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PPL Electric Utilities Annual Report to the Pennsylvania Public Utility Commission

PHASE III OF ACT 129 PY11 ANNUAL REPORT (JUNE 1, 2019 – MAY 31, 2020) FOR PENNSYLVANIA ACT 129 OF 2008 ENERGY EFFICIENCY AND CONSERVATION PLAN

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Acronyms

BDR	Behavioral Demand Response
C&I	Commercial and Industrial
CDD	Cooling Degree Day
CEI	Continuous Energy Improvement
CF	Coincidence Factor
CFL	Compact Fluorescent Lamp
CHP	Combined Heat and Power
C.L.	Confidence Limit
CSP	Conservation Service Provider or Curtailment Service Provider
Cv	Coefficient of Variation
DLC	Direct Load Control
DR	Demand Response
EDC	Electric Distribution Company
EDT	Eastern Daylight Time
EE&C	Energy Efficiency and Conservation
EM&V	Evaluation, Measurement, and Verification
EISA	Energy Independence and Security Act
EUL	Effective Useful Life
GNE	Government, Nonprofit, Educational
HDD	Heating Degree Day
HER	Home Energy Report
HIM	High-Impact Measure
HOU	Hours of Use
HVAC	Heating, Ventilating, and Air Conditioning
ICSP	Implementation Conservation Service Provider
IPMVP	International Performance Measurement and Verification Protocol
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-verified customers.

VERIFIED ENERGY SAVINGS

Phase III has so far saved **1,498,971 MWh/yr**

104% of the compliance target

113% of projected

PY11 saved **369,322 MWh/yr**

LOW-INCOME VERIFIED ENERGY SAVINGS

Phase III has so far saved **99,604 MWh/yr**

125% of the compliance target

130% of projected

PY11 saved **29,945 MWh/yr**

GNE VERIFIED ENERGY SAVINGS

Phase III has so far saved **188,429 MWh/yr**

373% of the compliance target

124% of projected

PY11 saved **71,681 MWh/yr**

DEMAND RESPONSE VERIFIED ENERGY SAVINGS

Phase III has so far saved **113 MW/yr**

123% of the compliance target

113% of projected

PY11 saved **104 MW/yr**

PORTFOLIO SATISFACTION, PARTICIPATION, AND EXPENDITURES

PY11 PARTICIPATION

A total of **356,719** participants

- **64** Demand Response programs
- **58,553** Low-Income programs
- **9,031** Non-Residential programs
- **289,071** Residential programs

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

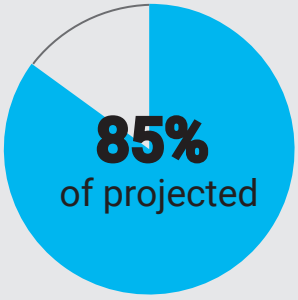
PROGRAM SATISFACTION

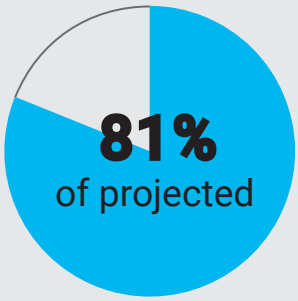
93% Satisfied with overall program

- **98%** satisfied with **Low-Income programs**
- **94%** satisfied with **Non-Residential programs**
- **90%** satisfied with **Residential programs**

EXPENDITURES

Phase III expenditures so far **$188,034**





PY11 expenditures **$48,086**

PARTICIPANT COMMENTS

"The process worked very well. My contractor gave me all the data I needed. The form was clear and easy to fill out."

"You're giving money back to customers who buy thoughtfully. I appreciated it and can't think of what you could do better."

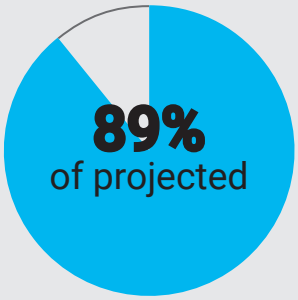
"[The Midstream Lighting] portal is nice, easy to navigate and offers transparency."

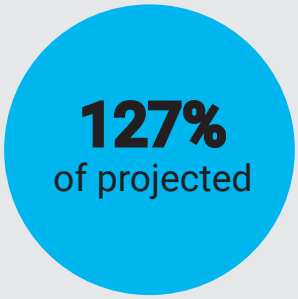
NON-RESIDENTIAL ENERGY EFFICIENCY PROGRAM

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

VERIFIED ENERGY SAVINGS

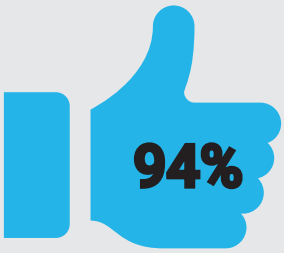
Phase III has so far saved **720,882 MWh/yr**





PY11 saved **229,943 MWh/yr**

PROGRAM SATISFACTION



Satisfied with overall programs

100% satisfied with **Midstream Lighting program** (distributors)

95% satisfied with **Efficient Equipment program**

88% satisfied with **Custom program**

PY11 PARTICIPATION

A total of **9,031** participants

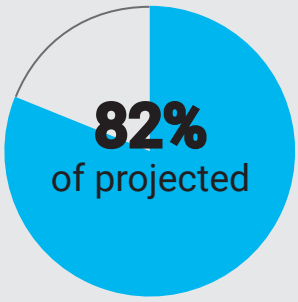
69 Custom

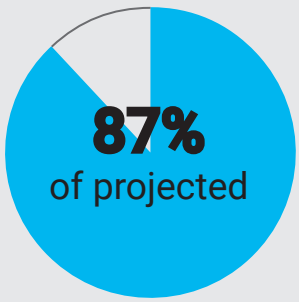
1,036 Efficient Equipment

7,926 Midstream Lighting

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$71,283**





PY11 expenditures **$21,162**

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.

VERIFIED ENERGY SAVINGS

Phase III has so far saved **700,449 MWh/yr**

108% of projected

100% of projected

PY11 saved **114,865 MWh/yr**

Totals exclude savings attributable to the low-income sector

PROGRAM SATISFACTION

90% Satisfied with overall programs

97% satisfied with the **Appliance Recycling Program**

91% satisfied with **Energy Efficient Home Program**

83% satisfied with the **Student Energy Efficient Education Program**

PY11 PARTICIPATION

A total of **289,071** participants

126,955	Home Energy Education
119,867	Efficient Lighting
19,634	Energy Efficient Home
13,117	Appliance Recycling
9,498	Student Energy Efficient Education

Totals exclude participants attributable to the low-income sector

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$72,236**

87% of projected

77% of projected

PY11 expenditures **$14,862**

Totals exclude expenditures attributable to the low-include sector

LOW-INCOME PROGRAMS

Low-income programs include two dedicated income-qualified programs that deliver energy education and energy-saving products and services, and two additional programs serving the low income community.

VERIFIED ENERGY SAVINGS

Phase III has so far saved **99,604 MWh/yr**

125% of the compliance target

130% of projected

PY11 saved **29,945 MWh/yr**

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

PROGRAM SATISFACTION

98% Satisfied with overall program

98% satisfied with the **Energy Efficiency Kits and Education Program**

97% satisfied with the **Winter Relief Assistance Program**

PY11 PARTICIPATION

A total of **58,553** participants

- **15,598** Energy Efficiency Kits and Education Program
- **11,656** Winter Relief Assistance Program
- **16,440** Home Energy Education Low Income Home Energy Reports
- **14,859** Student Energy Efficient Education Low Income Schools

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$37,409**

88% of projected

79% of projected

PY11 expenditures **$10,093**

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 runs 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 third program year of Phase III, Program Year 11 (PY11, June 2019–May 2020), 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 PY11. 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 PY11. Programs are operating effectively and are meeting or surpassing program objectives. Cadmus does not suggest any major course corrections. Recommendations suggest minor finetuning and possible areas of inquiry in future years.

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

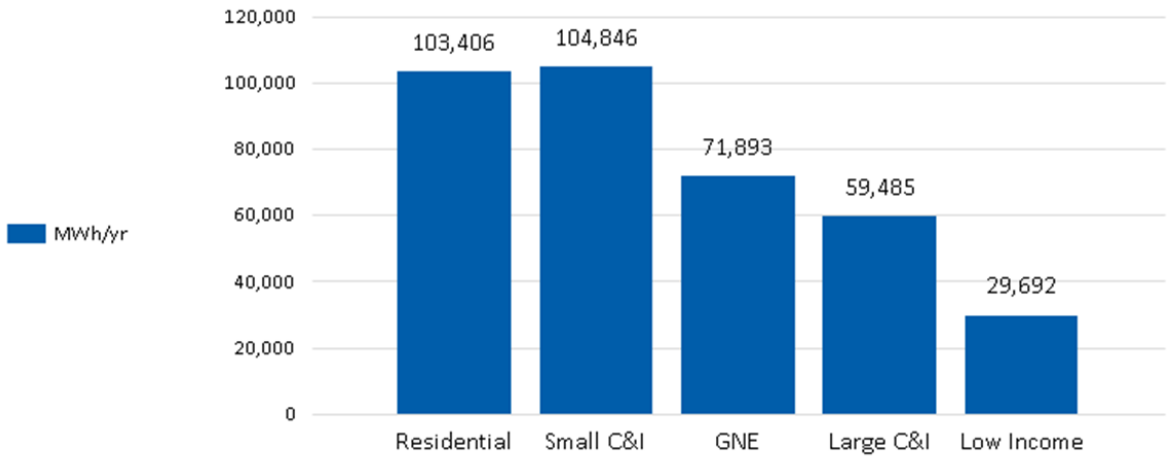
Verified energy savings achieved through PY11 exceed the savings projected for the phase-to-date shown in PPL Electric Utilities' EE&C plan.[2] Specifically, PPL Electric Utilities exceeded the PY11 cumulative projected estimate of 1,296,105 MWh/yr, achieving 1,498,971 MWh/yr in verified savings, or 116% of projections through PY11.

With verified savings of 1,498,971 MWh/yr through PY11, PPL Electric Utilities has achieved 104% 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 125% of the Phase III low-income verified gross energy savings target of 79,367 MWh/yr. It has achieved 373% of the Phase III GNE verified gross energy savings target of 50,507 MWh/yr, so it began placing GNE projects on a waitlist in January 2018.

Figure 1-1 shows PPL Electric Utilities' PY11 program year-to-date (PYTD) verified savings by sector.

Figure 1-1. PY11 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 90% of the PY11 cumulative projected budget estimated in the EE&C Plan, expending $53,471,128. The acquisition cost in PY11 is $0.13 per annual kWh (EDC expenditures/first year savings). The portfolio-level total cost of conserved energy (TRC costs/net present value [NPV] lifetime kWh, at generation) is $0.048. The portfolio-level utility cost of conserved energy (program administrator cost [PAC]/net present value [NPV] lifetime kWh, at generation) is $0.024. The TRC includes PPL Electric Utilities' costs as well as the customers' costs. The PAC includes only PPL Electric Utilities' costs.

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

A portfolio is cost-effective when the TRC benefit-cost ratio exceeds 1.0. The PY11 portfolio is cost-effective, with a portfolio-level TRC of 1.60.

Free ridership is low across the PY11 programs where it was estimated. The evaluated net-to-gross (NTG) ratio, including spillover attributable to some programs, is 0.78. Program offerings do not need modification to address free ridership.

In Phase III, PPL Electric Utilities established a goal to achieve 80% or greater of *very satisfied* and *somewhat satisfied* customers in each sector.[3] Respondents to participant satisfaction surveys across all sectors showed high levels of satisfaction with the programs. With the combined *very satisfied* and *somewhat satisfied* responses, portfolio satisfaction for PY11 is 93% (n=20,068), a statistically significant increase from the PY10 result of 88% (n=19,823).[4]

The low-income programs achieved customer satisfaction of 98% (n=2,052), the Non-Residential Program achieved customer satisfaction of 94% (n=109), and the residential programs achieved satisfaction of 90% (n=17,907). 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 10: June 1, 2018–May 31, 2019.* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2019.

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 PY11 on June 1, 2019. Table 2-2 shows the Phase III achievements to date.

Table 2-1. PY11 Energy Efficiency Achievements to Date

PYTD	Reported Gross Savings (PYRTD)	Verified Savings (PYVTD)(1)	Unverified (PYRTD) (2)	Realization Rate (1)
Energy Savings (MWh/yr)(3)	384,558	369,322	4,084	96%
Peak Demand Savings (MW/yr)(3)	54.98	49.26	1.38	90%

(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) Unverified savings are from the New Homes component of the Energy Efficient Home Program.
(3) 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

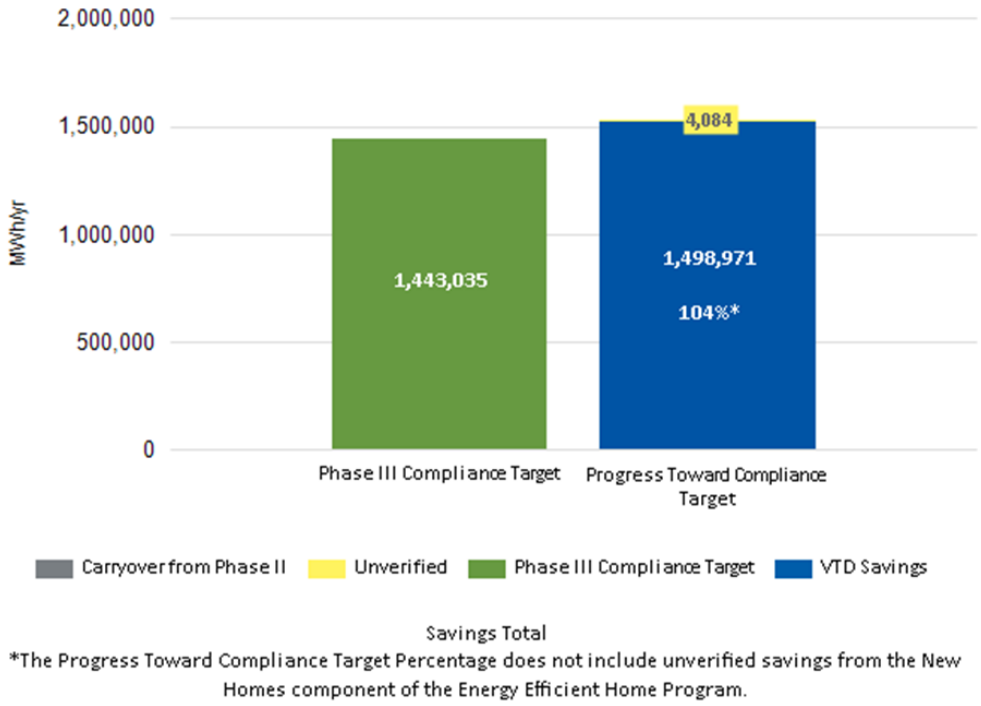
Table 2-2. Phase III Energy Efficiency Achievements to Date

P3TD	Reported Gross Savings (P3RTD)	Verified Savings (P3VTD)[1]	Unverified (P3RTD) [2]	Realization Rate [1]
Energy Savings (MWh/yr) [3]	1,581,626	1,498,971	4,084	95%
Peak Demand Savings (MW/yr) [3]	268.84	209.39	1.38	78%

[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] Unverified savings are from the New Homes component of the Energy Efficient Home Program.
[3] Savings may not match other tables or figures due to rounding.

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

Figure 2-1. EE&C Plan Performance Toward Phase III Portfolio Target



The Phase III Implementation Order directed the EDCs to offer conservation measures to the low-income customer sector based on the proportion of electric sales attributable to low-income households. For PPL Electric Utilities, the proportionate number of measures targeted is 9.95%.[8]

PPL Electric Utilities offers a total of 125 EE&C measures (products and equipment) to its residential and nonresidential customer classes.[9] It makes 25 measures available to the low-income customer sector at

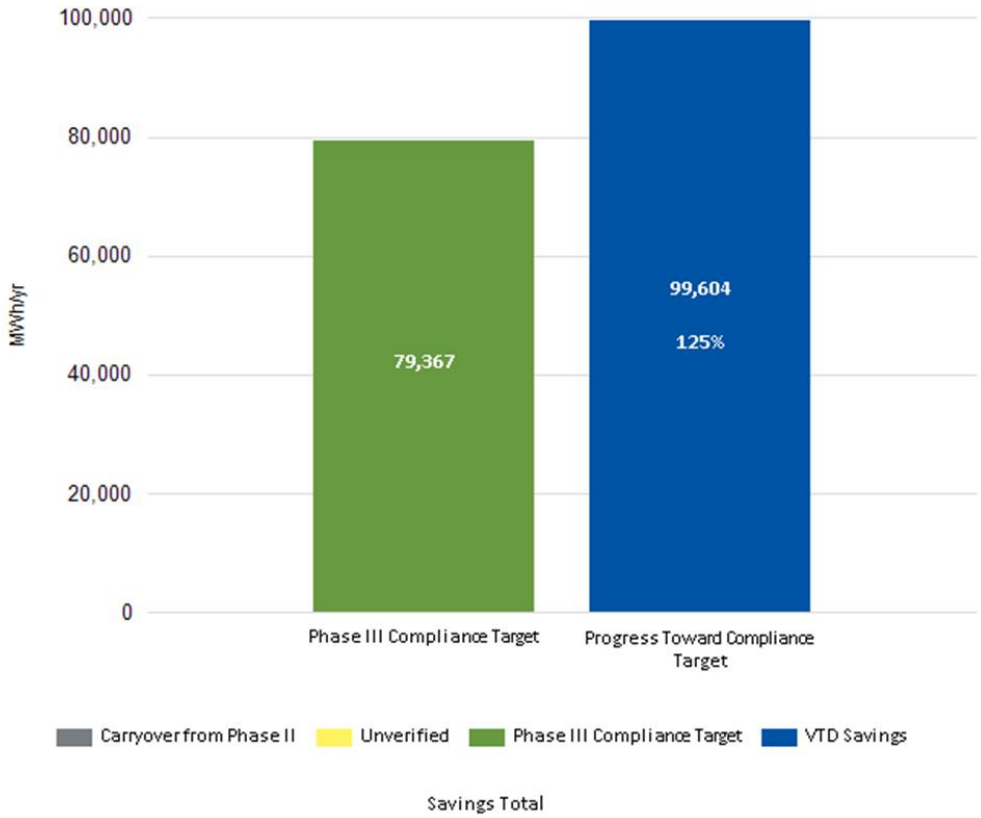
[8] Pennsylvania Public Utility Commission. *Phase III Implementation Order.* Docket No. M-2014-242-2424864. June 11, 2015.

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

no cost to the customer, which is 20% 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.[10] 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 PY11, PPL Electric Utilities has achieved 125% of the Phase III low-income energy-savings compliance target.

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

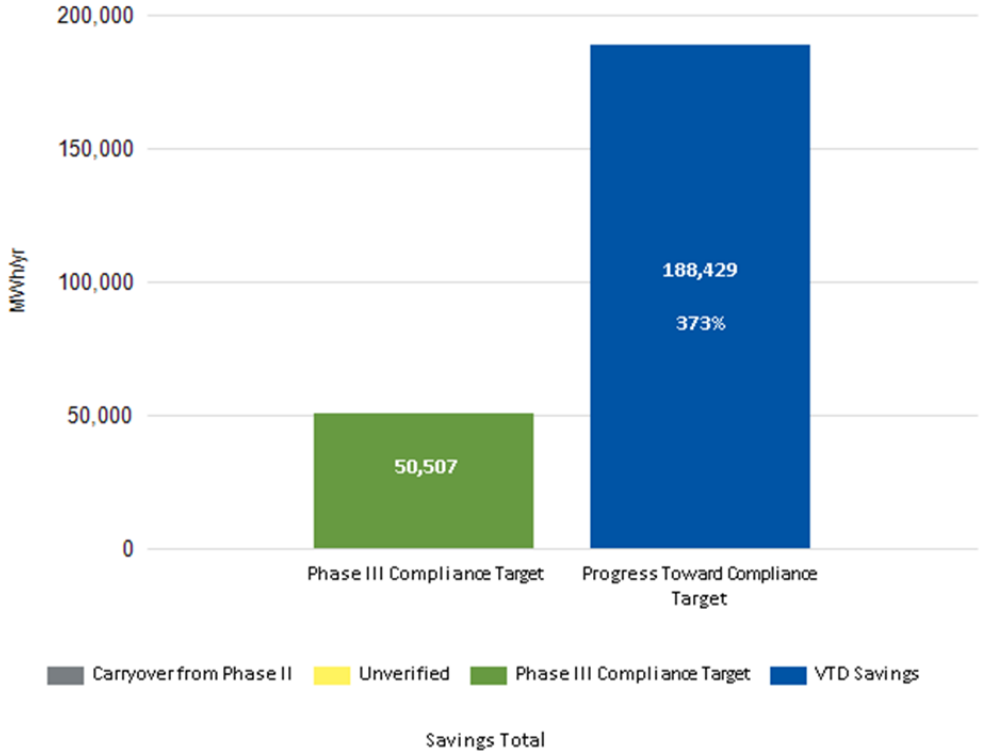


The Winter Relief Assistance Program (WRAP) includes savings for multifamily projects that are allocated to the GNE and small commercial and industrial (C&I) sectors based on the rate class of the buildings' meters. All savings from this component of the program are counted toward the low-income compliance 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).

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

The Phase III Implementation Order established a GNE energy savings compliance target of 3.5% of the portfolio savings.[11] 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 through PY11, PPL Electric Utilities has achieved 373% 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.

2.3 Phase III Demand Response Achievements to Date

PPL Electric Utilities' Phase III demand response compliance target is 92 MW/year. Compliance targets for demand response programs are based on average performance across events 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 line losses.

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

Act 129 demand response events are triggered by PJM Interconnection LLC regional transmission organization (PJM RTO) day-ahead load forecast. When the day-ahead forecast was above 96% of the peak load forecast for the year, a demand response event was initiated for the following day. In PY11, there were four 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. The table also lists the average demand response performance for PY11 and for Phase III to date. PPL Electric Utilities' average demand response performance to date exceeds the Phase III compliance reduction target of 92 MW by 23%.

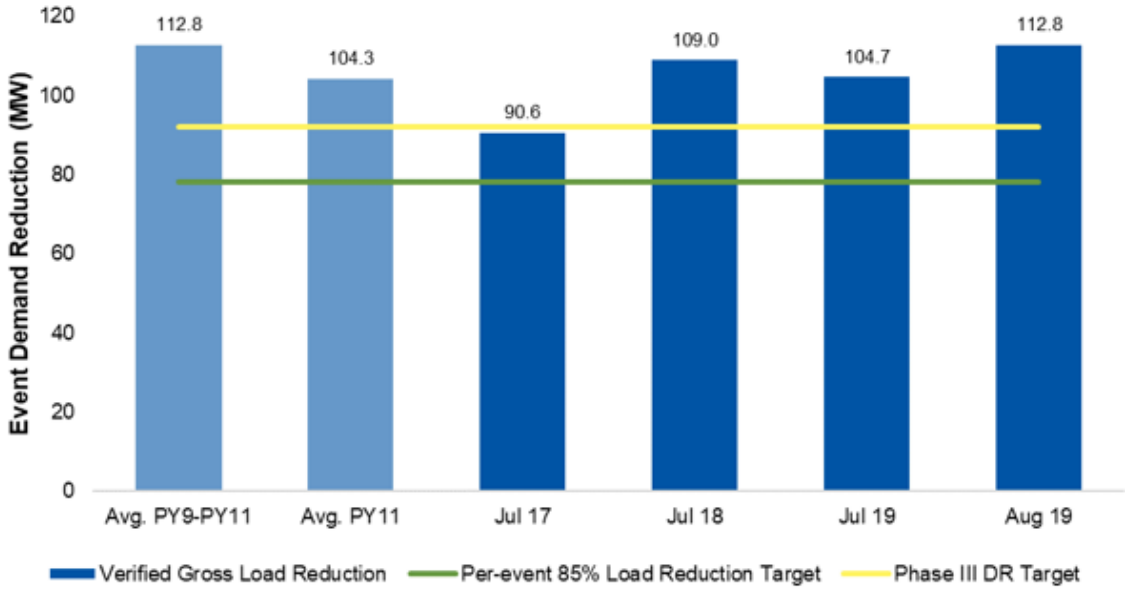
Table 2-3. PY11 Demand Response PYVTD Performance by Event

Event Date	Start Hour	End Hour	Load Curtailment			Portfolio MW/Event Impact [1]
			Small C&I	Large C&I	GNE	
Wednesday, July 17, 2019	2:00 p.m.	6:00 p.m.	1.7	82.4	6.5	**90.6**
Thursday, July 18, 2019	3:00 p.m.	7:00 p.m.	2.0	100.0	7.0	**109.0**
Friday, July 19, 2019	2:00 p.m.	6:00 p.m.	1.4	97.3	5.9	**104.7**
Monday, August 19, 2019	2:00 p.m.	6:00 p.m.	1.4	107.2	4.3	**112.8**
PYVTD - Average PY11 DR Event Performance						**104.3**
VTD - Average Phase III DR Event Performance						**112.8**

[1] Portfolio MW/event may not equal sum of customer segment MW/event because of rounding.

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 compares the performance of each of the demand response events in PY11 to the event-specific minimum and average targets.

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 PY11. 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. PY11 Summary Statistics by Customer Sector

Parameter	Residential	Low-Income	Small C&I	Large C&I	GNE	Total [1]
Reported Number of Participants [2]	282,693	60,372	9,740	1,398	2,606	356,809
PY11 Energy Realization Rate [3] [4]	104%	86%	97%	98%	98%	98%
PYVTD MWh/yr [3]	108,837	29,692	104,846	59,485	71,893	374,752
PY11 Demand Realization Rate [3] [4]	103%	106%	89%	99%	102%	98%
PYVTD MW/yr (Energy Efficiency) [3]	15.81	3.23	14.38	6.98	9.63	50.03
PYVTD MW/yr (Demand Response)	-	-	1.63	96.71	5.91	104.26
PY11 Incentives ($1000) [5]	$5,323	$0	$8,935	$4,490	$1,903	$20,651

[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] Realization rates exclude unverified savings from the New Homes component of the Energy Efficient Home Program.
[5] 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	1,363,902	129,796	62,600	3,091	7,451	1,566,840
P3TD Energy Realization Rate [2] [3]	100%	90%	91%	98%	98%	96%
VTD MWh/yr [2]	620,160	96,694	364,340	248,885	190,856	1,520,935
P3TD Demand Realization Rate [2] [3]	64%	107%	87%	101%	104%	86%
VTD MW/yr (Energy Efficiency) [2]	85.80	10.06	56.83	31.46	27.69	211.84
VTD MW/yr (Demand Response)	-	-	1.55	106.34	4.89	112.78
P3TD Incentives ($1000) [4]	$32,904	$0	$25,190	$17,636	$9,043	$84,774

[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] Realization rates exclude unverified savings from the New Homes component of the Energy Efficient Home 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. The incentives differ from Table 2-15 because incentives are discounted in Table 2-15.

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 PY11 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	PY11 TD Participation	P3TD Participation
Appliance Recycling	Unique job number; corresponds with each unique appliance decommissioned through the program during the program year.	13,117	51,547
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. The PY11 number reported in the infographic reflects the number of customers who participated in at least one event, 64; see Table 16-1.	70	227
Efficient Lighting	Person or business purchasing discounted bulbs. See the Efficient Lighting Chapter, Chapter 9.1.1 Definition of a Participant describing the approach to computing number of participants.	119,867	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. The PY11 number reported in the infographic reflects the number of participants who did not return a kit; 15,598; see Table 13-2.	15,682	55,137
Energy Efficient Home	Unique job number; corresponds to a rebated project. Households could have more than one rebated project.	19,634	84,235
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).	143,395	208,079
Non-Residential Energy Efficiency	*Custom:* Unique job number; commercially operable job that received an incentive payment during the reporting period. *Midstream Lighting Program:* Unique job number; corresponds to each purchase of discounted products. *Prescriptive Lighting and Equipment*: Unique job number; corresponds to each unique job that received a rebate.	9,031	25,544
Student Energy Efficient Education	Number of participants is counted as the number of energy conservation kits delivered.	24,357	96,381
WRAP	Unique bill account number; corresponds to an income-eligible household that receives an audit and program services. In PY8 (1), a participant was defined as a unique job, but the PY9 (2) updated definition is applied retroactively here. Therefore, the P3TD total will not match the PY8 total plus PY9TD + PY10TD + PY11TD. In PY10 (3), an LED giveaway component was added to the program. The participant count for this component is equal to the number of bulbs given away, 2,200 in PY11.	11,656	41,847
Portfolio Total (4)		**356,809**	**1,566,840**

Program	Participant Definition	PY11 TD Participation	P3TD Participation

[1] 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.
[2] 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.
[3] 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.
[4] The total does not match the total in the infographic due to adjustments noted above for the Energy Efficiency Kits and Education and the Demand Response Programs.

2.6 Summary of Impact Evaluation Results

During PY11, 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. PY11 Impact Evaluation Results Summary

Program	Energy Realization Rate [1]	Demand Realization Rate [1]	Net-to-Gross Ratio	Percentage of Total Portfolio Verified Gross	
				Verified MWh/yr	Verified MW/yr
Appliance Recycling	98%	99%	0.66 [2]	3%	1%
Demand Response	N/A	101%	1.0 [3]	0%	68%
Efficient Lighting	97%	94%	0.83 [4]	13%	4%
Energy Efficiency Kits and Education	78%	124%	1.0 [3]	3%	1%
Energy Efficient Home	105%	100%	0.66 [5]	5%	2%
Home Energy Education	107%	105%	1.0 [6]	10%	4%
Non-Residential Energy Efficiency	99%	89%	0.71 [7]	61%	19%
Student Energy Efficient Education	98%	104%	1.0 [3]	2%	0%
WRAP	91%	94%	1.0 [3]	4%	1%
Total	**98%**	**98%**	**0.78 [8]**	**100%** [9]	**100%** [9]

[1] Realization rates exclude unverified savings.
[2] PY10 evaluated NTG ratio.
[3] No free ridership is expected, nor measured, per the evaluation plan. Therefore, the NTG ratio is 1.0.
[4] PY8 evaluated NTG ratio.
[5] PY11 evaluated NTG ratio used for online marketplace program component. PY9 evaluated NTG ratios used for refrigerator and dehumidifier measures. PY8 evaluated NTG ratios used for all other measures. The 0.66 NTG ratio for the overall program is the verified gross population energy savings weighted average of the NTG ratios applied to each measure.
[6] Savings are determined using a randomized control trial and the NTG ratio is irrelevant.
[7] PY11 evaluated NTG ratio used for Custom, Efficient Equipment, and Midstream Lighting components.
[8] Weighted by PY11 program verified gross energy savings.
[9] 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 PY11 high-impact measures.

Table 2-8. PY11 High-Impact Measure Net-to-Gross

High-Impact Measure	Free Ridership	Spillover	Net-to-Gross Ratio
Efficient Equipment Commercial Lighting [1]	23% [2]	0%	0.77
Custom [1]	34% [2]	0%	0.66
Combined Heating and Power (CHP) [1] [3]	37% [2]	0%	0.63
Total	**28% [4]**	**0%**	**0.72**

[1] Estimated from PY11 survey data.
[2] Weighted by the survey sample-verified program kWh/yr savings.
[3] CHP projects are included in the Custom Program.
[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. New measures offered in the Energy Efficient Home Program are considered high-impact measures; however, no participants who purchased these measures completed a survey in PY11. Therefore, findings were determined using PY11 self-report surveys for commercial lighting and custom. Overall, the PY11 high-impact measure NTG research represents 53% of the total portfolio verified gross energy savings.

2.7 Summary of Energy Impacts by Program

Act 129 compliance targets are based on annualized savings (MWh/yr). Each program year, the annual savings achieved by EE&C program activity are recorded as incremental annual, or "first-year" savings, and added to an EDC's progress toward compliance. Incremental annual savings estimates are presented in the next section, *2.7.1 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 *2.7.2 Lifetime Energy Savings by Program* presents the lifetime energy savings by program.

2.7.1 Incremental Annual Energy Savings by Program

Figure 2-5 presents a summary of the program year-to-date (PYTD) energy savings by program for PY11. 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. PY11 PYTD Energy Savings by Energy Efficiency Programs

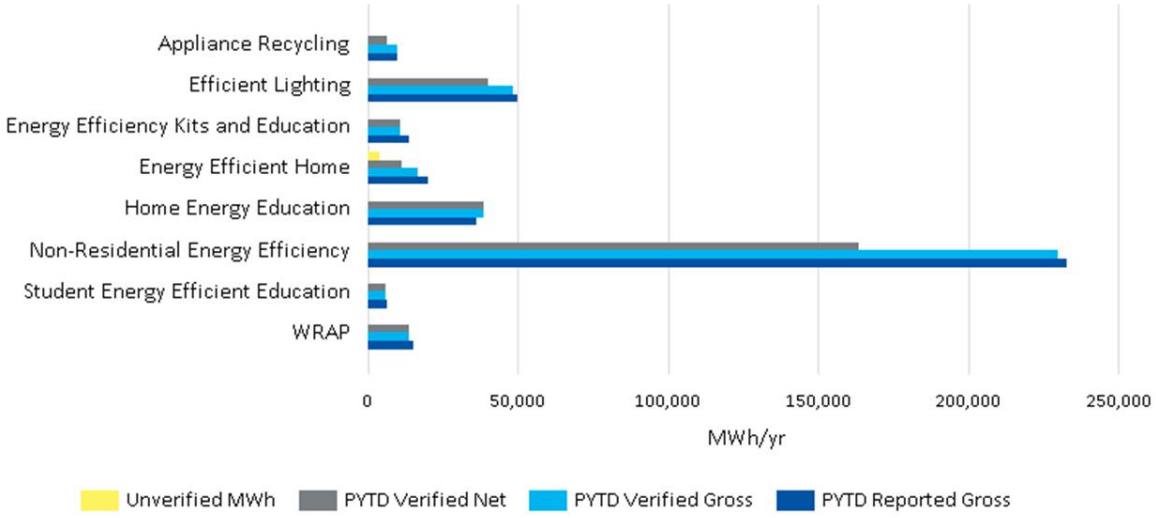
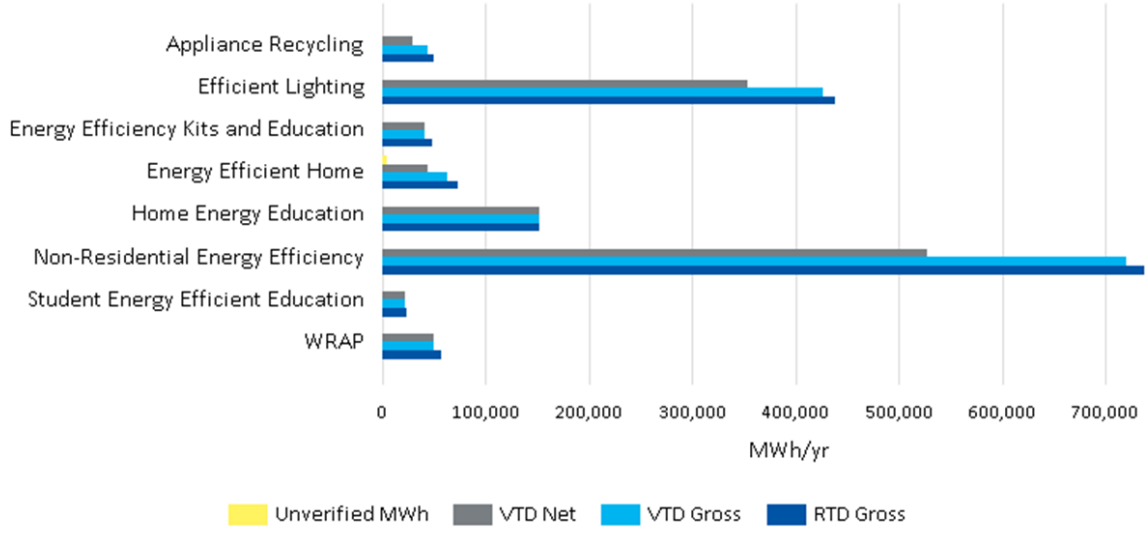


Figure 2-6 presents a summary of the energy savings by program for Phase III of Act 129.

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



A summary of energy impacts by program through PY11 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	10,119	9,945	-	6,564	49,903	43,883	-	28,963
Efficient Lighting	49,834	48,339	-	40,121	438,501	426,752	-	354,204
Energy Efficiency Kits and Education	14,011	10,888	-	10,888	48,719	41,240	-	41,240
Energy Efficient Home	20,261	16,929	4,084	11,192	73,021	63,336	4,084	43,669
Home Energy Education	36,145	38,787	-	38,787	152,567	152,174	-	152,174
Non-Residential Energy Efficiency	232,732	229,943	-	163,647	738,497	720,882	-	527,776
Student Energy Efficient Education	6,260	6,158	-	6,158	23,050	22,731	-	22,731
WRAP	15,197	13,764	-	13,764	57,369	49,937	-	49,937
Total[1]	**384,558**	**374,752**	**4,084**	**291,121**	**1,581,626**	**1,520,935**	**4,084**	**1,220,694**
Adjustment for Home Energy Education Double-Counted Savings		(5,431)	-	-	-	(21,964)	-	-
Adjusted Portfolio Savings [2] [3]		**369,322**	**-**		**1,581,626**	**1,498,971**	**-**	

[1] Unverified savings are attributed to the New Homes component in the Energy Efficient Home program.
[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 previously reported VTD savings from prior years, for the following program, have changed since the PY10 final annual report was submitted:

- **Efficient Lighting.** SWE audit activities recommended an adjustment of -916 MWh/year to the PY10 gross verified savings due to the SWE's finding that an incorrect baseline wattage was used for a small number of bulbs and fixtures. In the SWE's annual PY10 report, it noted that the TRM does not provide clear guidance for assigning baseline wattages to downlight fixtures and retrofit kits, which have become increasingly popular in the last couple years. The impact of the discrepancies the SWE identified on portfolio-level savings is minor, less than 0.06%.[12]

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

[12] Pennsylvania Public Utility Commission. *SWE Annual Report Act 129 Program Year 10.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and EcoMetric Consulting, LLC. Final Report, February 19, 2020.

Table 2-10. Savings by Reported and Verified Year

Program	Energy Savings (MWh/yr)							
Reporting Year	PY8		PY9		PY10		PY11	
Verified Year	PY8	PY9	PY9	PY10	PY10	PY11	PY11	Unverified in PY11
Appliance Recycling	11,844	-	10,731	-	11,362	-	9,945	-
Custom [1]	46,368	24,372	30,467	-	64,487	-	77,068	-
Efficient Equipment	70,917	-	115,994	-	96,197	-	125,081	-
Efficient Lighting	145,929	-	128,036	-	104,448	-	48,339	-
Energy Efficiency Kits and Education	9,219	-	11,829	-	9,304	-	10,888	-
Energy Efficient Home	9,943	-	18,802	-	17,661	-	16,929	4,084
Home Energy Education	34,326	-	36,232	-	42,829	-	38,787	-
Midstream Lighting	-	1,917	15,915	-	24,306	-	27,794	-
Student Energy Efficient Education	4,539	-	6,024	-	6,011	-	6,158	-
WRAP	2,652	11	14,412	-	19,097	-	13,764	-
Total	**335,739**	**26,299**	**388,442**	**-**	**395,702**	**-**	**374,752**	**4,084**

[1]The Custom Program includes Continuous Energy Performance (CEI) Program savings.

2.7.2 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.[13]

Table 2-11. Lifetime Energy Savings

Program	PY11		Phase III	
	PYVTD Gross Lifetime (MWh/yr)	PYVTD Net Lifetime (MWh/yr)	VTD Gross Lifetime (MWh/yr)	VTD Net Lifetime (MWh/yr)
Appliance Recycling	73,929	48,793	319,704	210,628
Efficient Lighting	215,800	179,114	3,161,616	2,624,143
Energy Efficiency Kits and Education	63,664	63,664	211,798	211,798
Energy Efficient Home	226,058	147,262	771,070	511,586
Home Energy Education	38,787	38,787	143,748	143,748
Student Energy Efficient Education	40,964	40,964	142,414	142,414
Non-Residential Energy Efficiency	3,396,961	2,419,773	10,072,407	7,456,243

[13] 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.

Program	PY11		Phase III	
	PYVTD Gross Lifetime (MWh/yr)	PYVTD Net Lifetime (MWh/yr)	VTD Gross Lifetime (MWh/yr)	VTD Net Lifetime (MWh/yr)
WRAP	75,078	75,078	267,659	267,659
Total[1]	**4,131,243**	**3,013,436**	**15,090,420**	**11,568,221**
Adjustment for Home Energy Education Double-Counted Savings	(5,431)	(5,431)	(20,695)	(20,695)
Portfolio Total [1] [2]	**4,125,812**	**3,008,006**	**15,069,725**	**11,547,527**

[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.

2.8 Summary of Demand Impacts by Program

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

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

Demand response goals are based on average portfolio impacts across all events called in dedicated demand response programs, so cumulative demand response performance is expressed as the *average* performance of each of the demand response events called in Phase III to date.

Because of these differences, demand impacts from energy efficiency and demand response are reported separately in the following subsections.

2.8.1 Energy Efficiency

Act 129 defines peak demand 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 PY11.

Figure 2-7. PYTD Demand Savings by Energy Efficiency Program

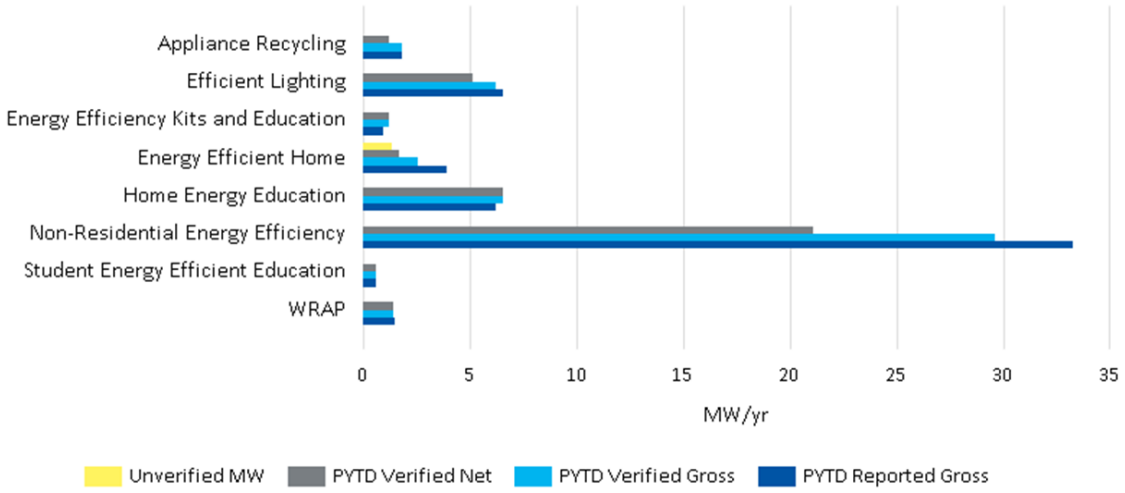
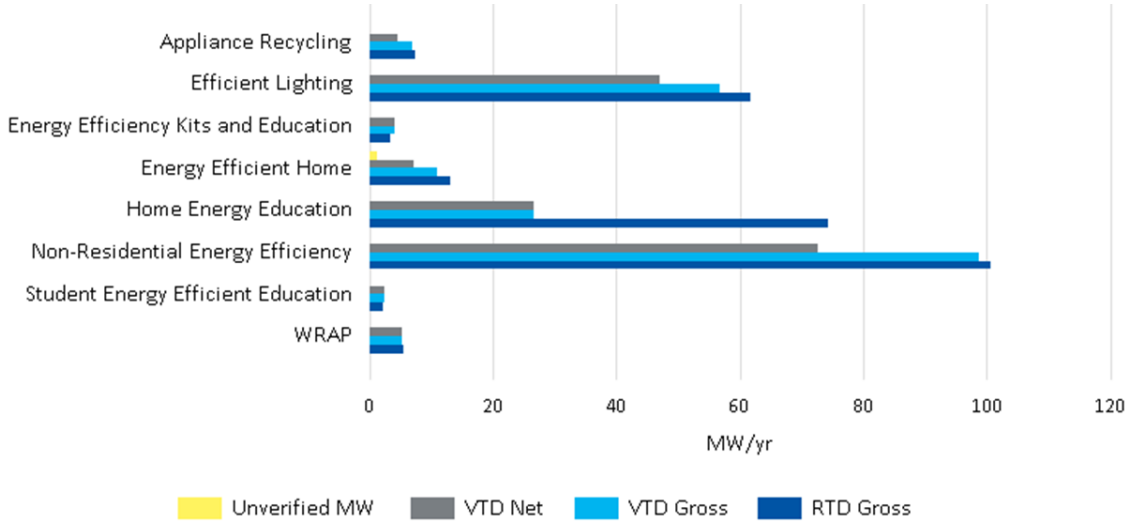


Figure 2-8 presents a summary of the P3TD demand savings by energy efficiency program for Phase III of Act 129.

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



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

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	1.84	1.82	-	1.20	7.55	6.87	-	4.54
Efficient Lighting	6.60	6.21	-	5.16	61.68	56.83	-	47.17
Energy Efficiency Kits and Education	0.97	1.20	-	1.20	3.43	4.13	-	4.13
Energy Efficient Home	3.95	2.57	1.38	1.68	13.17	11.05	1.38	7.27
Home Energy Education	6.23	6.55	-	6.55	74.45	26.64	-	26.64
Non-Residential Energy Efficiency	33.30	29.63	-	21.14	100.71	98.73	-	72.65
Student Energy Efficient Education	0.61	0.64	-	0.64	2.23	2.37	-	2.37
WRAP	1.49	1.40	-	1.40	5.62	5.22	-	5.22
Total[2]	**54.98**	**50.03**	**1.38**	**38.97**	**268.84**	**211.84**	**1.38**	**169.99**
Adjustment for Home Energy Education Double-Counted Savings		(0.77)				(2.45)		
Adjusted Total[2] [3]	**54.98**	**49.26**	**1.38**	**38.97**	**268.84**	**209.39**	**1.38**	**169.99**

[1] Unverified savings are attributed to the New Homes component in the Energy Efficient Home program.
[2] Total may not match sum of rows due to rounding.
[3] The adjustments in this table account for uplift (double-counting) in the Home Energy Education Program.

The previously reported VTD savings from prior years, for the following program, have changed since the PY10 final annual report was submitted:

- **Efficient Lighting.** SWE audit activities recommended an adjustment of -0.12 MW/year to the PY10 gross verified savings due to the SWE's finding that incorrect baseline wattage was used for a small number of bulbs and fixtures. In the SWE's annual PY10 report, it noted that the TRM does not provide clear guidance for assigning baseline wattages to downlight fixtures and retrofit kits, which have become increasingly popular in the last couple years.

2.8.2 Demand Response

Act 129 defines peak demand savings 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 (starting in PY11) 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 RTO 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.

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	104.3	3.5%	112.8	1.8%
Portfolio Total	**104.3**	**3.5%**	**112.8**	**1.8%**

2.9 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 PY11 and to date in Phase III.

Table 2-14. Phase III Fuel Switching Summary

Metric	PY11	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)	46,390 MWh/yr	110,249 MWh/yr
Increased Fossil Fuel Consumption Due to Fuel Switching Measures (MMBTU/yr)	153,320 MMBTU/yr	472,556 MMBTU/yr
Incentive Payments for Fuel Switching Measures ($1000)	$343	$2,602

2.10 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) PY11 costs and benefits are expressed in PY11 dollars (PY11 includes months in both 2019 and 2020). Net present value 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.

Table 2-15. Summary of Portfolio Finances – Gross Verified [12]

Row #	Cost Category	PY11 ($1,000)		P3TD ($1,000) [10]	
1	EDC Incentives to Participants [1]	$20,652		$76,212	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	$78,624		$242,182	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [9]**	**$99,276**		**$318,394**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	($1)	$54	$449	$476
6	Administration, Management, and Technical Assistance [3]	$1,915	$679	$8,280	$2,939
7	Marketing [4]	$1,068	$1,751	$4,884	$8,936
8	Program Delivery [5]	-	$24,450	-	$81,076
9	EDC Evaluation Costs	$2,073		$9,527	
10	SWE Audit Costs	$400		$1,738	
11	**Program Overhead Costs (Sum of rows 5 through 10) [9]**	**$32,389**		**$118,305**	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	**$8,101**		**$18,808**	
13	**Total NPV TRC Costs [6] [9] (Net present value of sum of rows 4, 11, and 12)**	**$139,766**		**$455,507**	
14	Total NPV Lifetime Electric Energy Benefits	$171,550		$537,119	
15	Total NPV Lifetime Electric Capacity Benefits	$30,011		$102,230	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$12,841		$77,828	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	$9,380		$19,226	
18	**Total NPV TRC Benefits [7] (Sum of rows 14 through 17) [9] [11]**	**$223,782**		**$736,403**	
19	**TRC Benefit-Cost Ratio [8] [9]**	**1.60**		**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.
[12] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.

Table 2-16 shows the TRC ratios by program and for the portfolio. The benefits were calculated using gross verified impacts. PY11 benefits and costs are expressed in PY11 dollars as the analysis is completed, using program years that align nominal calendar years values to a program year. The

Demand Response Program costs shown in Table 2-16 through Table 2-20 include those costs incurred for PY11 after the Semi-Annual Report to the PA PUC filed January 15, 2020.

Table 2-16. PY11 Gross TRC Ratios by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	$3,843	$2,156	1.78	$1,687
Efficient Lighting	$12,863	$4,281	3.01	$8,582
Energy Efficiency Kits and Education	$7,493	$1,373	5.46	$6,120
Energy Efficient Home [1]	$18,203	$13,684	1.33	$4,519
Home Energy Education	$2,358	$1,845	1.28	$513
Student Energy Efficient Education	$7,522	$1,654	4.55	$5,868
WRAP	$6,115	$8,161	0.75	($2,046)
Residential (Including Low-Income) Subtotal [2] [3]	**$58,397**	**$33,154**	**1.76**	**$25,245**
Non-Residential Subtotal [2]	**$160,902**	**$99,554**	**1.62**	**$61,348**
Demand Response	$4,803	$1,674	2.87	$3,129
Common Portfolio Costs and Uplift	($319)	$5,385		($5,704)
Portfolio Total [2]	**$223,782**	**$139,766**	**1.60**	**$84,016**

[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.
[2] Total may not match sum of rows due to rounding.
[3] Low-income is shown as a subsector of residential in this table.

Table 2-17 presents PY11 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 NTGR), and operations and maintenance (O&M) benefits.

