious that business operations had been disrupted, as electricity consumption remained below normal and the levels observed in previous years. However, in June, as the Pennsylvania economy reopened, it appears many impacted businesses resumed normal operations and electricity consumption increased to expected levels. These normal operations persisted through summer. This lessened Cadmus' concerns that the existing baseline calculation methods may not be valid.

In addition, Cadmus conducted an interim evaluation of the demand response savings for the July 20, 2020, event to evaluate the performance of the baseline calculation methods and the reasonableness of the savings estimates. For the six participant facilities with the greatest committed capacity (91 MW), Cadmus estimated demand savings within 11% of the committed capacity. In addition, Cadmus verified that the baseline calculation methods predicted accurately for recent non-event (placebo) days in July.

Overall, Cadmus concluded that despite the COVID pandemic disruptions, the baseline calculation methods remained valid and it was unnecessary to adjust them.

Act 129 Events in Program Year 12

Table K-4 presents the Act 129 event dates, hours, advance notification date and times, and the average outside temperature during events in PY12.

Table K-4. PY12 Act 129 Events Dates and Times

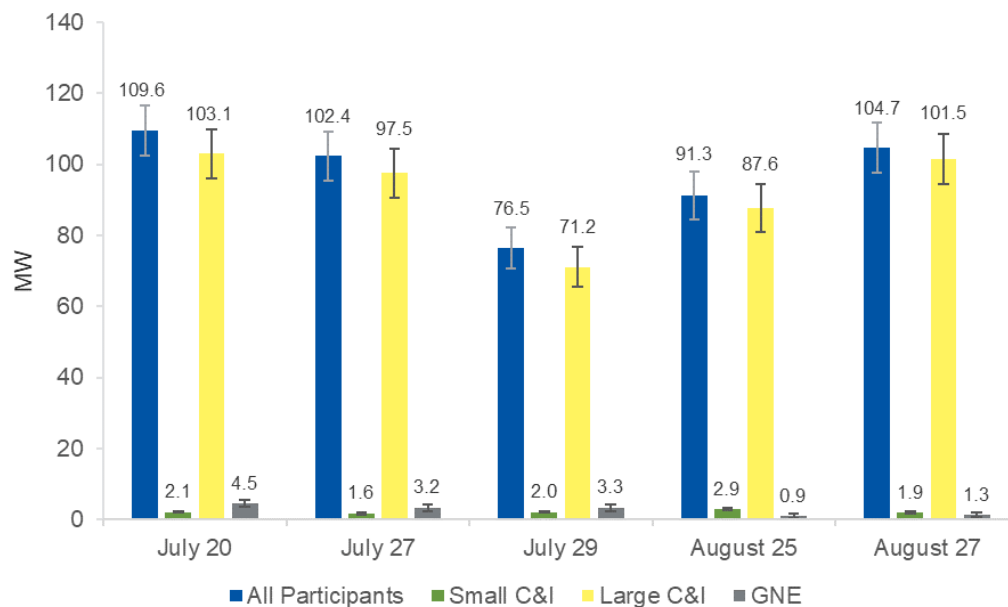
Event Date	Event Hours	Advance Notification Date and Time	Average Outside Temperature (°F) During Event
Monday, July 20, 2020	2:00 p.m. – 6:00 p.m.	Sunday, July 19, 2020, at 10:42 a.m.	89.2
Monday, July 27, 2020	2:00 p.m. – 6:00 p.m.	Sunday, July 26, 2020, at 10:23 a.m.	89.6
Wednesday, July 29, 2020	3:00 p.m. – 7:00 p.m.	Tuesday, July 28, 2020, at 10:35 a.m.	88.6
Tuesday, August 25, 2020	2:00 p.m. – 6:00 p.m.	Monday, August 24, 2020, at 10:32 a.m.	84.6
Thursday, August 27, 2020	3:00 p.m. – 7:00 p.m.	Wednesday, August 26, 2020, at 10:32 a.m.	90.5

Note: Advance notification times were obtained from CPower, the ICSP, through Cadmus data request.

K.2.2 Results and Discussion

The estimates of program and customer segment demand savings for each PY12 Act 129 event date are presented in Figure 14-1 and Table 14-4 in the main content of this report (*Gross Savings Impact Evaluation Results*). In Figure K-1, Cadmus presents the results graphically. Unless noted otherwise, all demand load impacts have been adjusted for line losses.

Figure K-1. PPL Electric Utilities Act 129 Gross Verified Demand Savings, PY12



Notes: Estimates based on Cadmus analysis of AMI interval consumption data for participant facilities. Error bars show 90% confidence intervals. All savings estimates were adjusted for line losses.

In PY12, PPL Electric Utilities achieved average demand savings of 96.9 MW across the five 2020 Act 129 events. PPL Electric Utilities achieved the maximum event demand savings of 109.6 MW on July 20 and the minimum event demand savings of 76.5 MW on July 29. As Figure K-1 shows, large C&I customers were responsible for between 93% and 97% of the gross verified demand response savings depending on the event.

Table K-5 reports the gross verified demand savings, metered demand, estimated baseline demand, and the percentage demand savings by event for each customer segment and the program. All MW/hour have been adjusted for line losses and reflect demand at the generator. On average, the program produced demand savings of 47% relative to baseline consumption. The small C&I sector produced savings between 6% and 10% of baseline demand. The GNE sector produced savings between 14% and 50% of baseline demand. The large C&I sector produced savings between 50% and 57% of baseline demand.

Table K-5. Gross Verified Demand Savings, Metered Demand, and Baseline Demand by Customer Segment and Event

Stratum	Event	Gross Verified Demand Savings (MW/hour)	Metered Demand (MW/hour)	Baseline Demand (MW/hour)	Relative Precision at 90% C.L.	Percentage Demand Savings
Small C&I	July 20, 2020	2.1	27.3	29.3	11.4%	7.1%
	July 27, 2020	1.6	28.9	30.6	14.6%	5.4%
	July 29, 2020	2.0	26.7	28.7	11.2%	7.1%
	August 25, 2020	2.9	25.7	28.6	8.3%	10.0%
	August 27, 2020	1.9	26.6	28.5	11.7%	6.6%
Large C&I	July 20, 2020	103.1	81.5	184.6	6.7%	55.8%
	July 27, 2020	97.5	72.5	170.1	7.0%	57.4%
	July 29, 2020	71.2	56.0	127.2	8.1%	56.0%
	August 25, 2020	87.6	87.6	175.2	7.7%	50.0%
	August 27, 2020	101.5	83.9	185.4	6.8%	54.8%
GNE	July 20, 2020	4.5	6.9	11.4	22.2%	39.3%
	July 27, 2020	3.2	7.2	10.5	29.3%	31.0%
	July 29, 2020	3.3	5.9	9.3	27.1%	35.9%
	August 25, 2020	0.9	5.2	6.1	78.7%	14.1%
	August 27, 2020	1.3	1.3	2.5	59.8%	49.4%
All Participants	July 20, 2020	109.6	115.7	225.3	6.4%	48.7%
	July 27, 2020	102.4	108.7	211.1	6.8%	48.5%
	July 29, 2020	76.5	88.6	165.1	7.6%	46.3%
	August 25, 2020	91.3	118.6	209.9	7.4%	43.5%
	August 27, 2020	104.7	111.8	216.4	6.7%	48.4%
Average	-	96.9	108.7	205.6	3.1%	47.1%
Note: All MW/hour have line loss adjustments applied and represent demand at the generator. Event totals may not sum due to rounding. Difference between baseline demand and metered demand may not equal the gross verified demand savings due to rounding. The percentage demand savings may not equal the ratio of gross verified demand savings to baseline demand due to rounding.						