Table 2-17. PY11 Net TRC Ratios by Program ($1,000)

Program	TRC NPV Benefits	TRC NPV Costs	TRC Ratio	TRC Net Benefits (Benefits–Costs)
Appliance Recycling	$2,537	$2,156	1.18	$381
Efficient Lighting	$10,676	$3,792	2.82	$6,884
Energy Efficiency Kits and Education	$7,493	$1,373	5.46	$6,120
Energy Efficient Home [1]	$11,988	$9,751	1.23	$2,237
Home Energy Education	$2,358	$1,845	1.28	$513
Student Energy Efficient Education	$7,522	$1,654	4.55	$5,868
WRAP	$6,115	$8,161	0.75	($2,046)
Residential (Including Low-Income) Subtotal [2] [3]	**$48,689**	**$28,732**	**1.69**	**$19,957**
Non-Residential Subtotal [2]	**$114,576**	**$71,804**	**1.60**	**$42,772**
Demand Response	$4,803	$1,674	2.87	$3,129
Common Portfolio Costs and Uplift	($319)	$5,385	-	($5,704)
Portfolio Total [2]	**$167,748**	**$107,595**	**1.56**	**$60,153**

[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.
[2] Total may not match sum of rows due to rounding.
[3] 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	$14,242	$7,395	1.93	$6,847
Efficient Lighting	$184,109	$37,229	4.95	$146,880
Energy Efficiency Kits and Education	$19,341	$5,987	3.23	$13,354
Energy Efficient Home [1]	$54,167	$57,576	0.94	($3,409)
Home Energy Education	$7,281	$5,162	1.41	$2,119
Student Energy Efficient Education	$16,126	$4,251	3.79	$11,875
WRAP	$20,417	$26,747	0.76	($6,330)
Residential (Including Low-Income) Subtotal [2] [3]	**$315,683**	**$144,347**	**2.19**	**$171,336**
Non-Residential Subtotal [2]	**$408,223**	**$279,152**	**1.46**	**$129,071**
Demand Response	$13,474	$5,346	2.52	$8,128
Common Portfolio Costs and Uplift	($977)	$26,661	-	($27,638)
Portfolio Total [2]	**$736,403**	**$455,507**	**1.62**	**$280,896**

[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.
[2] Total may not match sum of rows due to rounding.
[3] 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, NTG ratios determined in PY8, PY9, and PY10 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	$13,194	$7,395	1.78	$5,799
Efficient Lighting	$182,355	$36,838	4.95	$145,517
Energy Efficiency Kits and Education	$19,341	$5,987	3.23	$13,354
Energy Efficient Home [1]	$49,183	$54,422	0.90	($5,239)
Home Energy Education	$7,281	$5,162	1.41	$2,119
Student Energy Efficient Education	$16,126	$4,251	3.79	$11,875
WRAP	$20,417	$26,747	0.76	($6,330)
Residential (Including Low-Income) Subtotal [2] [3]	**$307,897**	**$140,802**	**2.19**	**$167,095**
Non-Residential Subtotal [2]	**$371,068**	**$256,896**	**1.44**	**$114,172**
Demand Response	$13,474	$5,346	2.52	$8,128
Common Portfolio Costs and Uplift	($977)	$26,661	-	($27,638)
Portfolio Total [2]	**$691,462**	**$429,705**	**1.61**	**$261,757**

[1] Programs with unverified savings do not include verified or associated participant measure costs in cost-effectiveness.
[2] Total may not match sum of rows due to rounding.
[3] Low-income is shown as a subsector of residential in this table.

2.11 Comparison of Performance to Approved EE&C Plan

Table 2-20 presents PY11 expenditures, by program, compared to the budget estimates set forth in the EE&C plan for PY11.[14] All of the dollars in this table are presented in PY11 dollars.

Table 2-20. Comparison of PY11 Expenditures to Phase III EE&C Plan ($1,000)

Program	PY11 Budget from EE&C Plan	PY11 Actual Expenditures (1)	Ratio (Actual/Plan)
Appliance Recycling	$2,431	$2,156	89%
Demand Response	$3,227	$1,970	61%
Efficient Lighting	$5,005	$3,415	68%
Energy Efficiency Kits and Education	$1,596	$1,373	86%
Energy Efficient Home (2)	$8,864	$6,352	72%
Home Energy Education (3)	$2,230	$1,845	83%
Non-Residential Energy Efficiency	$24,283	$21,162	87%
Student Energy Efficient Education (3)	$876	$1,654	189%
WRAP (3)	$11,132	$8,161	73%
Total Direct Program Costs (4)	**$59,645**	**$48,086**	**81%**
Common Portfolio Costs (5)	-	$5,385	-
Portfolio Total (4)	**$59,645**	**$53,471**	**90%**

(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 this program include costs attributable to unverified projects; these costs were not included in the PY11 TRC analysis.
(3) The expenditures associated with the low income sector in the Home Energy Education and Student Energy Efficient Education programs are associated with the WRAP program in this table, to be consistent with how these expenditures were budgeted in the EE&C plan. Therefore, the expenditures for these programs will not match the totals reported in Table 4-1 and used in the TRC analyses for these programs.
(4) Total may not match sum of rows due to rounding.
(5) Common costs include SWE costs.

Table 2-21 presents P3TD expenditures, by program, compared to the projected budget estimates set forth in the EE&C plan through PY11. All dollars are presented in PY11 dollars.

[14] 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. Comparison of P3TD Expenditures to Phase III EE&C Plan ($1,000)

Program	Phase III Budget from EE&C Plan through PY11	Phase III Actual Expenditures through PY11 [1]	Ratio (Actual/Plan)
Appliance Recycling	$8,996	$8,253	92%
Demand Response	$9,256	$7,106	77%
Efficient Lighting	$36,217	$29,975	83%
Energy Efficiency Kits and Education	$5,766	$6,578	114%
Energy Efficient Home [2]	$25,743	$23,960	93%
Home Energy Education [3]	$7,765	$5,853	75%
Non-Residential Energy Efficiency	$86,409	$71,283	82%
Student Energy Efficient Education [3]	$4,243	$4,814	113%
WRAP [3]	$36,958	$30,212	82%
Total Direct Program Costs [4]	**$221,353**	**$188,034**	**85%**
Common Portfolio Costs [5]	$34,480	$29,398	85%
Portfolio Total [4]	**$255,833**	**$217,432**	**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 this program include costs attributable to unverified projects; these costs were not included in the TRC analysis.
[3] The expenditures associated with the low income sector in the Home Energy Education and Student Energy Efficient Education programs are associated with the WRAP program in this table, to be consistent with how these expenditures were budgeted in the EE&C plan. Therefore, the expenditures for these programs will not match the totals reported in Table 4-1 and used in the TRC analyses for these programs.
[4] Total may not match sum of rows due to rounding.
[5] Common costs include SWE costs.

Table 2-22 compares PY11 verified gross program savings compared to the energy savings projections set forth in the EE&C plan.

Table 2-22. Comparison of PY11 Actual Program Savings to EE&C Plan Projections for PY11

Program	PY11 EE&C Plan (MWh/yr)	PY11 Gross Savings (MWh/yr) [1]	Ratio (Actual/Plan)
Appliance Recycling	11,994	9,945	83%
Efficient Lighting	41,402	48,339	117%
Energy Efficiency Kits and Education	8,318	10,888	131%
Energy Efficient Home	19,454	16,929	87%
Home Energy Education	46,611	38,787	83%
Non-Residential Energy Efficiency	181,209	229,943	127%
Student Energy Efficient Education	2,816	6,158	219%
WRAP	14,755	13,764	93%
Total[2]	**326,560**	**374,752**	**115%**
Adjustment for Home Energy Education Double-Counted Savings		(5,431)	
Portfolio Total [2] [3]	**326,560**	**369,322**	**113%**

[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 PY11 (MWh/yr)	VTD Gross MWh/Yr Savings through PY11 (MWh/yr) [1]	Ratio (Actual/Plan)
Appliance Recycling	50,206	43,883	87%
Efficient Lighting	292,853	426,752	146%
Energy Efficiency Kits and Education	31,095	41,240	133%
Energy Efficient Home	51,160	63,336	124%
Home Energy Education	168,862	152,174	90%
Non-Residential Energy Efficiency	634,001	720,882	114%
Student Energy Efficient Education	15,991	22,731	142%
WRAP	51,936	49,937	96%
Total [2]	**1,296,105**	1,520,935	**117%**
Adjustment for Home Energy Education Double-Counted Savings		(21,964)	
Portfolio Total [2] [3]	**1,296,105**	**1,498,971**	**116%**

[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 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 83% of projected energy savings. The program did not meet the projected savings for PY11 because PPL Electric Utilities suspended the program in March 2020 due to concerns about in-person appliance pick-up due to COVID-19.
- **Demand Response.** In PY11, PPL Electric Utilities' Demand Response Program achieved 113% of the compliance target of 92 MW.
- **Efficient Lighting (residential sector).** The Efficient Lighting Program achieved 117% of its projected energy savings for PY11 and an energy savings realization rate of 97%. In PY11, baseline wattage adjustments increased program energy savings by 0.4%. However, cross-sector sales adjustments decreased program energy savings by 3.4%. Overall, these adjustments produced a net 3.0% decrease in verified savings compared to reported savings.
- **Energy Efficiency Kits and Education (residential low-income sector).** The program savings achieved 131% of the estimated projections for PY11, because the ICSP distributed more than 15,000 kits in PY11, many more than the 8,000 kits projected in the EE&C plan for PY11. PPL Electric Utilities and the ICSP made the decision to send more kits to increase the savings prior to phasing out kits in PY12.
- **Energy Efficient Home (residential sector).** The Energy Efficient Home Program achieved 87% of projected energy savings. Due to COVID-19, Cadmus was unable to conduct site visits and verify

the saturation rates of lighting and appliances in PY11, leaving more than 4,000 MWh/yr unverified, which meant the program did not meet its projected savings for PY11. Once these savings are verified in PY12, the program is expected to reach its PY11 projected energy savings.

- **Home Energy Education (residential sector).** The program achieved 80% of the estimated residential savings projections for PY11.[15] 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 are attributed to WRAP.
- **Non-Residential.** The Non-Residential Energy Efficiency Program exceeded its projected energy savings for the year, achieving 127% of the estimated projections for PY11. The following factors affected the program's progress toward the estimated savings projected for PY11:
  - The Lighting and Equipment components achieved verified savings of 54% of total program projected savings for PY11, at a realization rate of 102% for lighting and 86% for equipment.
  - The Custom component achieved verified energy savings that contributed 34% of projected savings for PY11, at a realization rate of 96%.
  - The Midstream Lighting component contributed verified savings of 12% to the program, at a realization rate of 94%.
  - 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 86% of the estimated residential projections for PY11.[16] PPL Electric Utilities' EE&C Plan added a low-income Student Energy Efficient Education offering to its portfolio in PY10. In PY11, the ICSP targeted schools with low-income students, increasing program participation in PY11. Sixty-one percent of the program's savings 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 PY11 are attributed to WRAP.
- **WRAP (residential low-income sector).** The program's verified savings met 119% of estimated savings projected for PY11, 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.[17]

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[15] Excludes savings attributable to the low-income sectors and does not match Table 2-22.

[16] Ibid.

[17] Includes low-income savings from the Home Energy Education and Student Energy Efficient Education programs and does not match Table 2-22.

Program Changes for PY12

PPL Electric Utilities has made the following program changes:

- **Appliance Recycling Program.** The program was suspended in March 2020. PPL Electric Utilities has been following state and county COVID-19 guidelines to ensure the safety of all who interact with PPL Electric Utilities' customers and teams. In PY12, PPL Electric Utilities began contactless pick-ups for wait-listed customers only. The program is expected to reopen in December 2020 to all customers, and appliance pick-up will remain contactless.
- **Demand Response.** Because of the COVID-19 pandemic, PPL Electric Utilities joined a petition with the Energy Association of Pennsylvania (EAP) and the other Pennsylvania EDCs requesting that PY12 of the Demand Response Program be altered to mitigate any associated unmanageable risk. The PA PUC granted the EDCs the ability to make the program voluntary, while encouraging them to continue offering the program. PPL Electric Utilities complied with this request and held five events in the final year of the program.
- **Home Energy Education.** The program was modified in PY11 to add a low-income component. PPL Electric Utilities began offering home energy reports (HERs) to low-income customers with specific messaging and tips to encourage these customers to enroll in its low-income programs (WRAP and OnTrack). Savings for this low-income component will be reported under WRAP. In PY12, HERs will be sent only to low-income customers.
- **Non-Residential**
  - **Custom.** In PY12, PPL Electric Utilities will continue to work with customers and contractors to safely fulfill the data logging requirements. Virtual site visits were used in PY11 and will continue in PY12.
  - **Efficient Equipment**. As of January 2020, all efficient equipment projects now require preapproval prior to construction. Preapproval for all projects will remain in effect in PY12.
- **Student Energy Efficient Education**. The PA PUC's approval of changes to PPL Electric Utilities' EE&C Plan in PY11 included the addition of a program component targeting low-income schools. In PY12, this program will continue to focus on schools in low-income areas of PPL Electric Utilities' service territory with a minimum of 45% reduced and free lunches, as documented by the Pennsylvania Department of Education. Savings for this low-income component will be reported under WRAP. Due to the COVID-19 pandemic, all classroom presentations will be completed virtually.
- **WRAP.** In March of PY11, the program was suspended due to COVID-19. PPL Electric Utilities worked with the ICSP to develop a virtual assessment offering the same products and equipment as before the pandemic.

2.12 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 PY11 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. PY11 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			**17,907**
Appliance Recycling	Online	All Records (4,580)	482
Energy Efficient Home Equipment	Online	All Records (6,940)	705
Energy Efficient Home Weatherization	Online	All Records (435)	
Energy Efficient Home In-home Audit	Online	All Records (72)	
Energy Efficient Home Online Assessment	Online	All Records (2,860)	
Energy Efficient Online Marketplace	Online	All Records (479)	
Student Energy Efficient Education	ICSP subcontractor-administered paper and online home energy worksheets (HEWs)	All Returned Surveys (16,720)	16,720
Non-Residential Sector			**109**
Custom	Online and telephone	All Records (34)	16
Efficient Equipment	Online and telephone	69	79
Midstream Lighting	Telephone: Participating Distributors	15	14
Low-Income Sector			**2,052**
Energy Efficiency Kits and Education	Paper kit survey	All Records (15,598)	1,897
WRAP	Telephone (residential participants)	155	155
Portfolio			**20,068**

(1) All records includes 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 PY11 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, *Evaluation Results by Program*, may not match each other.

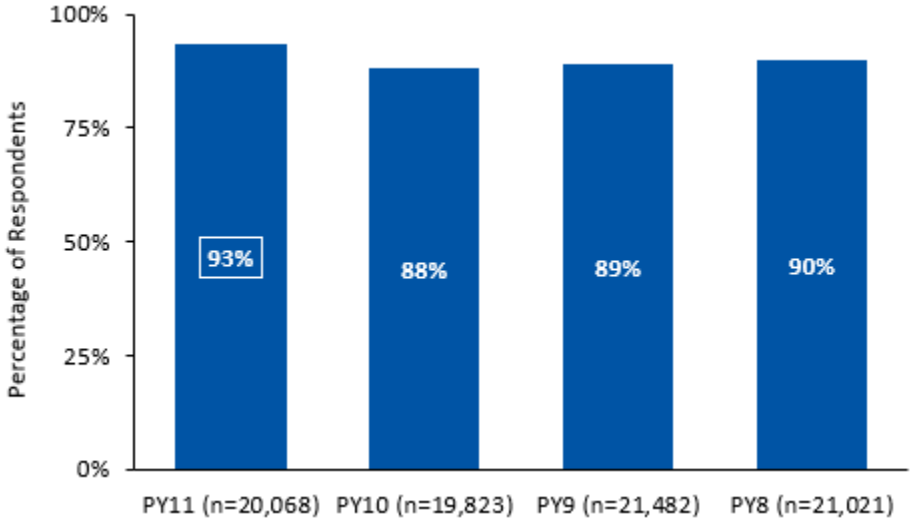
2.12.1 Portfolio-Level Program Satisfaction

Throughout this report, Cadmus refers to the PY8 through PY11 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, PY11 achieved high program satisfaction.

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



The program satisfaction results include all responses to the satisfaction question, averaged to compute the portfolio level satisfaction. The percentage in the white box indicates that the difference between PY11 and PY10 is statistically significant, p≤0.10. Source: Participant survey question, "How would you rate your overall satisfaction with the program?"
The PY9 Annual Report included the results for the Demand Response Program,
but in this figure the results for the Demand Response Program are not included in any of the other program years.

2.12.2 Program Satisfaction by Sector

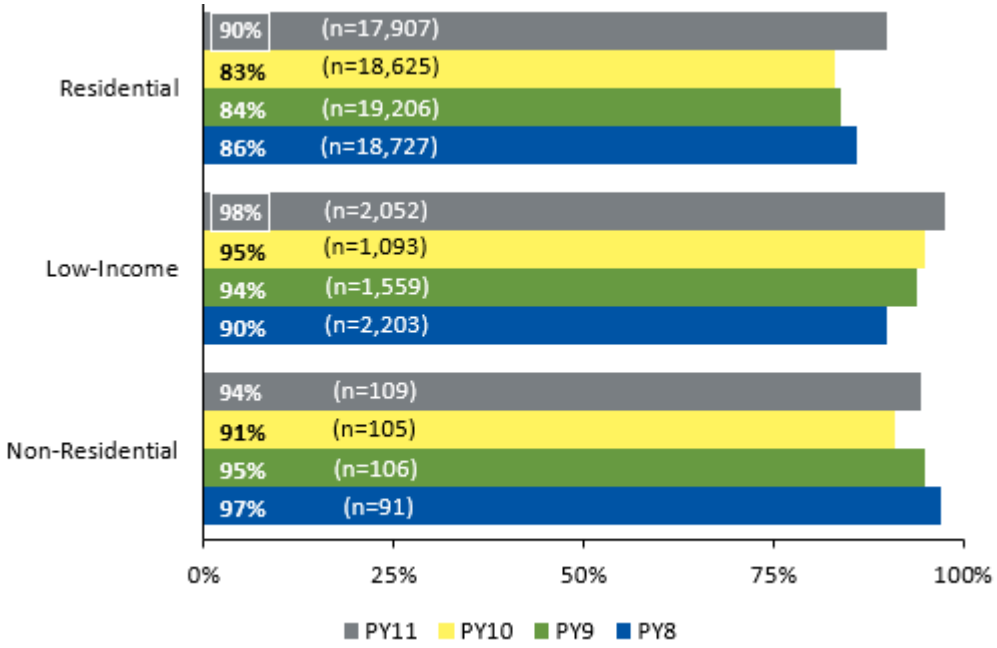
For Phase III, PPL Electric Utilities established a sector-level satisfaction goal to achieve 80% or greater of *very satisfied* and *somewhat satisfied* customers.[18] As shown in Figure 2-10, respondents across all three sectors showed high program satisfaction and exceeded the customer satisfaction goal of 80% or greater. The low-income sector achieved the highest percentage of satisfied respondents at 98% (n=2,052), compared to 94% for the nonresidential sector (n=109) and 90% for the residential sector (n=17,907). The residential and low-income sectors in PY11 observed a significant increase in program satisfaction from PY10.[19]

[18] 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.

[19] Difference is statistically significant, p≤0.10.

Figure 2-10. PY11 Program Satisfaction by Sector

Very and *Somewhat Satisfied* Combined



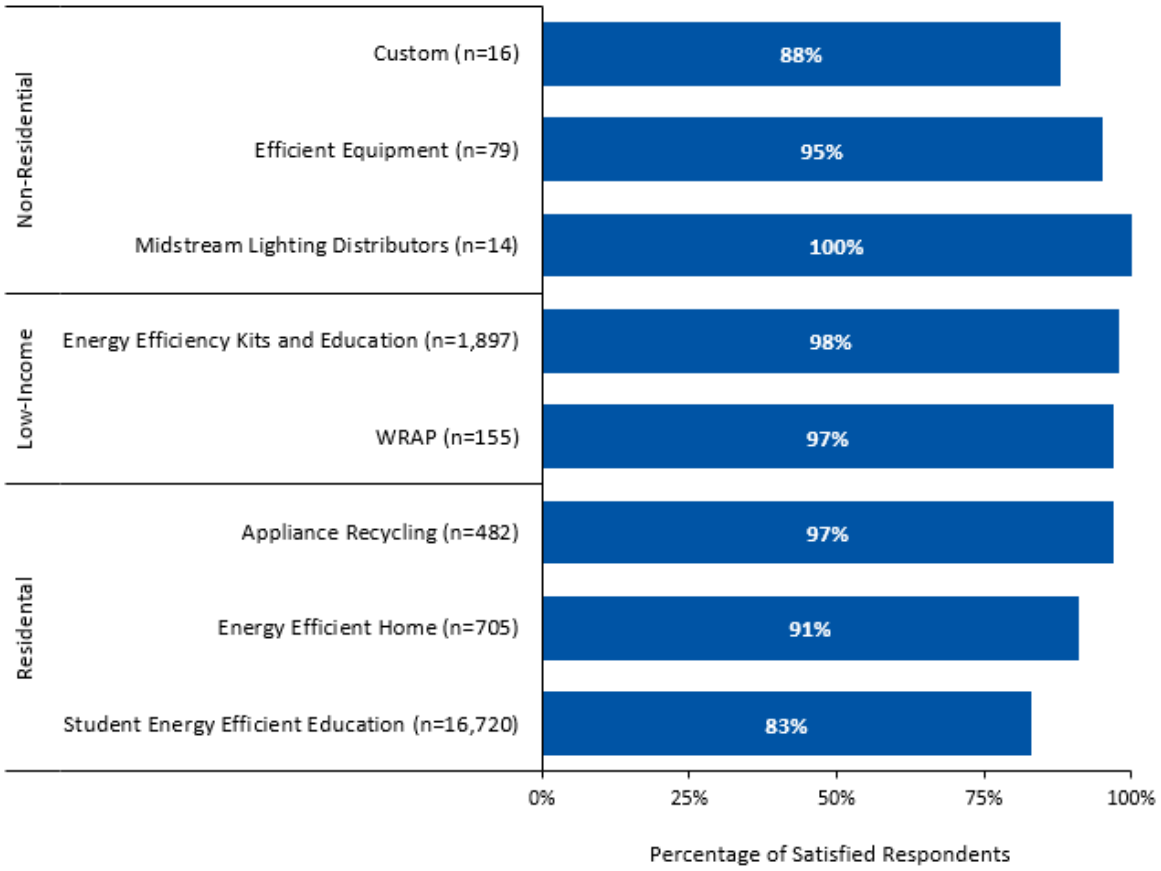
The percentage in the black box indicates that the difference between PY10 and PY11 is statistically significant, at p≤0.10 or better. The program satisfaction results include all responses to the satisfaction question. Source: Participant survey question, "How would you rate your overall satisfaction with the program?"

2.12.3 Program Satisfaction by Individual Program

Figure 2-11 shows the satisfaction results for each program. The Midstream Lighting Program achieved the highest satisfaction (100%, n=14). The Student Energy Efficient Education Program achieved the lowest satisfaction (83%, n=16,720).

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

Figure 2-11. PY11 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?"

2.13 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 PY11, along with the outcomes of those activities. The individual program chapters are organized by the largest contributor to PY11 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. PY11 Evaluation Activity Matrix

Program	Sector	Gross Impact	Net Impact	Process[1]
Appliance Recycling	Residential	✓		✓
Demand Response	Demand Response	✓		✓
Energy Efficient Home	Residential	✓	✓	✓
Energy Efficiency Kits and Education	Low-Income	✓		✓
Efficient Lighting	Residential	✓		
Home Energy Education	Residential	✓		✓
Non-Residential Energy Efficiency	Nonresidential	✓	✓	✓
Student Energy Efficient Education	Residential	✓		✓
WRAP	Low-income	✓		✓

[1] Cadmus conducted a limited process evaluation in PY11.

3.1 Impact Evaluation

Impact evaluation activities varied by program in PY11. 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 PY11 along with the number of site visits conducted for each program. Because of COVID-19, Cadmus converted some in-person site visits to virtual site visits.

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

Table 3-2. PY11 Impact Evaluation Activities by Program

Program	Impact Evaluation Activity						
	Database Review	Records Review	Desk Audits	Site Visits [1]	Metering	Engineering Analysis	Billing Analysis
Appliance Recycling	✓					✓	
Demand Response	✓	✓					✓
Energy Efficient Home	✓	✓				✓	
Energy Efficiency Kits and Education	✓	✓				✓	
Efficient Lighting	✓	✓				✓	
Home Energy Education	✓						✓
Non-Residential - Custom	✓	✓		✓ [2]	✓	✓	✓
Non-Residential - Efficient Equipment	✓	✓	✓	✓ [3]		✓	
Non-Residential - Midstream Lighting	✓	✓	✓	✓ [4]		✓	
Student Energy Efficient Education	✓					✓	
WRAP	✓	✓				✓	

[1] Site visits completed by Cadmus either in-person or virtually.
[2] Includes 45 visits (10 virtual) across 31 projects.
[3] Includes 11 equipment visits (2 virtual) and 19 lighting visits (3 virtual).
[4] Includes 4 site visits for 5 projects (2 virtual) with 8 jobs.

3.2 Process Evaluation

This section summarizes the process evaluation of PPL Electric Utilities' PY11 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 PY11, 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. PY11 Process Evaluation Activities by Program

Program	Completed Participant Survey [1]	Participant Satisfaction Analysis	Stakeholder Interview	Trade Ally Interview	Market Actor Interview
Appliance Recycling	552	✓	✓		
Demand Response	10	✓	✓		
Energy Efficient Home	700 [2]	✓	✓	11 [3]	
Energy Efficiency Kits and Education	1,927 [4]	✓	✓		
Home Energy Education		N/A	✓		
Non-Residential - Custom	16	✓	✓		
Non-Residential - Efficient Equipment	80 [5]	✓	✓		
Non-Residential - Midstream Lighting	14 [6]	✓	✓	32 [7]	
Student Energy Efficient Education	16,720 [8]	✓	✓		
WRAP	155	✓	✓		2 [9]
Total	**20,174**	**N/A**	**N/A**	**43**	**2**

[1] Includes all survey modes: online, telephone, and paper. For additional detail, see program chapter and appendix. This may not match the totals used to calculate program satisfaction.
[2] Includes 493 equipment, 7 in-home audit, 123 online assessment, 34 weatherization, and 43 online marketplace surveys.
[3] Includes 11 new homes builders.
[4] Includes 1,793 direct mail paper surveys and 134 agency paper surveys administered by the ICSP.
[5] Includes 14 equipment, 34 direct discount lighting, and 32 prescriptive lighting surveys.
[6] These are participating distributors.
[7] Includes 24 end-user purchasers and 8 contractor purchasers.
[8] Includes 16,720 paper and online home energy worksheets administered by the ICSP.
[9] Includes 2 master-metered multifamily property managers.

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 PY11 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.[20] 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. The dollar amounts are based on EDC tracking of expenditures with no adjustments to account for inflation.[21]

Table 4-1. PY11 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	$408	$72	$1,675	-	$2,156
Demand Response Program	$1,183	$27	$760	-	$1,970
Efficient Lighting Program	$2,008	$65	$1,341	-	$3,415
Energy Efficiency Kits & Education Program [2]	-	$42	$1,331	-	$1,373
Energy Efficient Home Program [6]	$3,096	$74	$3,182	-	$6,352
Home Energy Education Program	-	$57	$1,788	-	$1,845
Non-Residential Energy Efficiency	$13,957	$196	$7,008	-	$21,162
Student Energy Efficiency Education Program	-	$44	$1,609	-	$1,654
WRAP [2]	-	$240	$7,920	-	$8,161
Common Portfolio Costs [3]	-	$2,164	$748	$2,073	$4,985
Portfolio Total [3] [4]	**$20,652**	**$2,983**	**$27,364**	**$2,073**	**$53,071**
SWE Costs [5]	-	-	-	-	**$400**
Total [4]	**$20,652**	**$2,983**	**$27,364**	**$2,073**	**$53,471**

[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 low-income 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.
[6] Costs associated with the unverified New Homes component are included in this table but excluded in TRC calculations in Table 2-15. Summary of Portfolio Finances – Gross Verified [12]Table 2-15 and Table 11-11.

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

[21] 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	$1,515	$196	$6,542	-	$8,253
Demand Response Program	$4,041	$270	$2,795	-	$7,106
Efficient Lighting Program	$23,404	$244	$6,327	-	$29,975
Energy Efficiency Kits & Education Program [2]	-	$192	$6,386	-	$6,578
Energy Efficient Home Program [6]	$10,538	$234	$13,188	-	$23,960
Home Energy Education Program	-	$160	$5,693	-	$5,853
Non-Residential Energy Efficiency	$45,276	$786	$25,221	-	$71,283
Student Energy Efficiency Education Program	-	$196	$4,618	-	$4,814
WRAP [2]	-	$903	$29,309	-	$30,212
Common Portfolio Costs [3]	-	$11,931	$5,003	$10,564	$27,498
Portfolio Total [3] [4]	**$84,775**	**$15,111**	**$105,082**	**$10,564**	**$215,532**
SWE Costs [5]	-	-	-	-	**$1,900**
Total [4]	**$84,775**	**$15,111**	**$105,082**	**$10,564**	**$217,432**

[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 low-income 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.
[6] Costs associated with the New Homes component are included in this table but excluded in TRC calculations because there are no associated benefits because savings for this program are unverified in PY11.

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 PY11 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)	$24,840	$109,135
Small C&I	Small C&I (primarily GS1 & GS3)	$12,982	$39,214
Large C&I	Large C&I (primarily LP4 & LP5)	$7,609	$31,101
GNE	Residential, Small C&I, and Large C&I	$3,717	$16,552
Common [2]	-	$4,323	$21,430
Portfolio Total [3]	**-**	**$53,471**	**$217,432**

[1] Includes SWE costs.
[2] Includes program and common portfolio costs not collected at the sector level and will not match costs listed in program level tables. These costs are allocated to the sectors at the end of the phase.
[3] 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.

Descriptions of the Non-Residential Energy Efficiency Program components and the evaluation methodology, findings, conclusions, and recommendations for each are provided in separate chapters. PPL Electric Utilities did not offer the CEI component in PY11 so there is no chapter addressing this program. Due to COVID-19 restrictions, Cadmus did not conduct any in-person site visits from March through May 2020 and instead, based on guidance from the SWE, collected data through either virtual site visits or desk reviews.[22] These details are included in the individual chapters.

- ***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.

The objectives of the Non-Residential Energy Efficiency Program are these:[23]

- 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

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

[23] 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	Phase III Verified
MWh/yr	143,573	162,377	184,990	229,943	720,882 [(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 and demand savings, and incentive payments across all components of the Non-Residential Energy Efficiency Program in PY11 by customer segment.

Table 5-2. PY11 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	174	4,992	1,374	2,491	**9,031**
PYRTD MWh/yr	461	99,163	60,395	72,712	**232,732**
PYRTD MW/yr	0.09	14.76	7.87	10.57	**33.30**
PYVTD MWh/yr	493	98,364	59,485	71,600	**229,943**
PYVTD MW/yr	0.07	12.98	6.98	9.60	**29.63**
PY11 Incentives ($1000)	$33	$8,711	$3,377	$1,837	**$13,957**
[(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 and demand savings realization rates for the components of the Non-Residential Energy Efficiency Program in PY11.

Table 5-3. PY11 Non-Residential Energy Efficiency Program Gross Energy Savings Realization Rates by Component

Component	PYRTD MWh/yr	PYRTD MW/yr	Energy Savings Realization Rate	Demand Savings Realization Rate	PYVTD MWh/yr	PYVTD MW/yr
Efficient Equipment - Lighting	118,953	16.74	102%	96%	121,451	16.07
Efficient Equipment - Equipment	4,218	0.19	86%	89%	3,630	0.17
Midstream Lighting	29,537	6.49	94%	65%	27,794	4.24
Custom	80,023	9.87	96%	93%	77,068	9.14
Total [1]	**232,732**	**33.30**	**99%**	**89%**	**229,943**	**29.63**
[1] May not sum due to rounding.						

Table 5-4 and Table 5-5 show the Non-Residential Energy Efficiency Program's PY11 total reported energy savings and demand reduction, respectively.

Table 5-4. PY11 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	232,732	99%	N/A	2.80%	229,943
[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

Table 5-5. PY11 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	33.30	89%	N/A	5.33%	29.63
[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 PY11.

Table 5-6. PY11 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	0.77	121,451	53%	93,517
Efficient Equipment - Equipment	0.56	3,630	2%	2,033
Midstream Lighting	0.62	27,794	12%	17,232
Custom	0.66	77,068	34%	50,865
Total [1]	**0.71**	**229,943**	**100%**	**163,647**
[1] 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 PY11.

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	232,732	33.30
PYVTD Gross	229,943	29.63
PYVTD Net [2]	163,647	21.14
P3RTD	738,497	100.71
P3VTD Gross	720,882	98.73
P3VTD Net [2]	527,776	72.65

[1] Total may not match sum of totals from individual Non-Residential 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 PY11 dollars (PY11 includes months in both 2019 and 2020). 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.[24] A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix O. Non-Energy Benefits*.

[24] Guidance on the Inclusion of fossil fuel and H_2O 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) [9]	
1	EDC Incentives to Participants	$13,957		$39,981	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	$71,056		$204,081	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [1]**	**$85,013**		**$244,062**	
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$196	-	$713	-
7	Marketing [4]	-	-	-	$2,172
8	Program Delivery [5]	-	$7,008	-	$20,287
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$7,205**		**$23,172**	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	**$7,336**		**$11,919**	
13	**Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) [6]**	**$99,554**		**$279,152**	
14	Total NPV Lifetime Electric Energy Benefits	$140,175		$353,091	
15	Total NPV Lifetime Electric Capacity Benefits	$19,864		$55,026	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$9,202		$18,207	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	($8,338)		($18,101)	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7]**	**$160,902**		**$408,223**	
19	**TRC Benefit-Cost Ratio [8]**	**1.62**		**1.46**	

[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 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	$13,957		$39,981	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	$45,801		$183,825	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [2]**	**$59,758**		**$223,806**	
5	Design & Development [3]	-	-	-	-
6	Administration, Management, and Technical Assistance [4]	$196	-	$713	-
7	Marketing [5]	-	-	-	$2,172
8	Program Delivery [6]	-	$7,008	-	$20,287
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11[7]	**Program Overhead Costs (Sum of rows 5 through 10) [2]**	**$7,205**		**$23,172**	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	**$4,842**		**$9,919**	
13	**Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) [8]**	**$71,804**		**$256,896**	
14	Total NPV Lifetime Electric Energy Benefits	$99,753		$320,671	
15	Total NPV Lifetime Electric Capacity Benefits	$14,207		$50,489	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$6,713		$16,211	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	($6,097)		($16,303)	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [9]**	**$114,576**		**$371,068**	
19	**TRC Benefit-Cost Ratio [10]**	**1.60**		**1.44**	

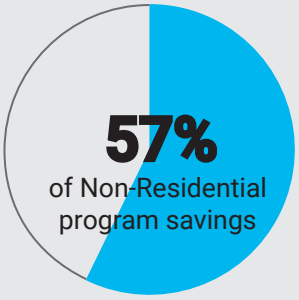
[1] All program year (PYTD) expenditures and benefits are discounted to PY8 dollars for the Phase (P3TD) total.
[2] May not sum to total due to rounding.
[3] All costs for Plan Design and Development are portfolio-level costs and are assigned to customer sectors at the end of the phase. These portfolio 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.

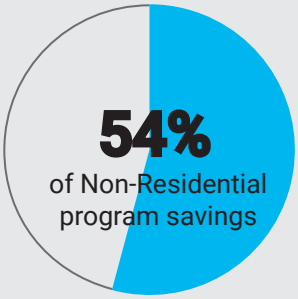
EFFICIENT EQUIPMENT PROGRAM

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 so far saved **408,189 MWh/yr**





PY11 saved **125,081 MWh/yr**

PY11 PARTICIPATION

A total of **1,036** participants

655	Prescriptive Lighting
337	Direct Discount Lighting
44	Equipment

PROGRAM SATISFACTION

95% Satisfied with overall program

100%	satisfied with **Direct Discount Lighting**
94%	satisfied with **Prescriptive Lighting**
86%	satisfied with **Equipment**
95%	satisfied with the **information provided about the application process**
93%	satisfied with the **professionalism** of the program representatives
88%	satisfied with the **time it took to process their application**
81%	satisfied with the **ease of the online application** process
74%	satisfied with the **ability to track their rebates**

6 Non-Residential Efficient Equipment Program

The Efficient Equipment wcomponent 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 commercial and industrial 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 and 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 PY11, the prescriptive lighting channel had 655 lighting jobs (18,193 individual database records) and 595 unique customers.

A **direct discount lighting participant** is defined as a unique job completed for a unique customer. In PY11, the direct discount lighting delivery channel had 337 jobs (3,038 individual database records) and 330 unique customers. In PY9, Cadmus evaluated the lighting jobs from the direct discount delivery channel as a separate stratum from the prescriptive lighting jobs. In PY10 and PY11, Cadmus grouped

the direct discount lighting jobs with the prescriptive lighting stratum because the PY9 evaluation[25] did not find meaningful differences in CV or realization rates between the two delivery channels.

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 PY11, by customer segment.

Table 6-1. PY11 Efficient Equipment Program Lighting Participation and Reported Impacts

Parameter	Residential	Small C&I	Large C&I	GNE	Total [1]
PYTD # Participants	1	802	86	103	**992**
PYRTD MWh/yr	18	74,310	29,571	15,053	**118,953**
PYRTD MW/yr	0.00	10.37	3.93	2.44	**16.74**
PYVTD MWh/yr	17	75,768	30,320	15,346	**121,451**
PYVTD MW/yr	0.00	9.91	3.79	2.37	**16.07**
PY11 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 E.1.2* Ex Post *Verified Savings Methodology for Lighting* for additional details. Cadmus verified 43 projects, of which 19 were verified through in-person or virtual site visits and 24 through desk reviews. All projects in the verification sample undergo a detailed records review. Due to COVID-19 restrictions, on-site inspections were not possible for projects sampled after Q2. Cadmus conducted virtual site inspections for three 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. PY11 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	992	90/10 (Minimum sample size of 10/stratum)	24	Desk review
			19	In-person or virtual site visit[2]
Program Total	**992**		**43**	

[1] A participant is defined as a unique job completed for a unique customer.
[2] Sixteen of the 19 site visits were conducted in-person, and three were virtual verifications.

[25] 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	Phase III Verified
MWh/yr	67,246	112,402	93,138	121,451	394,237 [1]

[1] Phase III verified savings may not match sum of program years due to rounding.

In PY11, the lighting portion of the Efficient Equipment Program reported energy savings of 118,953 MWh/yr, as shown in Table 6-4, and demand reduction of 16.74 MW/yr, as shown in Table 6-5. See *Appendix E.1 Site Visit and Desk Review Findings – Lighting f*or additional information.

Table 6-4. PY11 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	14,625	96%	0.13	7.98%	13,983
Lighting -- Medium	24,966	100%	0.00	0.47%	24,925
Lighting -- Large	36,782	108%	0.26	18.02%	39,891
Lighting -- Threshold	42,580	100%	0.00	0.00%	42,651
Lighting Total [2]	**118,953**	**102%**	**-**	**5.20%**	**121,451**

[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. PY11 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	2.13	86%	0.25	15.42%	1.83
Lighting -- Medium	3.14	99%	0.01	0.59%	3.12
Lighting -- Large	5.11	101%	0.05	3.71%	5.14
Lighting -- Threshold	6.36	94%	0.00	0.00%	5.99
Lighting Total [2]	**16.74**	**96%**	**-**	**1.89%**	**16.07**

[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 121,451 MWh per year of verified energy savings with a 102% energy realization rate and 16.07 MW/yr of verified demand reduction with a 96% demand realization rate. The primary contributors to the energy and demand realization rates that were different from 100% were differences in calculated hours of use from metered data, and 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 E.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,[26] 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 PY11. Additional details about methodology are in *Appendix E.1.2* Ex Post *Verified Savings Methodology for Lighting* and *Appendix Q Survey Methodology.*

Table 6-6. PY11 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	992	62[(1)]	Self-report survey
[(1)] Four 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. PY11 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	62	23% [(1)]	0%	0.77	11%	121,450,762
[(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 (HIM) and services to assess free ridership with greater certainty.[27] In the Efficient Equipment Program, Cadmus determined that commercial lighting projects contributed greater than 5% of the overall PY11 savings to the Non-Residential sector and classified commercial lighting as a high-impact measure. For net savings calculations, 62 lighting participants completed the NTG questions in self-report surveys. At 90% confidence, Cadmus calculated a NTG ratio of 0.77 with relative precision of 11% and at 85% confidence with a relative precision of 10%.

[26] 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.

[27] 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 PY11.

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

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD Gross	118,953	16.74
PYVTD Gross	121,451	16.07
PYVTD Net [1]	93,517	12.38
P3RTD Gross	398,621	55.86
P3VTD Gross	394,237	55.66
P3VTD Net [1]	294,570	41.57
[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 PY11, the equipment portion of this program had 44 equipment jobs and 43 unique equipment customers (100 database records). All but 10 of the PY11 equipment jobs followed the prescriptive delivery channel. Cadmus grouped the 10 direct discount delivery channel equipment jobs with the prescriptive stratum in PY11 due to the small number of projects in the population in this delivery channel for this program component.

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 PY11, by customer segment.

Table 6-9. PY11 Efficient Equipment Program Equipment Participation and Reported Impacts

Parameter	Residential	Small C&I	Large C&I	GNE	Total [1]
PYTD # Participants [2]	1	32	4	7	**44**
PYRTD MWh/yr	29	3,240	566	382	**4,218**
PYRTD MW/yr	0.00	0.15	0.01	0.03	**0.19**
PYVTD MWh/yr	29	2,827	483	290	**3,630**
PYVTD MW/yr	0.00	0.13	0.01	0.03	**0.17**
PY11 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.
[3] Incentives are tracked at the program level.

6.6 Gross Savings Impact Evaluation – Equipment

Cadmus verified 17 projects, of which 10 were verified through in-person or virtual site visits and seven through desk reviews. All projects in the verification sample undergo a detailed records review. Due to COVID-19 restrictions, on-site inspections were not possible for projects sampled after Q2. 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 E.1.2* Ex Post *Verified Savings Methodology for Equipment* and *Appendix Q Survey Methodology* for additional details.

Table 6-10. PY11 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	44	85/15	7	Desk review
			10	In-person or virtual site visit
Total	**44**	**85/15**	**17**	

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	Phase III Verified
MWh/yr	3,671	3,592	3,059	3,630	13,952 [(1)]
[(1)] Phase III verified savings may not match sum of program years due to rounding.					

In PY11, the equipment portion of the Efficient Equipment Program reported energy savings of 4,218 MWh/yr, as shown in Table 6-12, and demand reduction of 0.19 MW, as shown in Table 6-13.

Table 6-12. PY11 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)]
Agriculture	29	100%	0.00	0%	29
HVAC	870	101%	0.07	3.77%	876
Motors	150	20%	0.22	46.39%	30
Refrigeration	3,168	85%	0.14	5.98%	2,695
Total [(2)]	**4,218**	**86%**	**-**	**4.21%**	**3,630**
[(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. PY11 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]
Agriculture	0.00	100%	0.00	0%	0.00
HVAC	0.13	95%	0.12	6.17%	0.12
Motors	0.01	24%	1.30	270.85%	0.00
Refrigeration	0.05	85%	0.16	6.74%	0.04
Total [2]	**0.19**	**89%**	**-**	**4.58%**	**0.17**

[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 3,630 MWh per year of verified energy savings with an 86% energy realization rate. Equipment projects achieved 0.17 kW/yr of verified demand reduction with an 89% demand realization rate. The primary contributors to the energy and demand realization rates that were different from 100% were in-service rates, incorrect reported equipment capacities, incorrect operating parameters, and incorrect baseline classification. Additional information is in *Appendix E.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 PY11. Additional details about methodology are in *Appendix E.1.2* Ex Post *Verified Savings Methodology for Equipment* and *Appendix Q Survey Methodology*.

Table 6-14. PY11 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	44	14	Self-report survey

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

Table 6-15. PY11 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	14	44% [1]	0%	0.56	29%	3,630,193

[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 PY11.

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

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD Gross	4,218	0.19
PYVTD Gross	3,630	0.17
PYVTD Net [(1)]	2,033	0.10
P3RTD Gross	16,657	1.18
P3VTD Gross	13,952	1.00
P3VTD Net [(1)]	8,865	0.64
[(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 PY11 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 80 participants of the Efficient Equipment Program using a stratified random sample. Twenty-nine participants responded to the online survey and 51 to the telephone survey between February 2020 and July 2020. 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	N/A	100%
Participants	Equipment prescriptive and direct discount	Online survey	44	0.5	69	0	23	100%
		Telephone survey		0.5		14		
	Prescriptive lighting	Online survey	655	0.5		11	235	100%
		Telephone survey				21		
	Direct discount lighting	Online survey	337	0.5		18	234	100%
		Telephone survey				16		
Program Total			**1,038**	**N/A**	**71**	**82**	**492**	**N/A**

[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] For Direct Discount, 34 respondents completed the survey but one did not report overall satisfaction with PPL Electric Utilities
[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 *Appendix E.4 Survey Participant Profile*.
[4] Percent contacted means the percentage of the sample frame contacted to complete surveys.

Program Satisfaction

The Efficient Equipment Program was delivered effectively in PY11 and maintains high levels of customer satisfaction.

As shown in the program's infographic, 95% of PY11 respondents were satisfied with the overall program (73% were *very satisfied* and 22% were *somewhat satisfied*; n=79).[28] Though this was an increase from PY10,[29] where overall satisfaction was 91% (n=67), it was not a significant change. All direct discount lighting participants (100%, n=33), 94% of prescriptive lighting participants (n=32), and

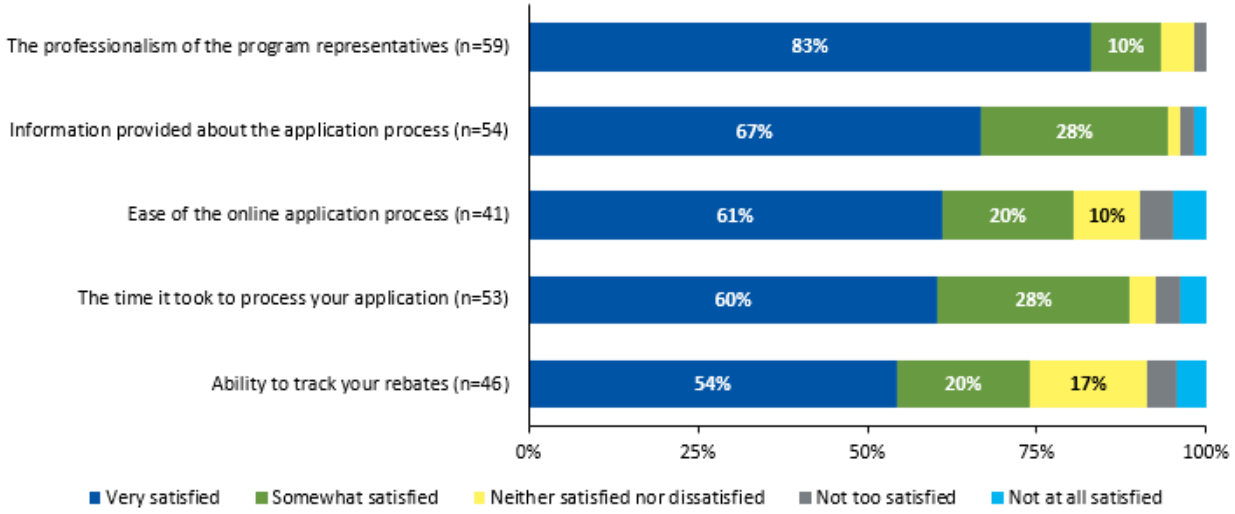
[28] Additionally, 3% were *neither satisfied nor dissatisfied*, 3% were *not too satisfied*, and 0% were *not at all satisfied* (n=79). One respondent did not answer the overall satisfaction question.

[29] PPL Electric Utilities. *Annual Report Program Year 10: June 1, 2018–May 31, 2019.* Presented to PA PUC. Prepared by Cadmus. November 15, 2019.

86% of equipment participants were *very* or *somewhat satisfied* (n=14).[30] Two prescriptive lighting respondents were *not too satisfied* with the program overall. One respondent said better communication in regard to the application is needed. The other respondent said the program could be more user-friendly.

As shown in Figure 6-1, participants were most satisfied with information about the application process (95%; n=54), which was a significant increase from 79% (n=54) in PY10.[31] Two equipment (n=7) and one direct discount lighting (n=19) respondents were *not too satisfied* or *not at all satisfied* with information provided about the application process. Satisfaction with all other program components increased from PY10.

Figure 6-1. PY11 Efficient Equipment Program Component Satisfaction



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

Areas for Improvement

The survey asked respondents if anything could change about the program to improve it. More than half (67%; n=70) said no changes were needed and 33% left a suggestion for improvement. Table 6-18 shows the suggested improvements.

[30] Eighty-two percent of direct discount lighting participants were *very satisfied* and 18% were *somewhat satisfied* (n=33). Seventy-eight percent of prescriptive participants were *very satisfied*, 16% were *somewhat satisfied*, and 6% were *not too satisfied* (n=32). Forty-three percent of equipment participants were *very satisfied*, 43% were *somewhat satisfied*, and 14% were *neither satisfied nor dissatisfied* (n=14). Totals may not sum to 100% due to rounding.

[31] Cadmus used a two-tailed t-test where p=0.0142.

Table 6-18. Suggested Improvements for Elements of the Efficient Equipment Program

Suggested Improvement	Percentage of Responses (n=23)
Provide clearer information/communication about the program	41%
Simplify or extend application process	36%
Increase rebate amount or types of rebates	14%
Reduce rebate processing time	9%
Source: Survey question, "What is the one thing PPL Electric Utilities or CLEAResult could change about the program to improve it?" (n=23).	

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 5.4 Cost-Effectiveness Reporting.*

6.11 Recommendations – Lighting and Equipment

Overall, the Efficient Equipment Program has been successful, with the verified savings of 125,081 MWh/year. Most survey respondents (95%; n=79) were satisfied with the program, and satisfaction with all program components increased from PY10. Recommendations are provided in Table 6-19, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: The realization rate for non-lighting projects could be improved through increased accuracy of reported values of key savings calculation inputs for small projects.

- For smaller Prescriptive and Direct Discount Equipment projects, the verification effort made several adjustments to key inputs to savings calculations such as in-service rates and motor capacity. This finding was mainly observed in the refrigeration and motors substratum. (See *section 6.6 Gross Savings Impact Evaluation – Equipment.*)

Table 6-19. Status of Recommendations for the Efficient Equipment Program

Efficient Equipment Program		
Conclusion	**Recommendation**	**EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)**
Conclusion 1: The realization rate for non-lighting projects could be improved through increased accuracy of reported values of key savings calculation inputs for small projects.	The ICSP could consider adding additional verification and quality control protocols for smaller projects to ensure that analysis inputs such as installed quantities and motor capacities are captured accurately in *ex ante* savings calculations.	Being considered.

MIDSTREAM LIGHTING PROGRAM

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 so far saved **69,931 MWh/yr**

PY11 saved **27,794 MWh/yr**

PROGRAM SATISFACTION

Satisfied with overall program

100% distributors satisfied with program

100% contractors satisfied with program

96% end users satisfied with program

PY11 PARTICIPATION

21 Distributors participated

7,926 Jobs

2,336 Unique PPL Electric Utilities customers

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 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 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 PY11.

Table 7-1. PY11 Midstream Lighting Program Participation and Reported Impacts

Parameter	Residential	Small C&I	Large C&I	GNE	Total [1]
PYTD # Participants	172	4,128	1,258	2,368	**7,926**
PYRTD MWh/yr	414	14,984	5,781	8,358	**29,537**
PYRTD MW/yr	0.09	3.24	1.32	1.84	**6.49**
PYVTD MWh/yr	447	13,951	5,408	7,987	**27,794**
PYVTD MW/yr	0.07	2.07	0.86	1.24	**4.24**
PY11 Incentives ($1000)	$31	$1,086	$391	$570	**$2,078**

[1] May not match due to rounding.

7.2 Gross Savings Impact Evaluation

7.2.1 Impact Evaluation Data Collection and Sample Design

In PY11, 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, consisting 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 ±15% precision at 85% confidence, assuming a coefficient of variation of 0.5. In PY11, the program reported 7,926 jobs in PPL Electric Utilities tracking database, corresponding to 6,702 unique combinations of distributor invoice numbers and account numbers (projects). Cadmus randomly

selected a sample of projects from the first three quarters from the population of Midstream Lighting jobs.[32] There were no threshold lighting jobs in the PY11 Midstream Lighting population.[33]

Cadmus defined a site as a business at a given address. While completing a site visit to verify a randomly sampled job, Cadmus verified additional jobs installed at that site during PY11. 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.

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 PY11.