K.3 Survey Participant Profile

Of the 38 enrolled companies (contracted by CPower, the ICSP), 68% had one facility enrolled in the PY12 program, 58% were manufacturing facilities, and 45% participated in all five events. The surveys captured six respondents.

These six survey respondents represented approximately 22% of the total enrolled demand response capacity (138.3 MW) in PY12.

K.3.1 Survey Sample Attrition

Table K-6 lists total contacts, the outcome (final disposition) of each record, and response rate.

Table K-6. PY12 Demand Response Participant Survey Sample Attrition Table

Description of Survey Outcomes	Count
Population (number of CPower, NRG, COI Energy Services, and Direct Energy enrolled facilities)	126
Removed: NRG, COI Energy Services, and Direct Energy contracted facilities	6
Removed: Duplicate facility contacts for managers with multiple enrolled facilities	82
Sample Frame (number of unique companies)	38
Removed: Records with no contact information	2
Survey Sample Frame (used for surveys)	36
Not started	26
Refused or opted out	4
Completed Surveys (online and telephone combined)	6
Response Rate (completed surveys divided by number of records)	17%

Appendix L. Non-Energy Benefits

L.1.1 Non-Energy Benefits of Water-Saving Products

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.¹⁴⁴ Non-energy benefits associated with water-saving products include the gallons of water saved. According to the recommendation in the Guidance Memo, Cadmus assumed \$0.01 in avoided cost, per-gallon saved, in TRC testing (after gross-up for distribution losses). Cadmus assumed 20% losses on water distribution, which is the low end of the range provided in the guidance memo (20% to 25%). The avoided cost of water is escalated over the TRC test horizon using the same inflation/escalation assumption embedded elsewhere in the TRC model.

L.1.2 Lighting Interactive Effects

Cadmus calculated lighting interactive effects according to the Guidance Memo, which states:

*"Installation of LED lighting equipment in homes and businesses with natural gas heating systems leads to an increase in gas usage because LEDs generate less waste heat than inefficient technologies. The reduced heat in the space must be compensated for by the heating system. The PA TRM provides interactive effect assumptions for electric heating and cooling systems, but not fossil fuel... The gas heating fuel share and percentage of lamps installed in interior sockets are taken from the 2014 Residential Baseline Study (Tables 5-29 and 5-50 and Figure 5-12)."*¹⁴⁵

L.1.3 Non-Energy Benefits of Natural Gas Savings

Per the Guidance Memo, Cadmus assumed that there is a natural gas therms penalty (negative benefit). Cadmus applied the therms penalty to the *ex post* kWh/yr savings, which incorporates the electric energy heating penalty in accordance with the TRM.

Cadmus calculated therm benefits using the average annual avoided gas costs submitted with PPL Electric Utilities' Phase III EE&C plan.¹⁴⁶ A distribution loss factor was applied to gross up impacts in the home to the water heating system.

Cadmus developed values for the non-residential programs from the 2014 PA C&I baseline study,¹⁴⁷ as shown in Table L-1, for the assumptions needed to compute the heating penalty in commercial buildings.

¹⁴⁴ SWE. *Guidance on the Inclusion of Fossil Fuel and H₂O Benefits in the TRC Test*. March 25, 2018.

¹⁴⁵ Ibid.

¹⁴⁶ PPL Electric Utilities' revised EE&C plan (Docket No. 2015-2515642) filed with the PA PUC November 2018.