Due to COVID-19 restrictions, on-site visits were not possible for projects sampled after Q2. Cadmus conducted virtual site visits for two projects by verifying details of installation and operation in phone interviews with customer representatives. These representatives also sent pictures of the installed lighting equipment.[34]

Cadmus verified eight jobs associated with five projects through site visits. Six of these jobs were part of randomly sampled projects, while the two additional jobs verified through site visits were siblings. Cadmus conducted desk reviews for 26 jobs associated with 19 randomly sampled projects and one additional job that was verified as a return from PY9.

Sample sizes are shown in Table 7-2. See *Appendix F Ex Post Verified Savings Methodology* for additional details about methodology.

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[32] Cadmus originally planned to use Probability Proportional Size sampling (PPS) but due to changes made in the PPL Electric Utilities participant tracking database, this was not possible so Cadmus switched to random sampling.

[33] Table 1-2 in section 1.2.3 of the 2016 TRM defines a threshold for C&I Lighting of >= 750,000 kWh/yr. Projects with estimated savings over this threshold require site-specific data, such as collected via end-user metering, vs using TRM defaults for variables used in *ex post* savings calculations.

[34] 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 7-2. PY11 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 PY11 Random Sample	6,702	0.5	23	Records review, and either desk audit, or in-person or virtual site visits
Midstream Lighting PY11 Convenience Sample[3]			2	
Program Total	**6,702**	**0.5**	**25**	

[1] In PY11, there were 7,926 job numbers in PPL Electric Utilities' tracking database corresponding to 6,702 unique combinations of distributor invoice numbers and account numbers (defined as a project) for Midstream Lighting.
[2] The 25 projects verified corresponded to 34 verified jobs in the sample.
[3] The convenience sample consisted of one sibling site visit project, and one verified return from PY9.

For the sampled jobs, Cadmus conducted a review of records, as well as either site visits or desk audits. Table 7-3 shows the number of verifications completed using a desk audit or a site visit. See *Appendix F.1 Evaluation Post Stratification* for details on these activities.

Table 7-3. PY11 Midstream Lighting Impact Evaluation Activities

Evaluation Activity	Randomly Sampled Projects	Convenience Sampled Projects (Sibling and PY9 Verified Return)[1]	Total Verified Projects	Total Verified Jobs	Notes
Records Review	23	2	25	34	-
Desk Audit (with phone verification)	19	N/A	19	26	Nested within records review sample
In-person or Virtual Site Visit	4	1	5	8	Nested within records review sample

[1] The convenience sample consisted of one sibling site visit project (including two additional jobs) and one verified return from PY9.

7.2.2 Gross Savings Impact Evaluation Results

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

Table 7-4. Midstream Lighting Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	Phase III Verified
MWh/yr	1,917	15,915	24,306	27,794	69,931 [1]

[1] Phase III verified savings may not match sum of program years due to rounding.

In PY11, Midstream Lighting reported energy savings of 29,537 MWh/yr and demand reduction of 6.49 MW/yr. Table 7-5 highlights the growth in verified savings, demand reduction, distributor participants, and customers from PY8 through PY11.

Table 7-5. Midstream Lighting Program PY8 through PY11 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

The program achieved realization rates of 94% for energy savings and 65% for demand reduction, as shown in Table 7-6 and Table 7-7, at a relative precision of ±10.29% for energy and 34.86% for demand. The precision for energy is better than the target of ±15% precision for the program evaluation. In most strata, the reported energy realization rates were between 78% and 294%, with stratum error ratios less than 0.5.

Table 7-6. PY11 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 – Convenience Sample[2]	78	78%	0.00	0.00%	61
Midstream Lighting -- Large	20,559	86%	0.41	14.45%	17,712
Midstream Lighting -- Medium	4,876	92%	0.22	15.52%	4,475
Midstream Lighting -- Medium-Large	3,355	106%	0.39	37.89%	3,570
Midstream Lighting -- PY9 Return[3]	-3	0%	N/A	N/A	0
Midstream Lighting – Small	672	294%	0.38	50.31%	1,977
Midstream Lighting Total[4]	**29,537**	**94%**	**N/A**	**10.29%**	**27,794**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] The convenience sample is included in the calculation of realization rates but not included in the calculation of evaluation relative precision.
[3] One job reported in PY11 was a return from PY9. In PY9, this job was verified as having been returned and assigned verified savings of zero; thus, the realization rate in PY11 for this job is zero, as no adjustment to cumulative verified savings is needed. This record was put into its own stratum such as to not impact the total relative precision in PY11.
[4] May not match due to rounding.

Table 7-7. PY11 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 – Convenience Sample [2]	0.02	51%	0.08	0.00%	0.01
Midstream Lighting -- Large	4.70	60%	1.47	51.84%	2.81
Midstream Lighting -- Medium	0.94	38%	1.62	112.41%	0.36
Midstream Lighting -- Medium-Large	0.70	98%	0.07	6.59%	0.69
Midstream Lighting -- PY9 Return[3]	0.00	0%	N/A	N/A	0.00
Midstream Lighting – Small	0.13	298%	0.37	48.71%	0.37
Midstream Lighting Total [4]	**6.49**	**65%**	**N/A**	**34.86%**	**4.24**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] The convenience sample is included in the calculation of realization rates but is not included in the calculation of evaluation relative precision.
[3] One job reported in PY11 was a return from PY9. In PY9, this job was verified as having been returned and assigned verified savings of zero; thus, the realization rate in PY11 for this job is zero, as no adjustment to cumulative verified savings is needed. This record was put into its own stratum such as to not impact the total relative precision in PY11.
[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 facility type, and *ex ante* baseline and efficient fixture types to qualified products as prescribed in the Midstream Lighting 2016 PA TRM – Interim Measure Protocol (IMP).[35] 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 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, which, in turn, determine the hours of use and coincidence factors specified by the IMP and the space conditioning type. The higher precision for demand is the result of adjustments Cadmus made to set the coincidence factors equal to zero for two projects in the evaluation sample that reported demand savings. One project was verified as exterior lighting, and the other was a warehouse that did not operate during the peak period. See *Appendix F. Verification Findings* for details on the verification findings.

[35] 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.

7.3 Net Savings Impact Evaluation

The methods used to determine net savings for midstream programs are provided in the Evaluation Framework,[36] 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.

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

Table 7-8 lists the methods and sampling strategy used to determine net savings for each component of Midstream Lighting in PY11. Additional details about methodology are in *Appendix F.*

Table 7-8. Midstream Lighting Component Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size	Achieved Sample Size	NTG Activity
Midstream Lighting	End-Users	4,242	24	Telephone in-depth interview

Table 7-9 shows the free ridership, spillover, and NTG ratios by program stratum.

Table 7-9. Midstream Lighting Component 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
Midstream Lighting	24	38%(1)	0%	0.62	38%	27,793,704

(1) Weighted by the survey sample-verified program kWh/yr savings. This method ensures that respondents who achieved higher energy savings through program products have a greater influence on the equipment-level free ridership estimate than do respondents who achieved lower energy savings.

End users in Midstream Lighting are the businesses where the lighting was installed and the ultimate beneficiary of the program discount. Cadmus determined that end users were the most appropriate program actors to answer the survey questions used to estimate free ridership (see *Self-Report Survey* section in *Appendix P. Net Savings Impact Evaluation*).

- End-user purchasers are the decision-makers at these businesses who determine when to make upgrades and how much to invest in lighting equipment.
- End-user non-purchasers are the customers for whom contractors purchased lighting products.

In PY11, Midstream Lighting's free ridership was 38%, determined using end user purchasers' survey data. Four of the 24 respondents accounted for 52% of the verified energy savings in the analysis sample and 33 percentage points of the overall 38% free ridership ratio.

[36] 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.

Assessing spillover in commercial settings via phone surveys is difficult because respondents cannot provide the level of detail needed to quantify spillover. Therefore, Cadmus collected self-reported survey data and reviewed the data qualitatively for spillover activity but did not quantify spillover.

7.4 Verified Savings Estimates

In Table 7-10, 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 PY11.

Table 7-10. PYTD and P3TD Midstream Lighting Program Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD	29,537	6.49
PYVTD Gross	27,794	4.24
PYVTD Net[1]	17,232	2.63
P3RTD	75,615	15.09
P3VTD Gross[2]	69,931	11.59
P3VTD Net[1, 2]	53,068	8.88

[1] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.
[2] PY9 savings that were unverified in PY9 were verified in PY11 as 0 kWh/yr.

7.5 Process Evaluation

7.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation in PY11. Activities were consistent with the evaluation plan but the sample composition was altered. The target for 30 purchaser interviews was achieved through eight contractor purchaser interviews and 24 end user interviews (Cadmus collected two completed interviews beyond the target, one additional contractor and one additional end user). The end-user interviews informed both the process evaluation and net savings analysis. Cadmus attempted every distributor multiple times in an effort to reach the target of 15 interviews but was only able to complete 14.

Table 7-11 shows the process evaluation sampling strategy.

Table 7-11. 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	21[4]	N/A	15	14	21	100%
End-Users	End-user customers who purchase directly from distributors or for whom contractors purchased equipment	Telephone in-depth interview	6,702[5]	N/A	23	24	1,671[4]	8.7%
Contractor Purchasers	Contractor purchaser for whom contact data were provided				7	8	212[4]	28.3%
Program Total			**6,725**	**N/A**	**47**	**48**	**1,906**	**-**

[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] Contractors and End-User started from the same population list. For the end-users, the list was based on unique customer sales invoice number and account number combinations, which Cadmus used to create the randomized sampling order. Cadmus then filtered down to unique account (1,671). For contractor purchasers, Cadmus used names to determine unique sampling records.

7.5.2 Program Satisfaction

In PY11, 21 unique distributors participated in the Midstream Lighting component. Cadmus attempted to contact all of them and completed in-depth interviews with 14, who represented approximately 84% of PY11 incentives paid. Five of these 14 distributors were not interviewed in PY10 (two were new to the program component in PY11). In PY11, 100% of the distributors were satisfied with the Midstream Lighting component (57% were *very satisfied* and 43% were *somewhat satisfied;* n=14). These results are not significantly different from PY10.[37]

[37] 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.

Cadmus interviewed eight contractor purchasers and 24 end users (17 purchasers and seven non-purchasers). Cadmus randomly selected a sample from each group from the PY11 ICSP tracking data.[38] All but one interview respondent (distributors, end users and contractors) said they were either *very satisfied* or *somewhat satisfied* with the Midstream Lighting component (98%; n=46). For end users (n=24), 88% were *very satisfied*, 8% were *somewhat satisfied*, and 4% were *neither satisfied nor dissatisfied*. For contractors (n=8), 100% were *very satisfied*.

Program Awareness

Distributors are the core drivers of awareness for the program, with 14 of 24 end users and six of seven contractors stating their distributor was how they learned about the program. Additionally, 19 of 24 end users and all seven contractors said the distributor specifically mentioned Midstream Lighting when they purchased lighting.

Program Delivery

In PY11, the ICSP began tracking which distributors were active in Midstream Lighting—that is, distributors who submitted to PPL Electric Utilities for reimbursement of $2,500 or more for discounts on purchases over a six-month period—to avoid directing customers to distributors who were not actively promoting program-qualifying products. The ICSP found that nine distributors had not met this threshold in PY11 and reached out to help them toward their sales goal next quarter. One of these distributors created an action plan with the ICSP, but the others chose to leave the program.

Reporting System

Distributors are happy with and successfully using the portal-based system, activated by the ICSP in PY10, to validate qualifying products and report sales. Distributors who used a similar portal for other midstream programs were pleased that PPL Electric Utilities made this change; two said the Midstream Lighting portal had a huge advantage over similar programs that did not have a portal.

Distributors cited several key benefits of the portal:

- Easy to navigate, making eligibility and address verification quick and easy
- Speeds up incentive processing (from ~90 days to ~30 days), with one stating that "it took away the worry of us becoming the bank for this program"
- Gives distributors more control over the tasks they need to get done
- Lessens the need for excessive email correspondence

When asked what they would like changed, three referred specifically to easing the upload process:

- Provide more information on why errors occur (consistent with PY10 feedback)
- Add capability to search by address instead of only by account number (consistent with PY10 feedback)

[38] Cadmus used the purchaser and customer name fields to estimate the type (end-user or contractor) for each job. The ICSP provided the name for approximately 80% of PY11 jobs.

- Increase portal capabilities by incorporating data analytics and ability to view status of $1,800+ job approval requests (new for PY11)

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=8); however, Cadmus confirmed that the products usually requested are offered by the program.

Other suggestions were to improve the upload process (n=4), increase the incentives for tLEDs (n=2), pay incentives for strong sales performance or compensate for time spent on program administration (n=2), increase general advertising (n=2), and not require the account number (n=1).

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.

Six of 12 distributors in PY11 reported expanding the number of program-qualifying products they stock to keep up with higher customer demand, which they attributed in part to utility program incentives, including those offered by Midstream Lighting. Two said they now tend to stock a greater variety of program-qualifying products as well. Four distributors with stores outside of PPL Electric Utilities' territory said that Midstream Lighting had some impact on the products these stores stock because their companies try to purchase in larger quantities to get better rates. Specifically, one distributor said, "[The program] shapes our negotiations with sellers on certain products, such as tLEDs and flat panels. [Because of Midstream Lighting], we're able to get better pricing for all our locations due to the volume we sell."

Eleven distributors were willing to estimate their percentage of sales in the three categories shown in Table 7-12. Three said they did not know enough to provide such estimates. As in PY10, LEDs were the majority of distributors' lighting sales, specifically LEDs eligible for PPL Electric Utilities' program. Additionally, distributors reported that program-qualifying LEDs were a larger share of sales in PY11 than in PY10.

Table 7-12. Distributor Sales Estimates Across Three Categories of Lighting Product Efficiency

Type	Efficient Products		Standard Efficiency Products
	Program-Qualifying	Non-Program-Qualifying	
Multiyear Distributor	80%	10%	10%
Multiyear Distributor	75%	25%	0%
Multiyear Distributor	75%	25%	0%
Multiyear Distributor	70%	25%	5%
Multiyear Distributor	70%	20%	10%
Multiyear Distributor	70%	20%	10%
Multiyear Distributor	63%	7%	30%
Multiyear Distributor	60%	15%	25%
Multiyear Distributor	50%	10%	40%
Multiyear Distributor	40%	45%	15%
Multiyear Distributor	30%	40%	30%
Average PY11 (n=11)	**62%**	**20%**	**18%**
Average PY10 (n=7)	***53%***	***20%***	***27%***
Note: Change from PY10 to PY11 is not statistically significant and should be interpreted as directional.			

As in PY10, several distributors said they served more smaller customers and noticed some increase in customers doing small jobs over the past year. They attributed this change to Midstream Lighting. Five of 13 distributors said they were more likely to promote program-qualifying products now that they were participating in Midstream Lighting. Specifically, they were more often recommending installing new fixtures over replacing like-for-like bulbs in an older fixture.

Likewise, all contractors interviewed tended to recommend efficient lighting to their clients, with five saying they always do and two saying they often do. One contractor noted recommending efficient lighting "as many times as [my clients] will listen." Contractors also credited Midstream Lighting discounts and distributors' recommendations in their clients' decisions to upgrade their lighting. On a scale of 1 to 5, six rated discounts as a 5 [*extremely influential]* and one rated discounts as a 4 for influence). On a scale of 1 to 5, three rated distributors' recommendations as a 5 (*extremely influential*) and three as a 3 for influence. These findings are consistent with PY10.

These findings suggest that, although Midstream Lighting does help drive sales of efficient lighting, its effects are mostly direct program effects. 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 influence contractors' recommendations, their practices can impact the market outside of the program. For more detail regarding specific findings, see *Appendix F*.

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 5.4 Cost-Effectiveness Reporting*.

7.7 Recommendations

Overall, the Midstream Lighting Program has shown continued growth in Phase III and had high realization rates. Participating distributors appreciated the improvements to the reporting process introduced via the new portal-based processing system and few participants reported issues with the new account number requirement. Recommendations are provided in Table 7-13, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: Realization rates, especially for demand, would improve by reducing the number of facility type adjustments needed during verification.	• 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*.) • The higher precision for demand is mainly driven by adjustments Cadmus made to coincidence factors with an evaluated value of zero for two projects in the evaluation sample, that reported demand savings.(See *Section 7.2.2 Gross Savings Impact Evaluation Results*.)
Conclusion 2: Distributors could benefit from more communication from the ICSP because they are unaware that incentives for products they ask to be added are already available.	• The most common suggestion for program improvement (n=8, some gave multiple suggestions) was the addition of more products to the program; however, Cadmus confirmed that the products requested are in most cases, offered by the program. *(See section 7.5.2. Suggested Improvements*)

Table 7-13. Status of Recommendations for Midstream Lighting

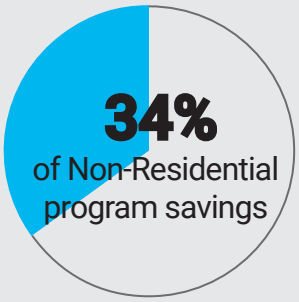
Midstream Lighting Program		
Conclusion	**Recommendation**	**EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)**
Conclusion 1: Realization rates, especially for demand, would improve by reducing the number of facility type adjustments needed during verification.	Consider adding building type to the customer information required in the distributor portal, at least for larger projects.	Being considered.
Conclusion 2: Distributors could benefit from more communication from the ICSP regarding program offerings.	Encourage ICSPs to discuss all offerings with distributors to increase product awareness and consider incorporating distributor suggestions for additional product offerings.	Implemented. The ICSP continues to hold mid-year reviews with distributors to communicate program offerings and review their sales and opportunities for growth.

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 so far saved **241,572 MWh/yr**



PY11 saved **77,068 MWh/yr**

PROGRAM SATISFACTION

Satisfied with overall program

93% satisfied with the **professionalism of the program representatives**

92% satisfied with the **information** provided about the **application process**

87% satisfied with the **time it took to process the application**

83% satisfied with the **ease of the online application process**

82% satisfied with the **ability to track your rebates**

PY11 PARTICIPATION

A total of **69** participants:

- **21** Motors
- **21** HVAC
- **7** Refrigeration
- **3** Combined Heating and Power (CHP)
- **2** Agricultural
- **1** Photovoltaic
- **1** Lighting
- **13** 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 equipment is purchased. 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 PY11 participant is defined as a project that was commercially operable and received an incentive payment between June 1, 2019, and May 31, 2020.[39] Projects for which customers submitted an application during this period that did not receive an incentive or projects commissioned during this period that did not receive an incentive are not counted as participants in PY11. An individual customer may have multiple participating projects.

[39] As defined by the Phase III Evaluation Framework, EDC-claimed savings are determined by the date the equipment is "installed and commercially operable." Equipment that is installed and not commissioned, or operating as intended, is not considered "commercially operable."

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 PY11 by customer segment.

Table 8-1. PY11 Custom Program Participation and Reported Impacts

Parameter	Small C&I	Large C&I	GNE	Total[1]
PYTD # Participants	30	26	13	**69** [2]
PYRTD MWh/yr	6,629	24,476	48,918	**80,023**
PYRTD MW/yr	1.01	2.62	6.25	**9.87**
PYVTD MWh/yr	5,818	23,273	47,976	**77,068**
PYVTD MW/yr	0.86	2.31	5.96	**9.14**
PY11 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 72 unique records corresponding to 69 unique projects in PY11. For two of these projects, the database contains three records for incentive adjustments, and one additional project was for incentive adjustments only.
[3] Incentives are reported at the program level.

Table 8-2 lists the types of projects completed in PY11 and percentage of reported savings.

Table 8-2. PY11 Program Custom Project Types

Project Type	Number of Participants (n=69) [1]	Percentage of Reported Savings Represented by Project Type (n=100%) [2]
Combined Heating and Power (CHP)	3	57.2%
Other [3]	13	22.8%
HVAC	21	9.2%
Motors	21	6.8%
Lighting	1	2.0%
Refrigeration	7	0.9%
Photovoltaic	1	0.6%
Agricultural	2	0.3%

[1] PPL Electric Utilities' tracking database includes 72 unique records corresponding to 69 unique projects in PY11. For two of these projects, the database contains three records for incentive adjustments, and one additional project was for incentive adjustments only.
[2] The sum of the column may not add to 100% due to rounding.
[3] The Other project type includes C&I improvements such as replacing old blow-mold injection machines, snow guns, process improvements, controls, new construction projects, heater insulation projects, and fan motor improvements.

8.1 Gross Savings Impact Evaluation

8.1.1 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 G Evaluation Detail – Custom Program*.

Due to COVID-19 restrictions, in-person site visits were not possible after PY11 Q2 through the end of PY11 Q4. Cadmus conducted virtual site visits for 10 sample projects in the small stratum by verifying details of installation and operation in phone interviews with customer representatives. These representatives also sent pictures of the installed equipment and in some cases recent trend data for parameters influencing savings calculations. For all 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.

Table 8-3. PY11 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	18 [1]	Census	18	18	File review, site-specific M&V plans, baseline and post-installation visits, deployed data loggers (if required), verified savings analysis and report
Small	48 [2]	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	3	Census	3	3	File review, site-specific M&V plans, baseline and post-installation visits, metering installed (if required), verified savings analysis and report
Total Participants	**69** [3]	**N/A**	**31**	**31**	

[1] The large stratum population does not include any incentive adjustments.

[2] PPL Electric Utilities' tracking database contained 51 records corresponding to 48 unique projects for small stratum in PY11. For two of these projects, the database contains three records for incentive adjustments, and one additional project was for incentive adjustments only.

[3] PPL Electric Utilities' tracking database includes 72 unique records corresponding to 69 unique projects in PY11. For two of these projects, the database contains three records for incentive adjustments, and one additional project was for incentive adjustments only.

8.1.2 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	Phase III Verified
MWh/yr	70,740	29,826	63,938	77,068	241,572 [(2)]

[(1)] Phase III verified savings may not match sum of program years due to rounding.

In PY11, the Custom Program reported energy savings of 80,023 MWh/yr, as shown in Table 8-5, and demand reduction of 9.87 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.[40] Energy savings for the program overall, including large, small, and CHP strata, are reported with 2.88% precision at the 85% confidence level.

Table 8-5. PY11 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	25,355	100%	0.00	0.00%	25,355
Custom – Small	8,859	67%	0.90	39.94%	5,904
Custom – CHP	45,810	100%	0.00	0.00%	45,810
Program Total [(2)]	**80,023**	**96%**	**N/A**	**2.88%**	**77,068**

[(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. PY11 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	2.86	100%	0.00	0.00%	2.86
Custom – Small	1.54	52%	1.84	81.04%	0.82
Custom – CHP	5.47	100%	0.00	0.00%	5.47
Program Total [(2)]	**9.87**	**93%**	**N/A**	**6.74%**	**9.14**

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

[40] 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.

For all projects verified in PY11 through site visits (virtual and on site), Cadmus updated the assumed equipment parameters or operating sequences used to determine the reported savings and calculated the verified savings (see *Appendix G 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 G Evaluation Detail – Custom Program.*

8.2 Net Savings Impact Evaluation

The methods used to determine net savings for downstream, upstream, and midstream programs are provided in the Evaluation Framework,[41] 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 PY11. Cadmus conducted online and telephone self-report surveys with 16 of 69 Custom Program participants between February 2020 and July 2020. Additional details about methodology are in *Appendix G.3 Net-to-Gross Ratio Findings* and *Appendix P Net Savings Impact Evaluation*.

Table 8-7. PY11 Custom Program Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population[(1)]	Achieved Sample Size	Response Rate [(2)]	NTG Activity
Custom	Participants	69	16	23%	Self-Report Surveys

(1) The total population was 69. 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 PY11 savings (incentive adjustments). The sample frame was 34, and 16 participants completed the survey.
(2) Response rate is calculated as the number of respondents who answered the free ridership questions (n=16) divided by the number of records in the population.

Table 8-8 shows the free ridership, spillover, and NTG ratio for the Custom Program for PY11. Free ridership was 34%, weighted by the size of the project completed by respondents. The respondents represented 74% of the program's verified population savings. One respondent had a large project, 13 had small stratum projects, and two had CHP projects.

[41] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC. Final version May 8, 2018.

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

Table 8-8. PY11 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)	16	34%	0%	0.66	7%
[(1)]Weighted by verified kWh/yr savings.					

Table 8-9 shows PY11 Custom Program free ridership by stratum. The weighted average free ridership for small stratum projects is low at 27%, but surveyed projects represent only 6% of the analysis sample verified savings. The overall program free ridership estimate of 34% is heavily weighted toward the CHP stratum free ridership of 37%, as CHP stratum respondents represent 77% of the overall custom analysis sample verified savings.

Table 8-9. PY11 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	1	25%	16%	36%	N/A
Custom – Small	13	27%	6%	62%	18%
Custom – CHP	2	37%	77%	97%	8%
Program Total	**16**	**34%**	**100%**	**74%**	**7%**
[(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 PY11. Cadmus did not identify any high-interest projects that were not already selected into the large, small, or CHP strata.

8.3 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 PY11 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	80,023	9.87
PYVTD Gross	77,068	9.14
PYVTD Net [1]	50,865	6.03
P3RTD	246,737	28.57
P3VTD Gross	241,572	29.88
P3VTD Net[1]	170,082	20.96
[1] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.		

8.4 Process Evaluation

8.4.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. The PY11 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. PY11 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	Custom	Online	69	N/A [3]	All participants	1	34	100%
		Telephone				15		100%
Program Total			**71**	**N/A**	**N/A**	**18**	**36**	**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 PY11 savings (incentive adjustments). This left 34 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.

Cadmus conducted online and telephone self-report surveys with 16 of 34 Custom Program participants between February 2020 and July 2020. To increase the response rate, PPL Electric Utilities key account managers provided additional outreach to non-responders. 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.

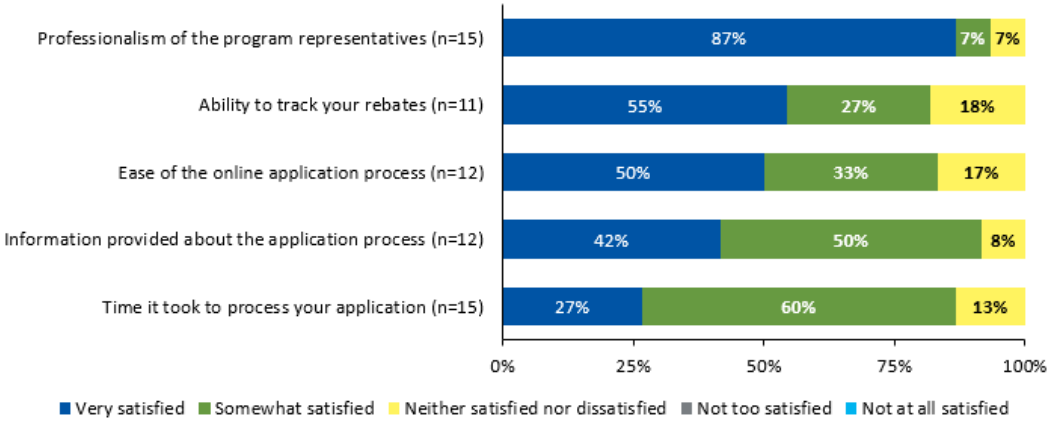
Satisfaction

The Custom Program was delivered effectively in PY11 and maintains high levels of customer satisfaction. The ICSP delivered the program in PY11 similar to PY10 except for one modification. In PY11, PPL Electric Utilities added Direct Install equipment to the Custom Program.

As shown in the program's infographic, overall, 88% of PY11 respondents were satisfied with the program (63% were *very satisfied* and 25% were *somewhat satisfied*; n=16).[42]

As shown in Figure 8-1, participants were most satisfied with the professionalism of program representatives (93% were satisfied; n=15). Most respondents were satisfied with the time it took to process the application (87% were satisfied; n=15), but only 27% of these respondents were *very satisfied*, the lowest rating for any program component.

Figure 8-1. PY11 Custom Program Component Satisfaction



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

Seven of 16 respondents provided recommendations to improve the program. The most common suggestion was to improve communication or the timing of communication. Respondents suggestions included these:

- "Better communication of requirements and process for determining rebate amount. This was a custom rebate for kWh reduction; however we were not provided any information on the potential rebate amount until six months after the equipment was installed."

[42] Additionally, 13% were *neither satisfied nor dissatisfied* (n=16). Percentages may not sum to 1 00% due to rounding.

- "Better planning. It took a lot of time for the calculations and other things to be completed on [PPL Electric Utilities'] end. However, whenever something was needed on my end I felt rushed and needed to fit them in immediately."
- "I made changes to two buildings but was only able to request rebates for one project. Very frustrating and costly."

8.5 Cost-Effectiveness Reporting

Because the Custom component is part of the Non-Residential Energy Efficiency Program, cost-effectiveness is presented in *Section 5.4 Cost-Effectiveness Reporting.*

8.6 Recommendations

Overall, the Custom Program has been highly successful, with the verified savings of 77,068 MWh/year. Nearly all program respondents (88%; n=16) were satisfied with the program. Because the program functioned well in PY11, Cadmus does not have any recommendations to make for the program moving forward.

EFFICIENT LIGHTING PROGRAM

The program encourages customers to purchase and install LED bulbs by providing incentives to participating manufacturers to discount the prices of a variety of bulbs sold at local retail stores.

VERIFIED ENERGY SAVINGS

Phase III has so far saved **426,752 MWh/yr**

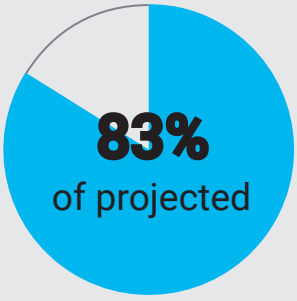
146% of projected

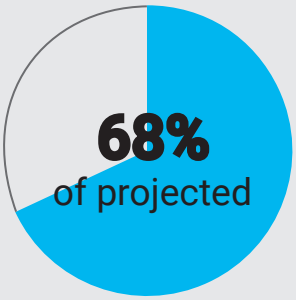
117% of projected

PY11 saved **48,339 MWh/yr**

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$29,975**





PY11 expenditures **$3,415**

PY11 BULBS SOLD

A total of **1,194,964** bulbs sold

(5,428 bulbs were giveaways)

BULB TYPE

66%	LED A-line bulbs *(includes 3-ways and giveaways)*
16%	LED reflector bulbs
8%	LED candelabra bulbs
5%	LED fixtures
4%	LED globes

RETAIL CHANNEL

53%	from home improvement stores
18%	from hardware stores
14%	from membership club stores
6%	from discount stores
6%	from mass merchandise stores
2%	from lighting and electronics stores
3%	from other stores *(including giveaways)*

9 Efficient Lighting Program

The Efficient Lighting Program, which PPL Electric Utilities discontinued at the end of 2019, encouraged residential customers to purchase and install LED bulbs by buying down the price of program-qualified ENERGY STAR® LEDs. The program provided upstream incentives to participating manufacturers to discount the prices of a variety of bulbs sold at local retail stores. The program targeted residential customers but was available to all PPL Electric Utilities customers and anyone who purchased discounted bulbs from participating retailers.

The program was primarily delivered by providing upstream incentives, but it also included occasional giveaway events at which bulbs were distributed directly to customers at no cost.

The ICSP, CLEAResult, managed program operations and provided support to participating retailers and manufacturers.

The objectives of the Efficient Lighting Program were these:[43]

- Provide a mechanism for customers to easily obtain discounted LED bulbs in local retail stores
- Develop and execute strategies aimed at transforming the market for LED bulbs
- Obtain approximately 293,000 MWh/year gross verified savings in Phase III
- Achieve high customer, retailer, and manufacturer satisfaction with the program
- Achieve widespread visibility of discounts through independent and regional retailers that carry program-eligible LED bulbs
- Engage retailers by educating and training retail sales associates about LED bulbs
- Educate customers on new lighting technologies

9.1.1 Definition of a Participant

A participant is a person or business that purchases discounted bulbs. However, because of the upstream design of the Efficient Lighting Program, the identities of purchasers are not known. Cadmus estimated the number of participants by dividing the total number of bulbs discounted in PY11 by deriving a bulb-per-participant count from residential and commercial customer telephone survey data collected in PY10. See *Appendix A. Upstream Lighting Cross-Sector Sales* for further details. Bulbs given away, at community events or via coupons, contribute 1:1 to the PY11 participant count.

9.1.2 Program Participation and Reported Impacts

Table 9-1 presents the participation counts, reported energy and demand savings, and incentive payments for the Efficient Lighting Program in PY11 by customer segment. The residential sector

[43] From PPL Electric Utilities Corporation. Energy Efficiency and Conservation Plan Act 129 Phase III. Docket No. M-2015-2515642. Approved November 2018.

accounted for 94% of bulbs sold and 87% of energy savings. The small C&I sector accounted for 6% of sales and 13% of savings. The process for allocating program sales and savings by customer segment is described in further detail in *Appendix A. Upstream Lighting Cross-Sector Sales*.

Table 9-1. PY11 Efficient Lighting Program Participation and Reported Impacts

Parameter	Residential	Small C&I	Total [1]
PYTD # Participants [2]	115,375	4,492	**119,867**
Reported Quantity (bulbs)	1,098,083	96,881	**1,194,964**
Verified Quantity (bulbs)	1,123,592	71,372	**1,194,964**
PYRTD MWh/yr	40,849	8,985	**49,834**
PYRTD MW/yr	4.71	1.89	**6.60**
PYVTD MWh/yr	42,190	6,149	**48,339**
PYVTD MW/yr	4.86	1.35	**6.21**
PY11 Incentives ($1,000)	$1,849	$159	**$2,008**

[1] Total may not match sum of columns due to rounding.
[2] The reported participant counts by sector use verified quantities divided by bulbs-per-participation assumptions, as described in *Appendix A. Upstream Lighting Cross-Sector Sales*.

9.2 Gross Savings Impact Evaluation

To evaluate the gross impacts of the Efficient Lighting Program, Cadmus verified the ENERGY STAR certification of all bulbs sold through the program and reviewed program tracking data. Each of these tasks is discussed in further detail in *Appendix H. Evaluation Detail – Efficient Lighting Program*.

9.2.1 Impact Evaluation Data Collection and Sample Design

Cadmus collected data from PPL Electric Utilities' tracking database to verify energy savings.

The impact evaluation sampling strategy is summarized in Table 9-2. The impact evaluation activities produced results with ±1.86% precision at 85% confidence.

Table 9-2. PY11 Efficient Lighting Program Gross Impact Evaluation Sample Design

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	Impact Evaluation Activity
Tracking Data	131,603 [1]	N/A	N/A	Census database review, QA/QC, and *ex post* adjustments

[1] Number of records (typically measured as all the information associated with a specific SKU for a given month and retail location, including its quantity sold) in PPL Electric Utilities' tracking database.

9.2.2 Gross Savings Impact Evaluation Results

Table 9-3 shows the program's verified gross program savings.

Table 9-3. PY11 Efficient Lighting Verified Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	Phase III Verified
MWh/yr	145,929	128,036	104,448	48,339	426,752 [1], [2]

[1] 80,945 MWh/yr of verified gross savings from the Efficient Lighting Program are attributed to small C&I. PY10 verified savings for the Efficient Lighting Program were reduced by 916 MWh/yr to conform with the SWE's PY10 Annual Report findings. The adjustment was divided proportionally (based on PY10 verified savings) between residential (87%) and small C&I sectors (13%). From Pennsylvania Public Utility Commission. *SWE Annual Report Act 129 Program Year 10*. Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and EcoMetric Consulting, LLC. February 19, 2020.

[2] Phase III verified savings may not match sum of program years due to rounding.

In PY11, the Efficient Lighting Program reported energy savings of 49,834 MWh/yr, as shown in Table 9-4, and demand reduction of 6.60 MW/yr, as shown in Table 9-5.

Table 9-4. PY11 Efficient Lighting Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MWh/yr
Upstream Lighting [1]	49,834	97%	N/A	1.86%	48,339

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

Table 9-5. PY11 Efficient Lighting Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MW/yr
Upstream Lighting [1]	6.60	94%	N/A	1.86%	6.21

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

In PY11, baseline wattage adjustments increased program energy savings by 212 MWh/yr (0.4%). However, cross-sector sales adjustments—which included changes to assumptions related to commercial sector hours of use (HOU), coincidence factor (CF), in-service rate (ISR), and proportion of program sales—decreased program energy savings by more than 1,700 MWh/yr (3.4%). Overall, these adjustments produced a net 3.0% decrease in verified savings compared to reported savings.

9.3 Net Savings Impact Evaluation

For the program's PY11 net savings results, Cadmus used the results from its PY8 net-to-gross (NTG) analysis, which used demand elasticity modeling to estimate participant free ridership of 17% and an NTG ratio of 0.83. The methodology and results of demand elasticity modeling in PY8 are discussed in the PY8 Annual Report.[44] Although free ridership may have changed due to declining LED costs and increased market shares, Cadmus used the PY8 results for net-to-gross analysis because the program ended in late 2019 and additional research was not needed.

[44] PPL Electric Utilities. *Annual Report Program Year 8: June 1, 2015–May 31, 2017.* Presented to Pennsylvania Public Utility Commission. Prepared by Cadmus. November 15, 2017.

9.4 Verified Savings Estimates

In Table 9-6, the realization rates determined by Cadmus (Table 9-4 and Table 9-5) are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the program in PY11.

Table 9-6. PYTD and P3TD Efficient Lighting Program Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD	49,834	6.60
PYVTD Gross	48,339	6.21
PYVTD Net [1]	40,121	5.16
P3RTD	438,501	61.68
P3VTD Gross [2]	426,752	56.83
P3VTD Net [1] [2]	354,204	47.17

[1] Net savings are not used to meet PPL Electric Utilities' energy saving compliance target
[2] 80,945 MWh/yr from the Efficient Lighting Program were attributed to Small C&I. PY10 gross verified savings for Efficient Lighting were reduced by 916 MWh/yr and 0.12 MW/yr to conform with the SWE's PY10 Annual Report findings; likewise, PY10 net savings were reduced by 760 MWh/yr and 0.10 MW/yr. The adjustment was divided proportionally (based on PY10 verified savings) between residential (87%) and small C&I sectors (13%).

9.5 Process Evaluation

Cadmus conducted process evaluations in prior program years and did not conduct a process evaluation in PY11. In addition, because the program did not change between PY10 and PY11, Cadmus did not interview program staff.

9.6 Cost-Effectiveness Reporting

A detailed breakdown of Efficient Lighting Program finances and cost-effectiveness is presented in Table 9-7. TRC benefits were calculated using gross verified impacts. NPV PYTD benefits and costs are expressed in PY11 dollars (PY11 includes months in both 2019 and 2020). NPV costs and benefits for P3TD financials are expressed in PY8 dollars. Participant costs are equal to the total of differences between retail bulb prices and baseline bulb costs.[45]

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.[46] A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix O. Non-Energy Benefits*.

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

[46] Guidance on the Inclusion of fossil fuel and H_2O benefits in the TRC Test, Statewide Evaluation Team, March 25, 2018.

Table 9-7. Summary of Efficient Lighting Program Finances – Gross Verified

Row #	Cost Category	PYTD ($1,000)		P3TD ($1,000) [9]	
1	EDC Incentives to Participants	$2,008		$22,087	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	$866		$9,228	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [1]**	**$2,874**		**$31,314**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$65	-	$222	-
7	Marketing [4]	-	$280	-	$957
8	Program Delivery [5]	-	$1,061	-	$4,736
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$1,406**		**$5,915**	
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]**	**$4,281**		**$37,229**	
14	Total NPV Lifetime Electric Energy Benefits	$8,967		$114,108	
15	Total NPV Lifetime Electric Capacity Benefits	$1,450		$19,954	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$2,868		$53,391	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	($422)		($3,344)	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7] [1]**	**$12,863**		**$184,109**	
19	**TRC Benefit-Cost Ratio [8]**	**3.01**		**4.95**	

[1] May not sum to total due to rounding.
[2] All costs for Plan Design and Development are portfolio-level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.
[4] Includes the marketing ICSP and marketing costs by program ICSPs.
[5] Includes ICSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, and 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 9-8 presents program financials and cost-effectiveness on a net savings basis.

Table 9-8. Summary of Efficient Lighting Program Finances – Net Verified

Row #	Cost Category	PYTD ($1,000)		P3TD ($1,000) [9]	
1	EDC Incentives to Participants	$2,008		$22,087	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	$377		$8,836	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [1]**	**$2,385**		**$30,923**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$65	-	$222	-
7	Marketing [4]	-	$280	-	$957
8	Program Delivery [5]	-	$1,061	-	$4,736
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$1,407**		**$5,915**	
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]**	**$3,792**		**$36,838**	
14	Total NPV Lifetime Electric Energy Benefits	$7,442		$112,886	
15	Total NPV Lifetime Electric Capacity Benefits	$1,204		$19,756	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$2,381		$53,000	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	($350)		($3,286)	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7] [1]**	**$10,676**		**$182,355**	
19	**TRC Benefit-Cost Ratio [8]**	**2.82**		**4.95**	

[1] May not sum to total due to rounding.
[2] All costs for Plan Design and Development are portfolio-level costs and are assigned to customer sectors at the end of the phase. These portfolio costs are not assigned to specific programs.
[3] Includes rebate processing, tracking system, general administration, program management, general management and legal, and technical assistance.
[4] Includes the marketing ICSP and marketing costs by program ICSPs.
[5] Includes ICSP rebate processing, direct program management, customer support, technical assistance to customers, site visits, legal, and 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.

9.7 Recommendations

Overall, the Efficient Lighting Program performed strongly until its discontinuation, with all bulbs sold meeting current ENERGY STAR certification criteria. Program data were complete, consistent, and accurate, and PPL Electric Utilities remained pleased with the implementation and performance of the program through its sunset at the end of 2019.

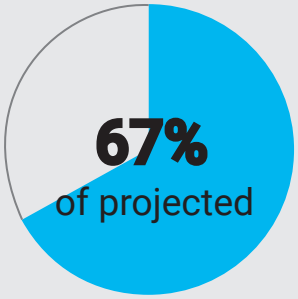
Because the program functioned well in PY11 and will not be delivered in PY12, Cadmus does not have any recommendations to make for the program moving forward.

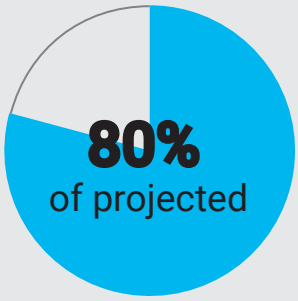
HOME ENERGY EDUCATION PROGRAM

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 so far saved **150,610 MWh/yr**



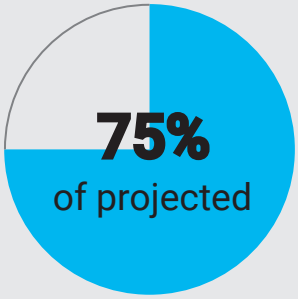


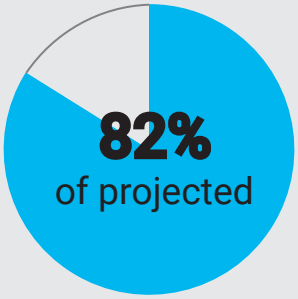
PY11 saved **37,223 MWh/yr**

Totals exclude savings attributable to the low-income sector

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$5,847**





PY11 expenditures **$1,839**

Totals exclude expenditures attributable to the low-income sector

PY11 PARTICIPATION

126,955

residential customers received Home Energy Reports

The Home Energy Reports promoted several components of the Energy Efficient Home Program (online marketplace, dehumidifiers, ductless heat pumps, and the online home energy assessment) and WRAP.

Total excludes participants attributable to the low-income sector

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 energy use, a comparison of household energy use to similar customers 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,[47] on which they can take a home energy assessment by entering detailed information about their home and request a kit with energy-saving products.[48]

CLEAResult, the ICSP for all of PPL Electric Utilities' residential programs, administers the Home Energy Education Program and oversees the home energy reports vendor. The ICSP subcontracts with Uplight (formerly Tendril) to develop and distribute the program's educational offerings—the home energy reports, online energy management portal, and online home energy assessments.

In PY11, the program mailed either two or three print home energy reports to customers, depending on the cohort the customer belonged to. Customers with valid email addresses also received these reports in electronic format and could ask to receive only the electronic reports. Customers could also access the program's energy management portal to set energy-saving goals, receive recommendations toward reaching these goals, and check off any actions they had completed.

The objectives of the Home Energy Education Program were these:[49]

- 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 operated 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 the home energy reports. Treatment group customers who did not wish to receive the reports could opt out of the

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47 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.

48 The savings for the kits and energy-saving products are reported in the Energy Efficient Home Program.

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

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 data 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, and in early PY8 Cadmus made the random assignments of these additional customers.

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. A participant who received only one report is retained in the treatment group for analysis, even if the participant subsequently opted out.

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 2010
- Phase I Legacy Wave 2 received first report in PY3, June 2011
- Phase II Expansion Wave received first report in PY6, October or December 2014
- Phase II Low-Income Wave 1 received first report in PY6, October or December 2014
- 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 2016

Cadmus evaluated the energy savings for five of the six waves in PY11. PPL Electric Utilities discontinued treatment for Low-Income Wave 2 in PY11 and PY12, following Cadmus' recommendation from the PY10 evaluation.[50] In the PY9 evaluation, Low-Income Wave 2 savings could not be distinguished from 0.0 kWh/day because of the small number of customers in the wave.[51] As a result, the PY9 evaluation recommended the discontinuation of the wave.

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.

[50] 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.

[51] 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.

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, 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.[52] In PY11, 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 PY11 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 PY11.

In PY11, the home energy report vendor treated the subset of customers in the Low-Income Wave 1 verified by PPL Electric Utilities as still having an income at or below 150% of the federal poverty level. The remaining customers in the Low-Income Wave 1 were last treated in February of PY10. However, because home energy reports are considered to have a one-year measure life, Cadmus calculated savings for these customers through January of PY11 and applied these savings to the residential sector.

Table 10-1. PY11 Home Energy Education Program Participation and Reported Impacts

Parameter	Residential	Low-Income [1]	Total [2]
PYTD # Participants [3]	126,955	16,440	**143,395**
PYRTD MWh/yr	34,994	1,151	**36,145**
PYRTD MW/yr	6.02	0.20	**6.23**
PYVTD MWh/yr	37,223	1,564	**38,787**
PYVTD MW/yr	6.29	0.26	**6.55**
PY11 Incentives ($1000)	$0	$0	**$0**

[1] A home energy report sent to low-income cohorts is an approved low-income measure. PY11 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 PY11.

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 energy savings. The program's experimental design and the large number of customers in the randomized treatment and control

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

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 applied the ratio of average peak demand savings per customer to the average energy savings per hour per -customer from the PY4 evaluation.

Because the home energy reports encouraged customers to participate in PPL Electric Utilities' other energy efficiency programs, Cadmus also estimated energy savings from participation in these programs (see *Appendix C.2 Uplift Analysis Methodology* for details). Cadmus subtracted the uplift savings from the residential portfolio savings to avoid double-counting the uplift savings. (See the *Uplift Analysis* section.)

The PY11 sampling strategy is summarized in Table 10-2. Cadmus included treatment group customers in the regression analysis regardless of whether they received treatment (a home energy report) because of the randomized experimental design. The regression analysis therefore results in an estimate of the intent-to-treat effect. This estimate is multiplied by the number of treatment group customers to obtain an estimate of the overall HER savings. Only customers with sufficient billing data were included in the regressions, but 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. PY11 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	
Low-Income Wave 1 – Residential [4]			N/A	53,703	13,457	
Phase III Expansion Wave 1	30,584	12,234	N/A	27,022	10,834	
Program Total [5]	**257,835**	**118,450**	**N/A**	**243,669**	**111,717**	

[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 PY11.

[4] In 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. However, all customers in the wave were treated through February of PY10 and were included in the PY11 regression analysis.

[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 verified gross energy savings.

Table 10-3. Home Energy Education Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	Phase III Verified
MWh/yr	34,326	36,232 [1]	42,829	38,787	152,174 [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 PY11, the Home Energy Education Program reported energy savings of 36,145 MWh/yr, as shown in Table 10-4, and demand reduction of 6.23 MW/yr, as shown in Table 10-5. Cadmus verified 107% of the reported energy savings and 105% of the reported demand savings.

Table 10-4. PY11 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	9,555	103%	0.13	18%	9,844
Legacy Wave 2	11,876	102%	0.19	28%	12,150
Expansion Wave 1	8,770	93%	0.27	39%	8,125
Low-Income Wave 1 – Low-Income	1,151	136%	0.80	115%	1,564
Low-Income Wave 1 – Residential	0	NA	0.29	42%	2,519
Phase III Expansion Wave 1	4,794	96%	0.26	37%	4,584
Program Total [2]	**36,145**	**107%**	**-**	**15%**	**38,787**

[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.

Table 10-5. PY11 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	1.63	102%	0.35	51%	1.66
Legacy Wave 2	2.04	101%	0.39	55%	2.05
Expansion Wave 1	1.52	90%	0.43	62%	1.37
Low-Income Wave 1 – Low-Income	0.20	131%	0.90	130%	0.26
Low-Income Wave 1 – Residential	0.00	NA	0.45	65%	0.43
Phase III Expansion Wave 1	0.83	93%	0.42	61%	0.77
Program Total [2]	**6.23**	**105%**	**-**	**27%**	**6.55**

[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.

The following factors affected the program's achievements in PY11:

- **The Phase III Expansion wave savings persisted in PY11.** The Phase III Expansion Wave, launched in PY8, achieved savings of almost 1.2% in PY11, maintaining the increase in savings observed in PY10 (1.1%) from PY8 (0.3%) and PY9 (0.7%). (See *Appendix C.1 Methodology* for the percentage savings over time by wave.)
- **Customers in Legacy Wave I and Expansion Wave I continued to save at expected levels in PY11.** Legacy Wave 1 customers reduced their energy consumption by between 1.9% and 2.0% in Phase III and achieved statistically significant savings of 1.9% in PY11. Customers in Expansion Wave 1 saved between 1.0% and 1.4% in PY8, PY9, and PY10 and, in PY11, reduced their consumption by 1.2%. (See *Appendix C.1 Methodology* for the percentage savings over time by wave.)
- **Savings may be declining in the Legacy Wave 2.** Legacy Wave 2 savings reached a peak in PY7 when customers reduced their energy consumption by 1.8%. However, savings steadily declined in Phase III. Customers reduced their consumption, on average, by 1.7% in PY8, 1.6% in PY9, and 1.5% in PY10. In PY11, customers in Legacy Wave 2 achieved, on average, savings of 1.4%, the lowest since their first year of treatment in PY2. (See *Appendix C.1 Methodology* for the percentage savings over time by wave.)
- **The ICSP did not treat customers in the Low-Income Wave 2 in PY11.** Cadmus could not detect statistically significant savings for customers in the Low-Income Wave 2 in PY8, PY9, or PY10 and recommended that PPL Electric Utilities cease treating customers in this wave altogether. The small size of the control groups (9,575 in PY10) and a year-long gap in treatment for most of PY8, the second year of the program for this wave, contributed to Cadmus' inability to distinguish program impacts from 0.0 kWh/day. (See *Appendix C.1 Methodology* for the percentage savings over time by wave.)

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

- In PY11, the HER vendor treated the subset of customers in the Low-Income Wave 1 verified by PPL Electric Utilities as still having an income at or below 150% of the federal poverty level. The remaining customers in the Low-Income Wave 1 were last treated in February of PY10. However, because home energy reports are considered to have a one-year measure life, the savings through January of PY11 for the remaining customers can be claimed as residential sector savings. Cadmus measured savings for these customers through January of PY11 and applied the savings to the residential sector. PPL Electric Utilities did not claim these residential savings in its tracking database, leading to a realization rate of over 100% in this wave.

10.3 Net Savings Impact Evaluation

The Home Energy Education Program evaluation resulted in an estimate of net savings. The estimate included any spillover that may have occurred 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 irrelevant 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 PY11. 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.[53] For example, installation of a high-efficiency air conditioner in PY4 is expected to yield savings in PY11 and through the expected life of the product. To estimate the home energy report savings in PY11 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.2 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 PY11. Home energy reports had a positive effect on participation in other programs if rates of cross-program participation were greater for treatment group customers. On average, across all waves, treatment customers participated in other PY11 programs at a rate 13% 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 PY11 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 PY11, Cadmus deducted Home Energy Education Program uplift savings of 5,431 MWh/yr (14%) and 0.77 MW/yr (12%) 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

[53] Pennsylvania Public Utility Commission. *Evaluation Framework for Pennsylvania Act 129 Phase III Energy Efficiency and Conservation Programs.* Prepared by NMR Group, Inc., EcoMetric Consulting, LLC, and Demand Side Analytics, LLC. Final version May 8, 2018.

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 irrelevant 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	36,145	6.23
PYVTD Gross	38,787	6.55
PYVTD Net (1) (2)	38,787	6.55
P3RTD Gross	152,567	74.45
P3VTD Gross (3)	152,174	26.64
P3VTD Net (1) (2)	152,174	26.64

(1) Net savings are not used to meet PPL Electric Utilities' energy saving compliance target.
(2) The NTG ratio is irrelevant; 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. The PY11 limited process evaluation involved staff interviews with the ICSP and the home energy reports vendor to assess changes to program design and delivery from PY10 to PY11. Cadmus did not conduct the customer satisfaction survey and logic model review that were indicated in the evaluation plan.

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. Therefore, PPL Electric Utilities and Cadmus canceled the customer satisfaction survey in PY11. Cadmus reviewed the logic model in PY8 and PY9 and decided not to review it in PY11 because the program theory and logic had not changed.

10.5.1 Program Delivery

Treatment group customers in all but the Low-Income Wave 2 received print and/or electronic home energy reports in PY11,[54] and the number of reports varied by wave.[55] As shown in Table 10-7,

[54] Print and electronic home energy reports were identical in content.

[55] In PY11, the home energy reports vendor treated only the subset of customers in Low-Income Wave 1 identified by PPL Electric Utilities as still being at or below 150% of the federal poverty level.

treatment group customers received fewer reports in PY11 than in previous years because PPL Electric Utilities and the ICSP stopped sending the reports to residential customers in October 2019.

The PY11 home energy reports promoted several components of the Energy Efficient Home Program (online marketplace, the rebate on dehumidifiers, ductless heat pumps, and the online home energy assessment) and WRAP. The PY11 home energy reports did not promote the Appliance Recycling Program, which had been promoted every year previously.

Table 10-7. Home Energy Report Delivery Frequency

Wave (Launch Year)	PY8	PY9	PY10	PY11
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]
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 PY11, 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.

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 net present value program year to date (NPV PYTD) benefits and costs are expressed in PY11 dollars (PY11 includes months in both 2019 and 2020). 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	**ICSP**	**EDC**	**ICSP**
5	Design and Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$57	-	$142	-
7	Marketing [4]	-	$279	-	$777
8	Program Delivery [5]	-	$1,510	-	$4,244
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$1,845**		**$5,162**	
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]**	**$1,845**		**$5,162**	
14	Total NPV Lifetime Electric Energy Benefits	$1,894		$5,768	
15	Total NPV Lifetime Electric Capacity Benefits	$464		$1,513	
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]**	**$2,358**		**$7,281**	
19	**TRC Benefit-Cost Ratio [8]**	**1.28**		**1.41**	

[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.

10.7 Recommendations

Overall, the Home Energy Education Program achieved 38,787 MWh/yr savings in PY11. The home energy reports also increased the savings achieved through PPL Electric Utilities' other energy efficiency programs in PY11. Recommendations are provided in Table 10-9 along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: Low-Income customers in the Low-Income Wave did not achieve statistically significant savings from PY11 treatment.

- The evaluation did not find statistically significant savings from treatment in PY11 for low-income customers in the Low-Income Wave 1. (*See 10.2.2 Gross Savings Impact Evaluation Results.*)

Table 10-9. Status of Recommendations for the Home Energy Education Program

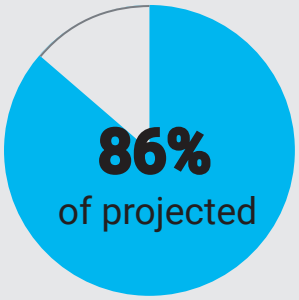
Home Energy Education Program		
Conclusion	**Recommendation**	**EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)**
Conclusion 1: Low-Income customers in the Low-Income Wave did not achieve statistically significant savings from PY11 treatment.	Continue to monitor the low-income status of customers in the Low-Income Wave 1 as the impacts of COVID-19 could cause customers who were last verified as not having low-income status to fall at or below 150% of the federal poverty level.	Under consideration. This wave has already received the two treatments planned for PY12 and PPL Electric Utilities is not expecting to send additional Home Energy Reports this program year (PY12).

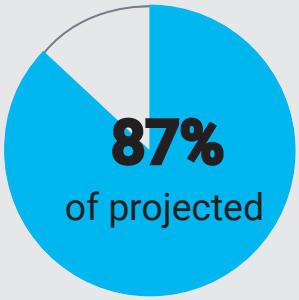
ENERGY EFFICIENT HOME PROGRAM

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

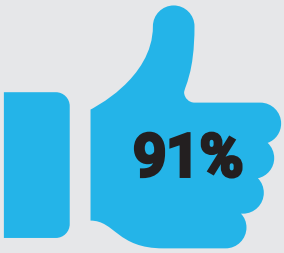
Phase III has so far saved **63,336 MWh/yr**





PY11 saved **16,929 MWh/yr**

PROGRAM SATISFACTION



Satisfied with overall program

94% satisfied with the **rebates** for qualifying equipment and services

91% satisfied with the **clarity of application** requirements

87% satisfied with the **information** about how to save energy

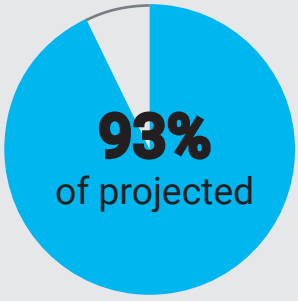
PY11 PARTICIPATION

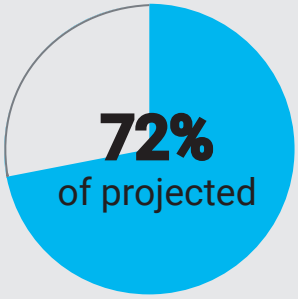
A total of **19,634** received rebates for

- **10,280** Efficient equipment
- **3,700** Online and in-home audit and energy conservation kits
- **3,515** Online marketplace
- **759** Weatherization
- **1,380** New homes

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$23,960**





PY11 expenditures **$6,352**

11 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 six components: New Homes (new home construction incentives), Audit and Kits (two components: in-home energy audits and online home energy assessments, both of which include energy-savings kits), Weatherization, Efficient Equipment, and the Online Marketplace.

New Homes. In PY11, 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.

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 currently 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 (SEER 16+), ductless heat pumps (< 5.4 tons, ≥ SEER 16, ≥ HSPF 8.6), central air conditioners (SEER 16+), heat pump water heaters (≥ 2.3 EF), efficient pool pumps (variable speed drive), ENERGY STAR or ENERGY STAR Most Efficient refrigerators and dehumidifiers, advanced smart thermostats, ASHP tune-ups, duct sealing, and 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 will not be 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 see the pre-incentive price as well. 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. In PY11, PPL Electric Utilities occasionally conducted marketing to drive marketplace sales and ran special manufacturer promotions on specific products.

PPL Electric Utilities' energy efficiency program staff provide overall strategic direction and program management. The EM&V 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 PY11, the objectives of the Energy Efficient Home Program were these:[56]

- 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

11.1.1 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.

11.1.2 Program Participation and Reported Impacts

Table 11-1 presents participation counts, reported energy and demand savings, and incentive payments for the Energy Efficient Home Program in PY11, by customer segment.

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

Table 11-1. Energy Efficient Home Program Participation and Reported Impacts

Parameter	GNE	Large C&I	Residential	Small C&I	Total [1]
PYTD # Participants [2]	11	1	19,543	79	**19,634**
PYRTD MWh/yr [2]	6.87	0.43	20,098	155	**20,261**
PYRTD MW/yr [2]	0.00	0.00	3.92	0.03	**3.95**
PYVTD MWh/yr [3]	7.34	0.46	16,756	165	**16,929**
PYVTD MW/yr [3]	0.00	0.00	2.54	0.03	**2.57**
PY11 Incentives ($1000) [2]	$6	$0	$3,061	$29	**$3,096**

[1] May not match due to rounding.
[2] Includes the New Homes component.
[3] Does not include the New Homes component, which will be verified in PY12.

11.2 Gross Savings Impact Evaluation

11.2.1 Impact Evaluation Data Collection and Sample Design

To evaluate PY11 savings, Cadmus conducted database reviews for all rebated products in the Audit and Kit, Weatherization, Efficient Equipment and Online Marketplace program components. The team also conducted records reviews for select products and services in the Audit and Kit, Weatherization, and Efficient Equipment program components, and used participant surveys to calculate an in-service rate (ISR) for measures in the Online Marketplace component.

Cadmus did not verify PY11 savings for the New Homes component because necessary site visits were not practical because of COVID-19 safety precautions. PY11 savings will be verified in PY12.

With the exception of New Homes, Cadmus conducted a database review for a census of projects. This process included assessing reported inputs for reasonableness, and independently calculating savings to verify savings were calculated by the ICSP using the appropriate PA TRM algorithms and inputs. Cadmus also verified that dehumidifiers, refrigerators and Online Marketplace LED bulbs were ENERGY STAR-certified in accordance with the TRM. For products that did not receive a records review, Cadmus calculated the realization rate by comparing the total *ex post* savings from the database review to total reported savings.

For six items (in-home audit kits, insulation projects, HVAC tune-ups, fuel switching central heating systems, fuel switching water heaters, and dehumidifiers), Cadmus also used a sampling approach to conduct records reviews. For these measures, Cadmus calculated the realization rate using the *ex post* savings from the records review of the sampled projects, compared to the reported savings for those projects. Through the records review, Cadmus examined all available records and documentation for a sample of projects to accomplish the following:

- Verify that reported equipment and customer data in PPL Electric Utilities' tracking database matched information from rebate applications, Air Conditioning, Heating, and Refrigeration Institute (AHRI) certificates, invoices, and other supporting documentation, where applicable

- Calculate the *ex post* savings and realization rate for the sample, using the PA TRM algorithms and applying verified equipment and customer data, TRM assumptions, or evaluated inputs as appropriate

In PY11, Cadmus used participant survey data to calculate ISRs for high-volume Online Marketplace products (smart thermostats, LEDs, smart strips, and weatherstripping). For the other Online Marketplace products (dehumidifiers, lighting strings, lighting controls and night lights), Cadmus assumed a 100% ISR, and for products in other program components, Cadmus used ISRs calculated in PY10.

The evaluation sampling strategy is summarized in Table 11-2. Cadmus evaluated all components with basic levels of rigor and used stratified random sampling for records reviews. In the sampling approach, products and services each represented a stratum and program components represented a stratum group. Cadmus identified which products and services received a records review based on historical evaluation findings or whether they were new to the program.

Table 11-2. PY11 Energy Efficient Home Program Gross Impact Sample Design

Stratum Group	Population Size [1]	Impact Evaluation Activity	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size
Audit and Kit	3,700	Records review [2]	0.5	40	40
Weatherization	759	Records review [3]	0.5	40	20
Efficient Equipment	10,280	Records review [4]	0.5	160	123
Online Marketplace	3,515	Verification online survey [5]	0.5	All eligible participants	43
Program Total	**18,254**				**226**

[1] The number of unique rebates available in PPL Electric Utilities' PY11 tracking database. Does not include the New Homes component.

[2] Cadmus sampled 40 in-home audit projects.

[3] Cadmus sampled 20 insulation projects. There were no duct sealing projects in PY11.

[4] Cadmus conducted records reviews for 14 HVAC Tune-ups, 40 fuel switching central heating systems, 29 fuel switching water heaters, and 40 dehumidifiers.

[5] Online survey conducted with online marketplace participants.

Cadmus completed fewer records reviews than planned in the Weatherization and Efficient Equipment components due to small population sizes for the specific products selected for review. In the Weatherization component, there were no duct sealing projects and therefore no records to review. In the Efficient Equipment component, Cadmus completed fewer reviews than planned for HVAC tune-ups and fuel switching water heaters because the initial target exceeded this component's confidence and precision target of 85/15. Also, in the case of fuel switching water heaters, the 29 projects Cadmus reviewed included all completed projects. For the Online Marketplace component, Cadmus issued the online survey to all eligible participants through Q2.

The Program's gross impact evaluation activities produced results with ±0.33% 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 using sampling weights (w_i) proportional to the sampling probability of each unit.[57] For more information about how program-level *ex post* savings were calculated, *see Appendix I Evaluation Detail – Energy Efficient Home Program.*

11.2.2 Gross Savings Impact Evaluation Results

Table 11-3 shows the program's verified and unverified gross savings. Unverified gross savings will be verified in PY12.

Table 11-3. Energy Efficient Home Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	PY11 Unverified [1]	Phase III Verified
MWh/yr	9,943	18,802	17,661	16,929	4,084	63,336 [2]

[1] PY11 unverified savings are from the New Homes component and will be verified in PY12.

[2] Phase III verified savings may not match sum of program years due to rounding.

In PY11, the Energy Efficient Home Program reported energy savings of 20,261 MWh/yr, as shown in Table 11-4, and demand reduction of 3.95 MW/yr, as shown in Table 11-5.

Table 11-4. PY11 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]	1,041	87%	N/A	6.05%	906
Weatherization	673	100%	N/A	7.43%	672
Efficient Equipment	13,883	107%	N/A	0.18%	14,858
Online Marketplace	580	85%	N/A	6.44%	493
New Homes (Unverified)	4,084	N/A	N/A	N/A	0
Program Total [2]	**20,261**	**105%[3]**	**N/A**	**0.50%[3]**	**16,929 [3]**

[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] Realization rates and PYVTD exclude unverified energy savings. The program-level realization rate is weighted by stratum.

[57] National Renewable Energy Laboratory. April 2013. *Chapter 11: Sample Design Cross-Cutting Protocols. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* Prepared by Cadmus. http://energy.gov/sites/prod/files/2013/11/f5/53827-11.pdf

Table 11-5. PY11 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]	0.11	85%	N/A	5.60%	0.09
Weatherization	0.06	86%	N/A	6.42%	0.05
Efficient Equipment	2.35	101%	N/A	0.24%	2.39
Online Marketplace	0.04	106%	N/A	2.26%	0.04
New Homes (Unverified)	1.38	N/A	N/A	N/A	0.00
Program Total [2]	**3.95**	**100%[3]**	**N/A**	**0.33%[3]**	**2.57[3]**

[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] Realization rates and PYVTD exclude unverified energy savings. The program-level realization rate is weighted by stratum.

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 reduction. This section presents highlights from the analysis. Additional information can be found in *Appendix I* for each of these program components.

- **Audit and Kit.** The Audit and Kit stratum group had a 87% realization rate for energy and 85% realization rate for demand, increased from 66% for both in PY10. For both in-home audits and online assessments, the increase was primarily because the ICSP updated the ISRs used in its reported savings calculations to the PY8 evaluated values. Cadmus used the PY10 evaluated ISRs, which were lower than the PY8 values and accounted for the remaining difference between the actual realization rates and 100%.[58,59]
  - As in PY10, Cadmus' records review of in-home audit forms did not show that the auditors had set back the water heater temperature so Cadmus applied zero savings. The water heater setback was originally expected to contribute about 18% of the savings from electric hot water kits, so this decreased the realization rate for in-home audits. PPL Electric Utilities noted that the in-home auditor form was revised for PY12 to improve the instructions on how to fill out the water heater setback, the issue was conveyed to auditors, and ICSP data entry staff were trained on how to accurately read and enter the data from the form into the database.

58 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. http://www.puc.pa.gov/pcdocs/1544671.pdf

59 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. Available online: http://www.puc.pa.gov/pcdocs/1645614.pdf

- **Weatherization.** The Weatherization stratum group had a 100% energy realization rate and a 86% demand realization rate.
  - Air sealing had a realization rate of 100% for both energy and demand savings. Insulation projects had a lower realization rate of 85% for demand savings. This difference is because the ICSP applied the PA TRM's alternate cooling EFLH to calculate reported demand reduction, whereas Cadmus used the PA TRM's default cooling EFLH.
  - Cadmus also identified a small number of calculation errors in reported savings for wall insulation projects related to the baseline R-value.
- **Efficient Equipment.** Overall, the Efficient Equipment stratum group had a 107% energy realization rate and a 101% demand realization rate. Several factors resulted in slightly higher realization rates for this component compared to PY10.
  - Cadmus used the PA TRM EFLH default values, which resulted in an adjustment to reported energy savings, depending on the specific measure. Default EFLH values were higher than reported for most heating and cooling systems but lower for electric baseboards and fossil fuel boilers. As a result, energy savings for most heating and cooling measures increased slightly. Savings for fuel switching central heat systems showed a net increase, but realization rates for fuel switching boilers and any fossil fuel equipment that replaced electric baseboards were slightly lower because of the lower EFLH for those systems.
  - Dehumidifiers had a realization rate of 153% for both energy and demand savings. Cadmus calculated the *ex post* savings based on the ENERGY STAR model number and whether the equipment qualified for ENERGY STAR Version 4.0 or Version 5.0, which achieve higher savings than earlier ENERGY STAR specifications. Reported savings relied on ENERGY STAR Version 3.0.
  - The energy realization rate for downstream smart thermostats was 97%. The small decrease in realization was due to the fact that *ex ante* savings included multiple units per customer for a small number of records (29 out of 1,119), yet the approved interim measure protocol for connected thermostats specifies whole-home savings based on the home's central heating and cooling system. While its possible customers purchased thermostats for multiple homes, the rebate form only captures information for one heating and cooling system.
- **Online Marketplace.** The Online Marketplace stratum group had an 85% energy realization rate and a 106% demand realization rate. The difference in reported and evaluated energy savings was driven mainly by the evaluated ISRs that Cadmus applied from the PY11 survey. The ISR for smart thermostats was 66% and for weatherstripping was 70%.

11.3 Net Savings Impact Evaluation

Cadmus used PY11 survey data to calculate net savings for the Online Marketplace component. To calculate net savings for other components, Cadmus applied net savings rates from PY8 (most products) or PY9 (dehumidifiers and refrigerators only). A detailed explanation of the methodology for these components and equipment types can be found in the PY8 and PY9 Annual Reports.[60,61] Cadmus attempted to collect survey data to inform net savings calculations for the duct sealing, HVAC tune-up, and hot water heater fuel switching participants, but no participants completed surveys for these offerings in PY11. Cadmus calculated net savings only to inform future program planning. Energy savings compliance targets were met using verified gross savings.

Table 11-6 lists the methods and sampling strategy used to determine net savings for the Online Marketplace stratum group in PY11. Additional details about methodology and findings are in *Appendix P Net Savings Impact Evaluation* and *Appendix I.4 Net-to-Gross Ratio Findings*.

Table 11-6. PY11 Energy Efficient Home Program Net Impact Evaluation Sample Design

Stratum	Stratum Boundaries	Population Size [(1)]	Achieved Sample Size [(2)]	NTG Activity
Online Marketplace	Participants (Customers) [(1)]	549	37	Participant online survey
Program Total		**549**	**37**	

[(1)] Population refers to unique projects at the time of the survey.

[(2)] Achieved sample size is based on number of survey respondents answering the first free ridership question K1, "Which of the following would have happened if the [MEASURE] you purchased from the PPL Energy Efficiency Marketplace was not discounted?" and answering at least of one of the questions from K2a to K2e, "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. K2a. The discount for the [MEASURE], K2b. PPL Electric Utilities' information about energy efficiency, K2c. Convenience of being able to buy online from PPL Electric Utilities, K2d. Information about the type of products on the PPL Energy Efficiency Marketplace, K2e. Information about saving energy from the PPL Energy Efficiency Marketplace online chat."

Table 11-7 shows the free ridership, spillover, and NTG ratios by program component.

60 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.

61 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.

Table 11-7. Energy Efficient Home Program Net Impact Evaluation Results

Stratum	PYVTD kWh/yr	Evaluation Year	Free Ridership (%) [1]	Spillover (%)	NTG Ratio
Audit & Kit	905,522	PY8	7%	9%	1.02
Weatherization	672,376	PY8	49%	7%	0.58
Efficient Equipment	14,857,980	PY9 [2] & PY8	43%	7%	0.64
Online Marketplace	493,021	PY11	25%	0%	0.75
New Homes [3]	N/A	N/A	N/A	N/A	N/A
Program Total [4] [5]	**16,928,900**		**41%**	**7%**	**0.66**

[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] Refrigerators and dehumidifiers were the only products evaluated for NTG ratio in PY9. PY8 NTG ratio results were used for all other equipment categories of the Efficient Equipment stratum.
[3] PY11 savings will be verified in PY12. PY11 NTG results will be applied to PY11 verified gross savings in PY12.
[4] 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 0.66.
[5] Total may not match sum of rows due to rounding.

11.4 Verified Savings Estimates

In Table 11-8, the realization rates determined by Cadmus are applied to the reported energy and demand savings estimates to calculate the verified savings estimates for the Energy Efficient Home Program in PY11.

Table 11-8. PYTD and P3TD Energy Efficient Home Program Savings Summary

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD Gross	20,261	3.95
PYVTD Gross	16,929	2.57
PYVTD Net [1]	11,192	1.68
PY Unverified Savings [2]	4,084	1.38
P3RTD Gross	73,021	13.17
P3VTD Gross	63,336	11.05
P3VTD Net [1]	43,669	7.27
P3 Unverified Savings [2]	4,084	1.38

[1] Net savings are not used to meet PPL Electric Utilities' energy savings compliance target.
[2] Unverified savings are for the new homes component. The savings will be verified in PY12.

11.5 Process Evaluation

11.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. The PY11 limited process evaluation of the Energy Efficient Home Program was to assess participant satisfaction using data collected through online participant surveys and interviews with home builders. These activities were consistent with the evaluation plan. Table 11-9 shows the sampling strategy for the process evaluation. Cadmus conducted one additional interview with PPL Electric Utilities Program Staff via email, which is why the achieved sample size is one higher than the target sample size.

Table 11-9. Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size [1]	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame [3]	Percent of Sample Frame Contacted to Achieve Sample [4]
Program Stakeholders	PPL Electric Utilities Program and ICSP Staff	Telephone in-depth interview	2	N/A	2	3	N/A	N/A
Participants [1]	In-Home Audit and Kit	Online survey	84	90/10	All records	7[2]	72	100%
	Online Assessment	Online survey	3,082	90/10	All records	123[2]	2,860	100%
	Equipment	Online survey	10,275	90/10	All records	493[2]	6,940	100%
	Weatherization	Online survey	735	85/15	All records	34[2]	435	100%
	Online Marketplace	Online survey	549	90/10	All records	43[2]	479	100%
Builders	New Homes	Telephone interview	53	N/A	10	11	53	100%
Program Total			**14,780**	**-**	**-**	**714**	**10,839**	**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. 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.

Participants completed 700 online surveys, as shown in Table 11-9. Cadmus contacted all eligible participants for each program component and administered the online survey in waves throughout PY11. To provide timely respondent feedback and information to PPL Electric Utilities and the ICSP, the

survey was administered during Q1 and Q2 for the Online Marketplace participants, Q1 and Q3 for the online assessments, and Q1 and Q4 for the in-home audits, weatherization, and equipment projects. 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.

Cadmus generated the New Homes builder sample frame from PPL Electric Utilities' participant tracking database of submitted rebates. Cadmus included unique builders who completed projects in PY11.

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

11.5.2 Program Satisfaction

Participant satisfaction with the Online Marketplace, Efficient Equipment, Audit and Kit (online assessments and in-home audits), Weatherization, and New Homes components are reported in this section.

In PY11, 91% of respondents (n=705) said they were satisfied with the Energy Efficient Home Program (±5% at 90% confidence, shown in this program's infographic).[62] Seventy-two percent were *very satisfied* and 19% were *somewhat satisfied*.[63] Satisfaction was significantly higher than in PY10, where 87% of respondents (n=495) said they were satisfied with the Program.[64]

Component-Level Satisfaction

Across program components, nearly all participants were satisfied with their experience in the Energy Efficient Home Program (Table 11-10). Satisfaction with the program was significantly lower for online assessment participants (80%, n=123) than for participants in the Equipment (95%) and Weatherization (94%) components.[65] This is consistent with PY10, when 81% of online assessment participants were satisfied with the program. As discussed in this component-level section and in the *Suggested Improvements (All Program Components)* section, online assessment respondents were not as satisfied with the report they received and requested that it be more customized to their needs. This contrasts with PY10, when the kit was the program aspect that most online assessment respondents asked to be improved.

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[62] 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.

[63] Of the remaining respondents, 4% were *neither satisfied nor dissatisfied*, 3% were *not too satisfied*, 2% were *not at all satisfied* with the overall program, and three said don't know. The total may not sum to 100% due to rounding.

[64] Cadmus used a two-tailed t-test (p-value = 0.0224).

[65] Equipment: p=.0000; Weatherization: p=.0482; In-Home Audit and New Homes sample sizes were too small.

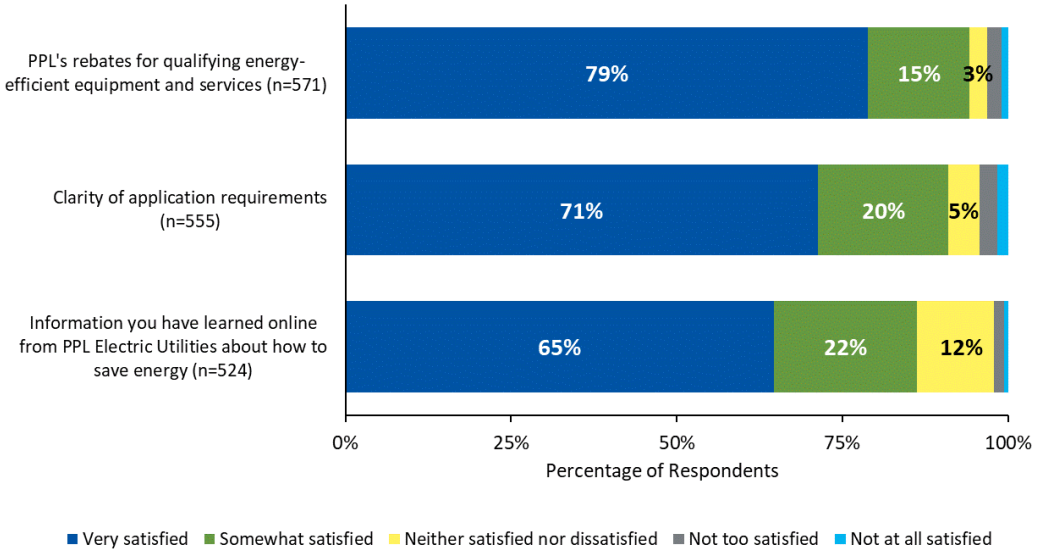
Table 11-10. Overall Satisfaction by Program Component

Component	Percent Satisfied (*very* or *somewhat satisfied*)
In-Home Audit (n=7)	100%
New Homes (n=11)	100%
Equipment (n=488)	95%
Weatherization (n=34)	94%
Online Marketplace (n=42)	88%
Online Assessment (n=123)	80%
Total (n=705)	**91%**

Program Delivery

Participants reported their satisfaction with various elements of program delivery. Equipment, In-home Audit, and Weatherization participants (Figure 11-1), were highly satisfied with all program aspects, with over 80% saying they were *very satisfied* or *somewhat satisfied* with each program delivery element in the participant survey. Results in PY11 are not significantly different from PY10.

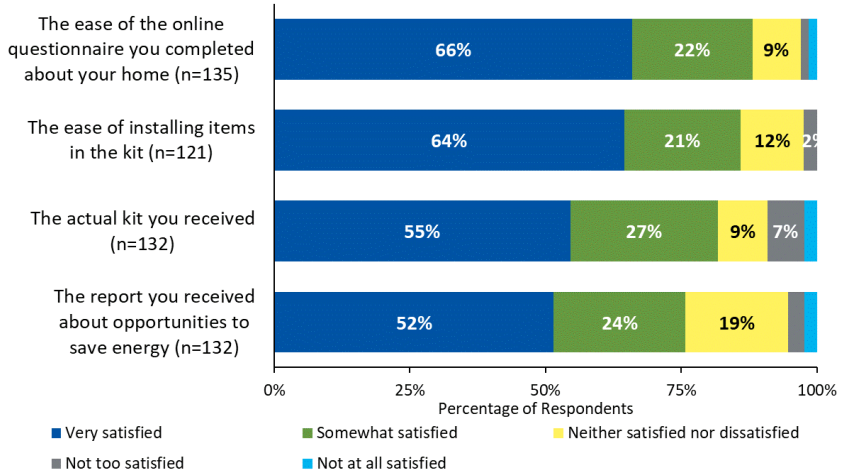
Figure 11-1. PY11 Program Element Satisfaction: Equipment, In-Home Audit, Weatherization Components



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 participants rated their satisfaction with specific aspects of the program's delivery (Figure 11-2). Though satisfaction was still nearly 80% for all program elements, the percentage of respondents satisfied with "the report you received about opportunities to save energy" and "the actual kit you received" was lower than other aspects of their experience.

Figure 11-2. PY11 Program Element Satisfaction: Online Assessment



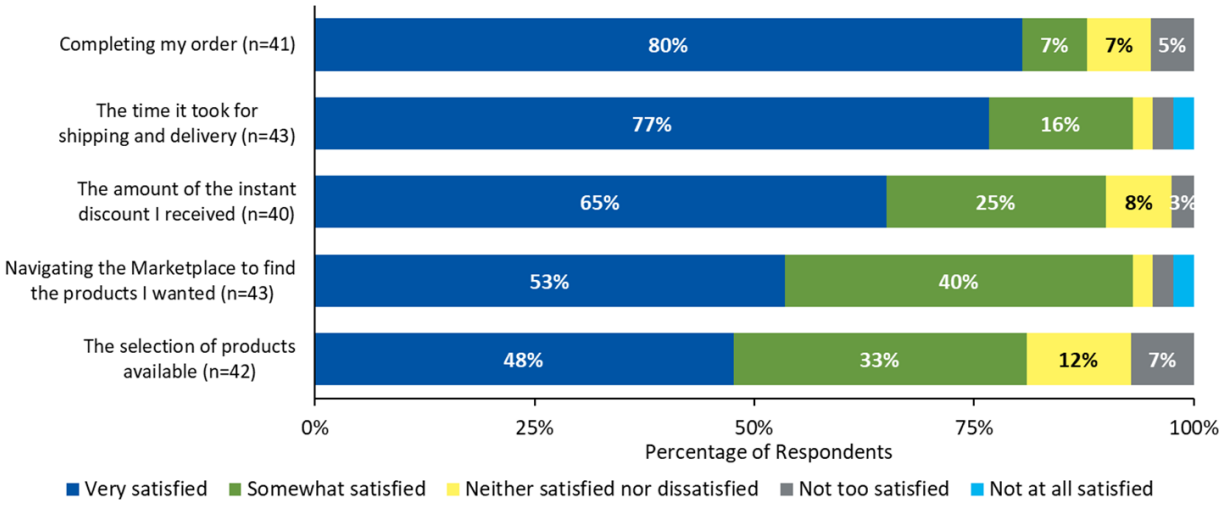
Source: Questions, "Please indicate how satisfied you are with each of the following program components: The ease of the online questionnaire you completed about your home, the report you received about opportunities to save energy, the actual kit you received, and the ease of installing items in the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

Online Marketplace

Participants were highly satisfied with the Online Marketplace, with 88% of customers reporting they were *very* or *somewhat satisfied* (n=42). As shown in Figure 11-3, participants were highly satisfied with their experience on the Online Marketplace, with over 80% of participants reporting they were either *very* or *somewhat satisfied* with each program element. Participants were significantly more likely to be *very satisfied* with completing their order in PY11 (80%) than in PY10 (65%, n=63) and with the time it takes for shipping and delivery in PY11 (77%) than in PY10 (45%, n=64).[66]

[66] Cadmus used a two-tailed t-test. Completing my order: p=.0901; Time it takes for shipping and delivery: p=.0012. The ICSP completed the PY10 survey with participants.

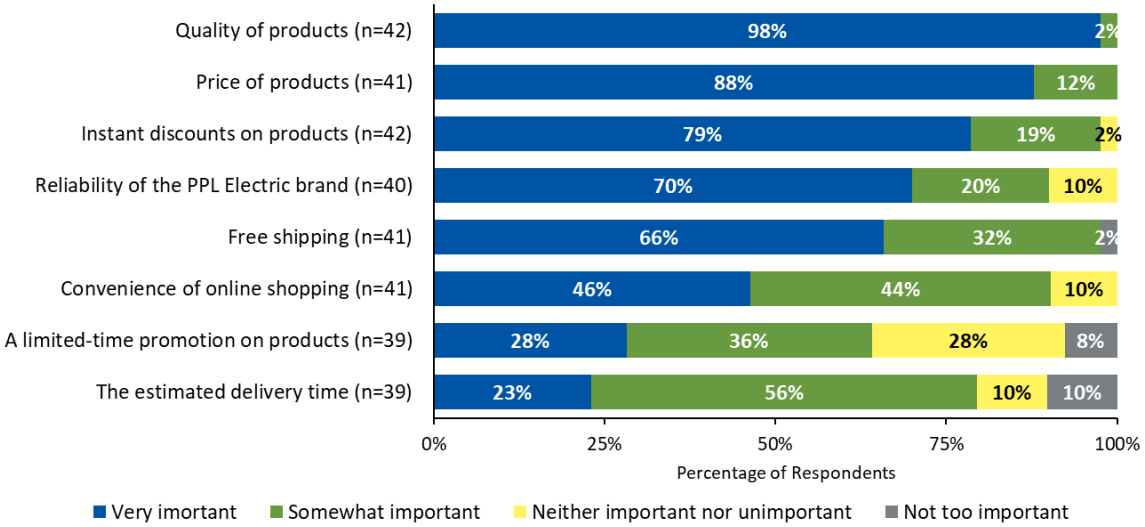
Figure 11-3. PY11 Program Element Satisfaction: Online Marketplace



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."

Customers reported their reasons for choosing to shop on the Online Marketplace (Figure 11-4), which all focused on the products themselves.

Figure 11-4. 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."

New Homes

Builders were highly satisfied with the New Homes program. Of 11 builders, nine were *very satisfied* and two were *somewhat satisfied* (n=11). Four said the program was very easy to participate in or required low management time on their end, two said the program processed incentives in a timely manner, and two said the program helped to increase builder awareness of building energy use. Only four builders requested changes to the program. Specifically, two cited marketing support (more print literature and digital support), one said increasing the incentive amount, and one said speeding up the administrative process.

11.5.3 Suggested Improvements (All Program Components)

Respondents provided various suggestions to improve the program. These were the top suggestions, primarily driven by Equipment respondents (170 of 220):

- Improve program communication, such as providing more relevant information up front and on the website (69 of 220).
- Change or expand program scope (29 of 220), specifically by offering rebates for large appliances (10 respondents) and for a wider variety of less expensive models (4 respondents).
- Make the program easier to participate in (30 of 220, 25 Equipment and 5 Weatherization), specifically by simplifying the information required for the application (8 respondents), simplifying the application instructions and where customers can find the application online (5 respondents), and not having to resubmit the application (4 respondents).

Of the 34 Online Assessment respondents who had suggestions, 12 comments requested improvement of the report, specifically to provide a more customized report (3 responses) and more ways to save energy (3 responses). Other suggestions were to improve program communication (7 responses) and kit items (5 responses). This contrasts with PY10, when suggestions for improving the online assessment focused mostly on kit items (27 responses from 63 respondents), and indicates an improvement in how customers perceive the kit. Respondents could provide multiple suggestions.

11.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 11-11. 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 PY11 dollars (PY11 includes months in both 2019 and 2020). Net present value costs and benefits for P3TD financials are expressed in PY8 dollars. The TRC costs and benefits in this table do not include costs and benefits from unverified projects.

Table 11-11. 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	$3,096		$9,311	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	$6,997		$29,743	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [1]**	**$10,093**		**$39,054**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$74	-	$210	-
7	Marketing [4]	-	$333	-	$892
8	Program Delivery [5]	-	$2,419	-	$10,532
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$2,826**		**$11,634**	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	$765		$6,888	
13	**Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) [6] [1]**	**$13,684**		**$57,576**	
14	Total NPV Lifetime Electric Energy Benefits	$9,928		$29,949	
15	Total NPV Lifetime Electric Capacity Benefits	$1,671		$6,226	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$39		$532	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	$6,565		$17,460	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7] [1]**	**$18,203**		**$54,167**	
19	**TRC Benefit-Cost Ratio [8]**	**1.33**		**0.94**	

[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. 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 11-12 presents program financials and cost-effectiveness on a net savings basis.

Table 11-12. 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	$3,096		$9,311	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	$3,340		$26,810	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [1]**	**$6,436**		**$36,121**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$73	-	$210	-
7	Marketing [4]	-	$333	-	$892
8	Program Delivery [5]	-	$2,419	-	$10,532
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$2,825**		**$11,634**	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	$489		$6,667	
13	**Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) [6] [1]**	**$9,751**		**$54,422**	
14	Total NPV Lifetime Electric Energy Benefits	$6,462		$27,169	
15	Total NPV Lifetime Electric Capacity Benefits	$1,083		$5,755	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$35		$529	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	$4,409		$15,730	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7] [1]**	**$11,988**		**$49,183**	
19	**TRC Benefit-Cost Ratio [8]**	**1.23**		**0.90**	

[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.

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.[67] A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix O Non-Energy Benefits*.

[67] Guidance on the Inclusion of fossil fuel and H_2O benefits in the TRC Test, Statewide Evaluation Team, March 25, 2018.

11.7 Recommendations

Overall, the Energy Efficient Home Program continues to deliver reliable savings and receives positive ratings from participants. The program achieved 16,929 MWh/yr in verified savings and reported another 4,084 MWh/yr from the New Homes component that will be evaluated in PY12. The majority of participants, 91%, were *very* or *somewhat satisfied* with the program in which they participated.

Recommendations are provided in Table 11-13, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: Online Assessment participants are not as satisfied as participants in other program components and would like a more customized program experience.	• Though the majority were satisfied, participants in the online assessment component were significantly less satisfied with the program (80% *very satisfied* or *somewhat satisfied*, n=123) than respondents in the Equipment or Weatherization components. *(*See the *Program Satisfaction* section.*)* • Online assessment respondents were less satisfied with the kit (82% satisfied) and the online assessment findings (76% satisfied) than with other parts of the program. See the *Program Satisfaction* section.*)* • When asked what they would like changed about the program (open-ended), participants in the online assessment component most often requested a more customized report on how they can save energy in their home (12 of 34) or for other items in the kit (5 of 34). *(*See the *Suggested Improvements (All Program Components)* section.)
Conclusion 2: Collecting data on multiple heating and cooling systems may increase savings from the downstream smart thermostat measure for customers purchasing more than one unit.	• Cadmus calculated verified savings according to the smart thermostat IMP, which calculates savings on a whole-home basis according to the central heating and cooling system. Because the rebate form only captures information for one system, Cadmus could not verify savings for multiple thermostats. This resulted in a realization rate below 100% for the 29 records with multiple thermostats. (See the *Gross Savings Impact Evaluation Results* section.*)*

Table 11-13. Status of Recommendations for the Energy Efficient Home Program

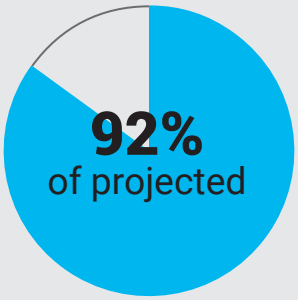
Energy Efficient Home Program		
Conclusion	**Recommendation**	**EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)**
Conclusion 1: Online Assessment participants are not as satisfied as participants in other program components and would like a more customized program experience.	Consider ways to increase the personalization of the report findings, such as helping customers understand how the recommended actions are derived from their responses to the online questionnaire.	Being considered.
	Consider including a series of videos to help customers understand how to use the products they received through the kit; leverage videos already produced for other programs.	Being considered in Phase IV for kits delivered through other components.
Conclusion 2: Collecting data on multiple heating and cooling systems may increase savings from the downstream smart thermostat measure for customers purchasing more than one unit.	Consider adjusting the application process to collect information on the system controlled by each thermostat rebated; such as a separate rebate application for each unit rebated.	Implemented. This action was taken in PY12 by updating the rebate form requesting that customers submit one rebate form per smart thermostat being installed in the home.

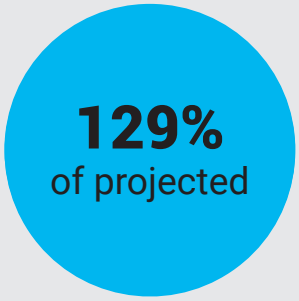
WINTER RELIEF ASSISTANCE PROGRAM (WRAP)

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

VERIFIED ENERGY SAVINGS

Phase III has so far saved **58,364 MWh/yr**

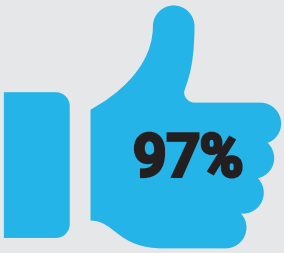




PY11 saved **19,057 MWh/yr**

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

PROGRAM SATISFACTION



Satisfied with overall program

96%	satisfied with the **quality of work** provided by WRAP auditor
95%	satisfied with the **energy education received**
94%	satisfied with the **ease of program enrollment**
94%	satisfied with the **quality of energy efficiency products**

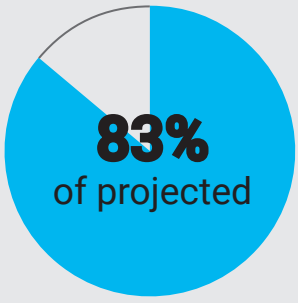
PY11 PARTICIPATION

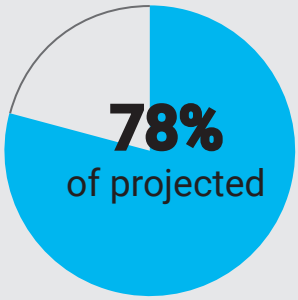
A total of **42,955** participants

4,346	Baseload jobs
3,887	Low-cost jobs
2,200	LED Giveaway
1,216	Manufactured homes
7	Master-metered multifamily buildings
0	Full-cost jobs
16,440	HEE Participants
14,859	SEEE Participants

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$30,832**





PY11 expenditures **$8,719**

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

12 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 low-income customers.

PPL Electric Utilities offers services to income-qualified customers residing in single-family homes, master-metered multifamily units, individually metered multifamily units, and manufactured homes.[68]

WRAP is delivered by CMC Energy, the ICSP, which is responsible for outreach, customer recruitment, audits, education, 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-savings products and services and replacing outdated and inefficient equipment with program-qualifying energy-efficient equipment. CMC Energy and its subcontractors, Franklin Energy and York Home Performance, are responsible for targeted outreach and recruitment for the manufactured homes located in manufactured or mobile home parks.

All qualifying customers receive a free energy audit that evaluates their home for eligible energy-saving products. The home energy auditor refers to a preapproved list of products and services along with criteria to determine if appliances and other large equipment can be replaced cost-effectively and are within the program's plan (program acquisition cost and total funding). For all qualifying customers, PPL Electric Utilities offers direct installation of a range of energy efficiency products and services,[69] including HVAC, lighting, weatherization, water saving and heating, appliances, appliance recycling, and home health and safety. WRAP also offers energy education delivered by auditors who make recommendations to encourage customers to conserve energy.

Through WRAP, PPL Electric Utilities provides four types of service (also known as job types) at no cost to the income-qualified customer. These services are baseload (offered to customers without electric heat and without an electric water heater), low-cost (offered to customers without electric heat but with electrically heated water), full-cost (offered to customers with electric heat), and an initiative that offers services to targeted manufactured home park customers.

The objectives of WRAP are these:[70]

- Provide low-income customers with an array of no-cost energy-saving equipment, products, and education to help reduce their energy costs

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[68] Individually metered low-income multifamily residences are eligible for the same improvements as individually metered single-family low-income 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.

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

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

- 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

12.1.1 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.

Each master-metered multifamily building has a unique billing account number. As shown in Table 12-1, WRAP participation counts each master-metered multifamily building as a single participant. The population size for the WRAP gross impact sample design counts individual tenant units in master-metered multifamily buildings, as shown in Table 12-2.

In PY11, the ICSP organized three LED giveaway community events. During these events, a total of 2,200 LED bulbs were given away at area food banks. Cadmus calculated the total number of participants by the total number of packs of LED bulbs distributed. See *Ex Post Savings Calculation Methodology for LED Giveaway Events* for details about participation counts for LED giveaway community events.

12.1.2 Program Participation and Reported Impacts

Table 12-1 presents the participation counts, reported energy and demand savings, and incentive payments for WRAP in PY11 by customer segment. (See *Appendix J Evaluation Detail – Winter Relief Assistance Program* for additional discussion about participant counts.)

Table 12-1. WRAP Participation and Reported Impacts

Parameter	Low-Income [1]	Small C&I	Government/ Nonprofit/ Education (GNE)	Total [2]
PYTD # Participants	11,649 [3]	3 [4]	4 [5]	**11,656** [6]
PYRTD MWh/yr	14,869	54	275	**15,197**
PYRTD MW/yr	1.47	0.00	0.02	**1.49**
PYVTD MWh/yr	13,512	42	211	**13,764**
PYVTD MW/yr	1.38	0.00	0.02	**1.40**
PY11 Incentives ($1,000)	$0	$0	$0	**$0**

[1] This does not include results from Student Energy Efficient Education and Home Energy Education Low-Income components. While these savings are counted toward the low-income compliance target, they are reported in the individual program chapters; *Chapter 15 Student Energy Efficient Education Program* and *Chapter 10 Home Energy Education Program.*
[2] Total may not match sum of columns due to rounding.
[3] Low-Income category consists of 9,449 WRAP jobs (baseload, low-cost, full-cost, and Manufactured Home Initiative) and 2,200 LED bulbs distributed at LED giveaway community events.
[4] Small C&I category consists of three master-metered multifamily buildings.
[5] GNE category consists of four master-metered multifamily buildings.
[6] Total number for participants counts each master-metered multifamily building as a single participant based on the participant definition.

12.2 Gross Savings Impact Evaluation

Cadmus conducted the activities described below to evaluate the 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 the five strata listed in Table 12-2. 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 the five strata listed in Table 12-2 and used the findings from the audit records review as inputs to the engineering algorithms from the PA TRM.[71]
- **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.

[71] Pennsylvania Public Utility Commission. June 2016. *Technical Reference Manual.*

12.2.1 Impact Evaluation Data Collection and Sample Design

In PY11, Cadmus collaborated with PPL Electric Utilities and the ICSP to collect the required data to verify energy savings and demand reduction for WRAP. The ICSP provided Cadmus with the ERMS database extract for verification and assessment of participant records and the audit records each quarter for a random sample of sites. Cadmus conducted a phone survey with a stratified random sample of participants to verify that products were installed as reported.

The verification sample for WRAP was designed to meet requirements of 85% confidence with ±15% precision. To examine savings in detail, Cadmus organized the population into the five strata listed in Table 12-2.[72] Cadmus sampled the population by project number instead of by account number because master-metered multifamily jobs are tied to a single account number. Within each stratum, Cadmus applied a simple random sampling method to select a sample of homes for verification.

Each master-metered multifamily building is defined as a single participant. However, for purposes of home audit records review and engineering analyses, the population for the master-metered multifamily stratum counts individual tenant units. The sampling strategy is shown in Table 12-2.

Table 12-2. PY11 WRAP Gross Impact Evaluation Sample Design

Stratum	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Impact Evaluation Activity
Baseload	4,346	0.5	24	24	Records review and engineering analysis
Low-Cost	3,887		24	24	
Full-Cost (1)	N/A		N/A	N/A	
Manufactured Home Initiative (all job types)	1,216		24	24	
Master-Metered Multifamily (all job types) (2)	537 (2)		23	23	
Program Total	**9,986** (3)		**95**	**95**	

(1) No full-cost jobs were completed in PY11.

(2) Seven master-metered multifamily buildings (four under GNE category and three under Small C&I category) that participated in WRAP in PY11 have a total of 537 tenant units and therefore 537 jobs were added to the total number of jobs. Cadmus conducted home audit records review and engineering analysis for individual tenant units in master-metered multifamily buildings. Therefore, the population size for the WRAP gross impact sample design counts individual tenant units in master-metered multifamily buildings individually. See *Appendix J Evaluation Detail – Winter Relief Assistance Program* for additional discussion about participant counts.

(3) The 2,200 LED bulbs distributed in LED giveaway community events are not part of the PY11 WRAP gross impact sample design and are not included in this total. See *Ex Post Savings Calculation Methodology for LED Giveaway Events* for details about energy savings verification for LED giveaway events.

[72] Cadmus did not sample the LED giveaway portion.

12.2.2 Gross Savings Impact Evaluation Results

Table 12-3 shows the program's verified gross savings.

Table 12-3. Winter Relief Assistance Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	Phase III Verified
MWh/yr	2,652	14,423 [1]	19,097	13,764	49,937 [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 PY11, WRAP reported energy savings of 15,197 MWh/yr, as shown in Table 12-4. In PY11, WRAP achieved a program energy realization rate of 91%, weighted by stratum. Table 12-5 shows demand reduction of 1.49 MW/yr. Both tables are shown by program stratum.

Table 12-4. PY11 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	5,424	87%	0.12	3.60%	4,744
Low-Cost	6,885	92%	0.06	1.77%	6,349
Full-Cost [1]	N/A	N/A	N/A	N/A	N/A
Manufactured Home Initiative (all job types)	2,489	94%	0.08	2.20%	2,347
Master-Metered Multifamily (all job types)	328	77%	0.10	2.64%	253
LED Giveaway	71	100%	N/A	0.00%	71
Program Total [2]	**15,197**	**91%**	**N/A**	**1.50%**	**13,764**

[1] No full-cost jobs in PY11.
[2] 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.

Table 12-5. PY11 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	0.54	91%	0.10	3.20%	0.49
Low-Cost	0.67	95%	0.06	1.84%	0.64
Full-Cost [1]	N/A	N/A	N/A	N/A	N/A
Manufactured Home Initiative (all job types)	0.25	97%	0.06	1.86%	0.24
Master-Metered Multifamily (all job types)	0.02	92%	0.07	1.72%	0.02
LED Giveaway	0.01	100%	N/A	0.00%	0.01
Program Total [2]	**1.49**	**94%**	**N/A**	**1.40%**	**1.40**

[1] No full-cost jobs in PY11.
[2] 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 the following factors that led to differences between reported and verified savings and the overall realization rate for WRAP in PY11:

- The most important factor driving the program's overall realization rate is **energy education.**
  - The ICSP reported *ex ante* savings of 160 kWh/yr for every participant. Cadmus estimated energy education savings from each survey wave as 53 kWh/yr in PY11 Q1-Q2 and 37 kWh/yr in PY11 Q3-Q4. Cadmus applied these energy education results to the corresponding jobs delivered in PY11 Q1-Q2 and PY11 Q3-Q4.
  - The number of jobs delivered in each half of the year was not equal. The ICSP delivered 64% of the total jobs in PY11 Q1-Q2 and 36% of the total jobs in PY11 Q3-Q4. Therefore, the lower energy education results in PY11 Q3-Q4 had less effect on the overall realization rate because fewer jobs were completed in PY11 Q3-Q4.
- Differences in reported and evaluated **ISRs for six products** (LEDs, LED nightlights, efficient showerheads, power strips, and kitchen and bathroom aerators) also contributed to the difference in reported and verified savings. Evaluated ISRs for the program in PY11 are consistent with PY9[73] and PY10[74] results and remained high compared to PY8[75]—99% for LEDs, 96% and above for aerators and showerheads, and 94% for smart strips. Tier 2 smart strips' PY11 ISR was the highest found in Phase III so far.
- **Minor differences in the reported savings and Cadmus' calculations in the record reviews** were infrequent and had a small effect on the overall realization rate. See the *Records Review Findings* section in *Appendix J Evaluation Detail – Winter Relief Assistance Program* for additional details.