¹⁴⁷ Nexant, Inc. (with GDS Associates, Research Into Action, and Apex Analytics). *Pennsylvania Statewide Act 129 2014 Non-Residential End Use & Saturation Study*. Prepared for the PA PUC. April 4, 2014. http://www.puc.state.pa.us/Electric/pdf/Act129/SWE-2014_PA_Statewide_Act129_Non-Residential_EndUse_Saturation_Study.pdf

Table L-1. Non-Residential End-Use Penetration and Fuel Shares

End Use	Penetration	Fuel Share				
		Electric	Natural Gas	Fuel Oil	Other ⁽¹⁾	n-values ⁽²⁾
Lighting	100.0%	100.0%	0.0%	0.0%	0.0%	-
Space Heating ⁽³⁾	100.0%	6.8%	84.4%	4.3%	4.5%	449
Space Cooling	84.3%	100.0%	0.0%	0.0%	0.0%	-
Plug Load	100.0%	100.0%	0.0%	0.0%	0.0%	-
Refrigeration	35.0%	100.0%	0.0%	0.0%	0.0%	-
Cooking	27.9%	53.3%	42.5%	0.0%	4.2%	659
Water Heating ⁽³⁾	92.7%	37.8%	56.3%	1.9%	3.8%	540
Other ⁽⁴⁾	100.0%	100.0%	0.0%	0.0%	0.0%	-

⁽¹⁾ "Other" fuel share includes LPG, purchase HW or steam, wood, and misc. fuels.

⁽²⁾ n-values for fuel share only.

⁽³⁾ Fuel shares for space heating and water heating are based on square footage served and tank capacity, respectively. All others are per premise.

⁽⁴⁾ "Other" end use includes pumps, motors, and miscellaneous equipment.

Appendix M. Net Savings Impact Evaluation

M.1.1 Self-Report Survey Methodology

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.

Following methods defined in the Phase III Evaluation Framework,¹⁴⁸ Cadmus assessed free ridership. This assessment 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.

Cadmus summed the intention and influence components to estimate the total intention/influence method free ridership average by product or stratum. Nonresidential scores are weighted by *ex post* gross kWh/yr savings.

Intention Score

Cadmus assessed intention by asking questions to determine how the participant’s decisions would have differed in the absence of the program. For example, surveys asked the following key questions to determine how the residential respondent’s decisions or the business organization’s project-related decisions would have differed in the absence of a 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 [you/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 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.

¹⁴⁸ 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. Final version May 8, 2018.

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:

- “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 various program components. Cadmus assessed influence from participants’ ratings of how important various program elements were in their decision to purchase energy-efficient equipment.

Spillover

Following methods defined in the Phase III Evaluation Framework,¹⁴⁹ Cadmus estimated spillover. To estimate spillover, surveys included questions to determine whether participants installed specific additional high-efficiency products and, if so, whether participation in the program was important to their decision. Additional high-efficiency product purchases counted toward spillover only if the customer did not receive a rebate and the program had been important to the decision to purchase and install the products. Typically, the data collected through the surveys do not provide enough information to reliably quantify spillover; therefore, spillover is reported qualitatively.

¹⁴⁹ 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. Final version May 8, 2018.

Appendix N. Survey Methodology

In presenting interview and survey data in the report, the percentage or frequency of responses is followed by the sample size for the particular question. Sample size (denoted by “n”) refers to the number of respondents who answered the question. Sample sizes may vary by question, because of survey logic and skipped questions. Respondents could skip questions if they did not want to answer them; not all respondents provided an answer to every question.

N.1.1 Survey Bias

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 issues and biases using these best practices:

- Avoid questions that are leading, ambiguous, or contain more than one topic
- Employ randomization of list-based survey items to reduce order effects
- Use consistent survey wording and response options for online and phone surveys when relevant
- Employ stratified random sampling when relevant

The SWE team and PPL Electric Utilities reviewed and approved **new** surveys that Cadmus fielded in PY12.

N.1.2 Survey Contact Instructions

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. Cadmus also excluded inactive customers and customers who were selected for another survey. This cleaning and survey sample preparation process reduced the available sample.

For online surveys, Cadmus sent email invitations to the remaining contacts with email addresses and followed up with one reminder email invitation. For telephone surveys, Cadmus attempted each record up to five times at different times of the day and weekend and left messages with voice mail where possible. For multimode surveys, Cadmus first contacted all participants with email addresses to complete an online survey, sent one reminder email invitation and 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 programs with limited population.