12.3 Net Savings Impact Evaluation

WRAP is offered to income-eligible customers in the low-income community, and the work is completed at no cost to the customer. No free riders are anticipated among participants 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.

12.4 Verified Savings Estimates

Cadmus applied PY11 realization rates to the reported energy and demand savings estimates to calculate the verified savings estimates for WRAP in PY11 (Table 12-6). Because the NTG ratio is 1.0, net savings are the same as verified gross savings.

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[73] 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.

[74] 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.

[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.

Table 12-6. PYTD and P3TD WRAP Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD Gross	15,197	1.49
PYVTD Gross	13,764	1.40
PYVTD Net [(1) (2)]	13,764	1.40
P3RTD Gross	57,369	5.62
P3VTD Gross	49,937	5.22
P3VTD Net [(1) (2)]	49,937	5.22
[(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 low-income program. Therefore, no net savings analyses were conducted.		

12.5 Process Evaluation

12.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. In PY11, the limited process evaluation of WRAP assessed participants' and multifamily building property managers' satisfaction with the program. The evaluation activities were consistent with the planned activities with one exception. Cadmus did not review the logic model because there were no substantial program changes in PY11. Details about Cadmus' approach to contacting customers and the sample attrition are presented in *Appendix J Evaluation Detail – Winter Relief Assistance Program* and *Appendix Q Survey Methodology*.

Table 12-7 lists the process evaluation sampling strategy.

The sample frame excluded any participant who completed a survey in the past three months or requested not to be contacted. Completed participant surveys produced a measurement of program satisfaction with ±10% precision at 90% confidence. In PY11, Cadmus achieved 4% response rate among 4,215 phone records attempted (see *Appendix J Evaluation Detail – Winter Relief Assistance Program* for attrition and *Appendix Q Survey Methodology* for phone survey methodology).

Table 12-7. WRAP Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame [1]	Percent of Sample Frame Contacted to Achieve Sample [2]
PPL Electric Utilities Program and ICSP Staff	Key Individuals from PPL Electric Utilities and ICSP	Telephone in-depth interview	3	N/A	3	3	3	100%
Market Actor Interviews	Master-Metered Multifamily Property Managers	Telephone in-depth interview	6[3]	N/A	3	2[4]	6	100%
Participant	Program Participants (Baseload, Low Cost & Manufactured Home Park Initiative)	Telephone survey	9,449	0.5	155 [5]	155	5,470	77%
Program Total			**9,458**		**161**	**160**	**5,483**	

[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 called to complete surveys.
[3] A total of six property managers managed all of the master-metered multifamily buildings (7 building`s with 537 units) that participated in WRAP in PY11. The ICSP provided Cadmus with contact information for all six property managers.
[4] Cadmus contacted each property manager at least five times via phone or email to request an interview. Cadmus was able to obtain two of the three targeted interview completes.
[5] Cadmus developed the target sample size of 155 participants to achieve ±10% precision at 90% confidence for each wave of surveys. Cadmus conducted the first wave of participant phone surveys in February 2020 (n=75) and the second wave in July 2020 (n=80).

12.5.2 Master-Metered Multifamily Building Property Manager Program Satisfaction

Cadmus conducted interviews with two of the six property managers who oversaw master-metered multifamily buildings and participated in WRAP in PY11. These six property managers oversaw a total of seven master-metered multifamily buildings with 537 units. The ICSP provided Cadmus with contact information for all six property managers. Cadmus reached out at least five times by email or phone. The two property managers Cadmus interviewed managed a total of three master-metered multifamily buildings.

Both property managers said they were *very satisfied* with the program. One noted that the program's enrollment process went very smoothly and expressed interest in participating again in the future. The other property manager liked that the ICSP contractors completed the direct install process faster than

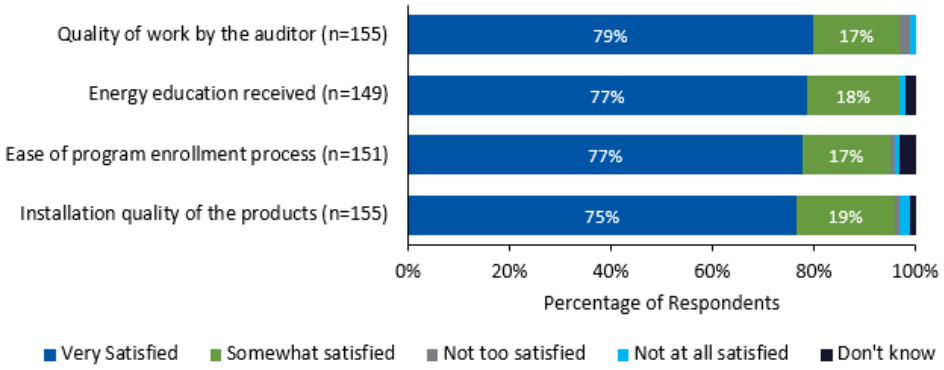
they estimated and that an inspector came to examine their work. Unlike in PY10, no property managers mentioned installation or performance issues with any measure.

12.5.3 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=75) in February 2020 and the second wave (n=80) in July 2020. The surveys asked identical questions. Cadmus stratified the random sample to target 59 baseload job participants, 48 low-cost job participants, and 48 manufactured home park participants across the two waves, a total of 155 survey respondents.

Cadmus found that 97% of PY11 survey respondents were satisfied (82% were *very satisfied* and 15% were *somewhat satisfied*; n=155) with their overall program experience, as shown in this program's infographic.[76] Respondents were generally satisfied with the program components listed in Figure 12-1. Respondents were most satisfied with the quality of work by the WRAP auditor.

Figure 12-1. PY11 Participant Satisfaction with Different Program Components



Source: Survey Question "Please indicate how satisfied you are with each of the following components…"

12.5.4 Program Delivery

Overall, Cadmus found that the ICSP continued to deliver the WRAP well in PY11. The program added heat pump hot water heaters as a measure as well as some specialty bulbs. The ICSP reported that because of the difficulty in recruiting mobile home participants, it placed greater priority on conducting direct installs in single-family homes.

Areas Working Well

The ICSP reported success in increasing marketing efficiency with robocalls to single-family homes; customers press "1" when they would like to speak to a customer representative. The ICSP's

[76] Additionally, 1% were *not too satisfied*, 1% were *not at all satisfied* with the overall program, and 0% said don't know (n=155).

subcontractor also reported success by providing food at mobile home park pool parties and by retrofitting the mobile home park office so park residents could see the results.

Suggested Program Improvements

Customers, multifamily property managers, and the ICSP's subcontractor recommended additional equipment or partnerships to increase program offerings:

- When asked how the program could be improved, 45% of survey respondents recommended expanding program measures (45%, n=44). Respondents recommended windows, refrigerators, and showerheads (only customers with electric water heaters receive low-flow showerheads).
- Both interviewed multifamily property managers recommended that the program provide measures for multifamily common areas and expressed disappointment that common areas are excluded. They seemed unaware that these measures are available through PPL's non-residential programs.
- The ICSP's subcontractor recommended that PPL Electric Utilities coordinate with a third-party agency who funds windows, insulation, and health and safety upgrades to mobile homes because there is an unmet need for these measures in the mobile home community. Mobile homes receive baseload measures through WRAP, which does not include those measures. This coordination would allow mobile homes to receive PPL and third party services in the same timeframe.

12.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 12-8. TRC benefits were calculated using gross verified impacts. NPV PYTD costs and benefits are expressed in PY11 dollars (PY11 includes months in both 2019 and 2020). 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.

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.[77] A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix O. Non-Energy Benefits*.

[77] Guidance on the inclusion of fossil fuel and H_2O benefits in the TRC test, Statewide Evaluation Team, March 25, 2018.

Table 12-8. 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]	$240	-	$816	-
7	Marketing [4]	-	$312	-	$1,100
8	Program Delivery [5]	-	$7,608	-	$24,831
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$8,161**		**$26,747**	
12	NPV of increases in costs of natural gas (or other fuels) for fuel switching programs	**1**		**0**	
13	**Total NPV TRC Costs (Net present value of sum of rows 4, 11, and 12) [6] [1]**	**$8,161**		**$26,747**	
14	Total NPV Lifetime Electric Energy Benefits	$3,179		$10,020	
15	Total NPV Lifetime Electric Capacity Benefits	$443		$1,608	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$378		$3,012	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	$2,115		$5,778	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7]**	**$6,115**		**$20,417**	
19	**TRC Benefit-Cost Ratio [8]**	**0.75**		**0.76**	

[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

Overall, WRAP has performed according to the program design and is administered well. Satisfaction with the program was very high, with 97% of participants reporting they were *very* or *somewhat satisfied* with the program.

Recommendations are provided in
Table 12-9, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: Multifamily property managers are interested in incentives for improvements in common areas and seem unaware of incentives offered through the Non-Residential Program.

- Both multifamily property managers recommended that the program target multifamily common areas.

Table 12-9. 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: Multifamily property managers are interested in incentives for improvements in common areas and seem unaware of incentives offered through the Non-Residential Program.	Continue cross-promoting PPL Electric Utilities' programs for multifamily common areas to master-metered multifamily properties and pass on property manager contact information to the ICSP for those who seem interested in common area energy efficiency.	Implemented. PPL Electric Utilities will continue taking these actions when possible.

ENERGY EFFICIENCY KITS AND EDUCATION PROGRAM

The program delivers energy education and kits with energy-saving products to income-qualified customers at or below 150% of the federal poverty income guidelines.

VERIFIED ENERGY SAVINGS

Phase III has so far saved **41,240 MWh/yr**

110% of projected

131% of projected

PY11 saved **10,888 MWh/yr**

PROGRAM SATISFACTION

98% Satisfied with overall program

96% agreed the program **helped them understand** how much energy the **kit items could save**

86% agreed the kits **had what they needed** to **install the products**

PY11 PARTICIPATION

A total of **15,598** participants

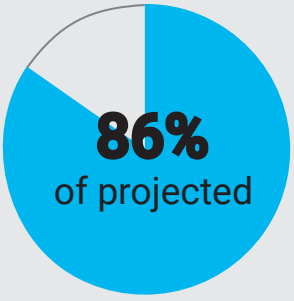
2,875 agency

12,723 direct mail

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$6,578**

114% of projected



PY11 expenditures **$1,373**

13 Energy Efficiency Kits and Education Program

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

Because the program has met its planned Phase III participation and energy savings and because EISA was set to take effect in 2020, PPL Electric Utilities is not offering the program in PY12. The program ended in December 2019.

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

- **Direct mail kits.** CMC Energy, the ICSP, conducted targeted email and mail outreach to invite qualified customers to participate in the Energy Efficiency Kits and Education Program. To receive a kit in the mail, recipients had to sign up online with the seven-digit code included on their mailer or with their account number. Otherwise, they could return the business reply card attached to the mailing. To generate the list of targeted outreach recipients, PPL Electric Utilities identified customers who had received Low-Income Home Energy Assistance Program (LIHEAP) benefits, were enrolled in PPL Electric Utilities' OnTrack Program, or were low-income-qualified and had been identified by the ICSP and PPL Electric Utilities through market research, data mining, or other means.
- **Agency delivery.** Through their day-to-day interactions with clients, agencies (community-based organizations, or CBOs) helped the ICSP's subcontractor AM Conservation Group (formerly Resource Action Programs or RAP) recruit qualified customers to participate in a one-hour energy education workshop or a one-on-one session with agency staff at the agency's office or via telephone. RAP provided agency staff with the tools they needed to introduce energy education and low-cost/no-cost energy efficiency products to their low-income clients. Once customers enrolled in the program, they received a kit mailed to their home.

In PY11, the Energy Efficiency Kits and Education Program distributed two kits—a base load kit and an electric kit—depending on the customer's fuel source for water heating because PPL Electric Utilities can claim savings only for water-saving products installed in homes with an electric water heater. Both kits contained self-installed products, energy education literature, and surveys to gather participation information for the program. Kits for customers with electric water heaters also included faucet aerators and low-flow showerheads. Kits for customers with a water heater fuel type other than electricity did not contain aerators or showerheads. Each kit also included a paper survey, along with a self-addressed, stamped envelope. Cadmus used the survey-collected data to determine ISRs and satisfaction with the program. Table 13-1 lists the items included in each kit.

The ICSP distributed more than 15,000 kits in PY11, many more than the 8,000 kits projected in the EE&C Plan for PY11. Early in the phase, PPL Electric Utilities and the ICSP made the decision to send more kits to increase the savings achieved in the low-income sector prior to phasing out kits before PY12.

Table 13-1. Products Included in PY11 Energy Efficiency Kits

Energy Efficiency Product	Base Load Kit	Electric Water Heater Kit
Six 9W LED Bulbs	✓	✓
Two LED Night Lights	✓	✓
One Furnace Whistle	✓	✓
Two Low-Flow Showerheads		✓
One Kitchen Aerator		✓
Tips on Energy Efficiency Behavior	✓	✓
Paper Survey	✓	✓

The objectives of the Energy Efficiency Kits and Education Program are these:[78]

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

13.1.1 Definition of a Participant

A participant in the program is defined as an income-eligible customer who received an energy-savings kit through the agency or the direct-mail delivery channel. For recordkeeping purposes, each kit is assigned a unique job number. Customers who receive more than one kit are assigned multiple job numbers, one per unique kit.

Any kits returned to the ICSP receive two unique job numbers: one to indicate the distributed kit and one to indicate the returned kit. Returned kits appear as separate records with negative reported savings in PPL Electric Utilities' tracking database.

13.1.2 Program Participation and Reported Impacts

Table 13-2 presents the number of records in the PPL Electric Utilities' tracking database, the participation counts (distributed kits that were not returned), and the program's reported energy and demand savings by customer segment in PY11. There are no incentive payments for this program. Income-qualified customers receive the kit for free. See *Appendix K Database Review Findings* for details about the count of kits.

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

Table 13-2. PY11 Energy Efficiency Kits and Education Program Participation and Reported Impacts

Parameter	Low-Income	Total [1]
PYTD # Participants [2]	15,682	**15,682**
PYTD Number of Participants Receiving Kits [3]	15,598	**15,598**
PYRTD MWh/yr	14,011	**14,011**
PYRTD MW/yr	0.97	**0.97**
PYVTD MWh/yr	10,888	**10,888**
PYVTD MW/yr	1.20	**1.20**
PY11 Incentives ($1000)	$0	**$0**

[1] Total may not match sum of columns due to rounding.
[2] The number of records is determined by the unique job numbers. Returned kits are assigned two unique job numbers: one for the distributed kit and one for the returned kit. Note that this is just for recordkeeping purposes. Two of these records had the same kit number but were delivered to two different accounts so Cadmus counted these two records separately in our impact analysis.
[3] In PY11, the ICSP distributed 15,598 unique kits. A total of 91 kits were returned, represented as 175 unique rows in PPL Electric Utilities' tracking database. In seven cases, a kit distributed in PY10 was returned in PY11, and thus only had one record in the tracking database.

13.2 Gross Savings Impact Evaluation

Cadmus completed the following activities to evaluate the gross impacts of the Energy Efficiency Kits and Education Program. Refer to *Appendix K Database Review Findings* for more detail on these activities.

- **Records review.** Cadmus reviewed the records in PPL Electric Utilities' tracking database and compared these to the records in the enrollment data provided by the ICSP. Cadmus discussed discrepancies with the ICSP prior to conducting any analyses.
- **Participant kit survey review.** Cadmus collected the kit surveys returned by mail to the ICSP and used the collected data in the *ex post* savings analysis. Cadmus also reviewed the records in the survey data and verified all discrepancies between the survey records and PPL Electric Utilities' tracking database with the ICSP.

13.2.1 Impact Evaluation Data Collection and Sample Design

Cadmus collected data to verify energy savings through the ICSP-administered participant surveys (paper surveys included in each kit). Cadmus also collected enrollment information from the ICSP's subcontractor to confirm the records in PPL Electric Utilities' tracking database.

The paper survey included in each energy-savings kit asked questions about installing the products and about the participant's experiences with the products and program. Participants returned the surveys to the ICSP throughout the year. The ICSP sent the survey data to Cadmus at the close of PY11 Q3, after the program stopped enrolling new customers. Cadmus used the data to estimate the program's energy savings in PY11.

The impact evaluation sampling strategy is shown in Table 13-3. Additional details about methodology are in *Appendix K Ex Post Verified Savings Methodology*.

Table 13-3. Energy Efficiency Kits and Education Gross Impact Sample Design for PY11

Stratum	Population Size [1]	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size [2]	Impact Evaluation Activity
Agency	2,875	N/A [3]	N/A [3]	134	ICSP-collected paper kit survey
Direct Mail	12,723	N/A [3]	N/A [3]	1,793	ICSP-collected paper kit survey
Program Total	**15,598**	**N/A [3]**	**N/A [3]**	**1,927**	ICSP-collected paper kit survey

[1] In PY11, the ICSP distributed 15,598 unique kits. A total of 91 kits were returned, represented as 175 unique rows in PPL Electric Utilities' tracking database. In seven cases, a kit distributed in PY10 was returned in PY11, and thus only had one record in the tracking database. (See *Appendix K Database Review Findings* for details about the count of kits.)
[2] Number includes partially completed surveys. Respondents could skip questions.
[3] Cadmus used survey responses collected by the ICSP from all participants who returned their surveys. Therefore, Cadmus did not have an assumed proportion of Cv.

13.2.2 Gross Savings Impact Evaluation Results

Table 13-4 shows the program's verified gross savings.

Table 13-4 Energy Efficiency Kits and Education Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	Phase III Verified [1]
MWh/yr	9,219	11,829	9,304	10,888	41,240

[1] Phase III verified savings may not match sum of program years due to rounding.

In PY11, the Energy Efficiency Kits and Education Program reported energy savings of 14,011 MWh/yr, as shown in Table 13-5, and demand reduction of 0.97 MW/yr, as shown in Table 13-6.

Table 13-5. PY11 Energy Efficiency Kits and Education Program Gross Impact Results for Energy

Stratum	PYRTD MWh/yr	Energy Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MWh/yr [1]
Agency	2,583	80%	0.48	5.84%	2,057
Direct Mail	11,427	77%	0.54	1.69%	8,831
Program Total [2]	**14,011**	**78%**	**N/A**	**1.75%**	**10,888**

[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. PY11 Energy Efficiency Kits and Education Program Gross Impact Results for Demand

Stratum	PYRTD MW/yr	Demand Realization Rate	Sample Cv or Error Ratio	Relative Precision at 85% C.L.	PYVTD MW/yr [1]
Agency	0.18	114%	0.70	8.53%	0.20
Direct Mail	0.79	126%	0.80	2.53%	1.00
Program Total [2]	**0.97**	**124%**	**N/A**	**2.53%**	**1.20**

[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.

Differences in reported and evaluated ISRs primarily drove the differences in reported and verified savings for most products (See *Appendix K* for additional details):

- Differences in reported and evaluated ISRs drove the differences in reported and verified savings for **furnace whistles**, **low-flow showerheads**, **kitchen faucet aerators** and **LEDs**. (See *Appendix K*.)
- For **nightlights,** the ICSP calculated the reported savings using ISRs of 87% for agency and 92% for direct mail and applied these to all nightlights. Cadmus evaluated savings for nightlights that replaced existing nightlights and evaluated negative savings for nightlights that were installed in an open socket. Across delivery channels, Cadmus found that 70% and 53% of respondents installed the first and second nightlights, respectively, by replacing an existing nightlight. For the majority of remaining nightlights, respondents indicated that they did not replace an existing nightlight (24% for the first nightlight and 26% for the second nightlight). These factors led to lower evaluated savings than reported for nightlights.
- For **energy education,** the ICSP reported savings of 253 kWh/yr for every participant, regardless of delivery channel and kit type. Cadmus, however, found that customers who received kits with water-saving products more frequently had electric water heating, electric space heating, and central cooling systems and therefore had higher energy education savings than customers who did not receive water-saving products. Cadmus estimated energy education savings for recipients of water-savings kits as 325 kWh/yr for agency and 386 kWh/yr for direct mail, higher than the ICSP's reported savings of 253 kWh/yr. This similarity in delivery channel is because of the high correlation between having electric water heating (required to receive water-saving products) and having electric space heating (required to achieve a large portion of the energy education savings).

  However, Cadmus estimated far less energy education savings for recipients of kits with no water-savings products (59 kWh/yr for agency and 55 kWh/yr for direct mail participants). The ICSP's assumption for per-kit savings for energy education does not apply as well to kits without water-saving products, and therefore the composition of kit types distributed to customers each year is a potential driver of the realization rates.
- The ICSP reported 0 kW/yr for **energy education**, and Cadmus found 0.0288 kW/yr on average across delivery channels, which increased the overall demand realization rates to 114% for the agency stratum and 126% for the direct mail stratum.

13.3 Net Savings Impact Evaluation

The Energy Efficiency Kits and Education Program is offered to income-eligible customers in the low-income community. No free riders are anticipated among the population receiving the energy-savings kits because income-constrained customers are not likely to purchase the items in these kits on their own. An NTG ratio of 1.0 is appropriate for this program; therefore, Cadmus did not estimate net savings.

13.4 Verified Savings Estimates

In Table 13-7, Cadmus applied the realization rates to the reported energy and demand savings estimates to calculate the verified savings estimates for the Energy Efficiency Kits and Education Program in PY11. Because the NTG ratio is 1.0, net savings are the same as verified gross savings.

Table 13-7. PYTD and P3TD Energy Efficiency Kits and Education Program Savings Summary

Savings Type	Energy (MWh/yr)	Total Demand (MW/yr)
PYRTD Gross	14,011	0.97
PYVTD Gross	10,888	1.20
PYVTD Net[(1) (2)]	10,888	1.20
P3RTD Gross	48,719	3.43
P3VTD Gross	41,240	4.13
P3VTD Net [(1) (2)]	41,240	4.13

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

[(2)] Net savings are equal to gross savings because the program is assumed to have an NTG ratio of 1.0.

13.5 Process Evaluation

13.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. The PY11 limited process evaluation of the Energy Efficiency Kits and Education Program assessed participant satisfaction with the program. Activities were consistent with the evaluation plan.

Table 13-8 lists the process evaluation sampling strategy.

Table 13-8. PY11 Energy Efficiency Kits and Education Program Process Evaluation Sampling Strategy

Stratum	Stratum Boundaries	Mode	Population Size	Assumed Proportion or Cv in Sample Design	Target Sample Size	Achieved Sample Size	Number of Records Selected for Sample Frame	Percent of Sample Frame Contacted to Achieve Sample [1]
Program Staff and ICSP	PPL Electric Utilities, CMC staff	Telephone in-depth interview	3	N/A	3	3	N/A	100%
Participants	Agency responders	Paper kit survey	2,875[2]	N/A	N/A	134	N/A	N/A
	Direct mail responders	Paper kit survey	12,723[2]	N/A	N/A	1,793	N/A	N/A
Program Total	**N/A**	**N/A**	**15,601**	**N/A**	**N/A**	**1,930**	**N/A**	**N/A**

[1] Percent contacted means the percentage of the sample frame contacted to complete surveys.
[2] In PY11, the ICSP distributed 15,598 unique kits. A total of 91 kits were returned, represented as 175 unique rows in PPL Electric Utilities' tracking database. In seven cases, a kit distributed in PY10 was returned in PY11, and thus only had one record in the tracking database..

13.5.2 Participant Satisfaction

Cadmus collected participant data from the paper survey included in the kits and returned to the ICSP. Completed participant survey responses produced a measurement of program satisfaction with ± 0.61% precision at 90% confidence.

Customers continue to be satisfied with the energy efficiency kit they received as part of the program in PY11. As shown in the infographic, overall, 98% of customers said they were satisfied (78% were *very satisfied* and 19% were *somewhat satisfied*; n=1,897).[79] Most respondents (96%) agreed the program helped them understand how much energy the kit items could save, and 86% agreed that the kits had what they needed to install the products.

13.5.3 Program Delivery

Overall, Cadmus found that the ICSP continued to deliver the Energy Efficiency Kits and Education Program well in PY11. Both PPL Electric Utilities and the ICSP reported that the program was delivered effectively through the two delivery channels (direct mail and 18 agencies). In PY11, program stakeholders did not make any changes to program delivery or the measures offered.

Areas Working Well

The ICSP reported achieving the highest marketing success with the direct mail customers who received multiple marketing touchpoints about the program. Though the ICSP's direct mail campaigns typically

[79] The sum of *very satisfied* and *somewhat satisfied* does not sum to 98% due to rounding. Additionally, 2% were *neither satisfied nor dissatisfied*, <1% were *not too satisfied*, and <1% were *not at all satisfied* with the overall program (n=1,897). The total satisfied does not sum due to rounding. Although 1,927 surveys were returned, only 1,897 answered the customer satisfaction question.

yield a 2% response rate, conducting its direct mail campaign shortly after PPL Electric Utilities marketed the program via bill inserts yielded a 25% response rate.

Suggested Program Improvements

The ICSP recommended the following for Phase IV if PPL Electric Utilities continues to offer a program similar to the Energy Efficiency Kits and Education Program:

- Add Tier 1 powerstrips to the kits. The 2021 TRM shows higher savings for Tier 1 powerstrips (89 kWh to 101 kWh) than the 2016 TRM (49 kWh to 75 kWh). However, the 2021 TRM assigns lower savings to Tier 2 powerstrips (141 kWh) than does the 2016 TRM (204 kWh to 307 kWh). The smaller gap in deemed savings between Tier 1 and Tier 2 powerstrips in the 2021 TRM, combined with the lower price point of Tier 1 powerstrips compared to Tier 2 powerstrips, could make Tier 1 powerstrips a viable option for future kits programs.
- Add specialty bulbs to the energy efficient kits to expand energy-savings opportunities.

13.6 Cost-Effectiveness Reporting

Details of program finances and cost-effectiveness are presented in Table 13-9. Cadmus calculated TRC benefits using gross verified impacts. The net present value program year-to-date (NPV PYTD) benefits and costs are expressed in PY11 dollars (PY11 includes months in both 2019 and 2020). Net present value 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 an NTG ratio of 1.0.

In the SWE's PY9 Annual Report,[80] the SWE recommended treating the cost of kits as incentives to participants in future program year reporting. Some differences of opinion exist as to what should be called an incentive. The term can be interpreted broadly to include almost anything. Direct rebates, interest payment subsidies, and even energy audits can be called incentives. Operationally, it is necessary to restrict the term to include only dollar benefits such as rebates or rate incentives (monthly bill credits).

PPL Electric Utilities incorporates the cost of kits into the TRC as program delivery costs rather than as incentives to participants. PPL Electric Utilities considered changing its approach to conform to the SWE's request. However, 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.

[80] 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. http://www.puc.pa.gov/Electric/pdf/Act129/Act129-SWE_AR_Y9_022819.pdf

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.[81] A summary of the methodologies Cadmus used to calculate the non-energy benefits of saved water, natural gas therms, and lighting interactive effects can be found in *Appendix O Non-Energy Benefits*.

Table 13-9. Summary of Energy Efficiency Kits and 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]	$42	-	$175	-
7	Marketing [4]	-	$95	-	$448
8	Program Delivery [5]	-	$1,236	-	$5,364
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$1,373**		**$5,987**	
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]**	**$1,373**		**$5,987**	
14	Total NPV Lifetime Electric Energy Benefits	$2,751		$7,897	
15	Total NPV Lifetime Electric Capacity Benefits	$493		$1,454	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$173		$1,265	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	$4,077		$8,725	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7] [1]**	**$7,493**		**$19,341**	
19	**TRC Benefit-Cost Ratio [8]**	**5.46**		**3.23**	

[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.

[81] Guidance on the Inclusion of fossil fuel and H_2O benefits in the TRC Test, Statewide Evaluation Team, March 25, 2018.

13.7 Recommendations

Overall, the Energy Efficiency Kits and Education Program has performed according to the program design and has exceeded both its projected participation and projected savings. Overall, 98% of survey respondents were satisfied with their energy efficient kit.

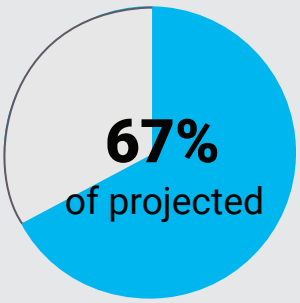
Because the program functioned well in PY11 and will not be delivered in PY12, Cadmus does not have any recommendations to make for the program moving forward.

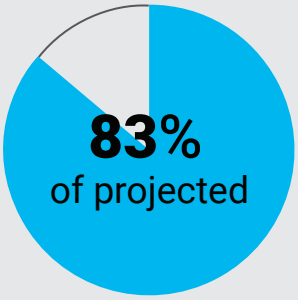
APPLIANCE RECYCLING PROGRAM

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

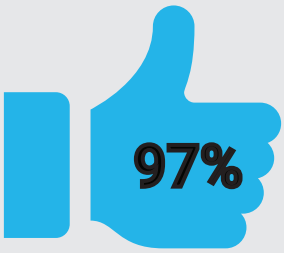
Phase III has so far saved **43,883 MWh/yr**





PY11 saved **9,945 MWh/yr**

PROGRAM SATISFACTION



Satisfied with overall program

95% satisfied with the **clarity of application** requirements

90% satisfied with the **PPL Electric Utilities rebates** for qualifying equipment and services

87% satisfied with the **information learned online from PPL Electric Utilities**

PY11 PARTICIPATION

A total of **13,117** participants recycled

7,510 refrigerators

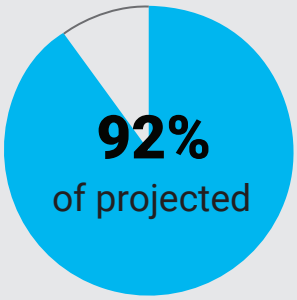
2,368 room air conditioners

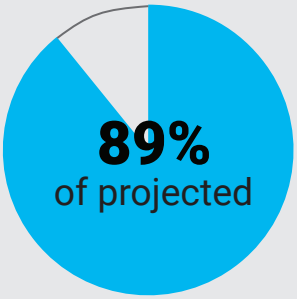
1,869 freezers

1,370 dehumidifiers

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$8,253**





PY11 expenditures **$2,156**

14 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. Though these appliances are not typically picked up as a stand-alone service, in PY11 PPL Electric Utilities offered several separate bulk recycling events where only these were eligible.

Table 14-1 shows the appliance eligibility parameters and incentives.

Table 14-1. 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 PY11, 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. Recleim, the ICSP's subcontractor, managed the pick-up, decommissioning, and recycling of appliances.

In March 2020, PPL Electric Utilities suspended the Appliance Recycling Program because of COVID-19. Customers wanting to sign up for the program are waitlisted and customers will be contacted once the program resumes.

The objectives of the Appliance Recycling Program are these: [82]

- 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

14.1.1 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.

14.1.2 Program Participation and Reported Impacts

Table 14-2 presents the participation counts, reported and verified energy and demand savings, and incentive payments for the Appliance Recycling Program in PY11 by customer segment.

Table 14-2. PY11 Appliance Recycling Program Participation and Reported Impacts

Parameter	GNE	Residential	Small C&I	Large C&I [1]	Total [2]
PYTD # Participants	86	12,890	141	-	**13,117**
PYRTD MWh/yr	75	9,915	128	-	**10,119**
PYRTD MW/yr	0.01	1.81	0.02	-	**1.84**
PYVTD MWh/yr	74	9,745	126	-	**9,945**
PYVTD MW/yr	0.01	1.80	0.02	-	**1.82**
PY11 Incentives ($1000)	$7	$379	$20	$1	**$408**

[1] The accounting data show incentives for this sector in PY11 due to an adjustment made at the end of July 2019 to correct sector allocations from a prior year.
[2] Total may not match sum of columns due to rounding.

14.2 Gross Savings Impact Evaluation

Cadmus completed a records review to evaluate the gross impacts of the Appliance Recycling Program. Cadmus reviewed the records in PPL Electric Utilities' tracking database and compared these to the

[82] 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.

records in the tracking data provided by the ICSP. Cadmus verified energy and peak demand savings for room air conditioners by verifying that the ICSP mapped data to the appropriate city, which reflect heating and cooling degree days and equivalent full-load hours (EFLH), as specified in the PA TRM. For dehumidifiers, Cadmus also verified the mapping of ZIP codes to the appropriate city by applying the fully deemed savings in the dehumidifier retirement interim measure protocol.[83]

14.2.1 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 PY11.

14.2.2 Gross Savings Impact Evaluation Results

Table 14-3 shows the program's verified gross savings.

Table 14-3. Appliance Recycling Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	Phase III Verified
MWh/yr	11,844	10,731	11,362	9,945	43,883[(1)]
[(1)] Phase III verified savings may not match sum of program years due to rounding.					

Table 14-4 shows the Appliance Recycling Program reported energy savings of 10,119 MWh/yr for PY11.

Table 14-4. PY11 Appliance Recycling 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)]
Appliance Recycling	10,119	98%	N/A	7.55%	9,945
[(1)] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

Table 14-5 shows the number of verified units recycled in PY11 and the verified energy savings by product.

Table 14-5. PY11 Gross Energy Results by Product Recycled

Product	PYVTD MWh/yr	Product Count
Refrigerator	7,214	7,510
Freezer	1,323	1,869
Room Air Conditioner	304	2,368
Dehumidifiers	1,105	1,370
Program Total [(1)]	**9,945**	**13,117**
[(1)] Total may not match due to rounding.		

[83] Approved by the Statewide Evaluator (SWE) July 7, 2017.

Table 14-6 shows a reported demand reduction of 1.84 MW/yr in PY11.

Table 14-6. PY11 Appliance Recycling 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]
Appliance Recycling	1.84	99%	N/A	4.61%	1.82
[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.					

In PY11, Cadmus applied PY10 verified gross per-unit kWh/yr savings for refrigerators and freezers.[84] The realization rate of 98% for the program was driven by slightly different inputs into the per-unit savings calculations for refrigerators and freezers.

14.3 Net Savings Impact Evaluation

Because the net-to-gross ratio has remained stable over time, Cadmus applied the PY10 ratio in PY11, 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).[85] This is consistent with the Uniform Methods Project (UMP) appliance recycling protocol to determine program net savings.[86]

14.4 Verified Savings Estimates

Table 14-7 shows the reported energy savings (PYRTD) and the verified gross and net energy savings estimates calculated by Cadmus for the Appliance Recycling Program in PY11.

Table 14-7. PYTD and P3TD Appliance Recycling Program Savings Summary

Savings Type	Energy (MWh/yr)	Demand (MW/yr)
PYRTD Gross	10,119	1.84
PYVTD Gross	9,945	1.82
PYVTD Net [1]	6,564	1.20
P3RTD Gross	49,903	7.55
P3VTD Gross	43,883	6.87
P3VTD Net [1]	28,963	4.54
[1] Net savings are not used to meet PPL Electric Utilities' energy savings compliance target.		

[84] PPL Electric Utilities. November 15, 2019. *Annual Report Program Year 10: June 1, 2018–May 31, 2019.* Presented to PA PUC. Prepared by Cadmus.

[85] Pennsylvania Public Utility Commission. Final version May 8, 2018. *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.

[86] National Renewable Energy Laboratory. September 2017. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures.* "Chapter 7: Refrigerator Recycling Evaluation Protocol." https://www.nrel.gov/docs/fy17osti/68563.pdf

14.5 Process Evaluation

14.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation earlier in Phase III. The PY11 limited process evaluation of the Appliance Recycling Program assessed participant satisfaction with the program. Although not planned as a PY11 activity, Cadmus did complete one interview with PPL Electric Utilities' program staff to review program design and implementation.

Table 14-8 lists the process evaluation sampling strategy. Details about Cadmus' approach to contacting customers and the sample attrition are presented in *Appendix L Survey Sample Attrition* and *Appendix Q Survey Methodology*.

Table 14-8. PY11 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	PPL Electric Utilities	Telephone in-depth interview	2	N/A	1	1	N/A	100%
Participants	Appliance Recycling	Online survey	8,695 [3]	-	As many as possible	552 [4]	4,580	100%
Total			**8,697**	**N/A**	**N/A**	**553**	**4,580**	**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 PY11 survey efforts.
[4] Number includes both completed and partially completed surveys. Respondents could skip questions.

14.5.2 Participant Satisfaction

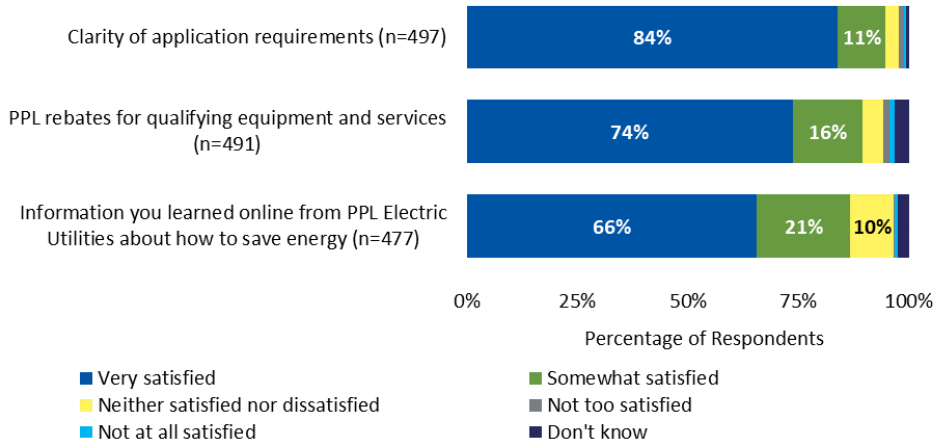
Overall Satisfaction

Cadmus contacted all Appliance Recycling Program participants with email addresses who recycled refrigerators and freezers in PY11 Q1 through Q3. Of the contacted participants, 552 answered some questions in the online survey. The PY11 online survey produced a measurement of program satisfaction

of 97% with ±1% precision at 90% confidence (n=482). Eighty-eight percent were *very satisfied* and 9% were *somewhat satisfied*.[87]

Participants also showed high levels of satisfaction for individual program components such as rebate amount, clarity of application requirements, and online information about ways to save energy (Figure 14-1). Despite generally high levels, satisfaction with each of these three components declined slightly in PY11 compared to satisfaction with the same components in PY10, however, only the program element "Information you learned online from PPL Electric Utilities about how to save energy" saw a significant decrease in satisfaction.[88]

Figure 14-1. ARP PY11 Component Satisfaction



Source: Survey question, "How satisfied are you with… [INSERT EACH STATEMENT]?" (n=477-497)

Pick-Up and Rebate Satisfaction

In PY11, Recleim made process changes related to scheduling, including the addition of text message scheduling and communication capabilities. In response, Cadmus added several questions to assess satisfaction related to scheduling, pick-up, and rebate processing. These questions were last asked in PY8. Table 14-9 shows the percentage of respondents who were *very satisfied* with each program component in years PY8 and PY11.

[87] Additionally, 1% were *neither satisfied nor dissatisfied*, 1% were *not too satisfied*, 0% were *not at all satisfied* with the overall program, and 0% said, "Don't know." The total does not sum up to 100% due to rounding. While 552 respondents started the survey, only 482 answered the overall satisfaction question.

[88] $p < .05$, based on two-proportions z-test test procedure

Table 14-9. ARP Scheduling, Pick-up, and Rebate Receipt Very Satisfied in PY8 and PY11

Program Element	PY8 *Very Satisfied* Percentage [1]	PY11 *Very Satisfied* Percentage
Scheduling appliance for pick-up	84%	88% [2]
Time it took to pick up appliance	73%	79% [2]
Time to receive the rebate	66%	83% [2]

Source: Survey question, "How satisfied are you with… [INSERT EACH STATEMENT]?" (PY8 n=547-548; PY11 n=504-507.)
[1] 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.
[2] Changes are statistically significant, p<.05. Significance test: two-proportion z-test.

The percentages of respondents who were *very satisfied* with scheduling the pick-up, the time it took to pick up the appliance, and the time it took to receive the rebate significantly increased in PY11 compared to those in PY8.[89] It is possible that the increase in satisfaction with scheduling the pick-up is partly attributed to improvements to the scheduling process implemented by the ICSP's subcontractor in PY11.

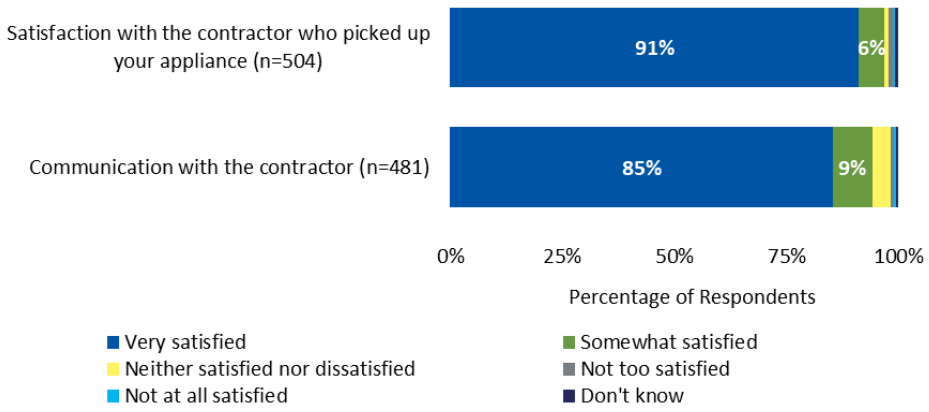
14.5.3 Program Communication

Despite overall high satisfaction, Cadmus investigated the drivers of dissatisfaction among the few dissatisfied participants. Participant suggestions for improvement most frequently emphasized a desire for more and improved program communication, both from contractors and from PPL Electric Utilities.

Pick-Up Contractors

In general, respondents were highly satisfied with the contractors that picked up their appliances (91% *very satisfied* and 6% *somewhat satisfied*). Respondents were also highly satisfied, though somewhat less satisfied, with the communication from their contractors (85% *very satisfied* and 9% *somewhat satisfied*). These results were consistent with PY8 results when the questions were last asked.

Figure 14-2. ARP PY11 Contractor Component Satisfaction



Source: Survey question, "How satisfied are you with… [INSERT EACH STATEMENT]?" (n=481-504)

[89] p < .05, based on two-proportions z-test test procedure

Twenty survey respondents (3.6%, n=552) provided information about what their contractor could have done to improve their experience. The most common suggestion was better contractor communication or customer service (seven respondents). Several expressed concern with their contractor's communication about pick-up cancellations. Feedback also suggests some participants may have expected appliance removal services that contractors do not provide as part of this program.

Of the remaining 13 respondents, four said contractors could be more professional during the visit, four said contractors could provide information about other PPL Electric Utilities energy efficiency programs, and five provided other miscellaneous feedback.

Participant Suggestions for Improvement

In general, the Appliance Recycling Program was a highly positive experience for participants. The most common feedback (22%, n=184) consisted of compliments for PPL Electric Utilities.

Survey respondents provided suggestions for how PPL Electric Utilities could improve the Appliance Recycling Program. The most frequent was to improve program communication (15%, n=184), such as clarifying what services pick-up contractors can provide, easing the application process, and providing information about eligible appliances:

- "[Make] it very clear that the contractor will only do simple, straight out [of] the door removal."
- "It was difficult to get the information needed to schedule [a] pick-up, but once pick-up was scheduled all went smoothly."
- "The recycling requirements are a little vague."

14.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 14-10. 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 PY11 dollars (PY11 includes months in both 2019 and 2020). Net present value costs and benefits for P3TD financials are expressed in PY8 dollars.

Table 14-10. Summary of Appliance Recycling Program Finances–Gross Verified

Row #	Cost Category	PYTD ($1,000)		P3TD ($1,000) [9]	
1	EDC Incentives to Participants	$408		$1,354	
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]**	**$408**		**$1,354**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$72	-	$173	-
7	Marketing [4]	-	$242	-	$744
8	Program Delivery [5]	-	$1,433	-	$5,125
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$1,748**		**$6,041**	
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]**	**$2,156**		**$7,395**	
14	Total NPV Lifetime Electric Energy Benefits	$3,186		$11,918	
15	Total NPV Lifetime Electric Capacity Benefits	$657		$2,325	
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]**	**$3,843**		**$14,242**	
19	**TRC Benefit-Cost Ratio [8]**	**1.78**		**1.93**	

[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 14-11 presents program financials and cost-effectiveness on a net savings basis.

Table 14-11. Summary of Appliance Recycling Program Finances–Net Verified

Row #	Cost Category	PYTD ($1,000)		P3TD ($1,000) [9]	
1	EDC Incentives to Participants	$408		$1,354	
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]**	**$408**		**$1,354**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$72	-	$173	-
7	Marketing [4]	-	$242	-	$744
8	Program Delivery [5]	-	$1,433	-	$5,125
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$1,748**		**$6,041**	
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]**	**$2,156**		**$7,395**	
14	Total NPV Lifetime Electric Energy Benefits	$2,103		$11,049	
15	Total NPV Lifetime Electric Capacity Benefits	$434		$2,145	
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]**	**$2,537**		**$13,194**	
19	**TRC Benefit-Cost Ratio [8]**	**1.18**		**1.78**	

[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.

14.7 Recommendations

As in prior years, the Appliance Recycling Program achieved very high satisfaction in PY11 in terms of both overall satisfaction (97%; n=482) and program component satisfaction. Despite high participant satisfaction with the program, Cadmus investigated the drivers of dissatisfaction among the few dissatisfied participants to help PPL Electric Utilities continually improve the Appliance Recycling Program. Recommendations are provided in Table 14-12, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: Though most participants in the Appliance Recycling Program were *very satisfied*, feedback from a few participants centered on improving program communication regarding cancellations and the removal process.

- Participants were somewhat less satisfied with communication from their contractors (85% were *very satisfied;* n=481) than with the contractors themselves (91% were *very satisfied;* n=504) (Figure 14-2). When asked what their contractor could have done to improve their experience, 20 respondents (n=552) suggested improvements including cancellation notification, appliance eligibility, and pick-up service requirements. (See section *14.5 Process Evaluation* subsection *Pick-Up Contractors* and section *14.5 Process Evaluation* subsection *Participant Suggestions for Improvement*.)

Table 14-12. Status of Recommendations for the Appliance Recycling Program

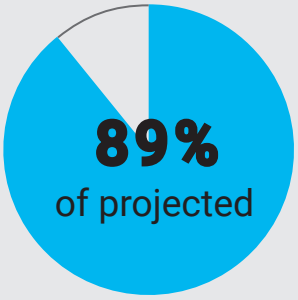
Appliance Recycling Program		
Conclusion	**Recommendation**	**EDC Status of Recommendation (Implemented, Being Considered, Rejected and Explanation of Action Taken by EDC)**
Conclusion 1: Though most participants in the Appliance Recycling Program were *very satisfied*, feedback from a handful of participants centered on improving program communication regarding cancellations and the removal process.	Review additional text message capabilities to address cancellations.	Being considered. The ICSP will review current messaging and create new ones as necessary.
	Consider creating an online tool that provides customers with a way to evaluate the size of their appliance to determine eligibility; this could include an image or video.	Being considered. There is already a document available for customers using the online scheduling tool. PPL Electric Utilities is considering including the link to this document on the landing page of the website.
	Consider reviewing program materials about eligibility and appliance pick-up instructions. Specifically, consider whether or not answers to the following questions in existing program materials can be made more clear or more readily available for participants: What is the contractor permitted to do when moving the appliance? Do the doors of the appliance need to be on or off? What constitutes clear and safe access to the appliance?	Being considered. The ICSP will review with the PPL Electric Utilities' marketing department to develop "What to Expect" language for customers.

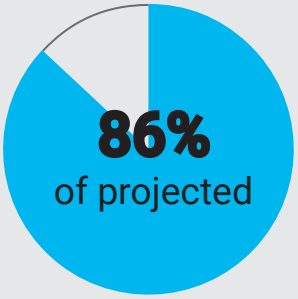
STUDENT ENERGY EFFICIENT EDUCATION PROGRAM

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 so far saved **15,868 MWh/yr**

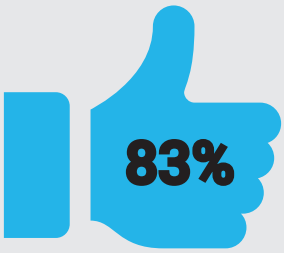




PY11 saved **2,429 MWh/yr**

Totals exclude savings attributable to the low-income sector

PROGRAM SATISFACTION



Satisfied with overall program

89%	Bright Kids (2nd – 3rd grades)
81%	Take Action (5th – 7th grades)
81%	Innovation Tier 1 (9th – 12th grades)
79%	Innovation Tier 2 (9th – 12th grades)

PY11 PARTICIPATION

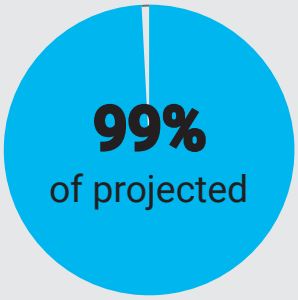
A total of **9,498** participants

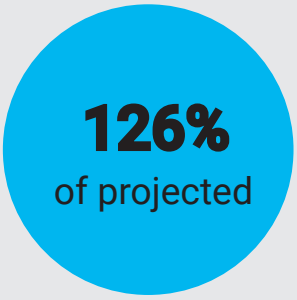
1,933	Bright Kids (2nd – 3rd grades)
5,293	Take Action (5th – 7th grades)
1,151	Innovation Tier 1 (9th – 12th grades)
1,122	Innovation Tier 2 (9th – 12th grades)

Totals are based on verified counts, exclude participation within low-income schools, and may not sum due to rounding.

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures so far **$4,200**





PY11 expenditures **$1,101**

Totals exclude expenditures attributable to the low-income sector

15 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.

Students receive educational materials and a take-home energy-savings kit of low-cost products to install at home. Each kit delivered to a student is counted as a program participant. The energy-savings kits are tailored to each grade level participating in the program and contain items such as LED bulbs, low-flow showerheads, faucet aerators, and smart power strips. Each kit includes a home energy worksheet (HEW) that asks questions to track rates of kit product installation as well as participant demographics and program satisfaction.

CLEAResult, PPL Electric Utilities' residential ICSP, identified National Energy Foundation (NEF) as the subcontractor to the ICSP. The ICSP's subcontractor undertakes a broad range of responsibilities that includes marketing to and recruiting potential schools and teachers, creating curricula correlated with Pennsylvania academic standards, securing support of the program components by the Pennsylvania Department of Education, and assembling and shipping the energy-savings kits.

PPL Electric Utilities collaborates with the ICSP on the program's strategic direction while maintaining the overarching Act 129 administrative, program support, evaluation, and data management systems. The ICSP provides oversight and direction to its subcontractor.

The objectives of the SEEE Program are these:[90]

- Expand and promote energy efficiency literacy through education outreach programs
- Provide energy efficiency education to students offered through school assemblies and classroom curriculum
- Confirm 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

[90] From PPL Electric Utilities Corporation. Energy Efficiency and Conservation Plan Act 129 Phase III. Docket No. M-2015-2515642. Approved November 2018.

15.1.1 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 PY11, the ICSP and the ICSP's subcontractor continued to split the Innovation cohort by offering some classrooms Tier 1 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.

15.1.2 Program Participation and Reported Impacts

Table 15-1 presents the participation counts and reported energy and demand savings for the SEEE Program in PY11 by customer segment (residential and low-income). The program does not offer incentives; the kits are offered free of charge.

In PY11, a portion of savings were attributed to the low-income sector, determined using the Pennsylvania Department of Education data specifying the percentage of students receiving reduced and free lunches. PPL Electric Utilities reallocated a portion of the program's energy savings, budget, and participants from this residential program to the low-income sector and reported this information under WRAP.

Table 15-1. PY11 Student Energy Efficient Education Participation and Reported Impacts

Parameter	Residential	Low-Income [1]	Total [2]
PYTD # Participants [3]	7,756	16,601	**24,357**
PYRTD MWh/yr	1,944	4,316	**6,260**
PYRTD MW/yr	0.19	0.42	**0.61**
PYVTD MWh/yr	2,429	3,729	**6,158**
PYVTD MW/yr	0.25	0.39	**0.64**
PY11 Incentives ($1,000)	$0	$0	**$0**

[1] Student education provided to students who qualify for free and reduced cost lunches is an approved low-income product. PY11 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 is based on the designation in PPL Electric Utilities' tracking database. This does not match the participant counts presented in the infographic. Cadmus verified 9,498 residential sector participants and 14,859 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% FPL used as the income qualification guideline for Act 129 low-income programs. Reduced-fee lunches are offered 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 within the school.[91] 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. In addition, Cadmus 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.

Therefore, Cadmus assigned program-verified savings of 6,158 MWh/yr to the residential and low-income sectors as follows:

- 3,624,047 kWh/yr savings for all students receiving free lunches assigned to the low-income sector (59% of program total)
- 104,581 kWh/yr savings for half the students receiving reduced-fee lunches assigned to the low-income sector (2% of program total)
- 2,429,016 kWh/yr savings assigned to the residential sector (39% of program total)

15.2 Gross Savings Impact Evaluation

15.2.1 Impact Evaluation Data Collection and Sample Design

Cadmus conducted the PY11 impact evaluation for the SEEE Program using PY11 survey data gathered through paper and online home energy worksheets (HEWs). Specifically, Cadmus used the PY11 HEW survey data to estimate savings for all energy savings products included in the kits, with the exception of the water heater setback.

[91] Pennsylvania Department of Education. "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

To calculate water heater temperature setback savings for the Take Action and Innovation cohorts, Cadmus used the average midpoint of the ranges and ISRs calculated from the PY9 HEW,[92] which provided results based on actual temperature setpoint change, whereas PY11 data did not.[93]

Table 15-2 summarizes the impact evaluation's sampling strategy. The impact evaluation activities produced energy and demand savings with ± 1.06% and ± 1.03% precision, respectively, each with 85% confidence.

Table 15-2. PY11 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 PY11 HEWs)	Impact Evaluation Data Source
Bright Kids 2nd – 3rd grades	5,168	N/A	3,619	PY11 paper and online HEWs
Take Action 5th – 7th grades	13,899	N/A	9,072	PY11 paper and online HEWs; PY9 paper and online HEWs (water-heater setback only)
Innovation Tier 1 9th – 12th grades	2,674	N/A	2,183	PY11 paper and online HEWs; PY9 paper and online HEWs (water-heater setback only)
Innovation Tier 2 9th – 12th grades	2,616	N/A	2,121	PY11 paper and online HEWs; PY9 paper and online HEWs (water-heater setback only)
Program Total	**24,357**	**N/A**	**16,995**	**N/A**
(1) Because this program's evaluation did not include sampling, Cv and planned precision are not meaningful.				

15.2.2 Gross Savings Impact Evaluation Results

Table 15-3 shows the program's verified gross savings.

Table 15-3. Student Energy Efficient Education Program Savings

	PY8 Verified	PY9 Verified	PY10 Verified	PY11 Verified	Phase III Verified
MWh/yr	4,539	6,024	6,011	6,158	22,731 (1)
(1) Phase III verified savings may not match sum of program years due to rounding.					

92 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. http://www.puc.pa.gov/pcdocs/1595564.pdf

93 The ICSP updated the PY10 and PY11 HEWs to simplify the water heater temperature reduction question by asking only whether the temperature was changed instead of for the degrees of temperature reduced. The reported savings calculation uses the PA TRM default (reduction of 11 degrees) for those who confirm they reduced their water heater temperature. However, because Cadmus found a large discrepancy between the average temperature reduction reported in PY9 (between 5.1 and 5.4 degrees depending on cohort) and the PA TRM default (11 degrees), Cadmus used the average reported temperature reduction from the PY9 survey to calculate PY11 energy savings for water heater setback.

The program exceeded its projected savings because of substantially greater participation in PY11 (24,357 participants) than had been planned (13,047 participants). PPL Electric Utilities' EE&C Plan proposed adding a low-income Student Energy Efficient Education offering to its portfolio in PY11. Therefore, the ICSP targeted schools with low-income students, which increased program participation in PY11.

In PY11, the SEEE Program reported energy savings of 6,260 MWh/yr, as shown in Table 15-4, and demand reduction of 0.61 MW/yr, as shown in Table 15-5.

Table 15-4. PY11 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	543	101%	0.09	0.98%	549
Take Action	3,839	99%	0.23	1.63%	3,808
Innovation Tier 1	801	99%	0.08	1.62%	792
Innovation Tier 2	1,077	94%	0.07	1.62%	1,008
Program Total [2]	**6,260**	**98%**	**N/A**	**1.06%**	**6,158**

[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 15-5. PY11 Student Energy Efficient Education 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	0.06	102%	0.09	0.97%	0.06
Take Action	0.37	107%	0.23	1.59%	0.40
Innovation Tier 1	0.08	101%	0.07	1.39%	0.08
Innovation Tier 2	0.10	97%	0.06	1.41%	0.10
Program Total [2]	**0.61**	**104%**	**N/A**	**1.03%**	**0.64**

[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 closely with verified savings in PY11. The following factors contributed to the 98% overall realization rate for the program:

- Reported savings for smart strips in PPL Electric Utilities' tracking database did not account for instances when smart strips were installed in entertainment centers. Smart strips installed in entertainment centers generate more savings than when installed in unknown locations, increasing realization rates.
- The ICSP used higher per-unit *ex ante* savings to calculate reported savings for showerheads than Cadmus found after analyzing PY11 HEWs, decreasing the realization rate.
- For kitchen aerators, which only the Take Action kits included, Cadmus used the number of persons per home provided in the HEWs, which was larger than the deemed number of persons per home in the PA TRM, increasing the realization rate.

For PY11, Cadmus used data gathered from the PY9 survey to determine the degrees by which participants lowered their water heater temperature settings to calculate *ex post* savings for the water heater temperature setback component of the kit. The analysis of the PY9 survey indicated that participants lowered their water heater temperature setting by 5.1 to 5.4 degrees depending on cohort, approximately half of the ICSP's value of 11 degrees, decreasing realization rates for PY11.

See *Appendix M Evaluation Detail – Student Energy Efficient Education Program* for additional details.

15.3 Net Savings Impact Evaluation

The SEEE Program is a select offering to schools, and kits are provided free of charge to teachers, who in turn provide the kits to their students. No free riders are anticipated among the population receiving the energy-savings kit. That is, Cadmus does not expect teachers to voluntarily purchase and provide kits to students in the absence of the program. Likewise, because the kits are sent home with children as part of the school's curriculum and households do not 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.

15.4 Verified Savings Estimates

In Table 15-6, 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 PY11.

Table 15-6. PYTD and P3TD Student Energy Efficiency Education Program Savings Summary

Savings Type	Energy (MWh/yr) [1]	Total Demand (MW/yr) [1]
PYRTD	6,260	0.61
PYVTD Gross	6,158	0.64
PYVTD Net [2], [3]	6,158	0.64
P3RTD	23,050	2.23
P3VTD Gross	22,731	2.37
P3VTD Net [2], [3]	22,731	2.37

[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.

15.5 Process Evaluation

15.5.1 Process Evaluation Data Collection and Sample Design

Cadmus conducted a full process evaluation of the SEEE Program earlier in Phase III. For PY11, a limited process evaluation assessed student participant satisfaction with the program. Activities were consistent with the evaluation plan with the exception of fewer program staff interviews. The evaluation planned to complete three interviews with program and ICSP staff but three were not needed because there were no major program changes.

Table 15-7 describes the process evaluation sampling strategy.

Table 15-7. PY11 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	Number of 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]	2	2	N/A	100%
Students	Bright Kids, Take Action, Innovation Tier 1 and Tier 2	ICSP subcontractor-administered paper and online HEWs	24,357	N/A [2]	All returned surveys	16,720 [3]	All eligible	100%
Program Total			**24,357+**		**2+**	**16,722**	**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 used for the Impact evaluation.

15.5.2 Student Satisfaction

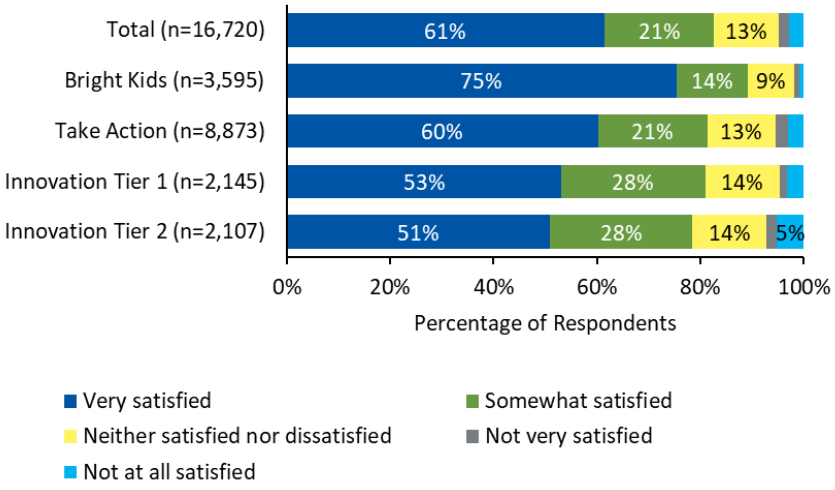
Student participants completed HEWs, which were developed and administered by the ICSP's subcontractor, either online or on the paper forms included in the energy-savings kits. The number of completed surveys produced a measurement of program satisfaction with ±0.27% precision at 83% confidence.

Sixty-nine percent of participants completed HEWs, a decrease from 73% in PY10. Figure 15-1 summarizes the results of the student satisfaction by cohort. Of 16,720 students, 83% said they were *very satisfied* (61%) or *somewhat satisfied* (21%) with the program overall,[94] which was similar to the satisfaction level in PY10.

In line with prior program year findings, the cohort most frequently *very satisfied* was Bright Kids (75%; n=3,595). The cohort least frequently *very satisfied* was Innovation (53% for Tier 1, n=2,145; 51% for Tier 2, n=2,107).

[94] The sum of *very satisfied* and *somewhat satisfied* does not sum to 83% due to rounding.

Figure 15-1. Participant Satisfaction with Student Energy Efficient Education Program Overall by Cohort



Home Energy Worksheet Q8 (*Bright Kids*) and Q23 (*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.

15.6 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 15-8. The TRC benefits were calculated using gross verified impacts. NPV PYTD benefits and costs are expressed in PY11 dollars (PY11 includes months in both 2019 and 2020). 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.

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.[95] A summary of the methodologies Cadmus used to calculate the non-energy benefits of natural gas savings is presented in *Appendix O. Non-Energy Benefits*.

[95] Guidance on the Inclusion of fossil fuel and H_2O benefits in the TRC Test, Statewide Evaluation Team, March 25, 2018.

Table 15-8. 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]	$44	-	$181	-
7	Marketing [4]	-	$195	-	$593
8	Program Delivery [5]	-	$1,415	-	$3,477
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1]**	**$1,654**		**$4,251**	
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]**	**$1,654**		**$4,251**	
14	Total NPV Lifetime Electric Energy Benefits	$1,736		$5,197	
15	Total NPV Lifetime Electric Capacity Benefits	$221		$800	
16	Total NPV Lifetime Operation and Maintenance (O&M) Benefits	$181		$1,420	
17	Total NPV Lifetime Non-Electric Benefits (Fossil Fuel, Water)	$5,384		$8,708	
18	**Total NPV TRC Benefits (Sum of rows 14 through 17) [7] [1]**	**$7,522**		**$16,126**	
19	**TRC Benefit-Cost Ratio [8]**	**4.55**		**3.79**	

[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.

15.7 Recommendations

Overall, the SEEE Program performed well in PY11, distributing more kits than projected and exceeding the program's planned savings. Satisfaction with the program was high, with 83% of students reporting they were *very* or *somewhat satisfied* with the program. Furthermore, the program successfully identified low-income schools in the first year of targeting them, increasing the proportion of verified low-income savings to 61%, compared to 52% in PY10, while overall verified savings held steady. Recommendations are provided in Table 15-9, along with a summary of how PPL Electric Utilities plans to address the recommendations.

Conclusion 1: The current wording of the water heater temperature setback question included in the HEW provides less reliable results than the previous wording (PY9).	• The ICSP updated the PY10 and PY11 HEWs to simplify the water heater temperature reduction question, asking only whether the temperature was changed, instead of asking for the degrees of temperature reduction. Consequently, the reported savings calculation uses the PA TRM default (reduction of 11 degrees) for those who confirm they reduced their water heater temperature. However, Cadmus found a large discrepancy between the average temperature reduction documented in the PA TRM default compared to reported in PY9 (between 5.1 and 5.4 degrees depending on cohort), using the previous wording of the survey question. (See *Gross Savings Impact Evaluation Results* section in *15.2 Gross Savings Impact* Evaluation.)
Conclusion 2: Current *ex ante* calculations for kitchen aerators and smart strips underestimate savings.	• For kitchen aerators, which only the Take Action kits included, Cadmus used the number of persons per home provided in the HEWs, which was larger than the deemed number of persons per home in the PA TRM, increasing the realization rate. The PA TRM likely underrepresents households with program-eligible children. • Reported savings for smart strips in PPL Electric Utilities' tracking database did not account for instances when smart strips were installed in entertainment centers. Smart strips installed in entertainment centers generate more savings than when installed in unknown locations, increasing realization rates. (See *Gross Savings Impact Evaluation Results* section in *15.2 Gross Savings Impact* Evaluation.)

Table 15-9. 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 current wording of the water heater temperature setback question included in the HEW provides less reliable results than the previous wording (PY9).	Consider reverting the wording of the water heater temperature setback question in the HEW back to the wording used in PY9 or use the PY9 finding moving forward to calculate *ex ante* savings.	Being considered for Phase IV. The ICSP will review the language with their subcontractor.
Conclusion 2: Current *ex ante* calculations for kitchen aerators and smart strips underestimate savings.	To better capture the size of households in the population targeted by the program (families), consider modifying the kitchen aerator *ex ante* savings calculations to reflect survey findings, rather than using the PA TRM, which reflects smaller household sizes in the general population.	Being considered for Phase IV. The ICSP chose a conservative approach to use a weighted deemed savings to simplify data processing.
	Consider modifying the smart strip *ex ante* savings calculations to account for instances where smart strips are installed in entertainment centers.	Being considered for Phase IV. The ICSP chose a conservative approach to assume all Tier II smart strips as 'Other' installs to simplify data processing.

DEMAND RESPONSE PROGRAM

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 has so far saved an average of **112.8 MW**

123% of Act 129 Target

113% of Act 129 target

PY11 saved an average of **104.3 MW**

PROGRAM SATISFACTION

80% Satisfied with overall program

80% satisfied with the **timing of event notifications**

80% satisfied with the **ICSP**

66% satisfied with the **online enrollment process**

PY11 PARTICIPATION

A total of **4** events with **26** unique participants

60 facilities curtailed 90.6 MW on July 17, 2019 event

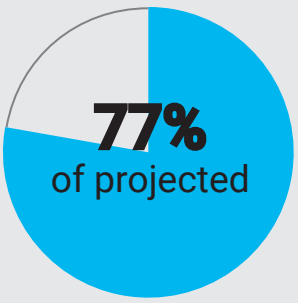
62 facilities curtailed 109.0 MW on July 18, 2019 event

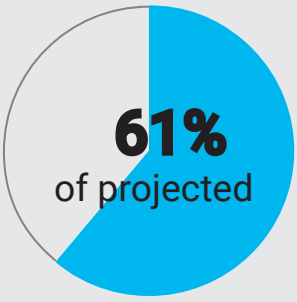
59 facilities curtailed 104.7 MW on July 19, 2019 event

60 facilities curtailed 112.8 MW on August 19, 2019 event

ACTUAL EXPENDITURES ($1,000)

Phase III expenditures through PY11 **$7,106**





PY11 expenditures **$1,970**

16 Demand Response Program

During Phase III, PPL Electric Utilities operates the Demand Response Program for commercial and industrial (C&I) customers and 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 customers to reduce electricity demand during Act 129 demand response events. After the summer season, the ICSP makes performance-based payments to participating customers.

According to the Act 129 Phase III Implementation Order, a maximum of six events can be called per program year.[96] In PY11, four events were called. All but one occurred on a non-holiday weekday between 2:00 p.m. and 6:00 p.m. The July 18 event occurred between 3:00 p.m. and 7:00 p.m.

The ICSP notified participating customers between 10:15 a.m. and 11:30 a.m. on the day before each event. Before the event started, customers confirmed their participation for specific hours by logging into the ICSP's online platform. Customers had the option of participating in all or a subset of event hours. In turn, the ICSP notified PPL Electric Utilities via an event enrollment report of those customers participating in the event and made any updates if a customer status changed.

Compliance targets for demand response programs were established at the system level, which means the load reductions measured at the customer meter must be escalated to reflect transmission and distribution line losses. The peak demand impacts presented in this report have been adjusted for these line losses.

16.1.1 Definition of a Participant

A participant in the Demand Response Program in PY11 is defined as a customer facility that participated in at least one of PPL Electric Utilities' Act 129 demand response events. The ICSP enrolled 32 customers representing 70 facilities in PY11. A total of 26 customers with 64 sites participated in at least one Act 129 demand response event.

16.1.2 Program Participation and Reported Impacts

Table 16-1 presents the participation counts, reported demand reductions, and incentive payments for the Demand Response Program in PY11 by customer segment and Act 129 event. In PY11 (summer of 2019), the program reported demand savings of approximately 87.4 MW on July 17, 109.4 MW on July 18, 104.1 MW on July 19, and 111.4 MW on August 19. Between 93% and 95% of the reported demand savings for each of these events were achieved by large C&I customers.

[96] Phase III Final Implementation Order. From the Public Meeting of June 11, 2015. Pennsylvania Public Utility Commission. Docket No. M-2014-2424864. Available at http://www.puc.pa.gov/pcdocs/1367313.doc.

Table 16-1. PY11 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]	31	21	12	**64**
Event 1, July 17, 2019, Reported MW	0.8	82.2	4.3	**87.4**
Event 2, July 18, 2019, Reported MW	2.1	101.8	5.5	**109.4**
Event 3, July 19, 2019 Reported MW	0.8	98.6	4.7	**104.1**
Event 4, August 19, 2019, Reported MW	1.4	106.2	3.8	**111.4**
Total Average Reported MW	1.3	97.2	4.6	**103.1**
PYVTD MW	1.6	96.7	5.9	**104.3**
PY11 Incentives ($1000)	$16	$1,114	$54	**$1,183**

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 (64), not the number enrolled in the program (70).

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 PY11, all PPL Electric Utilities demand response program participants were dual-enrolled participants. Table 16-2 reports the number of these participating facilities and the incentives paid.

Table 16-2. PY11 Dual-Enrolled Participants (PPL Act 129 and PJM programs)

Dual-Enrolled and Participating Customer Facilities	Act 129-Only Customer Facilities	Incentives Paid to Dual-Enrolled Customers	Incentives Paid to Act 129-Only Customers
64	0	$1,183,474.02	0

16.2 Gross Savings Impact Evaluation

16.2.1 Impact Evaluation Data Collection and Sample Design

The impact evaluation strategy is shown in Table 16-3. Cadmus analyzed consumption data to estimate Act 129 load impacts for the population of participating facilities (that is, there was no sampling). The impact evaluation counts as participants are all facilities that participated in at least one event from any of the three demand response aggregators—CPower or its subcontractors NRG and Direct Energy.

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.[97] 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 N Evaluation Detail – Demand Response Program*.

[97] Cadmus applied standard day-matching baseline calculation methods, such as selecting the seven days of the previous 10 with highest average demand, in accordance with SWE guidelines.

Table 16-3. PY11 Demand Response Program Gross Impact Evaluation and Sampling Strategy

Stratum	Event	Population Size [1]	Assumed Proportion or Cv in Sample Design	Achieved Sample Size	PYRTD MW	Impact Evaluation Activity
Small C&I	July 17	31	100%	31	0.8	Analysis of individual participating facility loads was performed for each event hour
	July 18	31	100%	31	2.1	
	July 19	30	100%	30	0.8	
	August 19	30	100%	30	1.4	
Large C&I	July 17	17	100%	17	82.2	
	July 18	20	100%	20	101.8	
	July 19	19	100%	19	98.6	
	August 19	20	100%	20	106.2	
GNE	July 17	12	100%	12	4.3	
	July 18	11	100%	11	5.5	
	July 19	10	100%	10	4.7	
	August 19	10	100%	10	3.8	
Program Total [2]	July 17	60	100%	60	87.4	
	July 18	62	100%	62	109.4	
	July 19	59	100%	59	104.1	
	August 19	60	100%	60	111.4	

The load impacts reported in this table have been grossed up to reflect transmission and distribution losses.
[1] Population size is the count of facilities that participated in one or more hours of the event as reported by the ICSP.
[2] Totals may not sum exactly due to rounding.

16.2.2 Gross Savings Impact Evaluation Results

PPL Electric Utilities is on track to meet its Phase III Act 129 Demand Reduction compliance target specified in the Implementation Order. In PY11, verified peak load reductions were 104.3 MW (equal to the average demand reduction over the four demand response events), a realization rate of 101% relative to the reported (*ex ante*) load reduction.

The P3TD verified peak 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, for 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 16-1 shows the gross verified savings for PY11 compared to the Act 129 targets during PY9 through PY11.

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 16-1. Gross Verified Savings in Comparison to Act 129 Targets

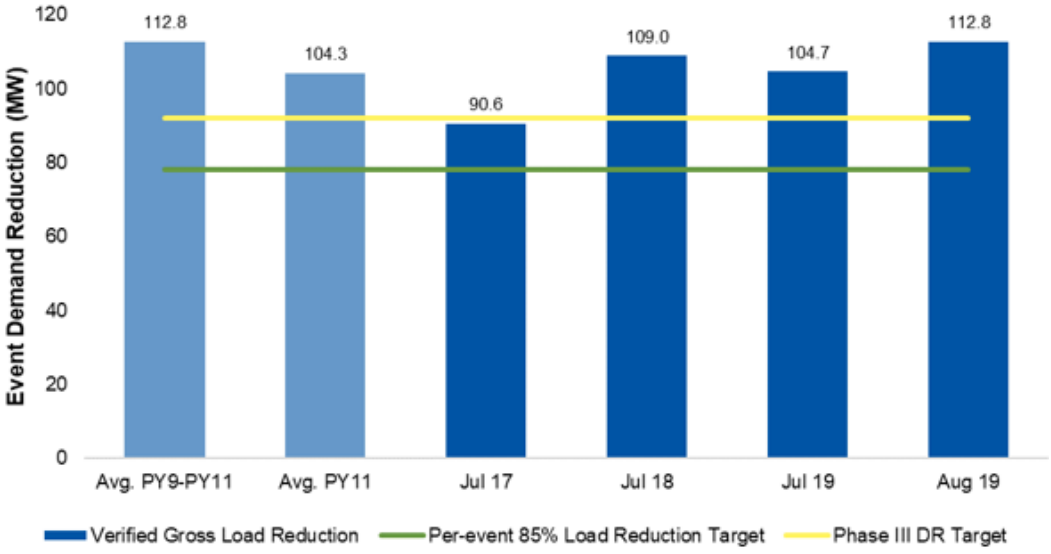


Table 16-4 shows PY11 Demand Response Program achievements by sector.

Table 16-4. PY11 Demand Response Program Gross Impact Results for Demand

Stratum	Event	Number of Participants	PYRTD MW	Demand Realization Rate	PYVTD MW [1] [2]	Standard Error	Relative Precision at 90% C.L. [3]
Small C&I	July 17, 2019	31	0.8	204%	1.7	0.14	13.5%
	July 18, 2019	31	2.1	96%	2.0	0.13	10.5%
	July 19, 2019	30	0.8	171%	1.4	0.14	16.0%
	August 19, 2019	30	1.4	97%	1.4	0.13	16.0%
Large C&I	July 17, 2019	17	82.2	100%	82.4	4.20	8.4%
	July 18, 2019	20	101.8	98%	100.0	4.52	7.4%
	July 19, 2019	19	98.6	99%	97.3	4.52	7.6%
	August 19, 2019	20	106.2	101%	107.2	4.55	7.0%
GNE	July 17, 2019	12[4]	4.3	152%	6.5	0.45	11.4%
	July 18, 2019	11	5.5	127%	7.0	0.36	8.4%
	July 19, 2019	10	4.7	127%	5.9	0.34	9.4%
	August 19, 2019	10	3.8	112%	4.3	0.35	13.5%
Event [5]	**July 17, 2019**	**60**	**87.4**	**104%**	**90.6**	**4.23**	**7.7%**
	July 18, 2019	**62**	**109.4**	**100%**	**109.0**	**4.53**	**6.8%**
	July 19, 2019	**59**	**104.1**	**101%**	**104.7**	**4.53**	**7.1%**
	August 19, 2019	**60**	**111.4**	**101%**	**112.8**	**4.56**	**6.7%**
Average		**64**	**103.1**	**101%**	**104.3**	**2.23**	**3.5%**

[1] Due to rounding, multiplying the PYRTD savings by the realization rate will not accurately reflect the final verified savings.
[2] Based on Cadmus' analysis of participant AMI consumption data. MW were grossed up to reflect transmission and distribution losses.
[3] Precision accounts for covariances of savings across hours of each event but not between events.
[4] The ICSP reported savings for 12 GNE facilities. The evaluation disqualified one facility's savings due to the ICSP not notifying PPL Electric Utilities that it was enrolling the facility in the event.
[5] Total may not sum due to rounding.

In general, the reported and evaluated savings were close, but the following factors may have contributed to differences between the reported and verified savings and the realization rates that deviated from 100%.

- **Different treatment of estimated readings**. The ICSP provided estimates rather than actual values for about 1% of all hourly interval readings for participating facilities on event or weekdays that were not holidays or notification days between April 1, 2019, and September 15, 2019. 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 all small C&I facilities, 92% of GNE facilities, and 24% 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.

16.3 Net Savings Impact Evaluation

There are no net savings because neither free riders nor spillover apply to this program. C&I and GNE participants are not expected to curtail their loads without notification of PPL Electric Utilities system peaks and without compensation.

16.4 Process Evaluation

16.4.1 Process Evaluation Data Collection and Sample Design

The process evaluation assessed program implementation and customer satisfaction. The main research objectives focused customer satisfaction. The PY11 process evaluation activities for the Demand Response Program featured interviews with PPL Electric Utilities and ICSP program managers and surveys with enrolled customers.

Table 16-5 lists the process evaluation sampling strategy. Unlike the impact evaluation, which analyzed the entire population of participating facilities, the process evaluation conducted a survey of enrolled customers contracted by the ICSP (29 unique companies). Customers did not have to participate in an event in PY11 to qualify for the survey but must have enrolled for the PY11 program and received the event notifications.

Table 16-5. PY11 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	29 [3]	N/A	12	10	29	100%
Program Total			**31**	**N/A**	**14**	**12**	**31**	**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 29 unique companies that enrolled in the PY11 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 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, and Direct Energy.

In November 2019, Cadmus interviewed the program managers from PPL Electric Utilities and the ICSP. Between November and December 2019, Cadmus contacted all 29 enrolled companies by email and telephone,[98] even if they did not participate in any PY11 events, to ask them to complete a short survey.

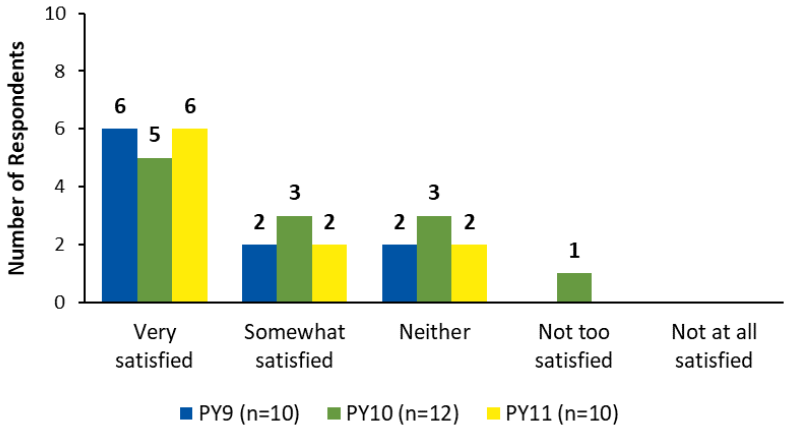
The survey was directed to the person who authorized the events at each company, typically an energy manager. Cadmus coordinated with the ICSP on emailing notice of the survey in advance. Cadmus made six attempts to gather survey responses. The first and second attempts were by email; the third, fourth, and fifth attempts were by telephone; and the sixth attempt was by email. Despite multiple attempts, Cadmus gathered data for 10 completed surveys, which was less than the target of 12 completed surveys. Because of the small number of respondents (n=10), 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 PY11, eight of 10 respondents were satisfied with the Demand Response Program—six were *very satisfied* and two were *somewhat satisfied*. No respondent said they were dissatisfied. Figure 16-2 shows overall satisfaction with the program for PY9, PY10, and PY11. PY11 achieved the same overall program satisfaction results as PY9.

[98] Cadmus did not survey the enrolled customers under contract with the demand response sub-contractors NRG and Direct Energy, only customers enrolled under contract with CPower.

Figure 16-2. Overall Satisfaction with Demand Response Program

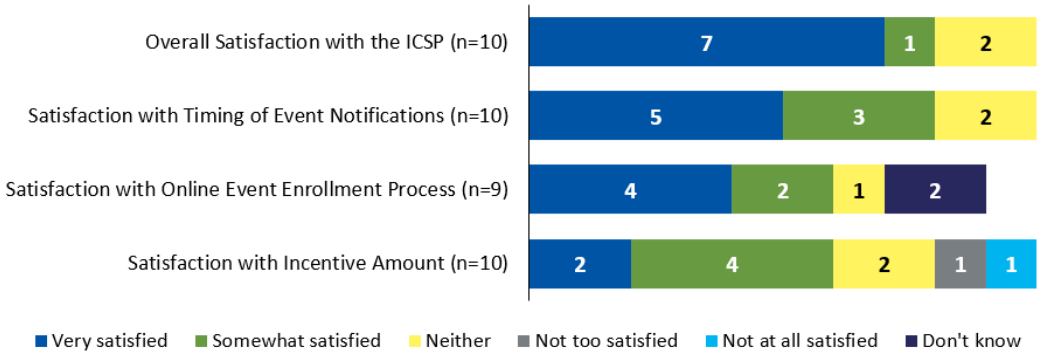


Source: Survey question, "How would you rate your overall satisfaction with the Demand Response Program?"

The survey asked respondents a follow-up question about the reason for their program satisfaction rating. The satisfied respondents said the event notifications and communications were very good. Respondents who gave a neutral rating said the program is fair and reasonable; however, they would like to receive additional compensation for participating in consecutive events.

Figure 16-3 shows component-level satisfaction for the program.

Figure 16-3. PY11 Demand Response Program Component Satisfaction



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

Program Delivery

In PY11, PPL Electric Utilities and the ICSP operated the program the same as in previous years. They implemented four events, three of which occurred on consecutive days (July 17, 18, and 19). This was the first time in Phase III that the program implemented three consecutive events.

As shown in Figure 16-1 in the *16.2.2 Gross Savings Impact Evaluation Results* section above, the program exceeded its per-event compliance target on each of the three consecutive events and performed better on the second and third day. The program achieved its highest per-event load

reduction on the fourth and final event (August 19), exceeding the per-event compliance target and the Phase III compliance target. The program's strong performance can be attributed to three factors:

- Having a familiar and clear set of operational procedures
- Oversubscribing the number of participating customers
- Knowing which participating customers could fill in load performance gaps

Event Experience

Cadmus's PY11 survey focused on the three-day consecutive event experience. Nine of the 10 companies that completed the survey participated in the three consecutive events; one company did not participate in any events during PY11.

Eight said they were aware of the forecast for the three consecutive events. Of these, six were concerned about adverse impacts on business operations, particularly the managers of manufacturing facilities who were concerned about the loss of production for their business. Two respondents said they were not concerned.

The survey asked the nine respondents who participated in at least two of three consecutive events how easy or difficult it was for their facilities to participate. Two said *somewhat easy*, and one said *very easy*. Six respondents said it was difficult—one said *very difficult*, and five said *somewhat difficult.* These respondents explained that the consecutive events required additional staff, operational planning, and communication to employees. Notably, the respondent who said it was *very easy* manages a higher education facility and explained that events in general were easy to implement because there were fewer occupants in the building during the summer semester.

16.5 Cost-Effectiveness Reporting

A detailed breakdown of program finances and cost-effectiveness is presented in Table 16-6. 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 PY11 costs and benefits, and P3TD values represent phase costs and benefits up to PY11. Net present value (NPV) PYTD costs and benefits are expressed in PY11 dollars. NPV costs and benefits for P3TD financials are expressed in PY8 dollars.

Table 16-6. 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	$1,183		$3,481	
2	EDC Incentives to Trade Allies	-		-	
3	Participant Costs (net of incentives/rebates paid by utilities)	($296)		($870)	
4	**Incremental Measure Costs (Sum of rows 1 through 3) [1]**	**$887**		**$2,610**	
		EDC	**CSP**	**EDC**	**CSP**
5	Design & Development [2]	-	-	-	-
6	Administration, Management, and Technical Assistance [3]	$27	-	$255	-
7	Marketing [4]	-	-	-	-
8	Program Delivery [5]	-	$760	-	$2,480
9	EDC Evaluation Costs	-		-	
10	SWE Audit Costs	-		-	
11	**Program Overhead Costs (Sum of rows 5 through 10) [1], [6], [10]**	$787		$2,736	
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]**	**$1,674**		**$5,346**	
14	Total NPV Lifetime Electric Energy Benefits	-		-	
15	Total NPV Lifetime Electric Capacity Benefits	$4,803		$13,474	
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]**	**$4,803**		**$13,474**	
19	**TRC Benefit-Cost Ratio [9]**	**2.87**		**2.52**	

[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.

16.6 Recommendations

In PY11, the Demand Response Program exceeded the Act 129 compliance target of 78 MW demand reduction for each event and is on track to meet the Act 129 compliance target of 92 MW demand reduction for Phase III. Most customers were satisfied with the program overall.

Because the program continues to successfully implement events and deliver strong performance, Cadmus does not have any program recommendations.

Appendix A. Upstream Lighting Cross-Sector Sales

The Efficient Lighting Program is intended to serve residential customers. However, because PPL Electric Utilities pays incentives directly to manufacturers, the actual participants are not known.

Owners of small businesses are assumed to comprise a portion of customers who buy discounted LEDs from participating retailers. LEDs installed in commercial settings are subject to different assumptions set forth by the PA TRM, and this affects annual savings. To determine the proportion of program LEDs purchased by commercial customers, Cadmus conducted a study called a cross-sector sales analysis.

For PY11 sector-specific reported savings and incentive expenditures, PPL Electric Utilities used results from the PY10 cross-sector sales analysis, the last one Cadmus conducted.[99] Cadmus used these PY10 results to make *ex post* adjustments to quantities and savings by sector to determine the realization rate.

In the PA TRM, assumptions regarding hours of use (HOU) and coincident factor (CF) vary by sector. For the residential sector, these assumptions are deemed. However, for the commercial sector, HOU and CF assumptions vary by building type, as described in Table 3-5 of the PA TRM. [100]

Table A-1 shows cross-sector sales assumptions reflecting the PY10 evaluation findings. Cadmus used these proportions in PY11.

Table A-1. PY10 Cross-Sector Assumptions by Sector, Used in PY11

Population	LEDs per Customer	Delta Watts (ΔW)	Hours of Use per day (HOU)	Coincidence Factor (CF)	In-Service Rate (ISR)	Interactive Effect: kWh	Interactive Effect: kW
Residential	10.17	34	3.00	0.106	92%	0.940	1.120
Small C&I	15.89	34	6.07	0.409	98%	1.000	1.192

[99] 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.

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

Appendix B. Site Inspection Summary

Table B-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 B-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	CLEAResult (the ICSP)	56	12	30	• Contractor/customer estimate of original savings was not accurate. • Actual metered data used in place of estimates. • Project not modeled accurately compared to installed condition. • Project scope deviation and possibly not understanding systems installed for Custom.
	Warren Energy Engineering, LLC (for Cadmus)	45	10	50	• Discrepancies only found on small sample sites (9 of 10 small sample virtual visits) though all equipment and quantities matched reported values.
Efficient Equipment Prescriptive Lighting	CLEAResult (the ICSP)	140	11	39	• 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.
	Warren Energy Engineering, LLC (for Cadmus)	11	3	10	• Wrong number of lights submitted on application. • Incorrect controls for baseline and post install fixtures. • Wrong HOU and CF given on Appendix C form vs. what was calculated using logger data. •Wrong space square footage in Appendix C form vs. what was verified using as-built drawings for new construction project. • Incorrect fixture wattage for baseline and post install fixtures. • Wrong space conditioning given on Appendix C form vs. what was found on site.

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In Person	Virtual		
Efficient Equipment Direct Discount Lighting	CLEAResult (the ICSP)	215	17	32	• Wrong number of lights submitted on application. • Wrong amount of bulbs in the ballast/fixture submitted. • Projects started before receiving preapproval. • 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).
	Warren Energy Engineering, LLC (for Cadmus)	5	0	2	• Wrong HOU given on Appendix C form vs. what was found from customer interviews on site. • Wrong TRM building type 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. • Wrong space conditioning given on Appendix C form vs. what was found on site.
Efficient Equipment HVAC	Cadmus	4	2	4	• Commercial CAC >5.4 Tons IEER: Implementer reported incorrect facility location (and associated TRM HOU and CF). • Commercial CAC >5.4 Tons IEER: Baseline AHRI performance different from reported. • Commercial DHP < 5.4 tons: AHRI capacity and performance are different from reported. • Commercial DHP < 5.4 tons: Unit quantities did not match reported *ex ante* savings.
Efficient Equipment Motors	Cadmus	1	1	1	• Variable Frequency Drive (VFD) Improvements: Differences in equipment capacity. • Variable Frequency Drive (VFD) Improvements: Differences in equipment efficiency. • Variable Frequency Drive (VFD) Improvements: Differences in in-service rate. • Variable Frequency Drive (VFD) Improvements: Implementer reported incorrect building type (and associated TRM HOU and CF).
Efficient Equipment Refrigeration	Cadmus	2	0	2	• Anti-Sweat Heater Controls Low/Medium Temp: Difference in refrigerator and freezer door counts with anti-sweat heaters installed.
Efficient Equipment Agriculture	Cadmus	0	0	0	None

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In Person	Virtual		
Efficient Equipment	CLEAResult (the ICSP)	8	1	1	• 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 for Custom.
Midstream Lighting	CLEAResult (the ICSP)	215	25	40	• Product not found; shipped to one location and moved to another facility. • Product not fully installed yet. • Product not installed in PPL Electric Utilities' territory (removed from program).
	Warren Energy Engineering, LLC (for Cadmus)	1	2	3	• Verified TRM building type different from IMP assumption. • 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.
Residential Sector					
Energy Efficient Home – New Homes Component	Performance Systems Development (PSD) (for the ICSP)	63	0	62	•Lighting (36): All lighting discrepancies involved an incorrectly reported percentage of energy-efficient bulbs. Raters often miscount or fail to identify all existing fixtures in the home, causing inconsistencies in reporting. These discrepancies increased in PY11 due to new data fields added for LED bulbs, increasing the chances of mistakes. •Cooling Equipment (23): Cooling discrepancies are caused by misreported equipment efficiency rating or equipment sizing. •Windows (20): Window discrepancies are caused by misreported window type, orientation, or square footage. •Appliances (14): Appliance discrepancies were most often caused by misreported equipment efficiency ratings.
WRAP Manufactured Homes	CMC (the ICSP)	81	77	67	Missed opportunity and professional improvement plan created through targeted inspections (clients with an electric water heater without any water-saving equipment installed) and monthly reporting. Customer service issues with defective product(s) resolved through replacement of defective product(s). Monthly scorecards reflect individual and group (agency) efforts in production.
WRAP Baseload including Master-Metered Multifamily	CMC (the ICSP)	528	418	58	Missed opportunity and professional improvement plan created through targeted inspections (clients without Tier II installations, excessive nightlight installations, lower production from a cost per job perspective) and monthly reporting. Customer service issues with defective product(s) resolved through replacement of defective product(s). Monthly scorecards reflect individual and group (agency) efforts in production.

Program	Inspection Firm	Inspections Conducted		Sites with Discrepancies from Reported Values	Summary of Common Discrepancies
		In Person	Virtual		
WRAP Low Cost including Master-Metered Multifamily	CMC (the ICSP)	239	439	54	Missed opportunity and professional improvement plan created through targeted inspections (clients with an electric water heater without any water-saving equipment installed) and monthly reporting. Customer service issues with defective product(s) resolved through replacement of defective product(s). Monthly scorecards reflect individual and group (agency) efforts in production.
WRAP Full Cost including Master-Metered Multifamily	CMC (the ICSP)	0	0	0	No full-cost jobs in PY11.

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 PY11. 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 PY11. 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 PY11, by treatment and control groups, by wave, and as originally randomized and active at the beginning of treatment in PY11. The attrition process captures customers whose accounts closed (became inactive) since the launch of the program and accounts for any customers who stopped receiving home energy reports.

Table C-1. PY11 Customer Attrition

Wave	Originally Randomized		Active at the Beginning of Treatment in PY11 [1]	
	Treatment	Control	Treatment	Control
Legacy Wave 1	50,000	50,000	31,701	31,676
Legacy Wave 2	55,040	25,003	36,691	16,621
Expansion Wave 1	48,711	12,653	36,194	9,371
Low-Income Wave 1-Low-Income [2]	73,500	18,560	16,970	4,370
Low-Income Wave 1-Residential			25,371	6,483
Phase III Expansion Wave 1	30,584	12,234	24,859	9,996
Program Total	**257,835**	**118,450**	**171,786**	**78,517**

[1] Customers active at the beginning of treatment in PY11 were not necessarily included in the billing data analysis if they had insufficient billing data. Customers in the regression analysis were also not necessarily active at the beginning of PY11 and only contributed to the estimation of previous program year estimates.
[2] When Low-Income Wave 1 customers were randomized into treatment and control groups in 2014, all customers were verified low-income except for those whose low-income status changed in between randomization and program launch.

Billing Data

Cadmus collected customer billing data for each wave from PPL Electric Utilities to supplement the billing data it had collected and cleaned in previous program years. After reviewing the Statewide Evaluator's Act 129 Program Year 10 Report,[101] 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 PY11 analysis sample from data cleaning. The final modeling sample included customers in Cadmus' final tracking data who were not dropped during the data cleaning and were included in the billing analysis. These customers were not necessarily active at the beginning of treatment in PY11.

Table C-2. PY11 Sample Attrition from Data Cleaning

Step in Attrition	Legacy Wave 1		Legacy Wave 2		Expansion Wave 1	
	Treatment	Control	Treatment	Control	Treatment	Control
Originally Randomized Customers	50,000 (100%)	50,000 (100%)	55,040 (100%)	25,003 (100%)	48,711 (100%)	12,653 (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%)
Included in Billing Data	49,243 (98%)	49,233 (98%)	53,689 (98%)	24,408 (98%)	48,083 (99%)	12,491 (99%)
Non-missing Zip Code	49,036 (98%)	49,022 (98%)	53,540 (97%)	24,343 (97%)	47,968 (98%)	12,463 (98%)
At Least One Posttreatment Month	48,723 (97%)	48,714 (97%)	53,158 (97%)	24,145 (97%)	47,582 (98%)	12,372 (98%)
At Least 11 Pretreatment Months	47,814 (96%)	47,805 (96%)	50,375 (92%)	22,820 (91%)	47,178 (97%)	12,257 (97%)
Final Modeling Sample	**47,814 (96%)**	**47,805 (96%)**	**50,375 (92%)**	**22,820 (91%)**	**47,178 (97%)**	**12,257 (97%)**

[101] Pennsylvania Public Utility Commission. *SWE Annual Report Act 129 Program Year 10.* Prepared by NMR Group, Inc., Demand Side Analytics, LLC, Brightline Group, and EcoMetric Consulting, LLC. Final Report, February 19, 2020. http://www.puc.state.pa.us/Electric/pdf/Act129/Act129-SWE_AR_Y10_021920.pdf

Step in Attrition	Low-Income Wave 1 Low-Income [1]		Low-Income Wave 1 Residential [1]		Phase III Expansion Wave 1	
	Treatment	Control	Treatment	Control	Treatment	Control
Originally Randomized Customers	17,735 (100%)	4,574 (100%)	55,762 (100%)	13,985 (100%)	30,584 (100%)	12,234 (100%)
Assigned to Only One Wave and Group	17,735 (100%)	4,574 (100%)	55,762 (100%)	13,985 (100%)	30,584 (100%)	12,234 (100%)
Included in Billing Data	17,735 (100%)	4,574 (100%)	55,419 (99%)	13,892 (99%)	28,357 (93%)	11,356 (93%)
Non-missing Zip Code	17,734 (100%)	4,574 (100%)	55,115 (99%)	13,820 (99%)	28,323 (93%)	11,338 (93%)
At Least One Posttreatment Month	17,734 (100%)	4,574 (100%)	54,367 (97%)	13,619 (97%)	28,323 (93%)	11,338 (93%)
At Least 11 Pretreatment Months	17,577 (99%)	4,544 (99%)	53,703 (96%)	13,457 (96%)	27,022 (88%)	10,834 (89%)
Final Modeling Sample	**17,577 (99%)**	**4,544 (99%)**	**53,703 (96%)**	**13,457 (96%)**	**27,022 (88%)**	**10,834 (89%)**

[1] Three treatment accounts and one control account were assigned to multiple waves or groups in Low-Income Wave 1, but Cadmus could not determine their low-income status and so excluded them from the originally randomized customers in this table. Therefore, the total Low-Income Wave 1 treatment customers (73,497) and control customers (18,559) are lower than the count of customers originally randomized in Table C-1 (73,500 treatment customers and 18,560 control customers).

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 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 PY11 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. No statistically significant differences existed in the pretreatment consumption between treatment and control groups in these waves.

In PY11, Cadmus ran separate regression models for customers in the Low-Income Wave 1, depending on if the customer was still at or below the 150% federal poverty level, because PPL Electric Utilities wanted to claim low-income savings for these customers and had identified these customers in both the treatment and control groups. Within both the low-income and residential customers in the Low-Income Wave 1, Cadmus found statistical differences in the annual pretreatment consumption between

treatment and control groups, as shown in Table C-3. Cadmus ran models that controlled for these pretreatment differences.

Table C-3. PY11 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	18,527	18,460	66.4	0.144
Legacy Wave 2	50,375	22,820	27,647	27,761	113.67	0.114
Expansion Wave 1	47,178	12,257	23,199	23,189	9.73	0.858
Low-Income Wave 1-Low-Income	17,577	4,544	13,240	13,434	194.31	0.099
Low-Income Wave 1-Residential	53,703	13,457	11,366	11,219	147.44	0.020
Phase III Expansion Wave 1	27,022	10,834	15,174	15,170	3.55	0.942

[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,[102] and the approach described in the Uniform Methods Project.[103,104] Methods also followed those described in the Phase III Evaluation Framework for behavioral programs.[105]

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[102] 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/

[103] 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

[104] 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

[105] 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.

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.[106] 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 PY11, 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 homes to treatment and control groups, and therefore ordinary least squares should result in an unbiased estimate of the average daily savings per customer. Cadmus clustered the standard errors on customers to account for arbitrary correlation in customer consumption over the analysis period.

The following sections provide additional details about each modeling approach.

Post-Only Model

The post-only model was specified assuming the average daily consumption (ADC_{it}) of electricity of customer 'i' in month 't' as given by Equation C-1.

Equation C-1

$$ADC_{it} = \beta_1 PART_i * PY_t + \beta_2 Pre\text{-}Usage_i + \beta_3 Pre\text{-}Summer_i + \beta_4 Pre\text{-}Winter_i + \beta_5 Pre\text{-}Usage_i \times \tau_t + \beta_6 Pre\text{-}Summer_i \times \tau_t + \beta_7 Pre\text{-}Winter_i \times \tau_t + W'\gamma + \tau_t + \varepsilon_{it}$$

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).

[106] Allcott, H., and T. Rogers. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review* 104 (10), 3003-3037. 2014.

β_2 = Coefficient representing the conditional average effect of 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 = Average energy use in month 't reflecting unobservable factors specific to the month. The analysis controls for these effects with month-by-year fixed effects.

β_5 = Coefficient representing the conditional average effect of 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	=	Average energy use in customer 'i' reflecting unobservable, non-weather-sensitive, and time-invariant factors specific to the customer. The analysis controlled for these effects with customer fixed effects.
τ_t	=	Average energy use in month 't' reflecting unobservable factors specific to the month. The analysis controlled for these effects with month-by-year fixed effects.
ϵ_{it}	=	Error term for customer 'i' in month 't'

Ex Post *Verified Savings across Time*

Figure C-1 through Figure C-7 provide the percentage daily savings across time for each pre- and posttreatment month through PY11. 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 reported post-only model specifications. The post-only monthly savings trend closely to the D-in-D fixed effects monthly savings, and they remain within the D-in-D fixed effects confidence interval across months and waves. This suggests that the savings estimated by each model specification are not significantly different. It also suggests that savings are robust and not dependent on the model specification (pre-post versus D-in-D fixed effects). For every wave, the confidence interval in the pretreatment period contains zero. This suggests that treatment and control groups had equivalent consumption prior to treatment, consistent with the random assignment to treatment.

Cadmus specified both the D-in-D fixed effects and post-only models with month and year fixed effects. To avoid linear dependency in the regressors, Cadmus dropped one month and year from each model specification. In the D-in-D fixed effects model specifications, Cadmus dropped the last month prior to treatment, which explains the gap in monthly savings in each figure for this month. Similarly, Cadmus dropped the first month of treatment in the post-only model specifications (since the post-only analyses did not include pretreatment bills).

Figure C-1 shows steady savings across months in PY11 for Legacy Wave 1. A slight upward trend is observed for Legacy Wave 1 that began after the Phase II ICSP resumed treatment in October 2014 and that persisted throughout Phase II. Legacy Wave 1 savings appear consistent through Phase III.

Figure C-1. Percentage Monthly Savings across Time: Legacy Wave 1

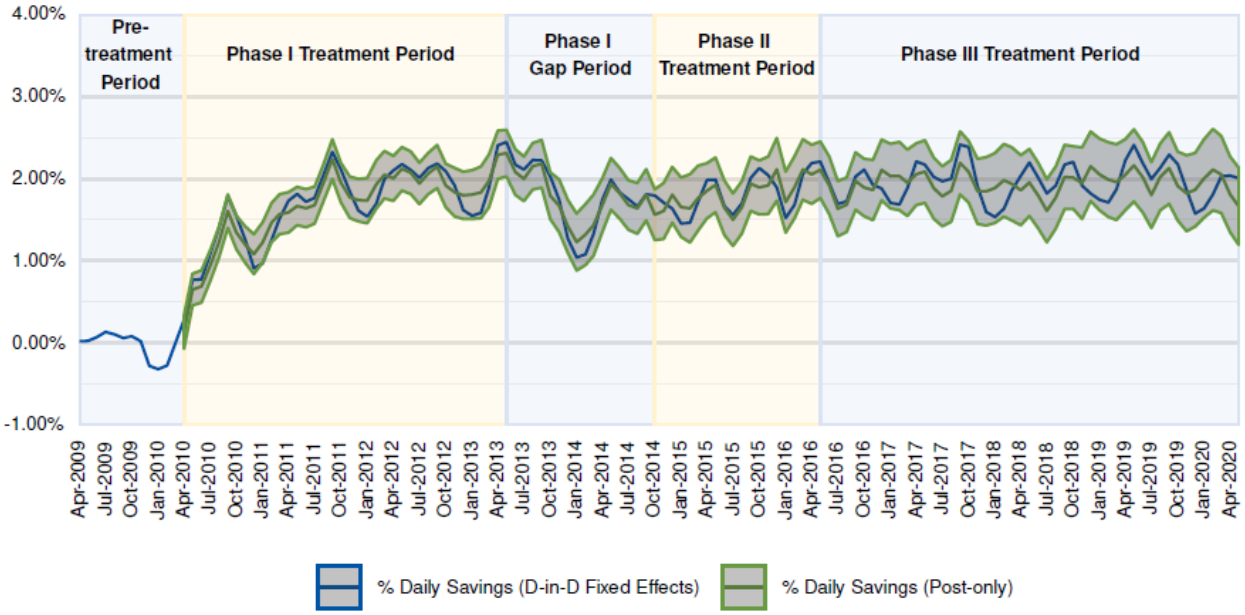


Figure C-2 and Figure C-3 show that month-to-month savings in Legacy Wave 2 and Expansion Wave 1 are more variable than in Legacy Wave 1, and these savings may have declined in Phase III from Phase II. Savings for Legacy Wave 2 customers appear to be steadily degrading over Phase III months, which could reflect savings fatigue or an increasingly efficient control group. Expansion Wave 1 savings appeared to also degrade in Phase III, but could be slightly rebounding. Monthly savings reflect actual weather, though, so small changes in savings from year to year may not be related to the program.

Figure C-2. Percentage Monthly Savings across Time: Legacy Wave 2

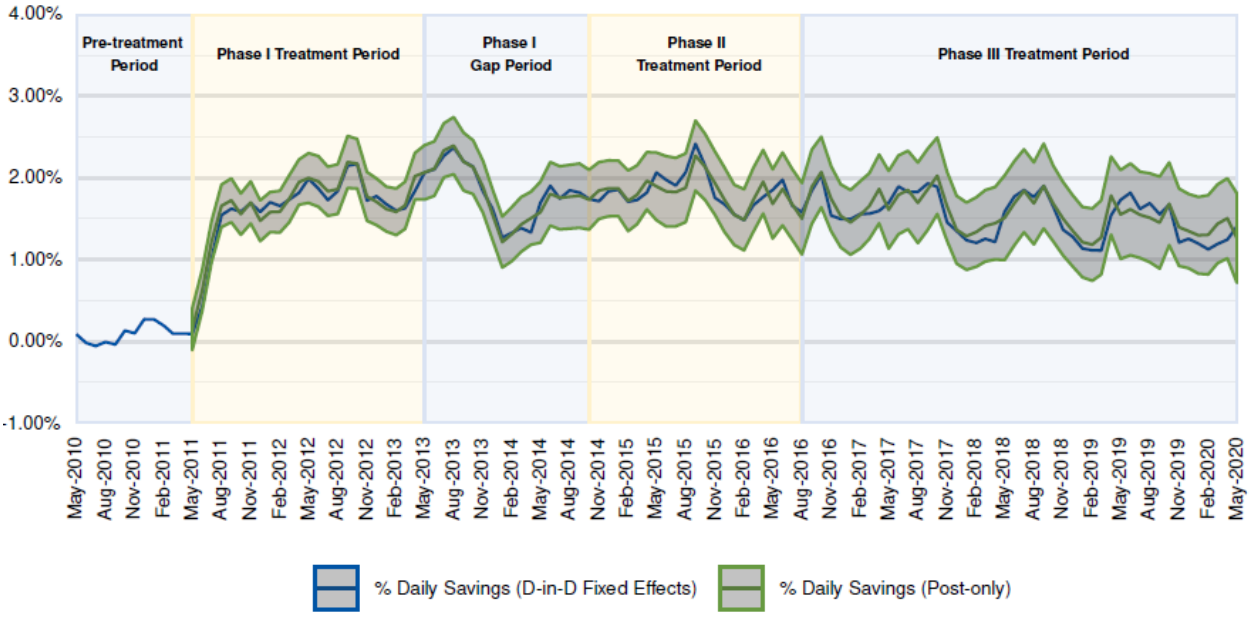


Figure C-3. Percentage Monthly Savings across Time: Expansion Wave 1

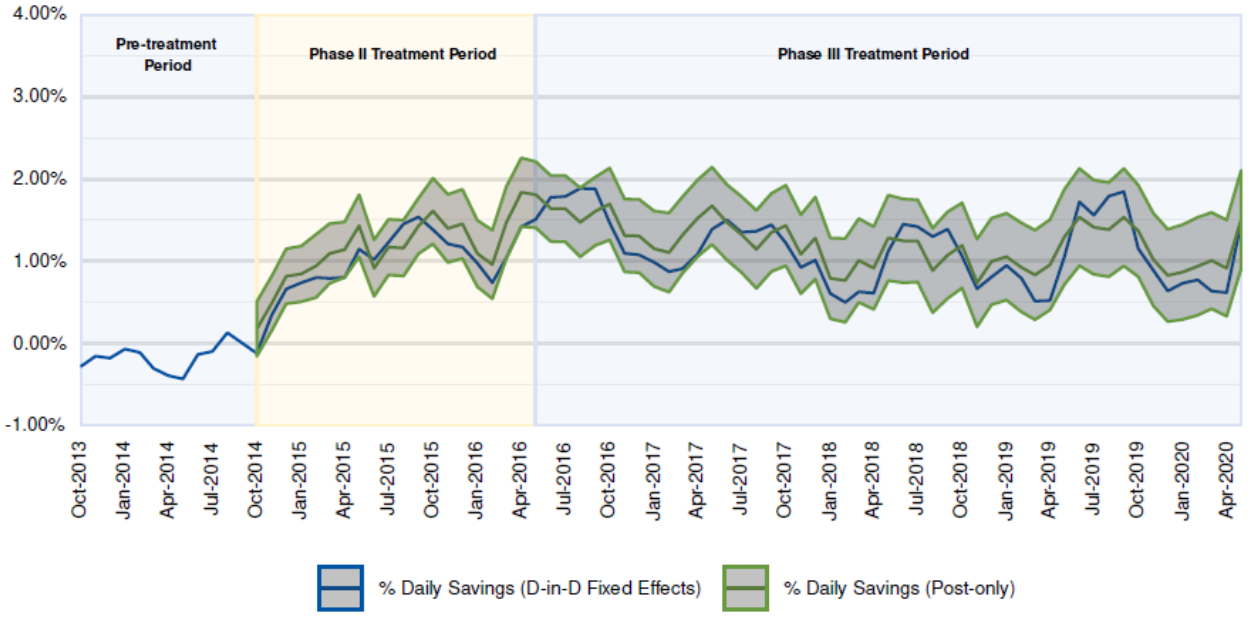


Figure C-4 and Figure C-5 show month-by-month savings for low-income and residential customers in the Low-Income Wave 1, respectively. Because there are few low-income control customers in the Low-Income Wave 1, average savings estimated for the low-income group are volatile and often include 0% savings in their 90% confidence intervals. Residential customers in the Low-Income Wave 1, however, appeared to maintain the high savings Cadmus found for all customers in this wave in PY10.

Figure C-4. Percentage Monthly Savings across Time: Low-Income Wave 1-Low-Income

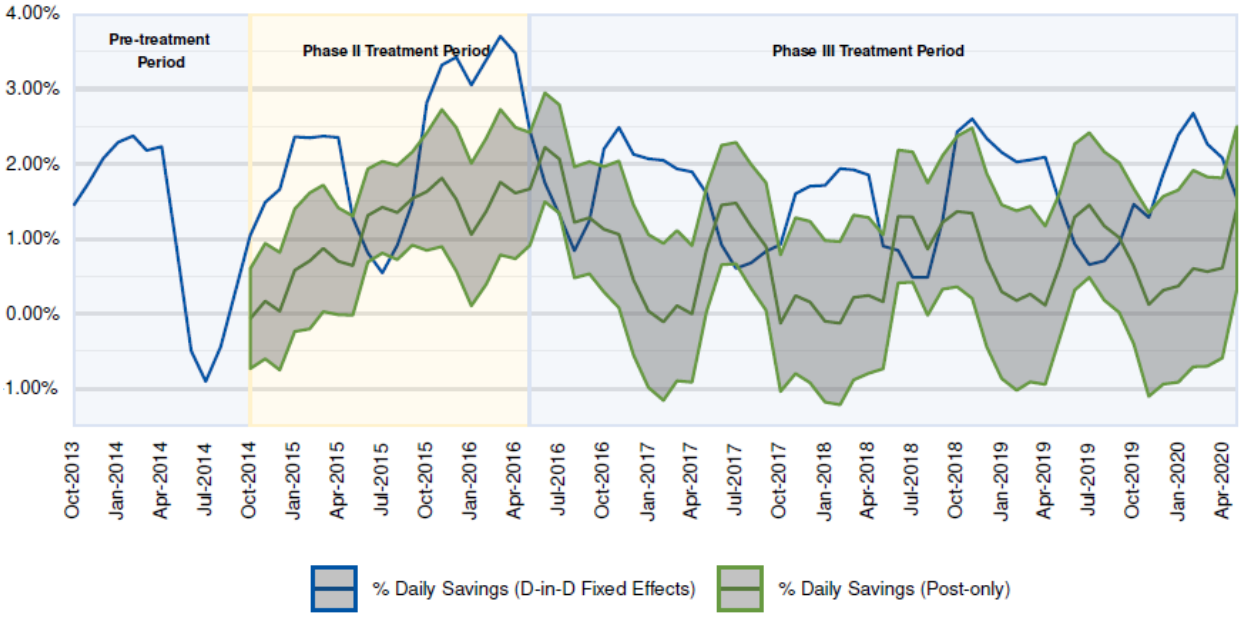


Figure C-5. Percentage Monthly Savings across Time: Low-Income Wave 1-Residential

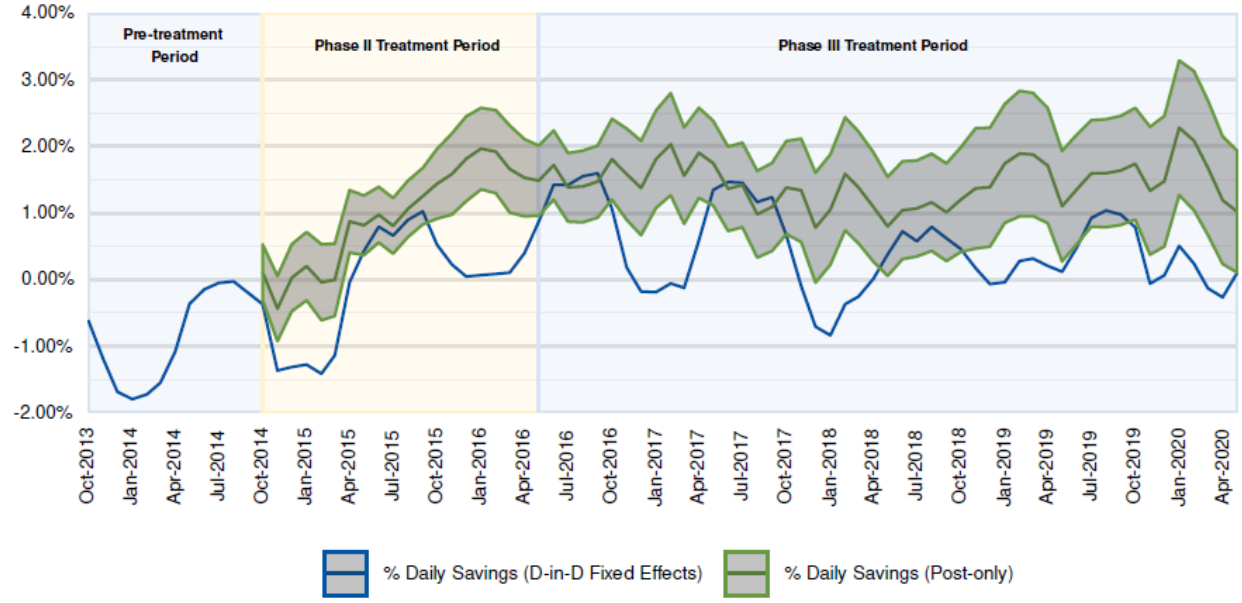
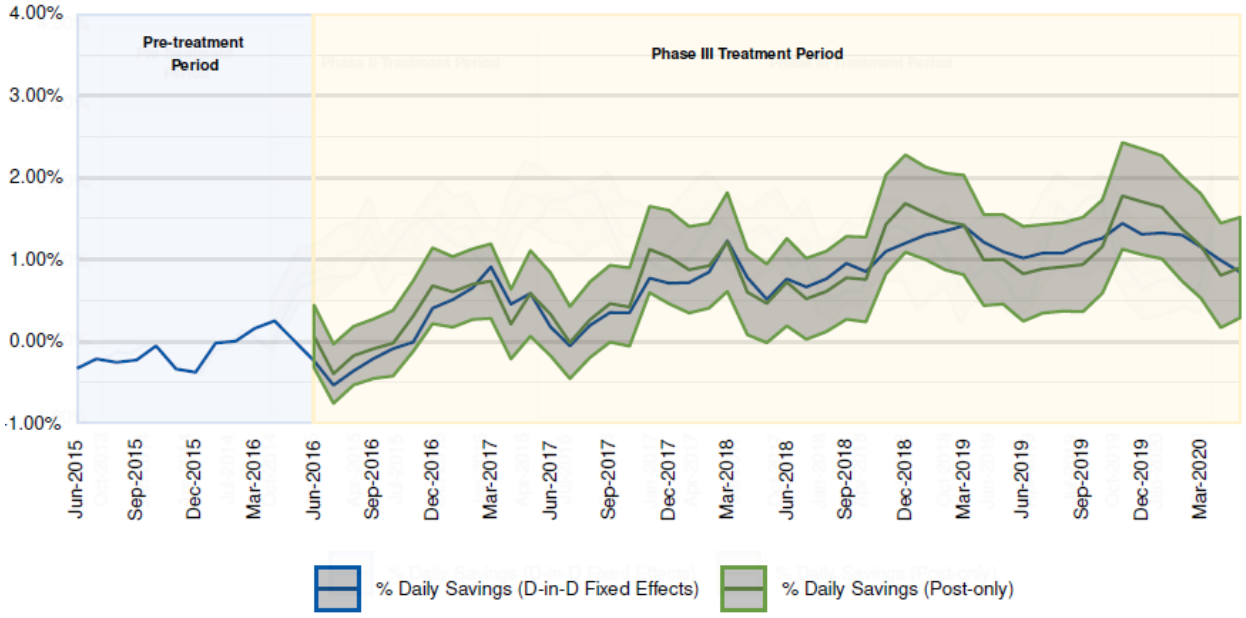


Figure C-6 shows the percentage daily savings by month for the Phase III Expansion Wave. The monthly percentage daily savings have increased since treatment began but may have reached a steady state. Cadmus found similar savings in PY11 as found in PY10.

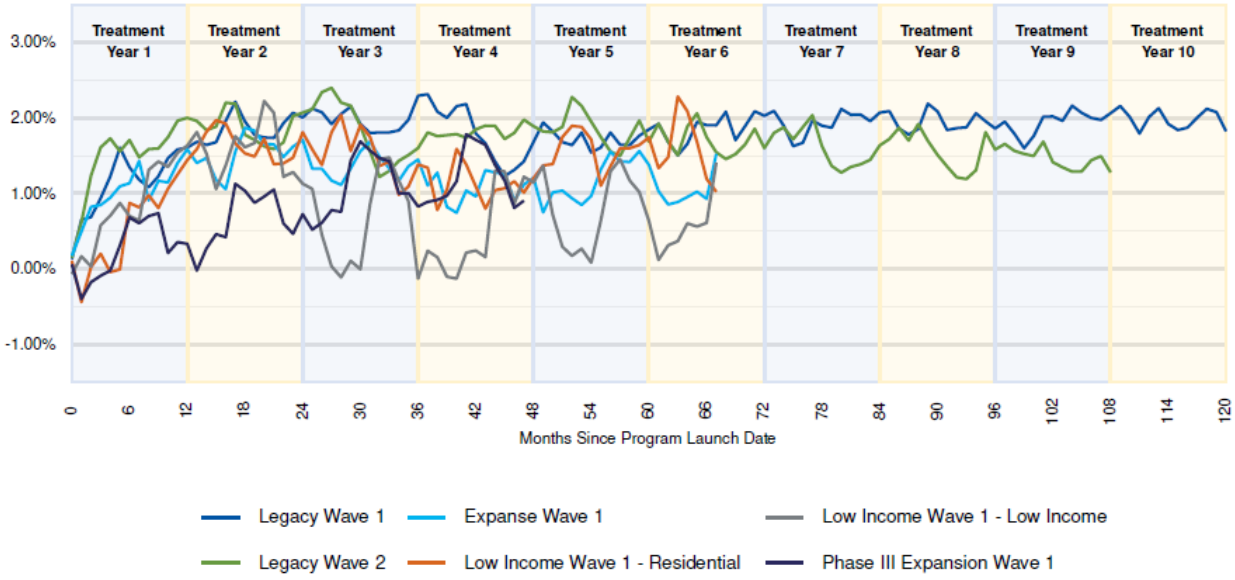
Figure C-6. Percentage Monthly Savings across Time: Phase III Expansion Wave 1



To compare how savings trended since treatment started across waves, Figure C-7 shows percentage daily savings by the number of months since first treatment for each wave. In the first year of treatment, savings peaked between 1% and 2% for each wave (excepting the Phase III Expansion Wave). Legacy Wave 1 and Legacy Wave 2 savings ramped up quicker than other waves in their first year of treatment, and they continue to generate the highest savings. Expansion Wave 1 and Low-Income Wave 1 ramped up at similar rates and both show slight decreases in savings the last two years.

The Phase III Expansion Wave ramped up more inconsistently than the other waves, but is now saving at a similar rate as other waves. Again, savings reflect changes in weather, which can explain some differences in savings by months of treatment.

Figure C-7. Percentage Average Monthly Savings from First Month of Treatment



Demand Reduction Evaluation Methodology

Cadmus did not evaluate demand reductions using hourly data in PY11. Instead, it converted each wave's PY11 average energy savings into demand reductions using the ratio of average peak demand savings per customer to the average energy savings per hour per customer from the PY4 evaluation. Across Legacy Wave 1 and Legacy Wave 2, Cadmus estimated average per-customer demand reductions of 0.041 kWh/hr and 0.056 kWh/hr for each wave, or 193% and 108% of each wave's average per-customer energy savings per hour, respectively. Cadmus used the weighted average of these ratios (148%) to convert PY11 program energy savings into demand reductions, assuming ratios stayed constant through time, and allowing demand reductions to be scaled by energy savings observed in PY11.

Note that the definition of peak demand changed between PY4 and PY11. In PY4, peak demand was calculated for the top 100 hours of PPL Electric Utilities' system demand. In PY11, peak hours are defined as hours with day-ahead forecasts for the PJM market that are 95% or more of the PJM peak summer forecast.

C.2 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 PY11, some customers who installed efficiency 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 PY11. 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.

C.2.1 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 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 receive the same marketing and are eligible for incentives from the utility for Product A. The impact of home energy reports on the 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 tracking data for energy efficiency program participation in PPL Electric Utilities' tracking database, starting in the month when treatment began through to the end of PY11.[107]

From PY2 through PY11, Home Energy Education Program treatment and control customers participated in nine downstream PPL Electric Utilities rebate programs. These were the Appliance Recycling Program, Energy Efficiency Kits and Education Program,[108] Energy Efficient Home Program, Low-Income WRAP, Renewable Energy Program, Residential Energy Assessment and Weatherization Program, Residential Home Comfort Program, and Residential Retail Program (equipment component).

[107] 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.

[108] Formerly named the E-Power Wise Program.

C.2.2 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 PY11, 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-4 shows participation uplift results for PY11. Phase III Expansion Wave customers had the greatest participation uplift compared to the other waves—on average, treatment customers in this wave participated in other PPL Electric Utilities programs at a rate 16% greater than control customers. It is important to note that these values are not cumulative across each waves' existence. These values reflect only customers' cross-program participation starting in PY11.

Table C-4. PY11 Home Energy Education Participation Uplift Summary

Wave	Control Group Participation Rate (per 1,000 Customers)	Participation Uplift (Treatment Effect on Participation Rate per 1,000 customers)	Percentage Participation Uplift
Legacy Wave 1	25	0.52	2%
Legacy Wave 2	30	2.74	9%
Expansion Wave 1	28	-0.73	-3%
Low-Income Wave 1 – Low-Income	62	0.32	1%
Low-Income Wave 1 - Residential	41	-1.31	-3%
Phase III Expansion Wave	27	4.45	16%
Program Total	**30**	**3.80**	**13%**

C.2.3 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,[109] 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

[109] 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 PY11. 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 PY11
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 PY11 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-5 and Table C-6 show energy and demand savings uplift results for PY11 resulting from PPL Electric Utilities' downstream programs. The home energy reports increased energy and demand savings in other downstream programs by 3,054 MWh/yr and 0.44 MW/yr, about 8% and 7% of program total energy and demand savings.

Table C-5. PY11 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	335	321	14	452	5%
Legacy Wave 2	392	354	38	1,386	12%
Expansion Wave 1	208	201	7	250	3%
Low-Income Wave 1 – Low-Income	459	437	21	361	24%
Low-Income Wave 1 – Residential	97	90	7	175	7%
Phase III Expansion Wave 1	158	140	17	431	10%
Program Total [(1)]	**N/A**	**N/A**	**N/A**	**3,054**	**8%**

[(1)] May not match due to rounding.

Table C-6. PY11 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	0.061	0.060	0.002	0.049	3%
Legacy Wave 2	0.062	0.058	0.004	0.147	7%
Expansion Wave 1	0.033	0.030	0.003	0.108	8%
Low-Income Wave 1 – Low-Income	0.058	0.054	0.003	0.056	22%
Low-Income Wave 1 – Residential	0.021	0.019	0.002	0.051	12%
Phase III Expansion Wave 1	0.024	0.022	0.001	0.034	4%
Program Total (1)	**N/A**	**N/A**	**N/A**	**0.444**	**7%**

(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-7 and Table C-8.[110]

Table C-7. 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	9,393	10	3.00%	281.78
Legacy Wave 2	10,765	9	3.00%	322.95
Expansion Wave 1	7,876	5.5	3.00%	236.27
Low-Income Wave 1 – Low-Income	1,203	5.5	3.00%	36.10
Low-Income Wave 1 - Residential	2,343	5	3.00%	70.30
Phase III Expansion Wave 1	4,153	4	3.00%	124.59
Program Total (2)	**35,733**	**N/A**	**N/A**	**1,072**

(1) Savings are adjusted to remove downstream uplift.
(2) Total may not sum to all rows due to rounding.

[110] 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-8. 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	1.61	10	3.00%	0.05
Legacy Wave 2	1.91	9	3.00%	0.06
Expansion Wave 1	1.27	5.5	3.00%	0.04
Low-Income Wave 1 – Low-Income	0.21	5.5	3.00%	0.01
Low-Income Wave 1 - Residential	0.37	5	3.00%	0.01
Phase III Expansion Wave 1	0.74	4	3.00%	0.02
Program Total [2]	**6.11**	**N/A**	**N/A**	**0.18**

[1] Savings were adjusted to remove downstream uplift.
[2] Total may not sum to all rows due to rounding.

Cadmus deducted an additional 1,305 MWh/yr and 0.14 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 Program. PPL Electric Utilities claimed savings from these bulbs in PY7. Cadmus deducted these savings from the residential sector because the savings were counted in the residential Home Energy Education program in PY11.

Appendix D. PY11 and P3TD Summary by Customer Segment and Carveout

Table D-1. PY11 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	9,745	43,120	-	-	126	434	-	14	74	314	9,945	43,883
	Efficient Lighting	42,190	345,807	-	-	6,149	80,945	-	-	-	-	48,339	426,752
	Energy Efficient Home	16,756	62,586	-	-	165	497	0	6	7	247	16,929	63,336
	Home Energy Education	37,223	150,610	1,564	1,564	-	-	-	-	-	-	38,787	152,174
	Student Energy Efficient Education	2,429	15,868	3,729	6,863	-	-	-	-	-	-	6,158	22,731
	Residential Program Total [3]	**108,343**	**617,991**	**5,293**	**8,427**	**6,440**	**81,877**	**0**	**21**	**82**	**561**	**120,158**	**708,876**
	Low-Income Compliance Total [1] [3]	**-**	**-**	**5,293**	**8,427**	**-**	**-**	**-**	**-**	**-**	**-**	**5,293**	**8,427**
	GNE Compliance Total [2] [3]	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**82**	**561**	**82**	**561**
Low-Income	Energy Efficiency Kits and Education	-	-	10,888	41,240	-	-	-	-			10,888	41,240
	WRAP	-	-	13,512	47,027	42	483	-	-	211	2,426	13,764	49,937
	Low-Income Program Total [3]			**24,399**	**88,267**	**42**	**483**			**211**	**2,426**	**24,652**	**91,177**
	Low-Income Compliance Total [1] [3]	**-**	**-**	**24,399**	**88,267**	**42**	**483**	**-**	**-**	**211**	**2,426**	**24,652**	**91,177**
	GNE Compliance Total [2] [3]	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

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
Non-Residential	Custom	-	662	-	-	5,818	24,975	23,273	105,752	47,976	110,183	77,068	241,572
	Demand Response	-	-	-	-	-	-	-	-	-	-	-	0
	Efficient Equipment	493	1,508	-	-	92,546	257,005	36,212	143,112	23,624	76,495	152,875	478,120
	CEI	--	-	-	-	-	-	-	-	-	1,190	-	1,190
	Non-Residential Program Total [3]	**493**	**2,170**			**98,364**	**281,980**	**59,485**	**248,864**	**71,600**	**187,868**	**229,943**	**720,882**
	Low-Income Compliance Total [1] [3]	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	GNE Compliance Total [2] [3]	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**71,600**	**187,868**	**71,600**	**187,868**
Portfolio Total	**Low-Income Compliance Total [1] [3]**	**-**	**-**	**29,692**	**96,694**	**42**	**483**	**-**	**-**	**211**	**2,426**	**29,945**	**99,604**
	GNE Compliance Total [2] [3]	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**71,681**	**188,429**	**71,681**	**188,429**
	Portfolio Compliance Total [3]	**108,837**	**620,160**	**29,692**	**96,694**	**104,846**	**364,340**	**59,485**	**248,885**	**71,893**	**190,856**	**374,752**	**1,520,935**
Adjustment for Residential Energy-Efficiency Behavior & Education Double-Counted Savings												**-5,431**	**-21,964**
Adjusted Total [3]												**369,322**	**1,498,971**

[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 D-2. PY11 and P3TD Demand Reduction Savings Summary

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	1.80	6.77	-	-	0.02	0.06	-	0.003	0.01	0.04	1.82	6.87
	Efficient Lighting	4.86	39.86	-	-	1.35	16.97	-	-	-	-	6.21	56.83
	Energy Efficient Home	2.54	10.87	-	-	0.03	0.09	0.0001	0.001	0.004	0.09	2.57	11.05
	Home Energy Education	6.29	26.38	0.26	0.26	-	-	-	-	-	-	6.55	26.64
	Student Energy Efficient Education	0.25	1.66	0.39	0.71	-	-	-	-	-	-	0.64	2.37
	Residential Program Total [1]	**15.74**	**85.53**	**0.65**	**0.98**	**1.40**	**17.12**	**0.0001**	**0.004**	**0.01**	**0.13**	**17.80**	**103.77**
Low-Income	Energy Efficiency Kits and Education	-	-	1.20	4.13	-	-	-	-	-	-	1.20	4.13
	WRAP	-	-	1.38	4.96	0.004	0.04	-	-	0.02	0.22	1.40	5.22
	Low-Income Program Total [1]	**-**	**-**	**2.58**	**9.08**	**0.004**	**0.04**	**-**	**-**	**0.02**	**0.22**	**2.60**	**9.34**
Non-Residential	Custom	-	0.02	-	-	0.86	3.00	2.31	12.09	5.96	14.77	9.14	29.88
	Demand Response	-	-	-	-	1.63	1.55	96.71	106.34	5.91	4.89	104.26	112.78
	Efficient Equipment	0.07	0.24	-	-	12.12	36.67	4.67	19.36	3.63	11.97	20.49	68.24
	CEI	--	-	-	-	-	-	-	-	-	0.60	-	0.60
	Non-Residential Program Total [1]	**0.07**	**0.26**	**-**	**-**	**14.61**	**41.21**	**103.69**	**137.80**	**15.51**	**32.23**	**133.89**	**211.50**
Total [1]		**15.81**	**85.80**	**3.23**	**10.06**	**16.01**	**58.38**	**103.69**	**137.80**	**15.54**	**32.58**	**154.29**	**324.61**
Adjustment for Residential Energy-Efficiency Behavior & Education Double-Counted Savings												**-0.77**	**-2.45**
Adjusted Total [1]												**153.52**	**322.17**

[1] Totals may not sum due to rounding.

Appendix E. Evaluation Detail – Efficient Equipment Program

E.1 Lighting

E.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.[111] The PY11 evaluation sampling plan was designed to meet 90% confidence and ±10% precision (90/10) for the lighting stratum because lighting is a high-impact measure, contributing 53% of savings to the Non-Residential Program and 33% 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.[112]

Table E-1 shows the PY11 sampling plan by quarter for a final sample size of 43 projects.

Table E-1. PY11 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	305	90/10	N/A	16	In-person and virtual site visits and desk reviews
Q2	228			12	
Q3	214			13	
Q4	245			2	
Total	992	90/10	34	43	

[(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*.[113] Cadmus determined the number of sample points,

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111 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.

112 Table 1-2 in the PA TRM defines the thresholds for end-use categories that must be reviewed with enhanced levels of rigor.

113 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.[114]

Table E-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 PY11, 23 of the 43 projects in the final verification sample were threshold lighting projects. This led to a larger evaluation sample than originally planned.

Table E-2. PY11 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	67,939	626	90,086	1,227	124,802	662	56,055	1,056
Medium	242,353	69,498	293,654	92,769	505,763	131,944	159,310	56,839
Large	743,556	250,831	608,335	300,449	748,437	589,019	682,735	177,725
Threshold	2,519,501	750,000	4,495,656	750,000	10,342,036	750,000	1,097,483	750,000

The PY11 lighting projects were post-stratified at the end of the program year into the final substrata shown in Table E-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 E-3. PY11 Efficient Equipment Program Lighting Post-Stratification

Substratum	kWh/yr High	kWh/yr Low	Reported Participants [(1)]	Reported Savings (MWh/yr)	Percentage Reported Savings
Small	66,462	0	683	14,625	12%
Medium	246,658	66,625	196	24,966	21%
Large	748,437	250,831	90	36,782	31%
Threshold	N/A	750,000	23	42,580	36%
Total [(2)]	**N/A**	**N/A**	**992**	**118,953**	**100%**

[(1)] Defined by unique job number.
[(2)] Total may not match sum of rows due to rounding.

E.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.

[114] 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.

E.1.3 Site Visit and Desk Review Findings – Lighting

Cadmus conducted in-person and virtual site visits and desk reviews for 43 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 desk reviews for the census of 23 threshold lighting projects. 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 23 threshold lighting projects, Cadmus conducted 21 desk reviews and two in-person or virtual site visits. Across the remaining strata, Cadmus conducted three desk reviews and 17 in-person or 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,[115] Cadmus selected and inspected a sample using 90/20 criteria for confidence and precision, according to the Phase III Evaluation Framework.[116] 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 had the largest impact on verified savings across the 43 projects. The magnitude of impact from the remaining adjustments for lighting verified savings was minimal.

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[115] 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.

[116] Sampling to meet 90/20 within a facility is based on section 3.3.3.2.3 in the *Evaluation Framework for Phase III of the Act 129 Energy Efficiency and Conservation Program.* Pennsylvania Public Utility Commission. October 21, 2016.

E.2 Equipment

E.2.1 Impact Evaluation Sampling Approach - Equipment

In PY11, 43 unique customers (billing accounts) completed 44 projects. Cadmus evaluated all sampled equipment projects with a basic level of rigor, according to the Phase III Evaluation Framework.[117]

The PY11 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 whether additional rebated equipment had been installed.

Cadmus reviewed the sample of 17 project records, which involved verifying information from PPL Electric Utilities' tracking database using rebate applications, customer-submitted supporting documentation, and information recorded by the ICSP to calculate energy savings.

In PY11, Cadmus conducted 10 site visits and seven desk reviews to verify 17 sampled projects.

Table E-4 presents annual population and sample sizes by substrata.

Table E-4. PY11 Efficient Equipment Program Equipment Sampling Strategy

Substratum	Population Size [(1)]	Target Levels of Confidence & Precision	Target Sample Size	Achieved Sample Size	Evaluation Activity
Agriculture	1	N/A [(2)]	N/A [(2)]	1	Desk review
HVAC	26			7	In-person or virtual site visit, desk review[(3)]
Motors	4			2	In-person or virtual site visit
Refrigeration	13			7	In-person or virtual site visit, desk review [(4)]
Equipment Total	**44**	**85/15**	**17**	**17**	

[(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 a desk review and customer inputs and the remaining through site visits.
[(4)] Cadmus verified five Refrigeration projects through a desk review and customer inputs and the remaining through site visits.

E.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

[117] 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.

and in-person and virtual site visits. Cadmus verified eligibility and installation rates for all sampled records.

E.2.3 Site Visit and Desk Review Findings – Equipment

Cadmus completed in-person or virtual site visits and desk reviews for 17 unique customers who received rebates for 17 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:

- Facility type
- Equipment quantity
- Equipment efficiency
- Baseline control type
- Equipment capacity

Overall, the factors that had the greatest impact on verified savings across the 17 projects were the equipment capacity and in-service rates, followed by reported facility type and equipment efficiency.

E.3 Net-to-Gross Ratio Sampling and Findings for Lighting and Equipment

Table E-5 lists the sampling strategy for the lighting and equipment strata.

Table E-5. PY11 Efficient Equipment Program Lighting and Equipment Stratum Sampling Strategy for Net Savings Research

Stratum	Stratum Boundaries	Population Size [1]	Assumed Cv or Proportion in Sample Design	Assumed Levels of Confidence & Precision	Target Sample size	Number of Records Selected for Sample Frame	Achieved Sample Size	Percent of Sample Frame Contacted to Achieve Sample [2]
Equipment	Equipment projects	44	0.5	85/15	69	23	14	100%
Lighting [3]	Lighting projects	992 [4]	0.5	85/15		469	62 [5]	100%
Total		**1,036**	**-**	**-**	**69**	**492**	**76**	**100%**

[1] Population refers to number of paid projects in PY11.
[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 combined.
[4] Combined population of prescriptive lighting and direct discount lighting participants.
[5] Four respondents did not respond to free ridership questions and are not included in the NTG analysis.

E.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 E-6 summarizes the intention, influence, and free ridership scores for each stratum. The savings weighted intention score found 31% of the equipment savings and 20% of the lighting stratum savings could be

classified as free ridership. The savings-weighted average influence scores showed 13% of the equipment stratum savings and 3% of the lighting stratum savings could be classified as free ridership.

Table E-6. Efficient Equipment Program
Intention, Influence, and Free Ridership Score by Stratum

Stratum	Number of Respondents	Intention Score	Influence Score	Free Ridership Score
Equipment	14	31%	13%	44%
Lighting	62	20%	3%	23%

E.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, five purchased additional energy-efficient lighting, one purchased HVAC equipment, one purchased variable speed pool filters, and one purchased glass window tinting for a whole building 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.

E.3.3 Net-to-Gross

Table E-7 shows the NTG ratio results for the equipment and lighting strata of the Efficient Equipment Program.

Table E-7. PY11 Efficient Equipment Program NTG Ratio Summary

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision
Equipment	14	44%	0%	0.56	29% [1]
Lighting	62	23%	0%	0.77	11% [2]

[1] At 85% confidence interval.
[2] At 90% confidence interval.

E.4 Survey Participant Profile

Cadmus reviewed PPL Electric Utilities' tracking database and developed a profile of the 1,036 unique Efficient Equipment Program participants. Table E-8 shows the survey population and total participant population by sector.

Table E-8. Total and Survey Population by Sector

Sector	Total Population (n=1,036)	Lighting Population (n=992)	Equipment Population (n=44)	Survey Respondents (n=80)
Large C&I	9%	9%	9%	16%
Small C&I	81%	81%	73%	69%
GNE	11%	10%	16%	15%
Residential	<1%	<1%	2%	0%
Source: PPL Electric Utilities' tracking database; may not total 100% due to rounding.				

Almost half of the survey respondents (49%; n=79) had participated in the Efficient Equipment Program prior to PY11, and of these 39 respondents, 69% said they worked with a contractor, vendor, or distributor for their project. Additionally, 55% of respondents said they did not know about the PPL Electric Utilities' rebate before interacting with their ESCO, contractor, vendor, or other consultant (n=77).

E.4.1 Survey Sample Attrition

After removing records from the participant population for the reasons cited in Table E-9, a census of participants were first invited to complete the survey via email. Respondents who did not complete the survey online were then contacted by telephone to complete the survey. Table E-9 lists the total records used for surveys and the outcome (final disposition) of each record.

Table E-9. Efficient Equipment Program Participant Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Online	
Population (number of unique jobs)	**1,036**
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	**544**
Removed: incomplete or invalid email address	**0**
Survey Sample Frame (email invitations sent)	**492**
Email was returned (bounce back), did not respond, or opted-out	18
PPL Electric Utilities or market research employee	4
Cannot confirm project location	1
Did not complete survey	440
Completed Surveys	**29**
Online Response Rate	**6%**
Telephone	
Population (number of unique jobs)	**492**
Removed: Respondents who completed the survey online, partially completed the survey online, or could not confirm project location.	51
Survey Sample Frame (used for telephone survey calls)	**441**
Not attempted [(1)]	**182**
Records Attempted	259
Not reached: No answer, answering machine, phone busy, refused	208
Screened out: Cannot confirm equipment/not aware of participation, employment, ESCO	0
Partial complete (not included in survey findings analysis)	0
Completed Surveys	**51**
Telephone Response Rate	**12%**
Total Completed Surveys (total for all modes)	**80**
Overall Response Rate	**16%**

[(1)] All equipment records were exhausted but the overall program survey target was reached before all lighting records were needed.

Appendix F. Evaluation Detail – Midstream Lighting Program

F.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 PY11.

Table F-1 provides the definitions, population, and sample sizes for all strata.

Table F-1. PY11 Midstream Lighting Impact Evaluation Stratum Definitions and Sample Sizes

Stratum	Reported Annual Energy Savings (kWh)	Population Size [1]	Sample Size
Midstream Lighting – Small	853	3,270	3
Midstream Lighting -- Medium	854 - 3,407	2,703	6
Midstream Lighting -- Medium-Large	3,408 - 5,622	775	4
Midstream Lighting – Large	> 5,622	1,175	18
Midstream Lighting – Convenience Sample [2]	N/A	2	2
Midstream Lighting -- PY9 Return[2]	N/A	1	1
Midstream Lighting Program Total [3]	**N/A**	**7,926**	**34**

[1] Population size in this table refers to the number of unique job numbers in each stratum. In PY11, there were 7,926 job numbers in PPL Electric Utilities' tracking database corresponding to 6,702 unique combinations of distributor invoice numbers and account numbers.
[2] This stratum was not limited by size of reported savings.
[3] May not match due to rounding.

F.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 Audit and Phone Interview

To calculate verified savings, Cadmus audited 25 projects and prepared a modified PA TRM Appendix C using information compiled during the records review and the phone verification interview. Cadmus used the desk audit phone survey instrument, 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.

A modified Appendix C lighting calculator tool was used for the desk audits that included columns to record the verified *in situ* baseline fixtures and their wattages, 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, using the methods detailed in the evaluation plan.

Site Visits

To calculate verified savings, Cadmus conducted two in-person site visits (comprised of five jobs, including two sibling jobs) and two virtual site visits (three jobs) for a total of eight jobs. Five of these jobs were verified in person and three jobs were verified through virtual site visits. Due to COVID-19 restrictions, on-site visits were not possible for projects sampled after Q2.

At the site of each sampled job, Cadmus reviewed additional sibling jobs associated with the site address for that program year. These additional jobs could be the same product as the sampled job, which could not be distinguished from the sampled record. The additional jobs could also be the same or different products at the site which could be distinguished from the sampled job.

During the 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 that has columns to record the observed *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. The list of jobs reviewed and verified during the site visit, including the sampled and sibling jobs, were included in the modified Appendix C. *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.

F.1.2 Verification Findings

In PY11, Cadmus conducted 24 site visit and desk audit verifications, for a total of 32 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 F-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 its sibling(s) and may be represented multiple times with the same savings adjustment type.

Table F-2. PY11 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	26	81%	Not typically known by ICSP, default is Unknown/Misc.
Hours of Use	26	81%	Based on facility type (or hours of use schedule verified during site visits).
Coincidence Factor	26	81%	Based on facility type.
Space Conditioning	19	59%	Not typically known by ICSP, verified during site visit or desk audit.
Baseline Lamp/Fixture Wattage	7	22%	Adjustments were all less than 1 watt due to rounding of reported IMP wattages.
Post-Install Lamp/Fixture Wattage	8	25%	Reported values differed from tested and verified wattages documented by the DesignLights Consortium (DLC). Half the adjustments were less than 1 watt due to rounding.
Fixture Control Type	10	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	5	16%	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%.
Pre-Install Lamp/Fixture Quantity	8	25%	Primarily due to de-lamping (fewer lamps installed than those replaced).
Total Number of Adjustments	**135**	N/A	

[1] Percentage of adjusted jobs is calculated based on the total of 32 sample job verifications.

F.2 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-3 summarizes the intention, influence, and free ridership.

The savings-weighted average intention score showed 29% of the end-user's verified kWh savings could be classified as free ridership. The savings weighted influence score found 9% of the end user's verified kWh savings could be classified as free ridership.

Table F-3. PY11 Midstream Lighting Intention, Influence, and Free Ridership Scores

Stratum	n	Intention Score	Influence Score	Free Ridership Score
Midstream Lighting	24	29%	9%	38%

Four of the 24 respondents accounted for 52% of the verified energy savings in the analysis sample and 33 percentage points of the overall 38% free ridership ratio.

Table F-4 shows the NTG ratio results for Midstream Lighting.

Table F-4. PY11 Midstream Lighting Component NTG Ratio

Stratum	n	Free Ridership (%)	Spillover (%)	NTG Ratio	Relative Precision at 90% C.L.
Midstream Lighting	24	38%	0%	0.62	38%

F.3 Process Details

F.3.1 Participant Profile

Distributors

The following is a summary of participating distributors Cadmus interviewed:

- Eight distributors reported a multistate presence, and their self-reported estimates of sales to customers in PPL Electric Utilities' service territory varied widely.
- Eight distributors said contractors or electricians made up the majority of their lighting sales.
- Two said sales between contractors/energy service companies and end users was relatively equal.
- One said sales between contractors and energy service companies was equal.
- Two said end-user purchasers made up 75% to 80% of their sales.
- Only one distributor said the firm sold a fair amount of lighting to residential customers.

Contractors

The following describes interviewed contractors who purchased Midstream Lighting products:

- Most had companies with 10 or fewer employees (6 of 7).
- Most served residential and commercial customers of various sizes (4 of 7) with the remaining three serving only commercial customers.
- Most provided both replacement lighting and managed maintenance repair operations (4 of 6).
- Most reported their clients keep very little lighting stock in storage, typically only a few bulbs (4 of 6).

End Users

The following describes interviewed end users who purchased Midstream Lighting products:

- Company sizes ranged from five employees to 20,000 employees.
- Most completed large scale replacements (16 of 23).
- Most kept less than 5% of their lighting stock in storage (14 of 17).

F.3.2 Survey Sample Attrition

In April through June 2020, Cadmus conducted telephone interviews with 14 distributors, 24 end users (17 purchasers and seven non-purchasers), and eight contractors (one was a partial complete).

Table F-5 lists total numbers of records and the outcome (final disposition) of each record.

Table F-5. PY11 Midstream Lighting Program Sample Attrition Table

Description of Call Outcomes	Number of Records		
	Distributors	Contractors	End Users
Telephone Interview			
Population (number of contact names) [1]	21	4,242 [2]	4,242 [2]
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	0	4,030	2,571
Interview Sample Frame (used for interview calls)	**21**	**212**	**1,671**
Not attempted	**0**	**152**	**1,524**
Records Attempted	**21**	**60**	**147**
Non-working number and wrong number	0	0	18
Refusal	0	10	14
No answer/answering machine/phone busy/non-specific or specific callback scheduled	7	42	91
Partial complete (not included in interview findings analysis)	0	1	0
Total Completed Surveys	**14**	**7**	**24**
Telephone response rate	**66.7%**	**11.7%**	**16.3%**

[1] Number of contacts available at the time of the survey effort.
[2] Contractors and End-Users started from the same population list.

Appendix G. Evaluation Detail – Custom Program

G.1 Evaluation Sampling Approach

Cadmus defined projects in the Custom Program 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. Any projects previously classified as large in PY8 through PY10 that were undergoing active evaluation in PY11 were retained in the large stratum. In PY11, this stratum had 18 projects.[118] Cadmus verified savings for all of these projects.
- **Small stratum.** Projects that were not classified as large or CHP were assigned to the small stratum. There were 51 small stratum records corresponding to 48 unique projects reported in PY11. Cadmus verified savings for a sample of 10 projects.
- **Combined heat and power (CHP) stratum.** All CHP projects were assigned to this stratum. Three CHP projects reported savings in PY11. Cadmus verified savings for all three projects.

Cadmus did not identify a "high interest" substratum in PY11, but one may be added in future program years. This substratum would include projects in which equipment or systems exhibit high uncertainty in system or equipment operation, calculated savings, or both. This substratum 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.

G.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.[119] The ICSP informed Cadmus of these projects during the application process.

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 to gather baseline data for all large stratum projects, except new construction (for which there was no existing condition).

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[118] The large stratum population is 18 projects, and none had an incentive adjustment.

[119] Reserved savings are based on early customer or contractor estimates of baseline and proposed equipment energy use and do not necessarily represent the reported or verified project savings.

Cadmus conducted post-installation site visits 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 possible for large stratum projects verified after PY11 Q2 through the end of PY11 Q4. For these projects, metered data was captured 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.

Cadmus verified savings for all large and CHP strata projects before the ICSP reported project savings.

G.1.2 Small Stratum

At the end of each quarter in PY11, Cadmus randomly selected 10 projects 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.

Due to COVID-19 restrictions, in-person site visits were not possible for the 10 sampled small stratum projects in PY11. Cadmus conducted virtual site visits by verifying details of installation and operation in phone interviews with customer representatives. These representatives also sent pictures of the installed equipment. In some cases, they provided recent trend data for parameters influencing savings calculations. Virtual video verification (via Zoom) was used for one small stratum project due to customer's privacy concerns.

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

G.1.3 CHP Stratum

In PY11, all three CHP projects with claimed savings were 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 three to six 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 conducted 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) and then annualized using a year of typical data (e.g., TMY3 weather data, average annual production) to determine first-year project savings.

All CHP project site visits were completed prior to COVID-19 restrictions, so there were no COVID-19 related impacts on evaluation efforts. One of the installations makes use of locally produced biogas

rather than natural gas. In another project, the engine uses a mix of biogas and natural gas. The program cost-effectiveness calculations include the impacts on grid-supplied natural gas.

G.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 PY11.

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 seven 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 two projects, the savings were reduced more than 50%.
  - The realization rates for three of these projects were between 83% and 100%.
  - For two projects, the savings were increased by 49% and 50%.
- For three projects, Cadmus collected additional post-installation metering or utility data. These expanded datasets resulted in small differences between the reported and verified savings. The realization rates for these projects were between 89% and 95%.
- A single project is responsible for 93% of the difference between the verified and reported kWh savings. It is unusual for a project with savings of this magnitude to be included in the small stratum. The savings for this project did not exceed the threshold for the large stratum at the time the savings were originally estimated by the ICSP. The low 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, and the collection of five months of post-installation data was a high-rigor approach. However, there is a difference between the reserved and *ex post* savings due to several changes to the *ex ante* analysis of the data.
- The baseline regression was updated for one cooling tower VFD project. The *ex ante* baseline regression assumed that the cooling tower fans would not operate below 50°F. The post-installation data showed that the fans run at all temperatures, so Cadmus changed the form of the baseline regression.

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**.**

G.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 G-1 summarizes the intention, influence, and free ridership score.

Table G-1. PY11 Custom Program Intention, Influence, and Free Ridership Scores

n	Intention Score	Influence Score	Free Ridership Score
16	34%	0%	34%

For the four largest projects of the survey respondents in PY11, the savings-weighted free ridership score was 35%. These four projects represented 95% of the analysis sample's verified savings,[120] and they accounted for 33 percentage points of the program-level free ridership estimate of 34%. Table G-2 lists the sector for the four projects with the largest verified savings.

Table G-2. PY11 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/CHP	41,616,097	73%	54%	38%
Large C&I/Large	9,191,160	16%	12%	25%
Small C&I/CHP	2,643,871	5%	3%	25%
Large C&I /Small	1,087,956	2%	1%	25%
Total [(1)]	**54,539,084**	**95%**	**71%**	**35%**[(2)]

[(1)] Total may not match due to rounding.
[(2)] Weighted by verified kWh/yr savings. Relative precision at 85% confidence is 9%.

G.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. Not all survey questions were answered by all respondents so totals for each question may differ. Table G-3 shows the sectors represented in the survey population and in the full participant population.

[120] The four largest projects in the analysis sample represented 71% of the verified savings for the Custom Program population.

Table G-3. PY11 Custom Program Sector Breakdown

Sector	Total Population (n=69)	Survey Respondents (n=16)
Large	38%	56%
Small	43%	31%
GNE	19%	13%
Source: PPL Electric Utilities' tracking database and survey question; may not total 100% due to rounding.		

More than three-quarters of survey respondents (81%; n=16) said they had previously participated in the Custom component of the Non-Residential Energy Efficiency Program before PY11.

Ten of 13 survey respondents said their facilities were 100,000 square feet or more. Eleven of 15 respondents said their facility had 100 employees or more.

Table G-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 G-4. PY11 Facility Types of Custom Program Participants and Survey Respondents

Facility Use	Total Population (n=69) [1]	Survey Respondents (n=15) [2]
Manufacturing	41%	53%
Hospital or healthcare	12%	13%
Retail	12%	0%
Warehouse	9%	7%
Dining	6%	0%
Agriculture	4%	13%
Education	4%	0%
Grocery – supermarket or convenience store	3%	0%
Motion picture theater	1%	0%
Office	1%	0%
Other	9%	13%[3]

[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 an aggregate producer and a poultry facility.

G.4.1 Survey Sample Attrition

Cadmus conducted online and telephone surveys, reaching out to all PY11 participants in February 2020 (Q1 and Q2 participants) and in July 2020 (Q3 and Q4 participants). PPL Electric Utilities key account managers provided outreach to increase response rates.

Cadmus' cleaning and survey sample preparation process reduced the available sample from 69 to 34. Additional information is found in *Appendix Q Survey Methodology*.

Table G-5 lists the total records used for surveys and the outcome (final disposition) of each record.

Table G-5. PY11 Custom Program Participant Survey Sample Attrition Table

Description of Call Outcomes	Number of Records
Online	
Population	**69**
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 PY11 (incentive adjustment)	35
Survey Sample Frame (email invitations sent)	**34**
Email was returned (bounce back), did not respond, opted out, or did not complete survey	1
Ineligible: PPL Electric Utilities employee/cannot confirm project location	0
Completed Surveys	**1**
Online Response Rate	**3%**
Telephone	
Population	**69**
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 PY11 (incentive adjustment)	35
Completed online survey	1
Survey Sample Frame (used for telephone survey calls)	**33**
Not attempted	**0**
Records Attempted	33
Not reached: no answer, answering machine, phone busy, refused	18
Ineligible: cannot confirm equipment/not aware of participation, employment, ESCO	0
Partial complete (not included in survey findings analysis)	0
Completed Surveys	**15**
Telephone Response Rate	**45%**
Total Completed Surveys (total for all modes)	**16**
Overall Response Rate (for both modes)	**47%**

Appendix H. Evaluation Detail – Efficient Lighting Program

H.1 Database Review

Cadmus reviewed PPL Electric Utilities' tracking database and verified ENERGY STAR certification, as detailed below.

H.1.1 ENERGY STAR Verification

The Efficient Lighting Program strives to offer incentives exclusively for ENERGY STAR lighting products. Using ENERGY STAR identification numbers or model numbers of every bulb tracked in PPL Electric Utilities' tracking database, Cadmus confirmed that all bulbs sold through the program met current ENERGY STAR certification criteria.

Cadmus used the following fields from ENERGY STAR's Qualified Products List (QPL) as critical impact evaluation inputs for identifying bulbs exempt from Energy Independence and Security Act (EISA) and determining baseline wattages:

- Lumens rating
- Bulb shape (A19, R20, etc.)
- Base type (E26, E12, etc.)
- Diameter (inches)
- 3-way ("yes" or "no")

Cadmus also used the QPL's efficient wattage ratings in its calculations to verify savings.

H.1.2 Tracking Data Review

Cadmus compared PPL Electric Utilities' tracking database files to the QPL to finalize impact evaluation inputs. Cadmus verified the following:

- Bulb-specific inputs such as bulb type, lumens, and wattages were consistent across all records for the same stock keeping unit (SKU).
- Reported wattages were consistent with the wattages provided in bulb type descriptions.

Cadmus also compared PPL Electric Utilities' tracking database files to ICSP reports to confirm consistency and reasonableness of data.

H.2 Baseline Adjustments

Prior to computing savings using PA TRM algorithms, Cadmus checked baseline wattages for each SKU against the baseline tables by bulb type in PA TRM Tables 2-2, 2-3, and 2-4 and made adjustments for records that did not align with these tables.[121] For bulbs with lumen ratings outside the ranges specified

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

in PA TRM Tables 2-2, 2-3, and 2-4, Cadmus used manufacturer-rated baseline wattages, as stipulated in the PA TRM.

Following a recommendation from the SWE, starting in PY11 Cadmus reviewed online sources (from retailers and/or manufacturers) to determine the bulb shape of lamps included in every LED fixture model in the PPL Electric Utilities tracking database. Cadmus then applied the appropriate baselines from Table 2-2 of the PA TRM to fixtures with bulbs shaped like A-lines or Table 2-4 of the PA TRM to fixtures with bulbs shaped like reflectors. Cadmus classified all LED retrofit kits as downlights (reflectors).

Cadmus adjusted baselines for roughly 17% of program bulbs, mostly to account for specialty bulb types exempt from the EISA ruling covering general service lamps (GSLs), such as 3-way LEDs and candelabra bulbs with medium bases (E26), and for some reflector lamp types, including those with diameters less than or equal to 2.5 inches. These adjustments, in aggregate, increased energy savings by 212 MWh/year (3% among adjusted bulbs and 0.4% overall).

H.3 Sales by Retail Channel and Bulb Type

PPL Electric Utilities sunset the Efficient Lighting Program in PY11, tapering down incentives completely by the second quarter (Q2). As indicated in the EE&C plan, in PY11, program sales were about half of PY10 sales.

Table H-1 shows program sales by retail channel in PY10 and PY11. Generally, sales patterns in PY11 were similar to PY10. PPL Electric Utilities sold more than half of its program bulbs through home improvement stores, increasing from 47% in PY10 to 53% in PY11. Sales at mass merchandise stores were 5.5% in PY11, a decrease by more than half the share of program bulb sales compared to 11.3% in PY10.

In addition to the retail channels listed in Table H-1, the program gave away (at no cost) more than 5,400 bulbs in PY11, which accounted for less than 0.5% of all program bulbs.

Table H-1. Program Unit Sales by Retail Channel and Program Year

Retail Channel	PY11 Program Unit Sales		PY10 Program Unit Sales	
	Count	Percentage	Count	Percentage
Home Improvement	626,073	53%	1,202,691	47%
Membership Club	161,684	14%	415,088	16%
Hardware	219,991	18%	409,572	16%
Mass Merchandise	65,596	6%	292,690	11%
Discount	66,118	6%	174,066	7%
Other	24,405	2%	43,261	2%
Lighting & Electronics	25,669	2%	35,814	1%
Giveaway Bulbs	5,428	< 1%	11,280	< 1%
Program Total (1)	**1,194,964**	**100%**	**2,584,462**	**100%**
(1)Total may not sum due to rounding.				

Table H-2 shows sales by bulb type in PY10 and PY11. Though the total bulb sales decreased in PY11, the distribution of sales remained consistent, with each bulb type increasing or decreasing by no more than 1.2 percentage points from PY10 to PY11.

Table H-2. Program Sales by Bulb Type and Program Year

Bulb Type	PY11 Program Sales		PY10 Program Sales	
	Count	Percentage	Count	Percentage
LED A-Line	785,691 [1]	66%	1,724,824	67%
LED Reflector	195,544	16%	430,384	17%
LED Candelabra	97,316	8%	223,278	9%
LED Fixture [2]	64,457	5%	108,933	4%
LED Globe	51,956	4%	97,043	4%
Program Total	**1,194,964**	**100%** [3]	**2,584,462**	**100%** [3]

[1] A-line LEDs include 6,893 three-way bulbs.
[2] Fixture LEDs include retrofit kits. To calculate verified savings, Cadmus categorized fixtures as either A-lines or reflectors, as described in Tracking Data Review.
[3] Total may not sum due to rounding.

Appendix I. Evaluation Detail – Energy Efficient Home Program

I.1 Ex Post *Savings Calculation*

As in previous years, Cadmus used a bottom-up approach to evaluate savings for the Energy Efficient Home Program, starting with products and services. Each component represented a stratum group. Cadmus calculated realization rates to assess *ex post* savings for each stratum, using either a database review to calculate the *ex post* savings and the realization rate or conducting a records review to calculate a realization rate that was then applied to the *ex post* savings from the database review.

Next, Cadmus summed the stratum total *ex post* savings to derive the stratum group *ex post* savings then summed the stratum groups 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.

I.2 In-Service Rates

In PY11, Cadmus used participant survey data to calculate ISRs for high-volume products in the Online Marketplace component. Cadmus contacted all eligible respondents through Q2 for an online survey. Although all Online Marketplace products were represented by at least one participant in the sample frame, Cadmus received responses for only the four measures with the highest participation.

To assess the ISR for bulbs, smart thermostats, and smart strips, the online survey asked 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 the respondent purchased to determine total linear feet installed. The ISR for weatherstripping was calculated as the total linear feet installed divided by the total linear feet purchased by the respondents.

Table I-1 shows the sample size (number of rebated items or linear feet) for each measure and the calculated ISR.

Table I-1. PY11 ISRs for High-Volume Online Marketplace Measures

Online Marketplace Measure	N (Measure Quantity)	PY11 Evaluated ISRs
LED bulbs[(1)]	128	98%
Smart thermostats	32	66%
Weatherstripping	580 (linear ft)	72%
Smart strips	10	100%

[(1)] Represents first-year installation only; not adjusted to account for installation of stored bulbs in later years.

I.3 Survey Participant Profile

The PY11 customer surveys collected demographic information about Energy Efficient Home Program participants.[122] The majority of respondents had the following characteristics:

- Lived in a single-family detached residence (83%; 584 of 700)
- Had an average household size of 2.2 people (n=663)
- Averaged 62 years of age (n=629)
- Had completed some college education or more (79%; 544 of 690)
- Had an annual household income of $50,000 or greater (72%; 361 of 501)

I.3.1 Survey Sample Attrition

Table I-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 Q. Survey Methodology*.

Table I-2. Energy Efficient Home Sample Attrition Table

Contract Outcome Description	Number of Records					
	In-Home Audit (Q1-Q4)	Online Assessment (Q1-Q3)	Weatherization (Q1-Q4)	Equipment (Q1-Q4)	Online Marketplace (Q1-Q2)	New Homes (Q1-Q3)
Population (number of unique jobs)[(1)]	**84**	**3,082**	**735**	**10,275**	**549**	**53**
Online						
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	217	195	1,252	49	0
Incomplete or invalid email address	7	2	105	2,088	21	0
Survey Sample Frame (email invitations sent)	**72**	**2,863**	**435**	**6,935**	**479**	**53**
Email was returned (bounce back), did not respond, opted-out, or did not complete survey	64	2,725	395	6,430	423	42
PPL Electric Utilities or market research employee	1	4	4	7	8	0
Cannot confirm equipment/not aware of participation	0	13	2	5	5	0
Completed Surveys	7	123	34	493	43	11
Response Rate	10%	4%	8%	7%	9%	21%

[(1)] Number of rebates available in PPL Electric Utilities' tracking database at the time of the final survey effort. Population number for New Homes component is number of unique builders at the time of data collection.

[122] Includes data on Online Marketplace, Efficient Equipment, Audit and Kit (online assessments and in-home audits), and Weatherization components.

I.4 Net-to-Gross Ratio Findings

Cadmus summed the intention and influence components of the net savings algorithm to estimate the free ridership average for the online marketplace stratum, weighted by *ex post* gross program savings. Table I-3 summarizes the intention, influence, and free ridership score for the Online Marketplace Stratum.

Table I-3. PY11 Energy Efficiency Home Program Intention, Influence, and Free Ridership Scores for Online Marketplace Stratum

n	Intention Score	Influence Score	Free Ridership Score
37 [(1)]	23%	2%	25%

[(1)] Achieved sample size is based on number of survey respondents answering the first free ridership question K1, "Which of the following would have happened if the [MEASURE] you purchased from the PPL Energy Efficiency Marketplace was not discounted?" and answering at least of one of the questions from K2a to K2e, "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. K2a. The discount for the [MEASURE], K2b. PPL Electric Utilities' information about energy efficiency, K2c. Convenience of being able to buy online from PPL Electric Utilities, K2d. Information about the type of products on the PPL Energy Efficiency Marketplace, K2e. Information about saving energy from the PPL Energy Efficiency Marketplace online chat."

The savings weighted intention score found 23% of the online marketplace stratum savings could be classified as free ridership. The savings weighted influence found 2% of the online marketplace stratum savings could be classified as free ridership.

No online marketplace stratum respondents attributed additional non-rebated non-lighting equipment purchases made after participating in the program to PPL Electric Utilities and the spillover percentage estimate for the online marketplace stratum is 0%.

Appendix J. Evaluation Detail – Winter Relief Assistance Program

J.1 Job Type Definitions and Verification References

J.1.1 Baseload Job Type

Baseload jobs require no additional qualifications beyond the general WRAP income-eligibility requirements. However, baseload customers generally have non-electric heating and a non-electric water heater.[123] Table J-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 J-1. PY11 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.	

J.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 J-2 and all items offered to baseload job types.

Table J-2. PY11 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
Residential Programmable Thermostat	Residential Thermostats – IMP

[123] If a customer had an electric water heater but refused water heater products, the customer was categorized as a baseload customer.

J.2 Master-Metered Multifamily Buildings

Master-metered multifamily buildings were eligible for baseload, low-cost, and full-cost products. However, in PY11, all buildings received only baseload or low-cost products. (See products and services listed in Table J-1 and Table J-2.)

J.3 Manufactured Home Initiative

Manufactured homes with electrically heated water qualified for low-cost jobs. If the home did not have electrically heated water, it qualified for a baseload job. In addition, some manufactured homes were eligible for the minor air sealing improvements—door caddies, door corner pads, closed cell foam weatherstripping, and window kits—based on the auditor's recommendations.[124] The exact combination of products delivered, along with minor air sealing, depended on the conditions of the individual home. Cadmus evaluated these savings using the weatherstripping interim measure protocol (IMP).[125]

J.4 Energy Education and Behavior Savings

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. Cadmus used the same energy education savings algorithms for participants of the Energy Efficiency Kits and Education Program (see *Appendix K Evaluation Detail – Energy Efficiency Kits and Education Program)*.

J.4.1 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 Phase III TRM's algorithms accordingly.[126]

J.4.2 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)[127]
2. Weighted the results based on WRAP PY11 survey results

J.4.3 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 Phase III TRM, which concerns low-flow showerheads but was a good proxy after adjusting the flow rate to be constant

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[124] Usually these homes had electric heat. All homes had either cooling, electric heat, or both.

[125] Pennsylvania Public Utility Commission. June 1, 2017. *Weather Stripping, Caulking and Outlet Gaskets IMP*.

[126] Section 2.2.8 of the PA TRM.

[127] 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.

(the weighted flow rate for WRAP participants), then added a term to subtract the energy education recommendation for shower length from the default.[128]

J.5 Ex Post Savings Calculation Methodology for LED Giveaway Events

The ICSP organized a total of three community events in PY11 and distributed a total of 2,200 LED bulbs at these food pantries:

- **Community Event 1 at Alpha Omega Community Center.** The ICSP distributed a total of 220 LED bulbs. For this community event, the ICSP selected a nonprofit agency that provides education and services to assist the Latino community and provided post cards in the LED packs to OnTrack customers. The event was not open to the public and was only available to customers who qualified for assistance through the food pantry's program.
- **Community Event 2 at Manheim Central Food Pantry.** The ICSP distributed a total of 280 LED bulbs. For this community event, the ICSP selected an organization that provides supplemental food to families or individuals and provided post cards in the LED packs to OnTrack customers. The event was not open to the public and was only available to customers who qualified for assistance through the food pantry's program.
- **Community Event 3 at Perry County Food Bank.** The ICSP distributed a total of 1,700 LED bulbs. For this community event, the ICSP selected an organization that provides supplemental food to families or individuals and provided post cards in the LED packs to OnTrack customers. The event was not open to the public and was only available to customers who qualified for assistance through the food pantry's program.

Cadmus determined verified energy savings from LED bulbs using the PA TRM entries.[129] Following this *ex post* savings calculation methodology, Cadmus verified total energy savings as 71 MWh/yr from LED giveaway events.

J.6 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 the same utility account number was associated with multiple job types or delivery channels. This occurred in cases where a job was initially in the baseload or low-cost stratum but was later determined to be in the manufactured home stratum. See Table J-3 which presents the participation counts for WRAP in PY11.

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[128] 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.

[129] Section 2.1.1 of the PA TRM.

Table J-3. PY11 WRAP Participant Counts

WRAP Job Type	No. of Accounts	Reported Participants	Difference	Notes
Baseload	4,359	4,346	13	Thirteen jobs were in the baseload stratum and the manufactured home stratum. These jobs were assigned to only one stratum, manufactured home.
Low-Cost	3,889	3,887	2	Two jobs were in the low-cost stratum and the manufactured home stratum. These jobs were assigned to only one stratum, manufactured home.
Full-Cost	0	0	0	
Manufactured Home Initiative (all job types)	1,216	1,216	0	
Master-Metered Multifamily (all job types)	7	7	0	
LED Giveaway	N/A	2,200	N/A	2,200 LED bulbs were provided.
Program Total	**9,471**	**11,656**	**15**	

J.7 Records Review Findings

This section presents the findings from Cadmus' review of records in Table J-4. These findings, along with the ISRs of products, are the reasons for the differences between reported and verified savings.

Table J-4. PY11 Record Review Findings

Product	Issue	Number of Jobs	Effect on Savings
LEDs	Using correct waste heat factors (WHFs) associated with gas heating or exterior bulbs	54	Increase
	90% of bulbs not efficient	1	Increase
Tier 2 Smart Strips	Smart strip installed in entertainment center with less than three devices plugged in	12	Decrease
	Multiple smart strips installed in multiple entertainment centers, but only listed number of devices plugged into one of the smart strips; derated other smart strip to unknown because unlikely multiple entertainment centers have three or more devices plugged into them	4	Decrease
Showerheads	Row house or manufactured home mapped to multifamily house	5	Decrease
Bathroom Aerators	Row house or manufactured home mapped to multifamily house	3	Increase
Kitchen Aerators	Row house or manufactured home mapped to multifamily house	3	Decrease
Thermostatic Restrictor Valves	Row house or manufactured home mapped to multifamily house	3	Decrease

J.8 Energy Education Savings Analysis Findings

Table J-5 shows the 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 and demand savings in each half of the year. The per-household verified energy education savings estimate is 52.64 kWh/yr in PY11 Q1-Q2 and 37.48 kWh/yr in PY11 Q3-Q4. Sixty-four percent of the jobs were delivered in PY11 Q1-Q2 and 36% were delivered in PY11 Q3-Q4.

The *ex ante* assumption was 160 kWh/yr; verified savings were lower than the *ex ante* savings.

Table J-5. 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 the winter and raise it in the summer	Programmable Thermostats – Section 2.2.8	2.00	0	1.78	0
Adjust Thermostats – Winter			45.28	0	34.54	0
Wash Clothes in Cold Water	Participants increase the number of loads of laundry they wash in cold water	Water Heater Temperature Setback – Section 2.3.6	3.50	0.0003	1.16	0.0001
Take Shorter Showers	Participants decrease the duration of each shower	Low Flow Showerheads – Section 2.3.9	1.87	0.0001	0	0
Total [(1)]			**52.64**	**0.0004**	**37.48**	**0.0001**

[(1)] Each component is summed to get the total. Total may not sum due to rounding.

Table J-5 shows that the main driver in the energy education savings was *adjust thermostats in the winter*. In PY11 Q1-Q2, 47% of survey respondents said they lowered their thermostat temperature in the winter. In PY11 Q3-Q4, 26% of survey respondents said they lowered their thermostat in the winter. Based on the number of jobs delivered in each half of the year, the weighted average is 39% for PY11.[130] This percentage is much lower than the 74% of survey respondents in PY10 who said they lowered their thermostat temperature in the winter.

Table J-6 shows the results of the overall percentage change of WRAP participants' who *take shorter showers* and *wash clothes in cold water*. Similar to previous years, many people already take these actions and many take no action, which combine to have a marginal effect on overall savings.

[130] The number of jobs delivered in PY11 Q1-Q2 is 64% and the number of jobs delivered in PY11 Q3-Q4 is 36%. Thus, the PY11 weighted average of those who lowered their thermostat in the winter is: (47% * 64%) + (26% * 36%) = 39%.

Table J-6. Calculation and Results of Energy Education Percent Change Components

Energy Savings Recommendation	Q1-Q2			Q3-Q4		
	Percent Before	Percent After	Percent Change	Percent Before	Percent After	Percent Change
Of Those Who Took Action						
Take Shorter Showers	49.60%	57.24%	**7.63%**	50.63%	50.59%	**-0.04%**
Wash Clothes in Cold Water	65.96%	76.52%	**10.57%**	65.46%	72.93%	**7.46%**
Overall Percentage Change						
Energy Savings Recommendation and Action	**Percent Change**	**Percent of Population [1]**	**Overall Percent Change [2]**	**Percent Change**	**Percent of Population [1]**	**Overall Percent Change [2]**
Take Shorter Showers - Action	7.63%	22.97%	**1.8%**	-0.04%	6.76%	**0.0%**
Take Shorter Showers - No Action	0.00%	77.03%		0.00%	93.24%	
Wash Clothes in Cold Water - Action	10.57%	17.40%	**1.7%**	7.46%	17.40%	**0.6%**
Wash Clothes in Cold Water - No Action	0.00%	82.60%		0.00%	82.60%	

[1] Percentage of surveyed population who took action—i.e., in PY11 Q1-Q2, 22.97% took shorter showers for a 7.63% average increase in shorter showers.
[2] 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. Also, Cadmus did not assign negative savings.

J.9 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 PY11 Q1-Q2 and PY11 Q3-Q4. Therefore, Cadmus aggregated survey results to determine the PY11 ISR for each of the products.

Table J-7 compares the ISRs in Phase III.

Table J-7. Comparison of ISRs in Phase III

Product	PY8 [1]	PY9 Q1-Q2	PY9 Q3-Q4	PY10	PY11
LEDs	94%	97%	99%	100%	99%
LED Nightlights	69%	83%	96%	96%	97%
Kitchen Aerators	78%	86%	95%	98%	96%
Bathroom Aerators	61%	76%	90%	93%	97%
Showerheads	88%	91%	93%	94%	99%
Tier 2 Advanced Power Strips	44%	66%	88%	85%	94%

[1] ISRs collected via site visit data.

J.10 Survey Participant Profile

In the participant phone surveys, Cadmus collected demographics and home characteristics. The respondents' homes had the following characteristics (n=150).[131]

- Single-family detached residence (36%)
- Attached house (townhouse, rowhouse, or twin) (25%)
- Mobile or manufactured home (21%)
- Multifamily apartment or condo building with four or more units (18%)

WRAP respondents have the following level of education (n=147):[132]

- Less than high school diploma or equivalent (11%)
- High school diploma or equivalent (40%)
- Technical or business school certificate/two-year college degree/some college (37%)
- Four-year college degree/bachelor's degree (11%)
- Graduate or professional degree/masters or doctorate degree (1%)

J.10.1 Survey Sample Attrition

Table J-8 lists the total number of WRAP records and the outcome (final disposition) of each record used for the telephone survey.

Table J-8. PY11 WRAP Sample Attrition Table for Participant Telephone Surveys

Description of Call Outcomes	Number of Records
Population (number of unique jobs) [1]	**9,449**
Removed: inactive customer, completed survey in past three months, on "do not contact" list, selected for a different survey, duplicate contact	1,752
Incomplete or invalid phone number or email	2,227
Survey Sample Frame (sent to subcontractor for telephone survey calls)	**5,470**
Not attempted [2]	**1,255**
Records Attempted	**4,215**
Non-working, wrong number, business, language barrier	1,486
Not reached: No answer, answering machine, phone busy, refused, terminated, non-specific or specific callback scheduled	2,514
Screened out: PPL Electric Utilities or market research employee, cannot confirm equipment/not aware of participation	60
Completed Surveys (telephone)	**155**
Telephone Response rate	**4%**
(1) Total records do not include master-metered multifamily building tenants as there is no contact data available for tenants. Cadmus evaluated satisfaction through interviews with master-metered multifamily building property managers. (2) Selected for sample but overall target was reached before attempted. All manufactured home participants included in the sample frame were attempted multiple times.	

131 Three percent of the participants preferred not to answer this question.

132 Six percent of the participants preferred not to answer this question.

Appendix K. Evaluation Detail – Energy Efficiency Kits and Education Program

K.1 Database Review Findings

Cadmus reviewed PPL Electric Utilities' program tracking database for all PY11 records for Energy Efficiency Kits and Education Program participants. It reviewed the PPL Electric Utilities account numbers, kit numbers, and home characteristics and compared these to information from the enrollment cards recorded in the ICSP's electronic database to ensure that records were traceable between both databases.

Prior to Cadmus' review of the database, PPL Electric Utilities' tracking database listed a total of 15,598 kits. As a result of the review, Cadmus decreased the total unique distributed (and not returned) kits to 15,507 program kits, representing 99% database accuracy for the program, as shown in Table K-1.

Table K-1. Accuracy of PY11 Data for Energy Efficiency Kits and Education Program

Sector	Product	PY11 Kits in PPL Electric Utilities' Tracking Database [(1)]	Database Accuracy	PY11 Verified Kits
Low-Income	Energy-savings kit	15,598	99%	15,507

[(1)] In PY11, the ICSP distributed 15,598 unique kits. A total of 91 kits were returned, represented as 175 unique rows in PPL Electric Utilities' tracking database. In seven cases, a kit distributed in PY10 was returned in PY11, and thus only had one record in the tracking database.

The number of unique CSP job numbers in PPL Electric Utilities' tracking database does not necessarily reflect the unique number of distributed kits, nor does it identify all kits that were returned in PY11. Cadmus verified 15,507 kits as distributed and not returned from the 15,682 unique CSP job numbers provided in PPL Electric Utilities' tracking database using these steps:

- Seven unique CSP job numbers were associated with kits returned in PY11 but initially distributed in PY10. Cadmus assigned these kits negative *ex post* to counter the positive *ex post* savings they were assigned in PY10.
- 84 unique CSP job numbers were associated with kits distributed and returned in PY11. Cadmus assigned these kits 0 kWh/yr and 0 kW/yr *ex post* savings.

K.2 Ex Post *Verified Savings Methodology*

Cadmus estimated *ex post* verified savings for the Energy Efficiency Kits and Education Program for each stratum—agency or direct mail delivery channels—and for the program overall using the ICSP-reported savings, paper survey responses, and data from enrollment cards collected by the ICSP.

K.2.1 Assigning Survey *Ex Ante* and Survey Verified Savings

Cadmus assigned survey *ex ante* and survey verified savings to program participants based on the criteria listed in Table K-2

Table K-2. Criteria for Assigning Survey *Ex Ante* and Survey Verified Savings

Criteria	Survey *Ex Ante* Savings [1]	Survey Verified Savings
Whether the respondent answered the product-specific question(s)	✓	✓
How the participant answered questions on the enrollment card about home characteristics	✓	✓
How the respondent answered the questions asking if products were installed		✓
How the respondent answered questions about actions taken that could result in behaviorally based energy savings		✓
[1] Cadmus used the ICSP-reported *ex ante* savings for survey-*ex ante* savings based on the listed criteria. The ICSP incorporated information from the enrollment cards when calculating reported *ex ante* savings.		

Cadmus assigned survey-verified savings using information from the enrollment card, specifically water heater configuration, clothes washing location, type of space heating, type of space cooling, and type of home. The ICSP assigned reported savings based on the data uploaded to PPL Electric Utilities' tracking database. Although there should be no discrepancies between data in PPL Electric Utilities' tracking database and in the enrollment cards, Cadmus investigated both sources and confirmed the correct information with the ICSP when the two sources did not match. Cadmus found several differences between the database and the enrollment cards and verified with the ICSP that the enrollment cards reflected the most accurate information. Cadmus therefore used information from the enrollment card and not the database to assign survey verified savings.

Cadmus calculated realization rates for each stratum as the ratio of survey-verified savings to survey *ex ante* savings. Because the kit contains one survey that asks questions about each item, survey responses for products may be correlated within customers. Cadmus accounted for these correlations by rolling savings up to the kit level prior to calculating realization rates and precision.

K.2.2 Survey-Verified Savings

Cadmus independently calculated survey-verified savings per the PA TRM and the associated algorithms. These algorithms involve open variables for which the ICSP or Cadmus can use either the default or the option of "EDC data gathering." Table K-3 lists the algorithm inputs and sources of the data collected.

K.2.3 *Ex Post* Verified Savings

To calculate stratum-level *ex post* savings, Cadmus applied the stratum-level realization rates to stratum *ex ante* savings and took the sum of stratum-level *ex post* savings to estimate the program-level *ex post* savings. Cadmus calculated confidence and precision for the *ex post* savings and realization rate estimates in each stratum and for the program as a whole.

Table K-3. 2016 PA TRM Open Variables

Product	Survey Data	Enrollment Card	Kit Specification Sheet
LED	ISR	-	Bulb wattage
LED Nightlight	ISR, Baseline Condition	-	Bulb wattage
Low Flow Showerhead	ISR	Water heater fuel type, type of home	Low flow GPM
Kitchen Faucet Aerator	ISR	Water heater fuel type, type of home	Low flow GPM
Tier 2 Advanced Power Strip	ISR, Equipment plugged into power strip	-	-
Furnace Whistle	ISR	Home heating fuel type, home cooling configuration	-
Adjusting Thermostat for Cooling in the Summer	ISR	Home cooling configuration	-
Adjusting Thermostat for Heating in the Winter	ISR	Home heating fuel type	-
Water Heater Temperature Setback	ISR	Water heater fuel type, laundry location	-

K.3 ISR Methodology and Findings

Each kit distributed through the Energy Efficiency Kits and Education Program included a paper survey for the participant to complete and mail back to the ICSP. These surveys collected the necessary data for Cadmus to calculate ISRs and determine the participant actions taken because of the program. Survey data were also used to calculate *ex post* per-unit savings for each item in the energy-savings kit.

Cadmus estimated ISRs for all products in the energy-savings kits. Table K-4 provides these ISRs and the ISRs the ICSP used for planning. As in PY9 and PY10, the differences in ISRs for LED bulbs was primarily driven by the delivery channel of the reported ISR; the data were gathered through surveys that were included in the kit in Phase II when the kits only included two bulbs. Cadmus observed that ISRs remained relatively high until after the third and fourth bulbs, when installations dropped off (particularly for the Direct Mail channel), ranging from 76% to 55% for the fifth and sixth bulbs. Generally results were similar across strata.

Cadmus found lower installation rates for nightlights since it only evaluated savings for nightlights that replaced existing nightlights and assigned negative savings for nightlights that were installed but did not replace an existing nightlight.

Finally, Cadmus found lower kitchen aerator ISRs than reported by the ICSP, leading to lower evaluated savings for the measure.

Table K-4. PY11 Energy Efficiency Kits and Education Program Product-Level ISRs

Product	Agency		Direct Mail	
	Survey-Gathered ISR	ICSP Planning ISR	Survey-Gathered ISR	ICSP Planning ISR
LED Bulbs	87%	96%	79%	98%
First Bulb	97%	96%	97%	98%
Second Bulb	97%	96%	94%	98%
Third Bulb	95%	96%	88%	98%
Fourth Bulb	85%	96%	78%	98%
Fifth Bulb	76%	96%	62%	98%
Sixth Bulb	74%	96%	55%	98%
LED Nightlight [(1)]	18%	87%	37%	92%
Low-Flow Showerhead	45%	64%	53%	72%
Kitchen Faucet Aerator	46%	63%	50%	72%
Furnace Whistle	19%	28%	20%	17%

[(1)] Cadmus used the number of nightlights that replaced an existing nightlight minus those installed in an open socket to calculate the LED nightlight ISR.

Table K-5 provides the ISRs for showerheads. To evaluate showerhead savings, Cadmus incorporated both the ISR questions from the kit survey as well as information on the enrollment card regarding the number of showers in participating homes. If respondents indicated installing two showerheads from the survey but only listed one shower in their household on the enrollment card, Cadmus applied savings for one showerhead. Few respondents indicated installing both showerheads, but more respondents than in previous years installed the first showerhead; in PY9 the ISRs for showerheads were 64% and 60% for agency and direct mail strata, respectively, when only one showerhead was included in the kits. The combined ISRs for both showerheads were still lower than reported. Since showerhead savings represented 34% of all reported savings, differences in reported and evaluated ISRs had large impacts on overall realization rates.

Table K-5. PY11 Energy Efficiency Kits and Education Program Showerhead ISRs

Showerhead	Agency		Direct Mail	
	Reported ISR	Evaluated ISR	Reported ISR	Evaluated ISR
Showerhead 1	64%	87%	72%	85%
Showerhead 2	64%	2%	72%	20%

As described in section *13.2.2 Gross Savings Impact Evaluation Results*, the low realization rate in PY10 and PY11 was driven by the saturation of kit types distributed to customers because the ICSP's planned per-unit energy education savings aligned closer to kits with water products than to kits without water products. Table K-6 provides the evaluated per-unit energy education savings participants achieved by delivery channel and kit type based on participant survey responses to key questions. The ICSP reported per-unit energy education savings of 253 kWh/yr for all participants, regardless of delivery channel or kit type.

Table K-6. Energy Education Savings by Delivery Method and Kit Type

Delivery Method	Kit Type	Average Evaluated kWh/yr	Average Evaluated kW/yr	Sample Size
Agency	Electric	325.23	0.0229	86
	Base Load	58.66	0.0166	40
Direct Mail	Electric	385.59	0.0364	853
	Base Load	54.99	0.0220	798

K.4 Behavior Savings Methodology

Cadmus estimated the impacts of electric consumption associated with behavior changes by participants in the Energy Efficiency Kits and Education Program using calculations derived from a combination of engineering estimates, secondary research, and survey data. These savings estimates were associated with the following behavior changes:

- Lowering the water heater temperature
- Washing more loads of laundry in cold water
- Adjusting the home thermostat per the heating or cooling season

The next sections provide details about the algorithms Cadmus used to estimate savings for these three behavior changes. Cadmus used the same energy education savings algorithms for participants of the Low-Income Winter Relief Assistance Program (WRAP) in PY11 (*Chapter 12 Winter Relief Assistance Program).*

K.4.1 Water Heater Temperature Reduction

The Energy Efficiency Kits and Education program encourages participants to reduce the temperature setting of their electric water heater to save energy. Cadmus estimated savings for this action by following the PA TRM engineering calculation.[133] The first term in the equation corresponds to the savings from tank losses, and the second term corresponds to savings from the clothes washer, as a result of changing the water heater setting.

Cadmus applied energy and demand savings to survey respondents who indicated on the enrollment card that the home had an electric water heater. Respondents who indicated the home did not have an electric water heater received zero electric savings for water heater temperature setback.

Furthermore, Cadmus applied the clothes washer portion of savings (corresponding to the second term in the equation) only to participants who indicated on the enrollment card that they had a washing machine in their home or apartment. Respondents who wash their laundry at an on- or off-site public laundry facility were not eligible to receive the clothes washer portion of water heater temperature reduction savings.

[133] Pennsylvania Public Utility Commission. *Pennsylvania Technical Reference Manual.* June 2016.

Table K-7 provides the per-respondent savings applied to eligible participants.

Table K-7. Electric Water Heater Temperature Reduction Savings

Unit	Tank Loss	Clothes Washer	Total
kWh/yr	86.77	79.09	165.85
kW/yr	0.0070	0.0064	0.0133

K.4.2 Washing More Loads of Laundry in Cold Water

Cadmus estimated the savings associated with washing more loads of laundry in cold water, a behavior encouraged by the Energy Efficiency Kits and Education Program. Cadmus estimated these savings by following the equation provided in the Phase III PA TRM,[134] in which the change in percentage of loads washed in cold water before and after the program is applied to the energy savings achieved when lowering the temperature of the water used by the clothes washer.

In PY11, the paper survey did not include a question appropriate for determining any behavior change related to program participation. To determine the change in the percentage of loads washed in cold water, Cadmus applied the average change estimated in the PY7 evaluation of the Energy Efficiency Kits and Education Program (formerly the E-Power Wise Program).[135]

Because these respondents did not report a change (by responding with the same pre- and post-percentage of loads washed in cold water), Cadmus applied clothes washer savings to all survey respondents with an electric water heater and in-home laundry, adjusting the starting temperature of water and input to the TRM savings equation depending on whether the respondent had lowered the water heater setting. As such, Cadmus did not double-count savings from water heater temperature setback.

Table K-8 provides the per-respondent savings applied to eligible participants.

Table K-8. Washing More Loads of Laundry in Cold Water Savings

Unit	Lowered Water Heater Setpoint	Did Not Lower Water Heater Setpoint
kWh/yr	81.95	96.04
kW/yr	0.0066	0.0077

[134] Pennsylvania Public Utility Commission. *Pennsylvania Technical Reference Manual.* June 2016.

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

K.4.3 Adjusting Thermostat for Heating and Cooling Season

The Energy Efficiency Kits and Education Program recommends to participants that they save energy by raising their thermostat setpoint for cooling in the summer and lowering their thermostat setpoint for heating in the winter. Cadmus applied the Phase III TRM savings equation for installing a programmable thermostat.[136] But Cadmus used the energy-savings factors for heating and cooling from the Iowa Energy Wise Program evaluations, [137] because these factors better reflect expected savings from adjusting thermostats for the heating and cooling seasons.

[136] Pennsylvania Public Utility Commission. *Pennsylvania Technical Reference Manual.* June 2016.

[137] Cadmus. *Iowa 2014 Energy Wise Program.* January 31, 2015. Prepared for Iowa Utility Association.
Cadmus. *Iowa 2015 Energy Wise Program.* January 30, 2016. Prepared for Iowa Utility Association.
Cadmus. *Iowa 2016 Energy Wise Program.* February 22, 2017. Prepared for Iowa Utility Association.
Cadmus. *Iowa 2017 Energy Wise Program.* March, 2018. Prepared for Iowa Utility Association.

Appendix L. Evaluation Detail – Appliance Recycling Program

L.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 PY11 evaluation.

L.1.1 Regression Variable Findings

In PY11, 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.[138]

L.2 Survey Participant Profile

The customer surveys conducted in PY11 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 (86%; 414 of 479)
- Had an average household size of 2.3 people (n=454)
- Had completed at least some college education (72%; 337 of 469)
- Had an annual household income of $50,000 or greater (64%; 218 of 343)

L.2.1 Survey Sample Attrition

Cadmus conducted online surveys with PY11 participants who recycled refrigerators and freezers and who had viable email addresses.

Table L-1 lists the numbers of records submitted to the survey subcontractor and the outcome (final disposition) of each record.

[138] 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 L-1. Appliance Recycling Program Online Survey Attrition

Description of Outcomes	Number of Records
Online Survey	
Population (number of unique jobs) [1]	**8,695**
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	1,349
Email was incomplete or invalid	2,766
Survey Sample Frame (email invitations sent to all eligible)	**4,580**
Email was returned (bounce back), did not respond, opted-out, or did not complete survey	4,004
PPL Electric Utilities or market research employee	22
Cannot confirm equipment/not aware of participation	2
Completed Surveys [2]	**552**
Response rate	**12%**

[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. Respondents could skip questions.

Appendix M. Evaluation Detail – Student Energy Efficient Education Program

M.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 M-1 lists the algorithm inputs, method of data collection, and source of the data collected.

Table M-1. Pennsylvania TRM Algorithm Open Variables

Cohort	Open Variable	Data Collection Method	Data Collector
LED			
Bright Kids Take Action Innovation Tier 1 Innovation Tier 2	ISR	PY11 HEW ISR	ICSP's Subcontractor
	Wattage of installed bulb	Spec sheet	ICSP
Showerhead			
Take Action Innovation Tier 1 Innovation Tier 2	ISR	PY11 HEW ISR	ICSP's Subcontractor
	gpm of installed	Spec sheet	ICSP
	Number of persons in household	PY11 HEW	ICSP's Subcontractor
	Number of showers in household	PY11 HEW	ICSP's Subcontractor
	Water heater fuel	PY11 HEW	ICSP's Subcontractor
Kitchen Faucet Aerator			
Take Action	ISR	PY11 HEW ISR	ICSP's Subcontractor
	gpm of installed	Spec sheet	ICSP
	Number of persons in household	PY11 HEW	ICSP's Subcontractor
	Number of showers in household	PY11 HEW	ICSP's Subcontractor
	Water heater fuel	PY11 HEW	ICSP's Subcontractor
Smart Power Strip			
Innovation Tier 1 Innovation Tier 2	ISR	PY11 HEW ISR	ICSP's Subcontractor
	Use (entertainment, computer, unspecified)	PY11 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)	PY9 HEW	ICSP's Subcontractor
	Washing machine located in home	PY11 HEW	ICSP's Subcontractor
	Water heater fuel	PY11 HEW	ICSP's Subcontractor

M.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. Cadmus calculated confidence and precision for the *ex post* savings and realization rate estimates for the Innovation Tier 2 cohort.

M.2 In-Service Rates

Table M-2 shows the verified ISRs for each of the items in the energy-savings kits by cohort for PY9, PY10, and PY11. Consistent with prior years, ISRs were higher for electric products (LED bulbs and smart strips) than for the water-saving products (showerheads and kitchen aerators).

Table M-2. Verified Student Energy Efficient Education ISRs for LEDs by Year and Cohort

Cohort	Product Number	PY9	PY10 [1]	PY11
LED [Survey, (Trajectorized)] [2]				
Bright Kids	1	62% (83%)	N/A	66% (84%)
	2	51% (77%)	N/A	53% (77%)
	3	40% (72%)	N/A	41% (72%)
	4	34% (69%)	N/A	37% (70%)
Take Action	1	62% (82%)	N/A	61% (82%)
	2	48% (77%)	N/A	51% (77%)
	3	41% (72%)	N/A	42% (72%)
	4	37% (69%)	N/A	37% (70%)
Innovation Tier 1	1	68% (85%)	N/A	64% (83%)
	2	57% (79%)	N/A	55% (79%)
	3	45% (74%)	N/A	46% (74%)
	4	39% (71%)	N/A	41% (72%)
Innovation Tier 2	1	67% (84%)	65% (83%)	64% (83%)
	2	58% (80%)	56% (79%)	54% (78%)
	3	49% (76%)	46% (74%)	44% (73%)
	4	42% (73%)	39% (71%)	39% (71%)
Showerhead [3]				
Take Action	1	32%	N/A	33%
Innovation Tier 1	1	35%	N/A	36%
Innovation Tier 2	1	41%	35%	30%
Kitchen Faucet Aerator [3]				
Take Action	1	29%	N/A	29%
Smart Power Strip				
Innovation Tier 1	1	77%	N/A	74%
Innovation Tier 2	1	58%	75%	75%

[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] For Phase III, Cadmus based the LED bulb ISRs on the survey-gathered ISRs an installation rate "trajectory" to include savings for all program bulbs assumed to be installed over time, as recommended in the Uniform Methods Project (UMP). (National Renewable Energy Laboratory. November 2014. *Uniform Methods Project. Chapter 21: Residential Lighting Evaluation Protocol.* Prepared by Apex Analytics, LLC. http://www.nrel.gov/extranet/ump/pdfs/ump-res-lighting-clean.pdf) The UMP uses the findings from the 2014 California Upstream and Residential Lighting Impact Evaluation, which suggested that bulb installation rates could be as high as 97% within four years of purchase. Discounting the future savings back to the current program year reduces the ISR from 97%. The Phase III evaluations used a weighted average nominal discount rate of 7.65% for all electric distribution companies (EDCs).

[3] 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 N. Evaluation Detail – Demand Response Program

N.1 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 PY11 Demand Response Program period (June 1, 2019, through September 30, 2019). In PY11, 64 facilities participated in one or more Act 129 events.

Cadmus estimated the event load impacts for a facility as the difference between 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 load curtailment 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.

N.1.1 Data Collection

Cadmus collected data from several sources to evaluate the PY11 Demand Response Program impacts. Table N-1 lists the data and sources.

PPL Electric Utilities provided 15-minute or one-hour interval consumption data between April 1, 2019, and September 15, 2019, for 64 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 N-1. Data Sources

Data	Population	Period	Variables	Source
Customer information system data	Demand Response Program participant facilities	From beginning of enrollment to end of summer 2019	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 2019	Event dates and hours	PJM Interconnection LLC website
Facility interval consumption data	PPL Electric Utilities Demand Response Program participants	April 1, 2019– September 15, 2019	15 minute or hour interval kWh, estimated read indicator	PPL Electric Utilities
Weather	11 weather stations in PPL Electric Utilities service area	April 1, 2019– September 15, 2019	Dry-bulb temperature	NOAA
Solar radiation	Penn State, Pennsylvania SURFRAD site	April 1, 2019- September 15, 2019	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.

Selection of Facility Baseline Calculation Methods

Before the beginning of PY11, Cadmus assigned each participating facility to one of the following day-matching baseline calculation methods or a regression method:

- 2 previous days
- 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.[139]

Table N-2 shows counts of participating facilities by final baseline modeling approach for all facilities, by customer segment, and for 19 facilities with capacity enrollments greater than or equal to 1 MW. These 19 facilities accounted for 95% of enrolled capacity.

Table N-2. Number of Facilities by Baseline Modeling Approach

Baseline	All Facilities	GNE	Large C&I	Small C&I	DR Capacity ≥ 1 MW
2 OF 2	4	0	4	0	4
3 OF 3	1	0	1	0	1
3 OF 5	1	0	1	0	1
4 OF 4	0	0	0	0	0
4 OF 5	1	0	1	0	1
5 OF 5	1	0	1	0	1
7 OF 10	6	1	5	0	5
10 OF 10	2	0	2	0	2
Day of Week 4 of 4	1	0	1	0	1
Day of Week 3 of 3	0	0	0	0	0
Regression	47	11	5	31	3
Total	**64**	**12**	**21**	**31**	**19**

Many large C&I facilities used day-matching approaches because they had nearly constant or highly variable day-to-day consumption between 2:00 p.m. and 6:00 p.m., and regression did not predict better than day-matching methods. For these facilities, the best predictor of consumption was the consumption in days within some range of the days of the events, so Cadmus selected X-of-Y-previous-day baseline methods for many large C&I facilities.

Act 129 Events in Program Year 11

Table N-3 presents the Act 129 event dates, hours, advance notification date and times, and the average outside temperature during events in PY11.

[139] 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.

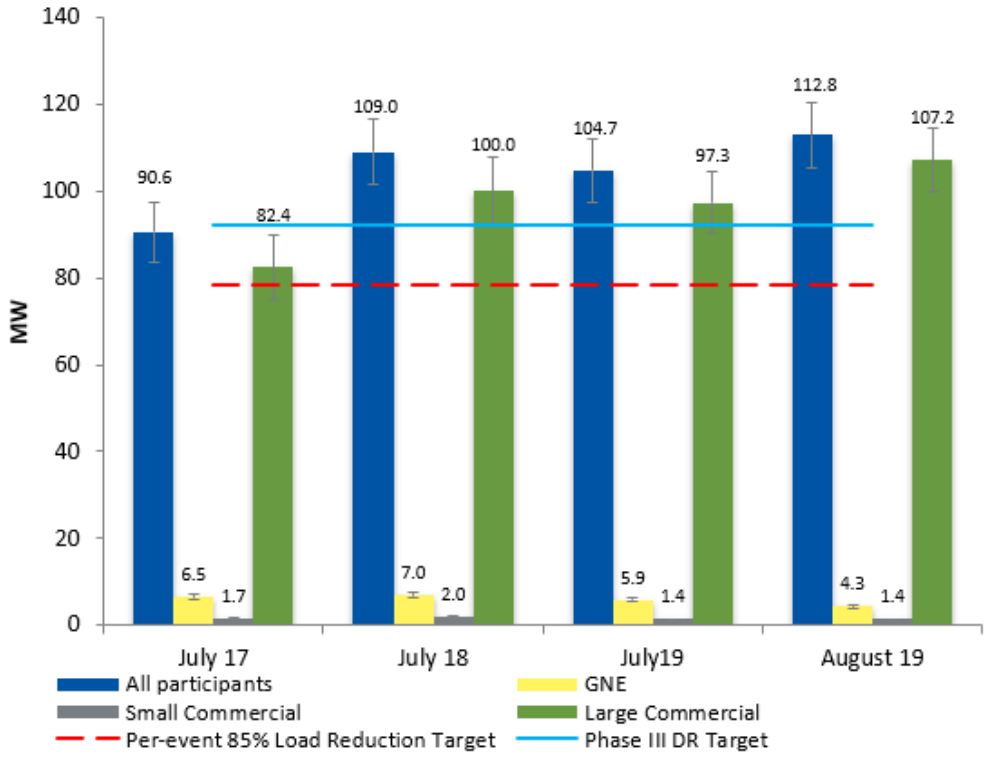
Table N-3. PY11 Act 129 Events Dates and Times

Event Date	Event Hours	Advance Notification Date and Time	Average Outside Temperature (°F) During Event
Wednesday, July 17, 2019	2:00 p.m. - 6:00 p.m.	Tuesday, July 16, 2019, 10:27 a.m.	87
Thursday, July 18, 2019	3:00 p.m. - 7:00 p.m.	Wednesday, July 17, 2019, 11:15 a.m.	87
Friday, July 19, 2019	2:00 p.m. - 6:00 p.m.	Thursday, July 18, 2019, 11:28 a.m.	94
Monday, August 19, 2019	2:00 p.m. - 6:00 p.m.	Sunday, August 18, 2019, 10:30 a.m.	90
Note: Advance notification times were obtained from CPower, the ICSP, through Cadmus data request.			

N.2 Results and Discussion

The estimates of program and customer segment demand savings for each PY11 Act 129 event date are presented in Figure 16-1 and Table 16-4 in the main content of this report (section *16.2.2 Gross Savings Impact Evaluation Results*). In Figure N-1, Cadmus presents the results graphically. Unless noted otherwise, all demand load impacts have been adjusted for line losses.

Figure N-1. PPL Electric Utilities Act 129 Gross Verified Demand Savings, PY11



Notes: Estimates based on Cadmus analysis of AMI interval consumption data for participant facilities. Error bars show 90% confidence intervals. The Phase III demand response compliance target for PPL Electric Utilities is 92 MW. All savings estimates were adjusted for line losses.

PPL Electric Utilities averaged 104 MW across the four 2019 events and 113 MW for all Phase III events, which puts the program on track to exceed PPL Electric Utilities' compliance target of 92 MW for Phase III of Act 129. PPL Electric Utilities achieved the maximum event demand savings of 112.8 MW on August

19 and the minimum event demand savings of 90.6 MW on July 17. As Table N-4 shows, large C&I customers were responsible for more than 90% of the demand response savings.

Table N-4 reports the evaluation estimated demand savings, metered demand, estimated baseline demand, and the percentage demand savings by event for each customer segment and the program. On average in PY11, the program produced demand savings of 42% relative to baseline consumption. The small C&I and GNE sectors produced savings between 15% and 25% of baseline demand. The large C&I sector produced savings between 40% and 50% of baseline consumption.

Table N-4. Event Demand Savings and Baseline Demand

Stratum	Event	Demand Savings (MW/hour)	Metered Demand (MW/hour)	Baseline Demand (MW/hour)	Relative Precision at 90% C.L.	Percentage Demand Savings
Small C&I	7/17/2019	1.7	8.3	10.0	8.1%	17%
	7/18/2019	2.0	6.8	8.8	6.4%	23%
	7/19/2019	1.4	8.3	9.8	8.9%	15%
	8/19/2019	1.4	7.4	8.8	8.9%	16%
Large C&I	7/17/2019	82.4	124.7	207.1	8.3%	40%
	7/18/2019	100.0	111.2	211.2	7.4%	47%
	7/19/2019	97.3	111.1	208.5	7.6%	47%
	8/19/2019	107.2	105.6	212.7	7.0%	50%
GNE	7/17/2019	6.5	22.2	28.7	10.1%	23%
	7/18/2019	7.0	20.8	27.8	8.3%	25%
	7/19/2019	5.9	23.0	28.9	9.2%	20%
	8/19/2019	4.3	23.0	27.3	11.0%	16%
Event [(1)]	**7/17/2019**	**90.6**	**155.2**	**245.8**	**7.6%**	**37%**
	7/18/2019	**109.0**	**138.8**	**247.8**	**6.8%**	**44%**
	7/19/2019	**104.7**	**142.5**	**247.2**	**7.1%**	**42%**
	8/19/2019	**112.8**	**135.9**	**248.8**	**6.6%**	**45%**
Average	**-**	**104.3**	**143.1**	**247.4**	**3.5%**	**42%**

[(1)] Event totals may not sum due to rounding.

N.2.1 Survey Sample Attrition

Table N-5 lists total contacts, the outcome (final disposition) of each record, and response rate.

Table N-5. PY11 Demand Response Participant Survey Sample Attrition Table

Description of Online Survey Outcomes	Count
Population (number of CPower, NRG, and Direct Energy enrolled facilities)	**70**
Removed: NRG and Direct Energy contracted facilities	5
Removed: Duplicate facility contacts for managers with multiple enrolled facilities	36
Sample Frame (number of unique companies)	**29**
Survey Sample Frame (used for surveys)	**29**
Not started	18
Refused or opted out	1
Completed Surveys (online and telephone combined)	**10**
Response Rate (completed surveys divided by number of records)	**34%**

Appendix O. Non-Energy Benefits

O.1.1 Non-Energy Benefits of Water-Saving Products

Cadmus quantified non-energy benefits in accordance with the SWE's Guidance Memo.[140] 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.

O.1.2 Lighting Interactive Effects

Cadmus calculated lighting interactive effects according to the Guidance Memo. The memo 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).*"

O.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.[141] 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,[142] as shown in Table O-1, for the assumptions needed to compute the heating penalty in commercial buildings.

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[140] SWE. *Guidance on the Inclusion of Fossil Fuel and H_2O Benefits in the TRC Test*. March 25, 2018.

[141] PPL Electric Utilities' revised EE&C plan (Docket No. 2015-2515642) filed with the PA PUC November 2018.

[142] 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. Available online: http://www.puc.state.pa.us/Electric/pdf/Act129/SWE-2014_PA_Statewide_Act129_Non-Residential_EndUse_Saturation_Study.pdf

Table O-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 P. Net Savings Impact Evaluation

P.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,[143] 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.

[143] 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,[144] 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.

[144] 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 Q. 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.

Q.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 PY11.

Q.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.